CIRPÉE
Centre interuniversitaire sur le risque, les politiques économiques et l'emploi

Cahier de recherche/Working Paper **06-37**

Bargaining under Large Risk - An Experimental Analysis -

Werner Güth
Sabine Kröger
Ernst Maug

Novembre/November 2006

Güth: Director Strategic Interaction Group, Max-Planck-Institute for Research into Economic Systems, Kahlaische Strasse, 07745 Jena, Germany. Tel.: +49 (3641) 686 620; Fax: +49 (3641) 686 623
gueth@mpiew-jena.mpg.de
Kröger: CIRPÉE and Economics Department, Laval University, Pavillon J.-A.-DeSève, Québec (QC) Canada G1K 7P4. Tel.: +1 (418) 656 2131 ext. 12896; Fax: +1 (418) 656 2707
skroger@ecn.ulaval.ca
Maug: Chair for Corporate Finance, University of Mannheim, 68131 Mannheim, Germany. Tel.: +49 (621) 181 1952; Fax: +49 (621) 181 1980
maug@corporate-finance-mannheim.de

We thank Tim Grebe for his help conducting the experiment. We are grateful to Charles Bellemare for providing his nonparametric OX-package. We also thank Jan Potters, Karim Sadrieh, Kristian Rydqvist and seminar participants at the Economic Seminar in Stockholm and the ENDEAR workshop in Amsterdam, the ESA International meeting in Boston, SUNY Binghamton and the 4th GEABA-Symposium in Frankfurt a. M. for helpful discussions and for sharing their thoughts on earlier drafts of this paper. Financial support from the Deutsche Forschungsgemeinschaft, SFB 373 and Max Planck Institute for Research into Economic Systems is gratefully acknowledged.

Abstract:
We present an experimental study to learn about behavior in bargaining situations under large risks. In order to implement realistic risks involved in the field, we calibrate the experimental parameters from an environment involving substantial variation in profits, the motion picture industry. The leading example is the production of a movie that may give rise to a sequel, so actors and producers negotiate sequentially. We analyze the data in light of alternative behavioral approaches to understanding bargaining behavior under large risk.

Keywords: Bargaining, Large Risk, Equity, Experiments, Calibration

JEL Classification: C72, C91, D81

1 Introduction

The study of ultimatum bargaining in laboratory experiments suggest that individuals may be concerned with more than their own profit in evaluating the final outcome of bargaining. Notions of fairness seem to play an important role and equal sharing of the surplus has been shown to be the predominant outcome in many studies investigating behavior in ultimatum bargaining experiments.[1]

In most of those studies the surplus to share between bargaining parties is certain. This is not very often the case in real life, where various gains from interaction might be possible and only their probability rather than the actual realization of the surplus is known to negotiation partners. Sometimes, uncertainty dissolves only after contracts have been specified. Risks involved can be rather substantial and might have an important impact on the behavior of bargaining parties. It is not clear to which extent regularities observed in standard ultimatum bargaining experiments hold under large risk. In this study, we want to shed light on how negotiations develop in the presence of large risks.

In order to study risk of realistic magnitude, we calibrate the experimental parameters based on empirical observations from an environment involving substantial variation in profits, the motion picture industry.[2] Parameters are determined so as to match the moments of an empirical distribution.[3] The model developed in this study relates to the structure of the bargaining process in this industry. We present such situations by a two-stage ultimatum bargaining game in which the first period surplus is stochastic. Only in case of a successful outcome at the first stage, i.e., that an agreement is reached and a particular surplus realized, a "sequel project" with a sure outcome can be negotiated with alternation of roles. Such repeated bargain-

[1]Starting with Güth, Schmittberger Schwarze (1982) there is a large literature on ultimatum bargaining experiments. Güth and Tietz (1990), Roth (1995) and Camerer (2003) provide excellent surveys.

[2]De Vany and Walls (2002) note that "Motion pictures are among the riskiest of products; each movie is a 'one-off' innovation with highly unpredictable revenues and profits."

[3]Our calibrations and the data for our study are based on a case study (Teichner and Luehrmann, 1992) that contains data on 99 movies in the 1989-season and some additional data on the profitability of sequels, based on 60 sequels produced between 1970 and 1990. Teichner and Luehrmann base their data on Variety Magazine and some other industry sources.

ing differs from sequential bargaining models in so far, that the second stage is only reached in case of previous agreement, an additional stochastic termination rule and that the surplus is additive.[4] The model structure therefore resembles risky partnerships and cooperations typical also for R&D joint ventures and venture capital.[5]

Related literature has studied asymmetric information in ultimatum bargaining. Introducing risk or uncertainty about the size of the surplus for the responder has been used to investigate strategic behavior of proposers in ultimatum bargaining games. Results from those studies indicate that notions of fairness appear to respond to strategic considerations. Since responders were deprived of the possibility to compare relative outcomes of proposed allocations and punish selfish offers, proposers took advantage of such situation and offered less or demanded more than observed in comparable experiments with symmetric information.[6]

The main differences of the current study to this literature is that in our study the surplus is extremely stochastic, i.e., involving large stakes and losses, and that there is no private information. Further, we feel that results may not be completely independent of the parameters chosen in the experiment. Choosing parameters that closely resemble those in the field, might illuminate better what happens in risky environments. Surprisingly, calibration of parameters is rarely used in experiments, although we consider it another way to overcome the parallelism problem of the lab and the field.[7]

[4] For experimental sequential bargaining studies see Binmore, Shaked, and Sutton (1985), Güth and Tietz (1990), and Ochs and Roth (1989).

[5] Venture capital firms finance their portfolio firms in stages. At each stage, the venture capitalist either negotiates another round of financing or refuses further financing and terminates the relationship (Gompers, 1995).

[6] Results are reported in Mitzkewitz and Nagel (1993), Straub and Murnighan (1995) and Rapoport and Sundali (1996), who study "offer games" in which the distribution of the stochastic surplus is common knowledge but its realization is private information of the proposer, who offers an amount to the responder. Kagel, Kim and Moser (1996) observe similar strategic behavior of proposers when exchange rates, which are private information and differ between proposer and responder, are revealed to the proposer only. Mitzkewitz and Nagel (1993) and Rapoport, Sundali and Seale (1996) study additionally "demand games" in which the distribution of the stochastic surplus is common knowledge but its realization is private information of the proposer, who demands an amount from the (to the responder unknown) realized surplus from the responder.

