

# Bargaining With A Residual Claimant: An Experimental Study

Matthew Embrey, Kyle Hyndman and Arno Riedl\*

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## Abstract

We conduct an experiment of two player bargaining in which the payoff to one player is subject to ex-post risk, while the other player receives a fixed payment, effectively making the player exposed to risk a residual claimant. Contrary to intuition, recent theoretical work argues that exposure to risk may actually be beneficial to the residual claimant, and we test this in a controlled lab experiment. Our results suggest that asymmetric exposure to risk creates different (self-serving) notions of fairness for the two types of players which leads to bargaining conflict, and even disagreements. Residual claimants are able to extract a larger share of the pie when bargaining over a risky distribution. Moreover, some residual claimants actually do better in an expected utility sense by being exposed to risk. However, contrary to the theoretical prediction, it is the comparatively less risk averse residual claimants who appear to benefit the most through their exposure to risk. In a subsequent study where residual claimants are able to choose between a less risky or a more risky distribution over which to bargain, few choose the riskier distribution, except when the possibility of an ex-posed fair split exists. Consistent with our earlier results, the relatively less risk averse residual claimants are more likely to choose the riskier distribution.

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## 1 Introduction

In many natural environments, two parties bargain over a division of some surplus, but one of the parties is exposed to ex-post risk. For example, in union-firm bargaining, the union members generally receive a fixed salary, while the firm is exposed to risk due to, for example, demand or cost uncertainty. In the supply-chain management literature, two common forms of contracting between a supplier and a retailer differ on which of the two parties is exposed

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\*Embrey and Riedl: Department of Economics, Maastricht University, PO Box 616, 6200 MD Maastricht, The Netherlands (E-mail: m.embrey/a.riedl@maastrichtuniversity.nl); Hyndman: Naveen Jindal School of Management, University of Texas at Dallas, 800 W. Campbell Rd (SM31), Richardson, TX 75080 (E-mail: KyleB.Hyndman@utdallas.edu). We thank Gary Bolton, Yusufcan Masatlioglu, Anja Sautmann, Rami Zwick as well as seminar participants [to add] and conference participants at the Economic Science Association (Zurich), INFORMS (Minneapolis) and the NYU-Economics Alumni Conference (2012) for valuable comments and Maastricht University for financial support.

to ex-post risk due to the potential for unsold inventory. In contract theory and liability, asymmetric exposure to risk may also arise when two parties transact but only one is liable for any damages that arise from an accident or cost overruns (e.g., home repairs). Indeed, asymmetric exposure to risk appears to have played a prominent role in two recent high-profile labor negotiations between sports leagues and their players unions: regarding the National Football League, “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” and regarding the National Hockey League, “[b]ut owners bear all of the risk. Players talk about desiring a partnership, but they certainly don’t want to share the risk.”<sup>1</sup> Thus, how agents should divide the gains from trade when one side is exposed to risk, while the other is not, is an important question that arises in a broad spectrum of settings. Surprisingly, given its importance and apparent relevance, it is also one that has received little attention in the economics literature.<sup>2</sup>

The theoretical question has been addressed by White (2008). In an otherwise standard Rubinstein (1982) bargaining model, she provides conditions under which the exposed agent (henceforth, the residual claimant) increases her share of the pie when exposed to risk. Even more surprisingly, she is able to provide conditions under which a residual claimant *would actually prefer* to be exposed to risk, rather than to bargain over a riskless distribution. For the case of small additive risks, she shows that if  $U''' \geq 0$ , then the residual claimant’s receipts will rise with exposure to risk. Moreover, decreasing absolute risk aversion is a necessary and sufficient condition for the residual claimant to do better in expected utility terms, provided that the fixed-payoff player has pure fixed costs of bargaining. The intuition for these results comes from the literature on precautionary savings (cf. Kimball (1990)). Essentially when the residual claimant is exposed to risk (and has decreasing absolute risk aversion), the expected marginal utility of future consumption increases, leading to a precautionary saving motive. In our bargaining context, this effectively makes her more patient and, therefore, willing to hold out for a better agreement.

This striking result immediately suggests a number of empirical questions that we seek to investigate in this paper. First, in actual bargaining situations, is the residual claimant able to extract a risk premium for her exposure to risk? Our intuition, supportive of the residual claimant’s ability to extract a risk premium, is that the asymmetric exposure to risk works

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<sup>1</sup>The NFL quote comes from, “Key To The NFL CBA: Mitigating Risk”, by Andrew Brandt, *Forbes*, March 7, 2011. The NHL quote comes from, “Allen: How to solve NHL labor dispute” by Kevin Allen, *USA Today*, September 15, 2012.

<sup>2</sup>Several papers look at bargaining with one-sided private information, where one player knows the size of the pie, while the other does not (though she may know the distribution). Examples include, Forsythe et al. (1991), Rapoport and Sundali (1996), Rapoport et al. (1996), Mitzkewitz and Nagel (1993) and Croson (1996). Forsythe et al. (1991) looks at both unstructured bargaining and a random dictator game in order to explain the incidence of strikes. Rapoport and Sundali (1996) looks at ultimatum offers, while Rapoport et al. (1996) considers a Nash demand game between the informed and uninformed players. These papers are in contrast to ours since we are interested in a setting of symmetric but incomplete information.

to create two different norms for what constitutes a fair allocation. That is, the fixed-payoff players will view the 50-50 split of the expected pie as fair, while residual claimants will view an allocation which compensates them for their risk as fair. Several studies (e.g., Gächter and Riedl (2005) and Bolton and Karagözoğlu (2013)) have shown that when there are competing norms for fairness, agreements often fall between these norms.

Second, given that residual claimants extract a risk premium, is it sufficiently large that they are *better off* being exposed to risk? This is a much more difficult hurdle to cross and, to the extent that fixed-payoff players are able to pull the agreement closer to their (self-serving) belief that a 50-50 division is fair, it is, perhaps, less likely to be satisfied. Finally, our third question is more speculative. Specifically, when given the choice between two distributions over which to bargain, under what conditions does the residual claimant choose the one with higher risk?

We address these research questions through two laboratory studies. In the first study, referred to as the control environment, subjects are assigned either the role of the residual claimant or the fixed-payoff player. In an experiment with random matching and fixed roles, in each of 10 rounds bargaining pairs are given one of five distributions with varying levels of risk (in the sense of second-order stochastic dominance) and try to reach an agreement on the amount to give to the fixed-payoff player, with the residual claimant receiving the difference between the realized pie and the amount to the fixed payoff player. In this study, we document that, on average, fixed-payoff players receive less than half of the expected pie and their payment is decreasing as the riskiness of the pie increases. Thus, in answer to our first question: residual claimants are able to extract a risk premium. Consistent with a large body of work (e.g., Murnighan et al. (1987) and the references cited therein), we find that the payment to fixed-payoff player was decreasing in his own risk aversion and increasing in the risk aversion of the residual claimant.<sup>3</sup> Interestingly, although not predicted by the model, asymmetric exposure to risk increases the frequency of disagreements — the disagreement rate was nearly 20% with our riskiest distribution and only 4% with our riskless distribution. We attribute this result to the fact that bargaining conflict (as measured by the difference in perceived fair allocations for the two players) is increasing in the riskiness of the distribution.

Our control study does find that some residual claimants do, in fact, do better in expected utility terms through their exposure to risk. However, in contrast to the theoretical prediction, we actually find that it is the comparatively less risk averse residual claimants who are better off. One possible explanation for this unexpected result could be that since risk preferences are private information, fixed payoff players (begrudgingly) agree to compensate an “average” residual claimant for their exposure to risk. Then, when a fixed-payoff player is matched with a comparatively less risk averse residual claimant, the residual claimant is actually

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<sup>3</sup>One exception is Roth and Rothblum (1982) who show that increased risk aversion may be advantageous if the disagreement outcome is preferred to their opponent’s most-preferred allocation.

over-compensated for her risk.