[7] There exist a few studies (Grether and Plott, 1984, and Hong and Plott, 1982), in which experi-

We can summarize our results as follows. Firstly, responders rarely accept offers below their first-stage opportunity costs. This could be due to the enormous and for experimental studies quite unusual risk subjects face: in our calibrated parametrization the probability of being able to bargain for a lucrative sequel-contract at the second stage is only 25%, so the potential reward is too risky to make subjects pay for this opportunity by foregoing a certain outside option. Thereby proposers either have to become the only risk taker or have no joint project at all. On the other hand, there seems to be little reciprocation by responders who become proposers at the second stage. They hardly offer more than the outside option, keeping 3/4 of the sure second stage surplus for themselves. Interestingly, such self-serving behavior is widely accepted by second stage responders, a result quite different from standard ultimatum bargaining experiments.

We proceed as follows. In section 2, we introduce the model. Section 3 explains the procedure we followed for calibrating the parameters of the model. Details of the experimental design are described in section 4. Section 5 reports general results of the experimentally observed behavior. Section 6 is devoted to developing two behavioral approaches, one based on outcome maximization and an alternative approach based on equity concerns, both of which are confronted with the data in section 7. Section 8 resumes.

2 The Model

We analyze the bargaining between a producer of a movie, denoted by P, and an actor, denoted by A. Movie production is characterized by substantial risks: either the movie is a hit, in which case the producer's payoff is very large, or the movie is a flop. Then profits are small and often negative. In many cases, producers try to rehire core actors of top-grossing movies to produce a sequel. Producers seem to think that rehiring the main actors of the original is critical to the success of a sequel (in case of "When Harry met Sally," Meg Ryan and Billy Crystal, in case of

mental parameters have been chosen to resemble those in the field.

"Rocky," Sylvester Stallone).[8] Clearly, the bargaining power of the actor is high when negotiating the contract for the sequel.[9] Core actors of successful films know they are indispensable for the sequel, giving them effective monopoly power.

We present such situations by a two-stage bargaining game where "studios" have ultimatum power when casting the first film. Only if the original film has been successful, actors negotiate a second contract. Actors, now indispensable to the success of a movie the sequel, make a take it or leave it offer to the studio. The game starts with the producer making a wage offer W_1 to the actor. If the actor rejects the proposed wage, the game ends with the actor receiving his rather low outside option O_1^A and the producer the profit O_1^P which could be interpreted as the gain from producing the film with another (presumably less talented) actor.

If the actor accepts the wage offer W_1, the movie is produced. Then chance determines the success s of the movie, where $s \in \{f, h\}$. The surplus generated by the movie, to be divided between both bargaining parties, is denoted by C_1^s. With probability ω the movie is a "hit" (denoted by h) and generates a total surplus C_1^h, otherwise the movie is a "flop," denoted by f and generates only $C_1^f < C_1^h$, where $0 < \omega < 1$. The profit of the producer is given by $\Pi_1^s = C_1^s - W_1$.[10]

After a "flop" the game ends with the actor earning his wage W_1 and the producer the low profit Π_1^f of a "flop." After a "hit" the game proceeds to the second stage. Then the actor proposes a contract for the sequel project. The gain from pro-

[8] A notable exception are the James Bond-movies that led to a remarkable number of sequels, albeit with constant blocks of different actors.

[9] It is common for actors to sign profit sharing contracts. For those contracts, a contrast is often drawn between actors who have little bargaining power and sign contracts over "net-profit" shares and big stars -such as Tom Hanks- who are able to sign for shares of the "gross-profit" (Weinstein, 1998).

[10] Note that we do not allow for output-contingent contracts. Chisholm (1997) provides an empirical analysis of profit sharing vs. fixed pay contract choice in the motion picture industry. Her findings suggest that actor share contracts may be offered when the marginal impact of additional effort on the commercial success of the film is expected to be significant. However, we do not model effort-incentives, so the usual reasons for output-related pay do not apply. See Holström (1979) and Grossman and Hart (1983) for the traditional argument for output-contingent contracts. See Güth and Maug (2002) for an example of a principal-agent model with effort-incentives where pay is fixed.

ducing the sequel is known to be C_2.[11] The actor proposes a wage W_2 that leaves the producer with profits $\Pi_2 = C_2 - W_2$. The reversal of bargaining power to the agent captures that in case of a "hit" the formerly unknown actor is now a movie star and cannot easily be replaced. Accordingly, his outside option O_2^A could be larger than before what we, however, do not impose since there are no data allowing to estimate the possibly positive difference $O_2^A - O_1^A$.

If the producer rejects the actor's contract offer, the game ends and the actor receives his outside option O_2^A in addition to his previous payoff W_1 whereas the producer does not produce the sequel and earns the outside option O_2^P in addition to his previous earnings Π_1^h. If the producer accepts, then both players collect their contractual earnings from both movies. The extensive form of the game is therefore:

1. P offers a wage-contract to A that specifies a fixed wage W_1 for A and splits the uncertain gain from producing the original movie.

2. A can accept or reject. If A rejects, both parties receive their outside payoff and the game ends. If A accepts, the original movie is produced and the game continues.

3. Nature determines the success state s of the movie. Both parties receive a payoff dependent on the success of the movie according to their contract. If the movie is a flop, the game ends. If the movie is a hit, the game continues.

4. A offers P a contract that specifies a fixed wage for A and a fixed profit for P for producing a sequel to the original movie.

5. P can accept or reject this contract. If P rejects, both parties receive an additional payoff dependent on their outside opportunities and the game ends. If P accepts, the sequel is produced with gains from production C_2 that are split according to the contract and the game ends.

[11] Sequels are a much safer bet. Evidence comes from the case study (Teichner and Luehrmann, 1992) we base our calibration on as well as from Prag and Casavant (1994), who find a positive relation between a film's revenue and the film being a sequel.

3 Calibrating Parameters

We will determine the parameters of the model so as to match the moments of an empirical distribution. In the following we present the empirical data of movie production and discuss the calibration. From industry data we determine most parameters of the model through calibration. The data for calibration are found in the case "Arundel Partners - The Sequel Project" (Teichner and Luehrmann, 1992). The case assembles data for 99 movies produced by 6 major studios released in the United States in 1989. The data in this case study are taken from a database largely based on Variety Magazine, a trade magazine specializing on the movie industry. Based on Exhibit 7 of the case we calculate the net present value (NPV) of a first film as:[12]

$$NPV = \frac{PV\ of\ Net\ Inflows\ at\ year\ 1}{1.12} - PV\ of\ Negative\ Cost\ at\ year\ 0. \qquad (1)$$

Here, the present value of net inflows are gross box office proceeds in the US, plus international proceeds and revenues from video rentals net of distribution costs and expenses. These are discounted at an estimated cost of capital of 12%. Negative costs include all costs required to make the negative of the film of which prints can be made and rented to theaters. Negative costs include among others the salaries of actors and director, production management, special effects, lighting, and music. Table 1 gives the total number of films per studio, the number of films that generated a positive NPV on the initial investment, and the total net present value over all 99 films for six major Hollywood studios.

Hence, the average value of a first film is \$736.6m/99=\$7.44m, and 42 films are profitable with the median film making a loss of \$2.26m. The standard deviation is \$34.16m, showing that movie-production is risky. Also, the risks and payoffs are distributed somewhat unevenly across studios with MCA being by far the most profitable and Sony being the least profitable, making losses on 26 of their 34 films in 1989. The most profitable film in the sample is Batman (Warner Brothers, NPV= \$224.33m), the greatest disaster was The Adventures of Baron Munchhausen (Sony, NPV= $-$\$45.54m).

The case study estimates the value of potential sequels. On average, costs of se-

[12] The discount rate of 12% is suggested by the case writers.

Studio	Number of films	Positive NPV Films	Total NPV
MCA Universal	14	11	\$263.7
Paramount	10	5	\$25.7
Sony	34	8	−\$55.4
20^{th} Century Fox	11	5	\$23.2
Warner Brothers	19	7	\$233.1
Disney	11	6	\$246.2
Total	99	42	\$736.6

Table 1: *Profitability of first films*

Parameter	Symbol	Value
Probability of hit	ω	0.25
Pie in case of a hit	C_1^h	68
Pie in case of a flop	C_1^f	-10
Pie in case of the sequel	C_2	33
Outside option actor	$O_1^A = O_2^A$	2
Outside option producer	$O_1^P = O_2^P$	7

Table 2: *Experimental parameters*

quels are 120% of the costs of a first film, according to our model largely due to a change in bargaining power resulting in higher wages after a successful first film. Box office proceeds are on average 70% of the first film, and not every successful film in the sense of a large positive NPV leads to a potentially profitable sequel. Hence, on average sequels are less profitable than first (success) films. There are exceptions: Batman 2 was more successful than the original movie! Based on the calibration documented in appendix A we choose the parameters listed in table 2.[13] Effectively, we chose the model parameters so as to match the main features of the joint distribution of film values and sequel values (e. g., mean and standard deviation, ratio of sequel value to value of first film).

4 Experimental Design and Procedure

Our experimental design exactly matches the sequential game. In order to analyze bargaining behavior we rely on the estimated parameters from the case study. The computerized experiment was conducted at the laboratory of Humboldt University Berlin in November and December 2001. The computer program was developed using the software z-tree (Fischbacher, 1999). 72 Participants –mainly students of business administration, economics and information technology– were recruited via E-mail and telephone. We conducted six sessions, each consisting of two matching groups. To allow for learning, participants interacted for 18 rounds in the two-stage bargaining game. Participants first read the instructions and were then privately informed about their role.[14] Roles were neutrally framed as "participant A" and "participant B" for the role of the actor and producer, respectively. In the following, we continue to refer to participants as "actors" and "producers," although the experimental subjects were not aware of this interpretation. Participants remained either an actor or producer throughout the whole experiment. One matching group consisted of three negotiation groups each with one actor and one producer. After

[13]The full calibration results for the parameters are listed in table 9 in appendix A.

[14]See appendix D for a shortened and translated version of the instructions.

every round new actor-producer-pairs were formed randomly.[15]

Information feedback was as follows: After the first bargaining stage participants were told whether the actor had accepted the producer's offer. If the offer was accepted, they were informed about the randomly selected pie size and their first stage earnings. After the second stage participants were told whether the producer had accepted the actor's offer and what they have earned in the second stage. At the end of each interaction participants were additionally informed about their own cumulative payoffs.

A session lasted on average 140 minutes. The exchange rate was DM 2 for one experimental currency unit (ECU).[16] Participants were paid their average payoff of all 18 rounds which was on average DM 21. More precisely, producers received on average DM 25 with a minimum payment of DM 1 and a maximum of DM 71. Actors earned on average DM 17 with minimum payments of DM 8 and maximum of DM 26. Additionally, participants were paid an initial endowment of DM 10 and DM 5 for completely answering the post experimental questionnaire.

5 Data: First and Second Stage Offers

At the first stage which involved negotiations about the stochastic joint profit of either -10 (flop) or 68 (hit), we observe in total 648 W_1-offers. Table 3 and Figures 1 and 2 report medians, means, and standard deviations as well as histograms of offers, acceptances and rejections on both stages.

At stage one the producer offered on average 0.8 to the actor. In 435 cases actors accepted the offer with a mean of 4.5. Then chance decided for 143 producer-actor-pairs that a "hit" was realized and subjects continued at the second stage. At the second stage parties negotiated about a joint profit of 33. The average amount actors offer to the producer, Π_2, is close to the producer's outside option of 7 with a median Π_2-offer of 8 and 47% of all second stage offers were either 7 or 8. Π_2-

[15]Rematching was restricted to matching groups. Participants were not informed about the restriction of rematching within matching groups what should have further discouraged repeated-game effects.