In the second study, we seek to address our third question — namely, under what conditions will residual claimants choose to bargain over a relatively riskier distribution? After playing five bargaining rounds as in the control study, in each of the next five bargaining rounds, before bargaining began, the residual claimant could choose between a relatively low risk distribution and a relatively high risk distribution. Our first study provided strong evidence that fixed-payoff players are willing to compensate them for their risk, when the risk was exogenous. However, we were conjectured that if residual claimants consciously chose the riskier distribution, then fixed-payoff players would perceive this as an unfair act (see e.g., Konow (1996, 2000, 2001) and Cappelen et al. (2007)) and would, therefore, be unwilling to compensate the residual claimants for their risk. To investigate this issue, in one variation, the choice of the residual claimant was implemented for sure (the transparent choice treatment) and in another variation, the residual claimants choice was only implemented with probability 0.7 (the non-transparent choice treatment). Our conjecture was that, similar to Dana et al. (2007), residual claimants may exploit the wiggle room created by the lack of transparency and choose the riskier distribution more frequently. However, our results suggest a general unwillingness to choose the riskier distribution — regardless of whether the residual claimant’s choice was transparent or not. The only situation in which residual claimants frequently choose the riskier distribution is when one alternative is actually riskless and the other has the possibility of an ex-post equal split. Consistent with the results of our first study, we find that it is the relatively less risk averse residual claimants who are more likely to choose the riskier distribution. Moreover, bargaining over the riskier distribution is associated with a nearly 6 percentage point increase in the frequency of disagreements.<sup>4</sup>

The paper is organized as follows: the next section outlines some of the theoretical predictions of bargaining with asymmetric risk exposure and develops hypotheses for the case of an exogenously given distribution. Section 3 covers the particulars (experimental design, predictions and results) of the control environment. Section 4 discusses the choice treatments in which residual claimants choose the distribution over which to bargain. Section 5 concludes.

## 2 Theoretical Background and Hypotheses

In this section we briefly outline some of the main theoretical predictions for the bargaining problem with asymmetric exposure to risk. A more detailed account can be found in White (2008), which focuses on results based on the Rubinstein (1982) bargaining model, or the

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<sup>4</sup>Indeed, responses from our post-experiment survey validate our hypothesis 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.”

earlier working paper version, White (2006), which also contains results concerning the Nash solution to a cooperative bargaining game. Since we implement an unstructured bargaining framework in the lab, we focus on the results derived from the cooperative bargaining game.

As discussed in the introduction, some intuition for why exposure to risk may lead to a higher payoff for the residual claimant can be seen by looking at a simple consumption-savings problem. If there is no risk, then the Euler equation can be written as:

$$\frac{u'(c_1)}{\delta u'(c_2)} = (1 + r);$$

however, if we introduce risk into second-period consumption, then it becomes:

$$\frac{u'(c_1)}{\delta \mathbb{E}[u'(c_2)]} = (1 + r).$$

If  $u'''(\cdot) > 0$ , so that the marginal utility is convex, then a mean-preserving spread of  $c_2$  will increase the denominator. Hence, at the optimal solution the decision maker will be induced to increase savings. That is, an increase in risk makes the decision maker behave *as if* he is relatively more patient. As we know from the bargaining literature, the more patient is a player, the stronger is his bargaining position.

This link between the third derivative of the utility function and increased bargaining power is readily apparent in a structured Rubinstein (1982) bargaining model. Unfortunately, the intuition is less clear in the Nash bargaining framework. However, White (2006), provides conditions under which a residual claimant's share of the pie, as well as his welfare will increase when he faces a small risk relative to the no risk case for an expected pie of size 1 in such an environment. In her Proposition 6, White (2006) shows that the residual claimant's share of the pie will increase when faced with a small risk (relative to the risk-free case), as long as:

$$-\frac{u'''(x)}{u''(x)} > -\frac{u'(x)}{u(x)}.$$

If we assume that players have utility of the form  $u_i(x) = \frac{1}{1-\rho_i}x^{1-\rho_i}$  for  $i \in \{rc, fp\}$ , then this amounts to  $\frac{2}{x} > 0$ . That is, the residual claimant's receipts will always increase due to the exposure to risk. In our experiment, subjects bargain over an amount to allocate to the fixed payoff player. Therefore, this result says that the amount allocated to the fixed payoff player should decrease when the distribution of the pie is risky.

Turn next to the issue of welfare. The necessary and sufficient condition for welfare to improve is (White, 2006, Proposition 7):

$$u''_{rc}(x)/u'_{rc}(x) - u'''_{rc}(x)/u''_{rc}(x) \geq u'_{fp}(1-x)/u_{fp}(1-x) - u''_{fp}(1-x)/u'_{fp}(1-x).$$

If we assume a CRRA utility function, then this condition reduces to  $x \leq \frac{1}{2}$ . That is, the residual claimant will do better in expected utility terms if and only if he would, in the risk-free setting, receive less than half of the pie. Of course, we know that the residual claimant

will receive less than half of the pie in the Nash bargaining solution whenever  $\rho_{rc} > \rho_{fp}$ ; that is, whenever the residual claimant is *more risk averse* than the fixed payoff player.

In our experiment, the risks that the residual claimant is exposed to are not small, which means that this condition will not be exact. Instead, our numerical calculations suggest that  $\rho_{rc} > \rho_{fp}$  is neither necessary nor sufficient for the residual claimant's welfare to improve when exposed to the risks in our experiment. In particular, as long as both players are not too risk averse, then for some distributions, the residual claimant may do better even if he is slightly less risk averse than the fixed payoff player. On the other hand, as risk aversion increases, a residual claimant who is slightly more risk averse than the fixed payoff player may not have a welfare improvement relative to the risk-free distribution. Despite these caveats,  $\rho_{rc} > \rho_{fp}$  is a useful approximation for the residual claimant to do better in expected utility terms from being exposed to risk.

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

*HYPOTHESIS 1 As the riskiness of the bargaining distributions increases, provided that  $\rho_{rc} > 0$ , the amount allocated to the fixed payoff player should decline.*

*HYPOTHESIS 2 The amount allocated to the fixed payoff player is decreasing in  $\rho_{fp}$  and increasing in  $\rho_{rc}$ , regardless of the riskiness of the distribution.*

*HYPOTHESIS 3 Roughly speaking, whenever  $\rho_{rc} > \rho_{fp}$ , the residual claimant's welfare should be higher when faced with a risky distribution than a riskless distribution.*

*HYPOTHESIS 4 Across all distributions, the frequency of agreements is 100%.*

### **3 Study #1: Exogenously Given Pie Distributions**

In order to test the above hypotheses, we implemented in the laboratory an unstructured bargaining environment in which pairs of subjects have four minutes in which to exchange offers and, if possible reach an agreement. Except for exchanging offers, no other form of communication is possible. While both agents know the distribution of pie sizes, the actual value will only be determined after an agreement has been made. One agent is the residual claimant (RC), the other the fixed-payment player (FP). To divide the surplus, the agents must agree on the value of a fixed payment to the FP player that is paid irrespective of the realised value of the pie. The residual claimant receives what is left after this fixed payment is subtracted from the realised pie. If the agents do not agree then both receive zero.

We chose an unstructured bargaining framework because we wanted a more natural bargaining environment in which players would be able to express their views about what con-

stitutes a fair division and which does not create any possible confounds that might arise due to an exogenous bargaining protocol such as alternating offers.<sup>5</sup>

To test the aforementioned hypotheses, five pie distribution were implemented using a within-subject design. The first distribution subjects bargained over was a payoff of €20 for sure – that is, a distribution with no risk. Four mean-preserving spreads were then used, varying the extremes of the possible outcomes (low risk versus high risk) and the number of possible outcomes (binary lottery versus tertiary lottery), where each outcome was equally likely. This within-subject variation was chosen, first, to give subjects the opportunity experience the role that such ex-post risk might play in bargaining and, second, to give a direct comparison of how well the same residual claimant does under differing risk conditions. Figure 1 gives the support of the four uncertain pie-distributions that were implemented.

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

Figure 1: Summary of the distributions with uncertainty: the row indicates the type and the column the extremes, while each cell gives the support of the distribution, where each outcome is equally likely.

Fixing the type, the distribution including the outcomes 12 and 28 is riskier than the one including 16 and 24. Fixing the extremes, the binary distribution is riskier than the tertiary distribution. Finally, the off-diagonal conditions can also be ranked by second-order stochastic dominance, with the (16,24) distribution dominating the (12,20,28) distribution. Thus, the tertiary-high-risk condition is riskier than the binary-low-risk condition. From a behavioural perspective, a further difference between the binary and tertiary distributions is that the latter includes the 20 outcome. As a result, with the tertiary distributions, it is possible for both agents to earn ex-post the same payoff, should they agree to a 50-50 split of the expected value of the pie. With the binary distribution, the 50-50 split of the expected value of the pie necessarily leads to an ex-post unequal outcome.