[16]DM 1 $\approx$ EUR 0.51.

	Stage 1 offer (W_1)			
	Nobs	Median	Mean	Std.dev
All	648	3.0	0.8	6.8
Accepted	435	3.0	4.5	4.1
Not accepted	213	-10.0	-6.6	4.8

	Stage 2 offer (Π_2)			
	Nobs	Median	Mean	Std.dev
All	143	8.0	8.9	2.9
Accepted	121	8.0	9.3	2.3
Not accepted	22	8.0	6.6	4.4

Table 3: *Offers: number of observations, median, mean, and standard deviation*

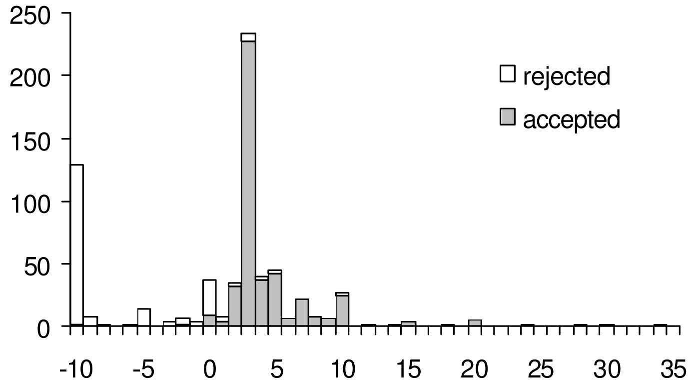

Figure 1: *Frequencies and acceptance/rejection of stage 1 offers (N=648)*

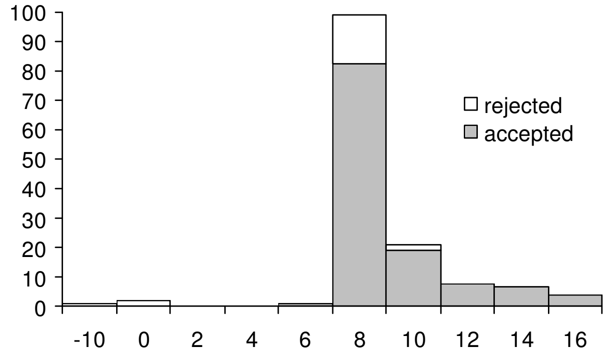

Figure 2: *Frequencies and acceptance/rejection of stage 2 offers (N=143)*

offers below the producer's outside option are rare (2.1%). Second stage offers with an average offer of 8.9 were mostly accepted (85%), leaving $W_2 = 24.1$ to the actor. The remaining 213 W_1-offers with a mean of -6.6 were not accepted and the round finished for these producer-actor-pairs immediately after stage one with both parties receiving their outside option. Furthermore, at stage one negative offers are almost never accepted (2%), and non-negative offers below the outside option are rarely accepted (26%). Offers above the outside option were accepted in 97% of the cases. Figure 3 presents a nonparametric estimate of the acceptance probability as a function of first stage offers. The concave relationship in the range of $[-4.5, 2]$ might portend (if at all) heterogeneous risk preferences rather than risk neutrality of actors.

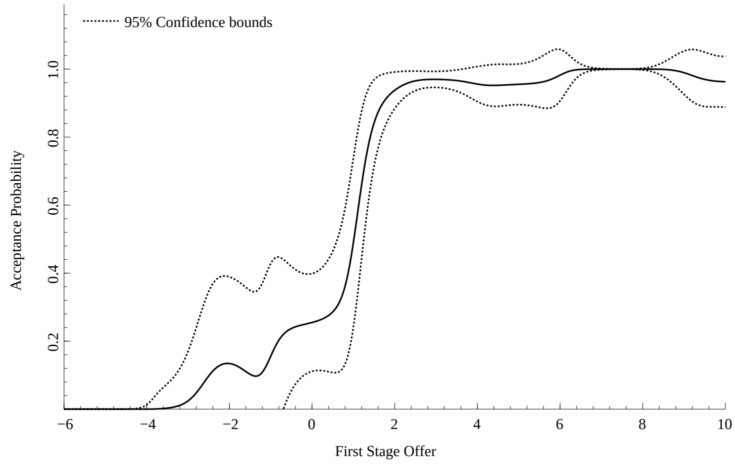

Figure 3: *Acceptance probability of first stage offers*

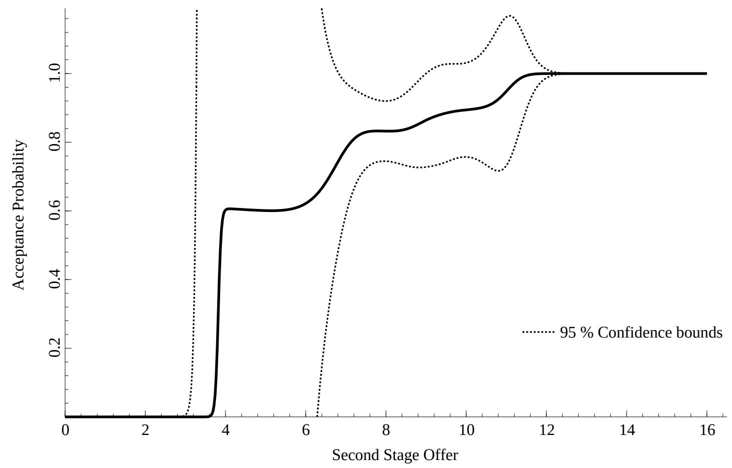

Figure 4: *Acceptance probability of second stage offers*

The nonparametric estimate of the acceptance probability at the second stage is presented in Figure 4. Low dispersion of second stage offers, which additionally were mostly accepted, explain the wide confidence bounds for offers below 7 and almost constantly high acceptance rates around 90% for offers above 8.

After this general description of the results, we will now propose two different behavioral approaches based on profit maximization and equity concerns and address the question how well those approaches explain the observed behavior in the experiment.

6 Behavioral Approach

In this section we present two approaches to analyzing the data, one based on the assumption of outcome maximizing decision makers and the other based on equity concerns.