### 3.1 Experimental Procedures

In total, 2 sessions were conducted with 24 subjects in each session separated into two matching-groups of 12, to give 48 subjects in total split over 4 matching groups. The experiments took place at the BEElab of Maastricht University, and all participants were students

<sup>5</sup>By using the unstructured format, the predictions of the theory are based on the Nash bargaining solution. Since this is a cooperative, rather than a non-cooperative, game theory concept, the comparative static predictions are only at the outcome level. That is, we do not have direct predictions on strategies.

at Maastricht University. Sessions took less than 1 hour and 30 minutes, and on average subjects earned between €20 and €23.

At the beginning of each session, subjects were randomly assigned either the role of the residual claimant (RC) or the fixed payoff player (FP), and they kept this role for all 10 bargaining rounds that they faced. At the beginning of a bargaining round, subjects were randomly matched into groups of two (one RC and one FP) and received information about the distribution of possible pie sizes over which they would bargain. During the round, subjects had four minutes to reach an agreement, which was framed as an amount to give to the FP player.<sup>6</sup> Subjects were free to make as many offers as they wished during this time, and subsequent offers were not required to improve upon one's previous offer. An agreement was reached when one of the two accepted the current offer of the other player. No communication beyond sending offers was permitted.

Subjects were randomly assigned into one of two matching groups and randomly re-matched between bargaining rounds within their matching group. During a session, the order in which they saw each distribution was the same for all subjects in a matching group. However, across matching groups the order of presentation was varied, although in all cases subjects bargained over a fixed pie of 20 in rounds 1 and 10.<sup>7</sup> After the 10 bargaining rounds were completed, one round was randomly selected to determine their payoff from the first part of the experiment.

During the second part of the experiment, subjects were given a risk elicitation task. Specifically, for six different binary lotteries, we elicited their certainty equivalents. It was important to get an estimate of subjects' risk preferences since the analysis of White (2008) provides conditions under which the residual claimants will receive a larger share of the expected pie when exposed to risk as well as conditions for which the share will be large enough so that they are actually better off in expected utility terms when exposed to risk. Along with the outcomes for individual residual claimants under the five different risk treatments, the elicited certainty equivalents can be used to assess this prediction at an individual level.

In Figure 2, we plot the distribution of estimated risk coefficients for fixed payoff players and residual claimants. As can be seen, all residual claimants (except for one, whom we estimate as being extremely risk loving, and is dropped from this figure), are risk averse. One can also see that it appears that the distribution of residual claimants' risk coefficients is

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<sup>6</sup>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 distribution). In all cases, this was greater than half of the expected pie size of 20.

<sup>7</sup>The order of presentation of the four uncertain pies was the same in bargaining rounds 6 to 9 as in bargaining rounds 2 to 5. Thus, by bargaining round 6, every subject in every session had experienced each pie distribution exactly once. Four order combinations were used by systematically varying whether the binary lotteries or the tertiary lotteries were shown first, and whether the low risk or high risk came first. That is, the four orders were: (16,24), (12,28), (16,20,24) and (12,20,28); (12,28), (16,24), (12,20,28) and (16,20,24); (16,20,24), (12,20,28), (16,24) and (12,28); (12,20,28), (16,20,24), (12,28) and (16,24).

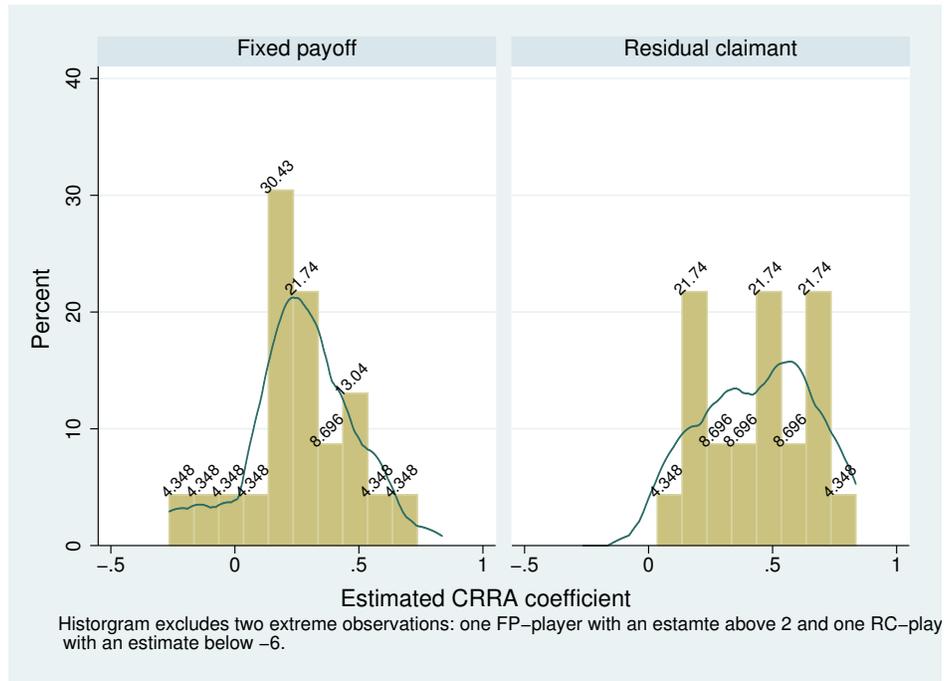


Figure 2: Histogram: estimated CRRA risk aversion coefficients

skewed towards more risk aversion than that of fixed payoff players. This could be due to the residual claimants' exposure to risk during bargaining influencing their subsequent answers in the risk elicitation part.<sup>8</sup>

At the end of the experiment, subjects answered a series of survey questions, including for each of the five pie distributions, their judgment of a fair allocation to the fixed payoff player (cf. Babcock et al. (1995)). Specifically, they were asked, "what would be, in your opinion, a 'fair' amount to give to the [fixed-payoff player] from the vantage point of a **non-involved neutral arbitrator**." Our expectation was that because of the asymmetric exposure to risk, there would be competing norms about what constitutes a fair division — perhaps due to self-serving biases (Babcock and Loewenstein, 1997). Specifically, our prediction was that fixed payoff players would claim that the 50-50 allocation is fair, while residual claimants would insist that a fair division is one which compensates them for their risk. It is also of interest to see how fairness norms change with the riskiness of the distributions.

<sup>8</sup>However, the same histogram in our second study points to no systematic difference in the estimated risk coefficients of residual claimants and fixed payoff players. Therefore, it is equally plausible that we randomly drew 24 relatively risk averse residual claimants.

### 3.2 Theory Driven Results

We begin our analysis by presenting some basic summary statistics based on the results of our experiment. Table 1 presents a summary of the bargaining outcomes. As can be seen, on average, the fixed payoff player receives less than half of the expected pie, and, consistent with Hypothesis 1, the amount is decreasing as the riskiness of the pie increases. This result holds both conditional and unconditional on an agreement being reached. Although not predicted by the theory, one can also see from Table 1 that the presence of risk leads to more disagreements and increases the time required to reach an agreement. Finally notice that, except for the riskiest distribution, fixed payoff players view the 50-50 division as fair, while in all cases, residual claimants believe that a fair allocation is one which compensates them for their risk; in 3 out of 5 cases, the difference is significant at the 1% level.<sup>9</sup> Moreover, for all risky pies, the average payoff, conditional on an agreement being reached, was between the (self-serving) fairness perceptions of the residual claimant and the fixed-payoff player.

Distribution of Pie	Payoff to FP Player (€)		Agreements (%)	Time Remaining (sec)	Fair Payoff to FP	
	Unconditional	Conditional			FP	RC
(20)	9.71	10.16	95.8	147	9.96	9.92
(16,20,24)	9.04	9.68	93.8	66	10.33	9.44
(16,24)	8.17	9.61	85.4	34	10.29	9.44
(12,20,28)	8.10	9.09	89.6	34	9.88	8.42
(12,28)	7.14	8.80	81.2	44	9.58	8.06

Table 1: Summary of bargaining outcomes and fairness perceptions in the control environment

We now turn our attention to Hypothesis 1, which we test in two ways. First, Table 2 provides a complete pairwise comparison of the difference in bargaining outcomes between pie distributions that are ranked by second-order stochastic dominance. One can see that if a distribution is riskier than another then it has a lower average payoff for the FP-player. These comparisons are, with few exceptions, significant when averaging over all FP-player payoffs.<sup>10</sup> However, conditioning on an agreement results in a number of the distribution comparisons no longer being significant, although the more extreme comparisons do remain.

Table 3 provides further support for Hypothesis 1. The dependent variable in these random-effects regressions is the payoff to the fixed payoff player (conditional on an agreement). Column (1) contains only the riskiness of the distribution as a regressor, where the variable “Risk” ranges from 0 to 4 as the riskiness increases in the sense of second-order stochastic dominance. As can be seen, the coefficient is negative and highly significant. Thus, riskier distributions lead to lower payments to the fixed payoff player. Column (2) of

<sup>9</sup>For each distribution, we conducted Mann-Whitney tests of fair allocation by bargaining role. Starting with the deterministic pie and going in order of increasing riskiness, the  $p$ -values are: 0.976, 0.006, 0.066, 0.001 and 0.001, respectively.

<sup>10</sup>Only the comparison between (20) and (16,20,24), and (12,20,28) and (16,24) are insignificant.

	(20)	(16,20,24)	(16,24)	(12,20,28)	(12,28)	(20)	(16,20,24)	(16,24)	(12,20,28)	(12,28)
<i>Unconditional on reaching an agreement</i>					<i>Conditional on reaching an agreement</i>					
(20)	9.71	>	>**	>***	>***	10.16	>	>**	>**	>***
(16,20,24)		9.04	>**	>**	>***		9.68	>	>*	>***
(16,24)			8.17	>	>*			9.61	>*	>***
(12,20,28)				8.10	>***				9.09	>
(12,28)					7.14					8.80

Table 2: Pair-wise comparison of the payoff to the FP player across treatments. 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.

	(1)	(2)
Risk of Distribution	-0.333*** [0.072]	-0.337*** [0.076]
$\rho_{fp}$		-2.003*** [0.666]
$\rho_{rc}$		1.052*** [0.379]
Constant	10.123*** [0.062]	10.200*** [0.171]
$R^2$	0.08	0.17
$N$	195	195

Table 3: Random effects regression of payoff to the fixed payoff player (conditional on agreement). The variable “Risk of Distribution” takes value 0 for the risk-free distribution and increases by 1 with each increase in the riskiness distribution according to second-order stochastic dominance.

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

the table, which includes our estimates of the risk coefficients of both the residual claimant ( $\rho_{rc}$ ) and the fixed payoff player ( $\rho_{fp}$ ) allows us to test Hypothesis 2. Consistent with this hypothesis, we see that the coefficient on  $\rho_{fp}$  is negative and highly significant, while the coefficient on  $\rho_{rc}$  is positive and also highly significant. Thus, risk preferences affect the payment to the fixed payoff player in the direction predicted by theory.

While the results of Table 3 shows that payoffs to the fixed payoff player vary in the appropriate way with the risk preferences of the bargaining pair, an even stronger test of the theory would be to examine the relationship between the actual payoff to the fixed payoff player and the predicted Nash bargaining solution payoff, given the risk preferences of the bargaining pair. In Figure 3 we plot the observed cumulative distribution of payoffs and the distribution which would have emerged had subjects played according to the Nash bargaining solution. There are several things to note about this figure. First, when there is no risk, nearly all agreements prescribe a 50-50 division of the pie. That is, differences in risk preferences lose salience and the norm to divide the pie “fairly” (i.e., equally) dominates.

Second, for the risky distributions, we see a much closer correspondence between the observed and predicted distributions of payoffs. Finally, for all distributions, it appears that subjects in the role of the fixed payoff player earn less than would be predicted by theory; indeed, for all distributions, except (12, 20, 28), the difference is significant at  $p < 0.05$ , while for the (12, 20, 28) distribution, the  $p$ -value is 0.06.

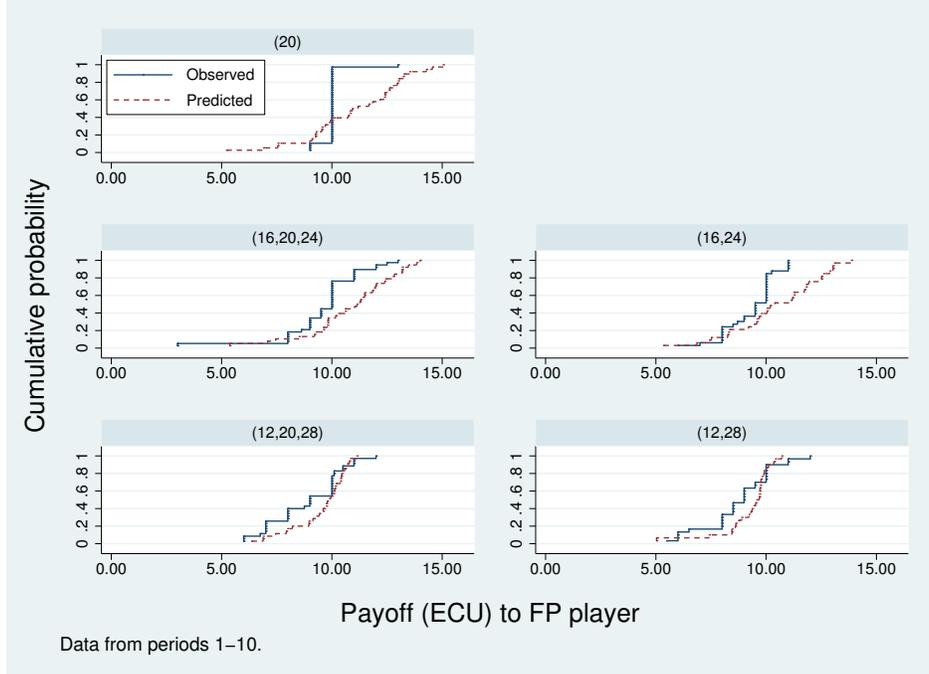


Figure 3: Cumulative distribution: Observed vs. predicted payoffs to the FP-player conditional on agreement

We next seek to test Hypothesis 3 which concerns whether, and under what conditions, residual claimants do better in terms of expected utility when faced with a risky distribution. Recall that roughly speaking the residual claimant is expected to have higher welfare, compare to the risk-free distribution, if he is more risk averse than the fixed payoff player. In order to address this issue, we ran a random-effects regression in which the dependent variable was the certainty equivalent to the residual claimant at the agreed upon division. The dependent variables were dummy variables for whether the distribution was risky or not ( $\mathbf{1}[Risk > 0]$ ) and whether or not the residual claimant was more risk averse than the FP-player ( $\mathbf{1}[\rho_{rc} > \rho_{fp}]$ ) as well as an interaction term. If Hypothesis 3 is correct then the sum of the coefficients on  $\mathbf{1}[Risk > 0]$  and the interaction should be positive. The results of this regression can be seen in Column (1) of Table 4. While the coefficient on risk is significantly positive, the coefficient on the interaction term is negative, and larger in magnitude than the coefficient on risk. Therefore, contrary to the theoretical prediction, it is actually the *less risk averse* residual claimants who have higher welfare when bargaining

	(1)	(2)
$\mathbf{1}[Risk > 0]$	0.744*** [0.283]	0.856 [0.562]
$\mathbf{1}[\rho_{rc} > \rho_{fp}]$	-0.052 [0.481]	
$\mathbf{1}[Risk > 0 \& \rho_{rc} > \rho_{fp}]$	-0.867*** [0.177]	
$\mathbf{1}[CE_{nbs} > CE_{nr}]$		0.124 [0.298]
$\mathbf{1}[Risk > 0 \& CE_{nbs} > CE_{nr}]$		-1.029* [0.592]
Constant	9.919*** [0.268]	9.846*** [0.150]
$R^2$	0.06	0.05
$N$	195	195

Table 4: Random effects regression of certainty equivalent of the residual claimant (conditional on agreement). The variable  $\mathbf{1}[Risk > 0]$  takes value 1 if the distribution is risky. The variable  $\mathbf{1}[\rho_{rc} > \rho_{fp}]$  takes value 1 if the residual claimant was more risk averse than the fixed payoff player. The variable  $\mathbf{1}[CE_{nbs} > CE_{nr}]$  takes value 1 if the predicted certainty equivalent according to NBS is higher than the predicted certainty equivalent if the same pair bargained over a risk-free distribution.