6.1 Outcome maximizing decision makers

Risk-Neutral Agents We first develop behavior in the game by assuming risk neutrality of procedures and actors. This solution serves as a benchmark. We solve this game by backward induction. At the second stage, the actor makes a take it or leave it-offer and offers the producer profits according to her outside option. Hence, the wage at the second stage is

$$W_2^* = C_2 - O_2^P \quad , \tag{2}$$

$$\Pi_2 = O_2^P \quad . \tag{3}$$

At the first stage, the producer makes a take it or leave it offer to A that makes the actor indifferent between accepting and rejecting the offer, so $W_1^* + \omega W_2^* = O_1^A$. Therefore,

$$W_1^* = O_1^A - \omega W_2^* \quad , \tag{4}$$

$$\Pi_1^s = C_1^s - O_1^A + \omega W_2^* \quad . \tag{5}$$

Equations (2), (3), (4), and (5) together with the assumption that offers (not) worse than the ones derived are (accepted) rejected represent the game-theoretic solution of the game for risk neutral agents.

Relaxing Risk Neutrality: Risk-Averse Actors Now we partially relax the assumption of risk neutrality by assuming that agents are risk-averse. Producers are typically large studios owned by diversified investors. As the risk of movie success or failure is idiosyncratic, producers can reasonably be assumed to behave as if they were risk-neutral whereas the same is not true for actors. Moreover, this modelling strategy allows us to build in reservation wages that may vary across actors, and producers may not have full information about actors' reservation wages in bargaining. Hence, we introduce two assumptions:

- Actors are risk-averse, while producers are risk-neutral.
- Producers are uncertain about actors' risk aversion.

We explore the implications of these assumptions for the game-theoretic solution in turn. Denote the agent's utility function by U and observe that there is no uncertainty at the second stage of the game, hence equations (2) and (4) still represent the solution to the second stage. Then we require:

$$U(O_1^A) \leq \omega U\left(W_1 + W_2^*\right) + (1-\omega)\, U\left(W_1\right) \tag{6}$$

for any acceptable W_1, where W_2^* is still given from (2). Then, define the lowest W_1 that is just acceptable to the agent by $\widehat{W}_1$. Clearly, for any risk-averse agent $\widehat{W}_1$ exceeds (4). Also, it follows directly from (6) that any wage offer $W_1 \geq O_1^A$ will be accepted, even by an infinitely risk-averse agent. Hence, we have:

$$O_1^A - \omega W_2^* \leq \widehat{W}_1 \leq O_1^A \quad . \tag{7}$$

In case the agent's utility function is common knowledge, we would now have $W_1^* = \widehat{W}_1$ as before. However, we assume now that $\widehat{W}_1$ is unknown to the producer, who believes that the actor's reservation wage is drawn from a continuous distribution $F(\widehat{W}_1)$ with density $f(\widehat{W}_1)$ and support given by (7). Hence, the producer's expected payoff as a function of her wage offer is:

$$\begin{aligned} E\left(\Pi\left(W_1\right)\right) &= \left[E\left(C_1^s\right) - W_1 + E(O_2^P)\right] F\left(W_1\right) + \left(1 - F\left(W_1\right)\right) O_2^P \\ &= \left[E(C_1^s + O_2^P) - W_1\right] F\left(W_1\right) + \left(1 - F\left(W_1\right)\right) O_2^P \end{aligned} \tag{8}$$

where according to our model $E\left(C_1^s\right) = \omega \cdot C_1^h + (1-\omega) \cdot C_1^f$. Solving first order conditions $\partial E\left(\Pi\left(W_1\right)\right) / \partial W_1 = 0$ yields:[17]

$$W_1^* + \frac{F\left(W_1^*\right)}{f\left(W_1^*\right)} = E\left(C_1^s + O_2^P\right) - O_1^P \quad . \tag{9}$$

[17]The second order condition for payoff maximization is $f'\left(W_1^*\right) F\left(W_1^*\right) > 2\left(f\left(W_1^*\right)\right)^2$.

We develop a parametric example in appendix B below, which allows us to obtain a closed-form solution for (10) and then convert this solution into quantifiable predictions.

Relaxing Risk Neutrality: Risk-Averse Actors and Producers The assumption that producers are risk-neutral is, given the above mentioned reasons, very likely to hold in reality. Nevertheless, the model will be investigated using a sample of subjects who are randomly assigned to the roles of actors and producers. If we assume risk preferences to be equally distributed over both sub-samples, we will also observe risk-averse producers. As we do not pre-select producers in the experiment according to their risk preferences, we relax the assumption of risk neutrality also for producers.

The producer chooses W_1 in order to maximize

$$\omega F\left(W_1\right) U(C_1^h + O_2^P - W_1) - (1-\omega) F\left(W_1\right) U(C_1^f - W_1) + (1 - F\left(W_1\right)) U(O_2^P) \tag{10}$$

A risk-neutral producer would offer at maximum $W_1 = O_1^A$, what even an infinitely risk-averse agent would accept. Independent of the risk aversion of the producer, the minimum offer a risk-neutral actor might accept is W_1^* (from equation (4)). Therefore, a producer offering $W_1 < O_1^A - \omega W_2^*$ could ensure rejection of the contract by the actor. Such offers could come from risk averse producers who are not willing to bear the risk of production. In appendix B we provide the intuition for a risk aversion-threshold parameter.

As we are mainly interested in the case where the movie is produced, we do not explicitly model risk aversion of producers. Relaxing the assumption of risk neutrality for producers allows for self selection of participants either to become a movie producer by offering within the range of equation (7) or to take the outside option by offering a wage

$$W_1 < O_1^A - \omega W_2^*. \tag{11}$$

Hence, all offers below O_2^A can be rationalized by game theory introducing also risk aversion for producers. As in reality, we will only observe movies made by risk neutral producers (or producers with a sufficient low risk aversion parameter). Equations (2), (3), and (7) represent the "game-theoretic" prediction (GT) of the game allowing for risk-averse actors, whereas equation (11) captures the self-selection of producers.

6.2 Decision making with Equality Concerns

Our second suggestion to solve the model is based on former results of ultimatum (bargaining) experiments, according to which one may expect that only claims which aim at equal splits will be accepted.[18]

Equity theory (Homans, 1961) predicts equal sharing but leaves open *what* is shared equally.[19] This can, for instance, be the total of the expected pie $E\left(C\right) = E\left(C_1^s + C_2\right) = \left[\omega(C_1^h + C_2) + (1-\omega)C_1^f\right]$. Sharing the expected stage pie separately at each stage would result in $W_1 = E\left(C_1^s\right)/2$ for the first stage offer and $\Pi_2 = C_2/2$ as second stage offer. However, there exists a range of possible first stage offers within which compensation on the second stage and therefore equal share of the total expected pie is still possible.[20] We therefore allow, more generally,

$$W_1 = E\left(C_1^s\right)/2 - \omega\Delta \quad , \tag{12}$$

$$\Pi_2 = C_2/2 - \Delta \quad , \; -C_2/2 \leq \Delta \leq C_2/2. \tag{13}$$

In this respect, equation (13) essentially predicts (positive and negative) reciprocity. Lower offers W_1 are followed by lower offers Π_2 such that Π_2 depends positively on W_1.[21] Nevertheless, if both agents follow equity considerations, too meager offers, i.e., $W_1 < E\left(C_1^s\right)/2 - \omega C_2/2$ and $\Pi_2 < C_2/2 - (1/\omega)(E\left(C_1^s\right)/2 - W_1)$, will be rejected. Equations (12) and (13) represent the "equity-theoretic" prediction (ET) of the game.[22]

[18]See Güth (1995) and Roth (1995) for surveys.

[19]See Güth (1988) for an attempt to add specificity to this concept.

[20]The actor will accept the lower offer and not be compensated with probability $(1-\omega)$. If the producer offers $E\left(C_1^s\right)/2 - \omega\Delta$ at the first stage in case of a hit the actor can offer $C_2/2 - \Delta$. To reach the equal split he should be compensated by Δ.

[21]Equity theory would predict $\Pi_2\left(W_1\right) = C_2/2 - E\left(C_1^s\right)/2\omega + W_1/\omega$.

[22]Other theoretical approaches allowing for other regarding preferences in final outcomes, consider aversion against inequity (Fehr and Schmidt, 1999) or aversion against being above or below the average income of bargaining parties (Bolton and Ockenfels, 2000) or concerns for the least well in the society (Charness and Rabin, 2002).

On the basis of table 2 we can distinguish between the predictions of the two theoretical approaches: (i) the game-theoretic solution allowing for risk-averse agents (GT) with equations (2)-(5), (7), and (11), (ii) the equity-theoretic solution based on the total expected profit (ET) with equations (12) - (13). Using the experimental parameters above, we obtain the predictions in table 4.

Prediction	Acronym	Model Predictions		
		W_1	Π_2	W_2
Game Theory	GT	$[-10, 2.0]$	7.0	26.0
	GT (i)	$[-10, -4.5)$	–	–
	GT (ii)	$[-4.5, 2.0]$	7.0	26.0
Equity Theory	ET	$4.75 - \omega\Delta$	$16.5 - \Delta$	$16.5 + \Delta$
		with $\Delta \in [-16.5, 26.5]$		

Table 4: *Predictions of game theory allowing for risk averse agents (eqs. (2)-(3), (7), (11)) and equity theory (eqs. (12)-(13))*

The game theoretic prediction can be subdivided in: (i) Self-selection of risk-averse producers. and (ii) Allowing for risk-averse actors, assuming risk-neutral producers.

Clearly, given our calibrated parameters game theory and equity theory provide quite different forecasts (see table 4). According to which W_1 would lie either in the interval of $[-10, 2.0]$ or $[-1.875, 8.875]$, respectively. Together, both approaches cover 24% of the total action space $[-10, 68]$, which can be decomposed in 15% for GT, 14% for ET, and 5% for an overlapping range at $[-1.875, 2]$.

At the second stage, there is no uncertainty about the joint profit of 33. Following game theory, actors will offer the producer his outside option, $\Pi_2 = 7$, resulting in a wage–claim (W_2) of 26. Whereas according to equity theory, actors would offer $\Pi_2 = 16.5$, or depending on the deviation from the equal split offer at stage one, $\omega\Delta$ with $\omega = 0.25$, reducing his offer by a compensation of Δ. Where $\Delta = 0$ would imply that expected profits at each stage are shared equally.[23]

The implications of the bargaining model differ depending on the theoretical approach applied.

(i) Predictions by game theory depend on the risk preferences of the actor as well as how desperate the actor is to join the risky project given his outside opportunities.

(ii) Equity theory does not take the outside options of the agents into account and concentrates only on the expected joint profit.[24] It allows for deviations from stage-wise equal split and predicts a certain relation of this deviation.

Hence, game theory requires knowledge of the real outside options of the actor and the producer as well as the risk preferences of the actor.

We will later estimate actors' risk parameters and producers' uncertainty about their bargaining partners' risk preference using the experimental data. From the observed experimental offers we also compute the stage-wise deviation from equal split.

7 Contrasting Behavioral Predictions

The average first stage offer lies in the overlapping range of GT and ET, a fact which seems to support both theories. Nevertheless, only higher offers with an average of $W_1 = 4.5$, $\Delta = 1$ (see table 3), which fall into the range of the equity prediction (see table 4) were accepted. However, at the second stage, offers are close to the game theoretic solution of 7. How well second stage offers match with the equity prediction can be deduced from the deviation of an equal split of the expected joint profit at stage one. Generally, second stage offers seem to be lower than ET would

[23]The range of Δ is determined by the experimental design, i.e., the range in which decision variables of participants were allowed to lie. Since at the second stage, the highest possible offer could be $C_2 = 33$, Δ could not be lower than -16.5. And since the lowest possible offer was -10, Δ could not be greater than 26.5.

[24]Equity theory does not take outside options into account as long as $O_1^A + O_1^P \leq E(C)$ and $O_1^i \leq E(C/2)$, for $i \in \{A, P\}$.

predict: given from accepted first stage offers that $\Delta = 1$, one might expect second stage offers to be around 15.5.