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

over a risky distribution. The second column of Table 4 hews more closely to the precise test of the hypothesis. Specifically, we calculate the predicted certainty equivalent of the residual claimant according to the Nash bargaining solution ( $CE_{nbs}$ ) and also the predicted certainty equivalent if the same pair bargained over the risk-free distribution ( $CE_{nr}$ ). The variable  $\mathbf{1}[CE_{nbs} > CE_{nr}]$  then takes value 1 if, in the given pair, the residual claimant is predicted to have higher welfare under the risky distribution. The qualitative results are exactly the same — namely, those who are predicted to do better when exposed to risk do not — but we lose some significance on the coefficients.

We end our initial analysis of Study #1 with some remarks on the frequency of agreements and the length of bargaining. As was apparent from Table 1, the presence of risk increased the frequency of disagreements, contrary to the prediction (cf. Hypothesis 4) of no disagreement, regardless of risk, and increased bargaining duration. In Table 5 we report the results of a series of pair-wise tests across bargaining distributions. As can be seen, except for the (16, 24) vs (12, 28) comparison, there are significantly more disagreements when the distribution is (12, 28) — the riskiest. This effect is moderated somewhat by experience: over the last five periods, we still see more disagreements for risky distributions, but in only one case is the difference significant at the 5% level. Finally, we also see that bargaining duration is significantly longer when the distribution is risky. This is true regardless of experience and regardless of whether we condition on an agreement being reached. All of these results

suggest, contrary to the theory, that the presence of risk also introduces other frictions into bargaining that increase delay and the likelihood of outright disagreement.

	All periods					Last 5 periods				
	(20)	(16,20,24)	(16,24)	(12,20,28)	(12,28)	(20)	(16,20,24)	(16,24)	(12,20,28)	(12,28)
<i>Percentage of agreements</i>										
(20)	95.8	>	>	>	>***	91.7	<*	>	>	>
(16,20,24)		93.8	>	>*	>***		100.0	>	>**	>
(16,24)			85.4	<	>			87.5	>	>
(12,20,28)				89.6	>**				83.3	>
(12,28)					81.2					79.2
<i>Time remaining in seconds</i>										
(20)	147	>***	>***	>***	>***	150	>**	>***	>***	>***
(16,20,24)		66	>***	>*	>***		64	>*	>***	>***
(16,24)			34	<	<			39	>	<
(12,20,28)				34	<				39	<
(12,28)					44					43
<i>Time remaining conditional on agreement in seconds</i>										
(20)	151	>***	>***	>***	>***	160	>**	>***	>***	>**
(16,20,24)		70	>***	>*	>		64	>	>	>**
(16,24)			38	>	<			44	<	<
(12,20,28)				37	<				46	<
(12,28)					53					48

Table 5: Pair-wise comparison of other measures of bargaining outcomes across treatments. 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.

To summarize our discussion thus far, we find strong support for Hypotheses 1 and 2: fixed payoff players earn less the riskier the distribution; moreover, the payoff to the FP-player is increasing in the risk aversion of the residual claimant and decreasing in her own risk aversion. However, with respect to Hypothesis 3, we actually find support for the opposite results: residual claimants do better when exposed to risk when they are relatively *less risk averse* than the FP-player. Finally, Hypothesis 4 is rejected: as the riskiness of the distribution increases, we find a significant increase in the frequency of disagreements.

### 3.3 Discussion

We now turn our attention to various aspects of our experiment for which the theory is largely silent, but which are interesting from a behavioral perspective nonetheless.

#### 3.3.1 Offers and Concessions

Although the theory predicts that the payment to fixed payoff players declines as risk increases, our unstructured bargaining environment makes no predictions about how this outcome arises. For example, although opening offers are not fully credible, because subjects

Distribution	Opening Offers		Final Offers		Fair Payoff to FP	
	FP	RC	FP	RC	FP	RC
(20)	12.631	8.612***	11.088	9.503***	9.96	9.92
(16, 20, 24)	12.619	6.752***	10.537	8.971***	10.33	9.44
(16, 24)	12.105	6.688***	10.797	8.743***	10.29	9.44
(12, 20, 28)	11.146	6.209***	9.768	8.150***	9.88	8.42
(12, 28)	10.875	5.672***	9.382	7.688***	9.58	8.06

Table 6: Opening and final offers by player type. FP = Fixed payoff player; RC = Residual claimant. The lightly shaded cells are significantly different from the (20) distribution at the 1% level, while the darkly shaded cell is significantly different from the (20) distribution at the 10% level. \*\*\* indicates that the offers between RCs and FPs are significantly different at the 1% level.

can always revise their offers, it is of interest to compare the opening offers of the two types of players. We do just this in the left-hand side of Table 6. It should be of little surprise to see that the opening offers of the residual claimant are always significantly lower than the opening offers of the fixed payoff player. Consistent with Bolton and Karagözoğlu (2013), opening offers are more extreme than subjects' reported fair allocation. Moreover, we see that residual claimants always demand a risk premium from the start whenever they are exposed to risk, and that the premium is increasing in the riskiness of the distribution. What is more interesting is that fixed payoff players also demand less as risk increases, but their opening offers are consistently above half the expected pie size. Finally, although not apparent from the table, opening offers are not significantly positively correlated with fairness perceptions.<sup>11</sup>

The two middle columns of Table 6 show a similar pattern for final offers (that is, the offers outstanding by both players either at the time of agreement or when bargaining expires without an agreement). Both the residual claimant and the fixed payoff player have conceded ground from their opening offers and, indeed, residual claimants now only demand a statistically significant risk premium (relative to the riskless pie) for the two riskiest distributions (for the (16, 24) distribution, it is only weakly significant). Note, however, that in all cases, residual claimants' final offers would still give less to the fixed-payoff player than even they consider fair. While residual claimants' final offer is still significantly lower than the fixed payoff players' final offer, the average difference is now only €1.8 (as compared to €5.3) for opening offers). As with opening offers, the final offer by fixed payoff players concedes to the residual claimant a statistically significant risk premium for the two riskiest distributions. Moreover, their final offers in the two riskiest distributions are actually slightly *less* aggressive than their perceived fair allocation. Therefore, it seems that there is broad agreement that the residual claimant should be compensated for his exposure to risk, but

<sup>11</sup>For the fixed payoff players, in a random-effects regression of opening offers on fairness ideals, and controlling for the riskiness of the distribution, the  $p$ -value of the coefficient on fairness perceptions is only 0.29. The same coefficient for residual claimants just misses significance at the 10% level, with a  $p$ -value of 0.11.

that the tension in bargaining is to determine precisely the magnitude of compensation. In contrast to the opening offers, for both players there is a strong positive correlation between final offers and fairness perceptions — though the effect appears to be stronger for residual claimants (coefficient of fairness perception: 0.425 ( $p = 0.003$ ) for residual claimants, and 0.133 ( $p = 0.002$ ) for fixed payoff players. Thus, although opening offers do not reflect the players’ perceptions of a fair division, the bargaining process brings final offers more in line with fairness perceptions.

Having examined opening and final offers it makes sense to study the process of concessions that players make. To this end, in Table 7, we report the results of random effects regressions of one’s own concessions on their match’s most recent concession, the current time since bargaining began and the difference between one’s own previous offer and their fairness ideal (i.e., how unfair *their* offer is) as well as the difference between the currently outstanding offer of one’s opponent and their own fairness ideal (i.e., how unfair their opponent’s offer is). Note that a positive coefficient on the variable “Other’s Concession” indicates that reciprocity plays a role in bargaining; specifically, the larger my match’s most recent concession, the larger is my own concession, while positive coefficients on the two fairness variables indicate that more unfair offers lead to larger concessions. Our conjecture is that the more unfair one perceives their own offer, the larger will be the concession, while the more unfair one perceives their opponent’s offer to be, the smaller will be the concession. As can be seen, for both player types, concessions appear to be reciprocal. Also, as predicted, we found that the more unfair was one’s own offer, the larger the concession. However, for fixed payoff players, we actually found that the more *unfair* was the offer of the residual claimant, the *larger* was her concession. We do not have a good explanation for this counterintuitive result, though its effect appears to moderate the role of reciprocity for the fixed payoff player.<sup>12</sup> Finally, it appears that concessions grow larger as the bargaining period nears the end. That is, consistent with much of the literature, serious bargaining only begins near the deadline.

Finally, we are interested in the likelihood that any particular offer is accepted. To this end, we ran a random-effects logit model where the dependent variable took a value of 1 if a proposal was accepted and zero otherwise, with explanatory variables being the difference between the offer and the player’s perceived fair allocation, the degree of conflict between the players’ offers, the risk coefficients of both players, the time at which the offer was made and dummies for the distribution. We found that the larger the difference between the offer and the perceived fair allocation, the less likely was the offer to be accepted ( $p = 0.025$ ). The effect is small (marginal effect 0.0066), because the chance that any particular offer (on average there are over 13 offers per bargaining pair) is accepted is small. Observe that if we compute the marginal effect at the last second, then the marginal effect increases to 0.016.

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<sup>12</sup>Specifically, if we remove the fairness variable from the regression, the coefficient on reciprocity is close to 0 and insignificant.

	FP	RC
Others's Concession	0.092**	0.194*
	[0.039]	[0.114]
time/100	0.366***	0.323***
	[0.062]	[0.109]
Difference Between Other's Offer and Own Fairness Ideal <sup>†</sup>	0.168**	-0.045
	[0.076]	[0.062]
Difference Between Own Previous Offer and Own Fairness Ideal <sup>†</sup>	0.500***	0.349***
	[0.090]	[0.125]
Constant	-1.159***	-0.669*
	[0.299]	[0.351]
$R^2$	0.20	0.22
$N$	429	630

Table 7: Random effects regression of concessions on concessions of match and other variables. FP = Fixed payoff player; RC = Residual claimant. \*\*\*1%, \*\*5%, \*10% significance using standard errors clustered at the matching-group level.

<sup>†</sup> Variable is defined so that larger positive numbers indicate a larger perceived **unfairness** of the offer.

### 3.3.2 Agreements and Disagreements

Recall from Table 5 that we saw more disagreements when the pie was riskier. We now briefly examine the role that the amount of bargaining conflict and risk preferences play. Specifically, in Table 8 we regress disagreements on the amount of bargaining conflict, measured as the absolute difference in final offers by the residual claimant and the fixed payoff player, risk preferences and dummy variables for each of our four risky distributions. As can be seen, the greater the bargaining conflict between a pair, the greater is the likelihood of disagreement. Risk preferences do not appear to play a role in disagreements. Finally, we see that even controlling for conflict and risk preferences, disagreements are still more likely to occur the riskier the distribution of the pie.

Given that there is still a significant amount of conflict in bargaining at the point of final offers, it is of interest to examine whether there are any differences regarding which player, if any, is the one to ultimately accept. Consistent with the idea that more risk averse subjects are in a weaker bargaining position, we would expect that as a subject becomes more risk averse, she is more likely to accept. We created a dummy variable which takes value 1 if the residual claimant was the one to accept and 0 otherwise, and regressed this on the risk parameters of both the fixed payoff player and the residual claimant. The results suggest that, conditional on an agreement, the more risk averse the residual claimant, the more likely it is that the residual claimant is the one to accept, though the result is only significant at  $p = 0.089$ . For example, while a risk neutral residual claimant accepts, on average, 32% of the time, a residual claimant with  $\rho = 1$ , accepts over 68% of the time. In contrast, there is no

Parameter	Coefficient	Std. Err.
Conflict	0.081***	0.011
$\rho_{fp}$	0.060	0.096
$\rho_{rc}$	-0.004	0.049
$\mathbf{1}[(16, 20, 24)]$	0.012	0.031
$\mathbf{1}[(16, 24)]$	0.061	0.070
$\mathbf{1}[(12, 20, 28)]$	0.069**	0.033
$\mathbf{1}[(12, 28)]$	0.152**	0.064
Constant	-0.109***	0.028
$N$	419	
$R^2$	0.258	

Table 8: Random effects regression of disagreement on control variables. The variable “Conflict” is the absolute difference between the final offers of the fixed payoff player and the residual claimant. We exclude subjects for whom we estimate  $|\rho| > 1$ .

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

effect of the risk coefficient of the fixed-payoff player, nor does the riskiness of the distribution play a significant role in which player ultimately accepts.

### 3.3.3 Bargaining Duration

Finally we turn our attention to a deeper analysis of bargaining duration. In Table 9 we report the results of a Weibull regression, where a player accepting an offer counts as a “hit” or “failure” in the language of duration models. We include a set of time-invariant explanatory variables, namely, the risk preferences of the fixed payoff player and the residual claimant, and dummies for the bargaining distribution. We also include a the time-varying coefficient which is the amount of bargaining conflict. 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, the amount of conflict has a strongly significant effect on duration; in particular, the greater the conflict, the longer that bargaining takes. This result is consistent with our previous analysis which showed that increased conflict increases the chance of disagreement.

Interestingly, we also see that greater risk aversion reduces bargaining duration; however, the result is only weakly significant for the residual claimant. Again, this is consistent with the idea that more risk averse subjects are in a weaker bargaining position, meaning that they are eager to conclude an agreement earlier. Combined with the previous result that more risk averse residual claimants are more likely to accept, goes a long way to explain why more risk averse residual claimants do worse when faced with risk: fearing disagreement, they hold out less for concessions from the fixed payoff player, and accept a relatively disadvantageous offer. Finally, notice that, consistent with our earlier result, bargaining lasts longer when the

Parameter	Coefficient	Std. Err.
Conflict	-0.243***	0.057
$\rho_{fp}$	0.041	0.133
$\rho_{rc}$	0.684*	0.387
$\mathbf{1}[(16, 20, 24)]$	-0.591*	0.344
$\mathbf{1}[(16, 24)]$	-0.861***	0.246
$\mathbf{1}[(12, 20, 28)]$	-0.842**	0.379
$\mathbf{1}[(12, 28)]$	-0.19	0.493
$\mathbf{1}[\text{Residual Claimant}]$	0.118	0.155
Constant	-11.06***	2.761
Num Obs	1523	
$LL$	-197.68	

Table 9: Weibull regression of bargaining duration, where an acceptance is a “hit”. We exclude subjects for whom we estimate  $|\rho| > 1$ .

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

distribution is risky, and that the relative magnitude of the coefficients on our distribution dummies are consistent with the summary statistics reported earlier in Table 5.

## 4 Study #2: Residual Claimant Chooses The Distribution

An additional prediction of White (2008) is that *if* a residual claimant would have higher welfare when bargaining over a riskier distribution, then, if given the choice, he should choose to bargain over a riskier distribution. Although the results of Study #1 were inconsistent with the theoretical prediction, we still found that some residual claimants do have higher welfare when bargaining over a riskier distribution. Therefore, Study #2 was designed to address the research question: If given the choice between distributions over which to bargain, under what conditions would the residual claimant choose the riskier distribution? Theory suggests that it is the relatively more risk averse who will do so, while our previous results suggest that it is the relatively less risk averse.

Note, however, that even though a residual claimant may have higher welfare when bargaining over a riskier distribution, there are several behavioral factors which might make a residual claimant reluctant to choose a riskier distribution. First, our result was *conditional* on an agreement, the relatively less risk averse residual claimants have higher welfare. However, we also saw that disagreements were more likely for riskier distributions. When one factors in the increased likelihood of disagreement, it is no longer clear that it is better to bargain over a riskier distribution. Second a large literature in behavioral economics emphasizes the role of bargaining norms, often based around fairness considerations, and the role of intentions — how “kindly” other players’ actions are perceived to be. Consequently,

FP-players may refuse to compensate the residual claimant for the risk she is exposed to if they knew that the risky distribution was actively chosen. That is, in such a situation, the residual claimant may be concerned that the other player may not perceive her position as credible, resulting in choosing the safer distribution.