In the following, we investigate the predictive power of the two theories using a nonparametric approach. For stage one, we estimate the probability of the observations to lie within one of the predicted intervals and determine the confidence bounds of these probabilities.[25] The probability estimates and their 95% confidence bounds are reported in table 5. The estimates indicate the likelihood that W_1 is offered within the predicted interval of GT to be 39%, whereas with 67% probability the offer lies in the ET interval. The overlapping range of ET and GT comprises 14% of all first stage offers.

W_1 (N = 648)	$\widehat{Pr}$	c_l	c_u
GT (N = 256)	39.0	35.2	42.7
GT(i) (N = 155)	23.9	20.4	27.2
GT(ii) (N = 101)	15.4	12.6	18.1
ET (N = 434)	67.0	63.4	70.6
ET & GT (N = 91)	14.0	11.4	16.7
Π_2 (N = 143, mg=12)	Sign test	Ties	p-value
GT : $\Pi_2 = 7$	1	0	0.006
ET : $\omega = 0.25$	2	0	0.043

Table 5: *Probability estimates $\widehat{Pr}$, 95% confidence bounds (c_l and c_u), and test statistics of the Sign test (two-sided) based on matching group (mg) averages. (49 W_1- offers lie outside the range of GT and ET.))*

[25] The probability that subject i's wage offer $(W_{1,i})$ lies in the theoretically predicted interval with the lower bound b_l and upper bound b_u is estimated as $\widehat{Pr} = \widehat{Pr}(W_{1,i} \in [b_l, b_u]) = 1/N \sum_{i=1}^{N} \mathbb{1}(W_{1,i} \in [b_l, b_u])$ with $\mathbb{1}(\cdot)$ denoting the indicator function. The confidence bounds are estimated as $\widehat{Pr} \pm 1.96 * \sqrt{\widehat{Pr}(1-\widehat{Pr})/N}$.

Second stage offers are compared to the prediction of GT and ET by a Sign test.[26] We test ET by comparing the compensation ratio claimed by second stage offers to its theoretically predicted value. The results of the test reported in table 5 indicate that the GT hypothesis $H_0 : \Pi_2 = 7$ is rejected in favor for $H_1 : \Pi_2 \neq 7$, $(p = .006)$.[27] Even though second stage offers are close to the GT prediction, they are mainly slightly bigger. According to ET the offer at the second stage will be an equal split of the second stage joint profit adjusted for the deviation of the first stage offer from equal sharing of the expected joint profit. From equation (12) we know that this deviation is: $E\left(C_1^s\right)/2 - W_1 = \omega\Delta$. The adjustment at the second stage will be equal to the deviation at the second stage weighted by the probability to reach the second stage: $C_2/2 - \Pi_2 = \Delta$. If behavior is guided by equity principles, then the ratio of stage-wise deviations from equity should be $\left(E\left(C_1^s\right)/2 - W_1\right) / \left(C_2/2 - \Pi_2\right) = \omega\Delta/\Delta = \omega$. Figure 5 plots the density of this "deviation ratio" $(\widehat{\omega})$ for all second stage offers and additionally in a separate graph of the 123 cases satisfying ET at the first stage. The median of the ratio density is with 21% close to the commonly known probability $(\omega = 25\%)$ of reaching the second stage. The density seems to be skewed to lower ω-values indicating that actors might try to overcompensate "losses" at the first stage in a self-serving way. This overcompensation is significant $(p = .043)$ but the difference of the deviation seems to be small, so that actors do not earn significantly more than producers.[28]

We can summarize our results so far:

Result 1

(i) Producers frequently offer negative wages W_1 which are almost never accepted; W_1-offers below the outside option of actors are rarely accepted which can be explained by risk aversion of actors (but not by equity theory). This also

[26] The Sign test compares the number of positive and negative deviations from the hypothesized median. For our data the test is appropriate as it does not require symmetry of the data under consideration. The distribution of second stage offers is skewed to the left (see figure 2). To control for individual dependencies, we will report results on the averages of (independent) matching groups.

[27] This result holds on the individual level at $(p = .000)$.

[28] In only 3 out of 12 sessions average earnings of actors are higher than average earnings of producers.

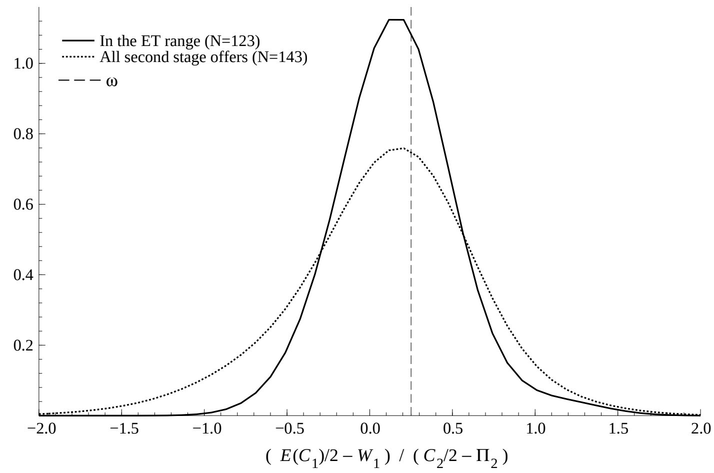

Figure 5: *Density estimate: Ratio of first and second stage deviations according to equity theory*

expresses that producers have to bear the risk of a flop alone or there is no movie production.

(ii) At the first stage equity theory receives generally better support. This suggests that unequal splits at the first stage are accepted if, in case of a success, the actor is compensated according to forgone profits.

(iii) Equity concerns seem to be indicated less strongly by second stage offers. As according to equity theory actors (over)compensate at the second stage for first stage inequality by (too) low second stage offers.

(iv) Compared to other ultimatum game experiments, (accepted) second stage offers are very low. Second stage proposals comprise on average 20% of the surplus. Accepted proposals are with an average of 28% of the surplus also surprisingly low.