If this behavioral reasoning turns out to be important, then it suggests a role for how accountable the residual claimant is for the choice of distribution. Specifically, if there is some randomness about which pie the players bargain over, then the fixed payoff player cannot conclude with certainty that the riskier distribution was purposely chosen by the residual claimant, making her more willing to compensate the residual claimant for the extra risk. If this is the case, this lack of transparency could, therefore, restore the residual claimant's willingness to choose the riskier distribution.

	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

Figure 4: Summary of the treatment variations for study #2: the column indicates whether the distribution choice by the residual claimant is transparent or not, and the row whether the uncertain distributions had low or high risk in rounds 6 and 7. Each cell gives the between subject conditions for a given treatment; within each cell is a list of the within-subject variation of the distribution choices and the probability with which the residual claimants choice would be implemented.

#### 4.1 Experimental procedures

As in Study #1, this experiment consisted of 10 bargaining rounds. In order to give subjects experience in bargaining under risk with a residual claimant, in rounds 1 through 5, subjects bargained over exogenously specified distributions of pies — experiencing each of the 5 possible distributions from Study #1 once. In rounds 6 through 10, at the beginning of each round, the residual claimant was given two possible distributions of pies and asked to choose one of them which would be implemented.

The experiment was a  $2 \times 2$  design in which we varied the riskiness of the distributions along one dimension and the frequency with which the RC’s choice of distribution would be implemented. In our *transparent choice* treatments, the RC’s chosen distribution was always implemented, and the FP player was aware of this fact and also knew the exact choice faced by the RC. In our *non-transparent choice* treatments, the RC’s chosen distribution was implemented 70% of the time and the non-chosen distribution was implemented 30% of the time. The FP player knew the choice problem faced by the residual claimant, but did not learn the actual choice made by the residual claimant.

All of the other procedures remained the same as in Study #1.<sup>13</sup> In particular, in each bargaining round, subjects had 4 minutes to reach an agreement and communication was not allowed. Between rounds, subjects were randomly rematched, but always kept their role as either a residual claimant or a fixed payment player. As before, after all 10 bargaining rounds, subjects then completed a risk elicitation task.

## 4.2 Theoretical Predictions and Conjectures

Based on our reading of the literature, we predict that fixed payoff players will be more willing to compensate residual claimants for their risk when there is some chance that the exposure to increased risk was due to chance, as in the non-transparent choice treatment. Consequently, we predict that residual claimants will seek to exploit this “wiggle room” and be more likely to choose the riskier distribution when choices are non-transparent. Formally,

*HYPOTHESIS 5 Residual claimants will be more likely to choose the risky distribution in the non-transparent choice treatment. Furthermore, the payoff to fixed-payoff players will be lower in the non-transparent choice treatment.*

While White’s (2008) theoretical results predict that the relatively more risk averse residual claimants will be more likely to choose the riskier distribution, our results from Study #1 suggest the opposite: more risk averse residual claimants fear disagreement and so concede more. We believe that this will carry over into the choice of distribution. Therefore, we have the following hypothesis:

*HYPOTHESIS 6 The likelihood of choosing the risky distribution is decreasing in the risk aversion of the residual claimant.*

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<sup>13</sup>In this experiment, the order of bargaining distributions was not changed across experimental sessions since our primary interest lies in the last five periods when the residual claimant must choose between distributions. In addition, since the order for these last five bargaining periods was fixed – since there was no obvious re-ordering as in the no choice case – the chosen order ensured that the distributions included in period 6 did not include the distribution given in periods 4 or 5.

### 4.3 Results: Exogenously Chosen Distribution (Periods 1–5)

In Table 10 we present some summary statistics on the bargaining outcomes over the first five periods, when the distribution was exogenously specified. Panel (a) reports results for the transparent choice treatment, while panel (b) reports results from the non-transparent choice treatment. Since these two treatments were exactly the same for the first five periods, we would not expect any significant differences between the two. While it appears that the payoff to the fixed payoff players is higher in the transparent choice treatment, the difference is not significant ( $p = 0.114$ ). As can be seen, subjects in the role of the residual claimant are generally able to extract a greater than 50% share of the expected size of the pie, and that their share is (generally) increasing as the risk increases.

Distribution of Pie	Payoff to FP Player (€)		Agreements (%)	Time Remaining (sec)
	Unconditional	Conditional		
(20)	10.28	10.73	95.8	133
(16,20,24)	9.14	10.20	89.6	84
(16,24)	8.44	9.88	85.4	91
(12,20,28)	9.01	9.42	95.8	62
(12,28)	8.20	9.15	89.6	70

(a) Transparent Choice

Distribution of Pie	Payoff to FP Player (€)		Agreements (%)	Time Remaining (sec)
	Unconditional	Conditional		
(20)	10.06	10.50	95.8	126
(16,20,24)	8.32	9.29	89.6	46
(16,24)	8.95	9.77	91.7	77
(12,20,28)	7.92	8.84	89.6	44
(12,28)	8.20	8.75	93.8	51

(b) Non-Transparent Choice

Table 10: Summary of bargaining outcomes in the Study 2 (First 5 Periods)

In Table 11 we report the results of random effects regressions on the payoff to the fixed payoff player and the certainty equivalent of the residual claimant on dummies for the distribution as well as the risk parameters of both types, conditional on an agreement and for the first 5 periods only. Consistent with the results of Study #1, the payoff to the fixed payoff player is lower when the distribution is risky; however, the relationship is not strictly monotone. The payoff to the fixed payoff player is about €1 less when the distribution is either (16, 24) or (16, 20, 24) and it is about €1.7 less when the distribution is either (12, 28) or (12, 20, 28). For fixed payoff players, as would be expected, we see that they earn less the more risk averse they are; however, we also find that the more risk averse the residual claimant, the lower is their payoff as well. Thus, unlike Study #1, it could be that more risk averse residual claimants are better able to extract a sufficiently large compensating premium for their exposure to risk. Indeed, turning to the second column, which looks at the certainty

	FP Payoff	Cert. Equiv. of RC
$\mathbf{1}[(16, 20, 24)]$	-1.153*** [0.312]	1.029*** [0.327]
$\mathbf{1}[(16, 24)]$	-0.908*** [0.287]	0.715** [0.307]
$\mathbf{1}[(12, 20, 28)]$	-1.667*** [0.306]	0.920** [0.358]
$\mathbf{1}[(12, 28)]$	-1.700*** [0.331]	0.479 [0.443]
$\rho_{rc}$	-0.948** [0.375]	-0.526 [0.401]
$\rho_{fp}$	-1.253** [0.509]	1.338*** [0.503]
Constant	11.563*** [0.407]	8.858*** [0.449]
$R^2$	0.14	0.06
$N$	392	392

Table 11: Random effects regressions of payoff to fixed payoff player and certainty equivalent to residual claimant (First 5 periods). We exclude subjects for whom we estimate  $|\rho| > 1$ .

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

equivalent of the residual claimant, we have a much stronger result than for Study #1: the certainty equivalent for the risky pie is significantly larger than the certainty equivalent of the riskless pie for all distributions except the riskiest – (12, 28). Moreover, the more risk averse is the fixed payoff player, the higher is the certainty equivalent to the residual claimant.

#### 4.4 Results: Endogenously Chosen Distributions (Periods 6–10)

Having demonstrated that the main results from Study #1 continue to hold for the first five periods of Study #2, we are now in a position to look at the choice of risky distribution in the last 5 periods in which the residual claimant chooses the distribution and to test our hypotheses. In Table 12 we report the fraction of residual claimants who, when faced with a binary choice between a relatively safe and a relatively risky distribution, chose the risky distribution. First, observe that, with two exceptions, the riskier distribution was chosen less than 50% of the time, indicating a general reluctance to choose to bargain over riskier distribution. Moreover, contrary Hypothesis 5, it is not true that subjects in the non-transparent choice treatment chose the riskier distribution a greater proportion of the time (though in 7 of 10 binary comparisons, the riskier distribution was chosen at least as often in the non-transparent choice treatment).

Instead, of transparency of choice determining whether a subject chooses the riskier distribution, it appears that subjects are most likely to choose the riskier distribution when the

Table 12: Fraction Choosing The Riskier Distribution (Periods 6 – 10)

Alternatives	Transparent Choice		Non-Transparent Choice	
	High Risk	Low Risk	High Risk	Low Risk
(20) vs. (12, 28)	33.3	NA	45.8	NA
(20) vs. (16, 24)	NA	29.2	NA	33.3
(20) vs. (12, 20, 28)	41.7	NA	62.5	NA
(20) vs. (16, 20, 24)	NA	58.3	NA	45.8
(12, 28) vs. (12, 20, 28)	20.8	NA	29.2	NA
(16, 24) vs. (16, 20, 24)	NA	37.5	NA	25.0
(16, 24) vs. (12, 28)	8.3	37.5	16.7	37.5
(16, 20, 24) vs. (12, 20, 28)	29.2	25.0	20.8	29.2

choice is between no risk and a risky distribution that includes the possibility of an ex post equal split (the shaded cells in Table 12). In the first column of Table 13, we report the results of random effects regressions of choosing the riskier distribution on the risk parameter of the residual claimant, the residual claimants average payoff in the first five periods and also a dummy for whether the choice of distributions was between no risk and a tertiary distribution. As can be seen, the coefficient on this dummy is both large in magnitude and significant at the 1% level. Also, consistent with Hypothesis 6, we find that more risk averse residual claimants are significantly less likely to choose the riskier distribution. Finally, we also see weak evidence that residual claimants who earned more in the first five periods were more likely to choose the riskier distribution in later periods. This could suggest that experience matters (e.g., a person who earned little in the first five periods does not want to increase bargaining conflict by choosing the riskier distribution and risk disagreement) or that there is something like “bargaining skill” and that more skilled bargainers are more likely to choose the riskier distribution because they expect to be able to exploit their exposure to risk to their advantage.

In the second column of Table 13 we look at the determinants of agreements over the last five periods. As can be seen, if subjects are bargaining over the riskier distribution (either because it was explicitly chosen in the transparent choice treatment, or because it was implemented in the non-transparent choice treatment), the frequency of agreements drops by 5.6 percentage points, indicating that there is a price to pay from choosing the riskier distribution. We also see that agreements are more likely the more risk averse are the subjects, but that the result is only significant for the fixed payoff player.

Turn next to Table 14, which reports random effects regressions of payoffs to the fixed payoff player and certainty equivalents to the residual claimant on distribution dummies as well as dummies for whether the residual claimant’s choice was transparent and whether or not subjects bargained over the riskier distribution. It also includes the risk parameter estimates of both types of players. From this we can see that the second part of Hypothesis

	Choose Risky Dist.	Agreement
Payoff (P. 1–5)	0.014* [0.008]	
20 vs. Tertiary	0.253*** [0.040]	
$\rho_{rc}$	-0.218*** [0.075]	0.035 [0.036]
$\rho_{fp}$		0.223*** [0.078]
Riskier Distribution		-0.056** [0.024]
Constant	0.222*** [0.081]	0.829*** [0.038]
$R^2$	0.07	0.05
$N$	460	427

Table 13: Random effects regressions of choice of distribution and of agreements. We exclude subjects for whom we estimate  $|\rho| > 1$ .

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

5 is also not supported. In particular, whether in the transparent or non-transparent choice treatment, fixed payoff players earn approximately the same. We also see that the payoffs to the fixed payoff player and the certainty equivalents to the residual claimant are the same whether the riskier distribution was implemented or not. This is consistent with our intuition that fixed payoff players would be unwilling to compensate residual claimants for risk if they chose the riskier distribution. Finally, we see that, over the last five periods, conditional on reaching an agreement, fixed payoff players earn significantly less when the distribution is risky; moreover, this appears to just compensate residual claimants for their risk — the coefficient on the distribution dummies are never significantly different from zero. Finally, we see that risk aversion plays largely the same role as before, with the lone exception being the negative (but insignificant) coefficient on  $\rho_{rc}$  for the payoff of the fixed payoff player.

## 5 Conclusion

In this paper we have experimentally studied the effect of asymmetric exposure to risk in bargaining. Our results confirm many aspects of the theoretical predictions — residual claimants are general able to extract a risk premium from the fixed-payoff player, and the amount is increasing in the riskiness of the distribution. However, there appear to be some behavioral nuances which go, in part, against the theory. First, disagreement is significantly more likely when bargaining over a risky distribution than a riskless distribution — with disagreements occurring 5% of the time under riskless distributions and nearly 20% of the time with the

	FP Payoff	Cert. Equiv. of RC
(16, 20, 24)	-0.370*** [0.141]	0.040 [0.106]
(16, 24)	-0.444** [0.209]	-0.005 [0.235]
(12, 20, 28)	-0.978*** [0.334]	0.240 [0.359]
(12, 28)	-1.546*** [0.397]	0.501 [0.412]
Riskier Distribution	0.064 [0.251]	-0.158 [0.262]
Transparent Choice	0.325 [0.308]	-0.286 [0.395]
$\rho_{fp}$	-1.558*** [0.493]	1.780*** [0.457]
$\rho_{rc}$	-0.261 [0.244]	-1.107*** [0.289]
Constant	10.723*** [0.397]	9.780*** [0.458]
$R^2$	0.12	0.08
$N$	385	385

Table 14: Random effects regressions of the payoff and certainty equivalent of the fixed payoff player and residual claimant, respectively over the last five periods and conditional upon reaching an agreement. We exclude subjects for whom we estimate  $|\rho| > 1$ .

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

riskiest distribution. The reason for this would appear to be due to competing self-serving norms increasing bargaining conflict. With no risk, the 50-50 norm is the most salient, and indeed, most agreements when risk is absent specify this division. However, as risk increases, the fixed-payoff players continue to believe that 50-50 is a fair split, while residual claimants believe that it is fair to be compensated for their risk. Hence bargaining conflict increases due to the incompatibility of these competing fairness norms, and disagreements occur more frequently. Another interesting difference is that, while some residual claimants are better off in expected utility terms, it is actually the less risk averse ones who benefit from risk. This suggests that fixed payoff players may be willing to compensate an “average” residual claimant for his exposure to risk. If the actual residual claimant is less risk averse than this average, then he will actually be over-compensated in expected utility terms, while the more risk averse residual claimants will be under-compensated.

We also documented that, when given the chance, except in a very particular case, residual claimants generally prefer to bargain over a less risky distribution. In part, this would appear for good reason. First, even when the distribution of the pie is exogenously given,

disagreements are generally increasing in the riskiness of the distribution and, second, our results show that when bargaining over the riskier distribution, disagreements are even more likely. That being said, some residual claimants do choose the riskier distribution and our results suggest that it is the ones who are relatively less risk averse who are more willing to do so. There is also some evidence that skill may play a role in the distribution choice, with “better” bargainers more willing to choose the riskier distribution.

We believe that the results of this experiment are quite interesting and point to the fruitfulness of examining exposure to risk in other bargaining settings. For example, in our experiments subjects were unable to communicate. Communication could allow subjects to justify their bargaining position by appealing more directly to their preferred fairness norm. It could also allow residual claimants to communicate their attitudes towards risk. Yet in this setting, communication is entirely cheap talk, so how it affects bargaining is not clear. Another important and relevant area where asymmetric exposure may be important is in dynamic bargaining environments in which agents interact repeatedly and must periodically negotiate to split a pie. This is potentially very relevant because not only are there competing norms of fairness in the static case, when dynamics enter the picture, the ex post allocation from one period may influence the players’ views on what is fair in the next period. One such example appears to concern North American automakers and their labor unions. Specifically, during the financial crisis of 2008, on the verge of bankruptcy, the automakers extracted large concessions from their unions. However, in subsequent years, the automakers have been more profitable than anticipated. Not surprisingly, the union wants “pay back” for its past sacrifices, while automakers claim that this is “the new normal”. This quote about recent negotiations between the Canadian Autoworkers Union and the automakers summarizes the bargaining positions, and competing fairness norms, very nicely: “[The automakers] also want wages to be more closely tied to profitability. That sets the stage for difficult bargaining, because the union is intent on raising wages and recovering some benefits they surrendered during the 2008-2009 auto crisis.”<sup>14</sup>

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<sup>14</sup>“Auto makers tell union wage hikes won’t happen,” by Greg Keenan, *The Globe and Mail*, June 6, 2012.

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