Together, both theories can explain most observed first stage offers which portends that the theories capture different behavioral rules which were applied in the bargaining process. Further analysis of offers which fall in the predicted range of GT (equation (7)) can help to shed light on individual risk aversion of actors and how producers take the uncertainty of unobserved heterogeneous risk preferences of their bargaining partners into account. Additionally, as both approaches seem to exhibit difficulties explaining behavior at the second stage, individual analysis of the offer and acceptance behavior will expose the applied behavioral rules and whether these can be rationalized in direction of equity or game theory. Therefore, we only summarize results of an analysis and estimation of risk parameters as well as of different individual reactions in stage two which can be found in the Appendix.

7.1 Risk Preferences

Producers Assuming risk-neutral producers and allowing for risk-averse actors, GT(ii) can account for 15.4% of all first stage offers (see tables 4 and 5). Taking the probability estimate of GT (allowing for risk aversion of all agents) of 39% into account, approximately one-quarter of all first stage disagreements are caused by producers' risk preferences. In Section 2 (p. 16) we discussed the self-selection opportunity for producers: offers below $W_1^* = -4.5$ will never be accepted, a fact which might be used by producers who do not want to get engaged in the risky joint project. In fact, 50% of all producers never offer a wage below this threshold, and 25% of all producers place only one third of their offers below W_1^*.

The following analysis of actors' risk preferences and producers' uncertainty about their bargaining partner's risk aversion takes only offers in the interval $[-4.5, 2]$ (equation (7)) into account, which can be rationalized and have a chance of being accepted according to GT.

Actors First we try to make inferences about actors' risk aversion from rejected and accepted offers. Here we assume that actors behave rational over all 18 periods and infer individual risk preferences from their choices. However, for many subjects in our experiment the results are not informative,[29] leaving us with only 15 out of 36 experimental subjects with usable results for estimating risk aversion. Esti-

[29]In total we excluded 21 subjects from the analysis for one of the following reasons: (1.) subjects rejected offers of $W_1 = 2$ and higher, which is inconsistent with any interpretation based on risk-aversion, (2.) the highest offer rejected was smaller than the lower bound $\underline{W} = -4.5$, (3.) the lowest accepted offer was higher than the highest offer rejected.

mating risk aversion $\rho(\widehat{W}_1)$ by the highest rejected offer we obtain individual risk parameters in the range $[.69, 7.13]$.[30,31]

Uncertainty about risk aversion We model producers' uncertainty about actors' risk aversion by choosing a parametric family of probability functions $F(\widehat{W}) = \left(\frac{\widehat{W}-\underline{W}}{\overline{W}-\underline{W}}\right)^{\gamma+1}$ with $\underline{W} = -4.5$ and $\overline{W} = 2$ in equation (9) above. We apply two ways to estimate the parameter γ. Our first approach is directly using the arithmetic mean of all offers in the range $[-4.5, 2]$. Our second approach also includes information of answers to those offers and applies maximum likelihood estimation. Details are explained in appendix C. The parameter estimate for γ is $\gamma_1 = 0.34$ for approach 1 and $\gamma_2 = 2.70$ for approach 2. This result suggests that producers seem to underestimate actors' risk aversion when making an offer since γ_1 lies below γ_2, the estimate they would have had they known the answers to their offers, as well as below the range of actors' estimated individual risk preferences above.[32]

7.2 Reciprocity

In a second analysis of individual behavior we investigate the repeated response to successful first stage offers. Despite the close resemblance of the data with equity considerations at stage one, actors hardly seem to respond in a way that conforms to the predictions of equity theory at the second stage. Regressing Π_2 on W_1 indicates a constant second stage offer around 9 and no reaction towards the offer at the first

[30]We estimate risk aversion by stipulating that $W_0 = 20$ (approximately equal to average experimental earnings) and solve equation (19) in appendix B for $\widehat{W}_1$.

[31]Another way to estimate risk preferences would be to assume that the acceptance threshold lies in the middle of the interval of the highest rejected and the lowest accepted offer. For this case, we can estimate $\widehat{W}_1$ by averaging the highest rejected and the lowest accepted offer and we obtain a larger range of risk parameters $[.21, 26.17]$.

[32]Nevertheless, those findings should be interpreted cautiously as only 44% of the subjects in the actor position could be used in the estimation of the risk aversion parameter. The decisions of all remaining subjects were not informative because their highest rejected offer did not exceed their lowest accepted offer. Also the estimation of the $\gamma-$parameter of the threshold density function cannot account for all data. It considers only offers in the interval $[-4.5, 2]$ which comprises only 15% of all first stage offers.

stage.[33] One possible explanation might be that actors react in heterogeneous ways. We will now investigate how individual actors reciprocate. Second stage offers conditional on first stage offers indicate three different types of behavior:

- constant offers, i.e., no reaction regardless of the first stage offer,
- reciprocity, reacting to high (low) first stage offers by a increase (decrease) of second stage offers, and
- idiosyncratic reaction.

We separate those 34 actor-subjects for which the number of second stage experiences ranges from 2 to 7 into three subgroups:[34]

- 6 participants of a constant type (with no variation of Π_2) who all offer either O_2^P or the equal split (**Opportunistic/Fair Proposers**),
- 9 reciprocal participants (who respond in kind, i.e., react positively with Π_2 to W_1) (**Reciprocators**), and
- 19 participants, who neither relied on the same Π_2-offer nor reciprocated (in the above sense) (**Experimenters**, who try out different offers Π_2 in idiosyncratic ways).

Four actors of the first type behave rather opportunistically after a hit by offering producers essentially their outside option. The remaining 2 actors can be regarded as equity minded with respect to the second stage joint profit with constant Π_2-offers of 16 and 14. Reciprocators respond to a low (high) wage offer at the first stage by a lowering (increasing) their second stage offer. A linear regression $\left(\Pi_2^i = \alpha_0 + \alpha_1 \cdot W_1^i + \varepsilon^i\right)$ for those participants results in $\alpha_0 = 6.9\ \ (0.2)\,, \alpha_1 = 0.41\ \ (0.04)$ for the estimates with standard errors in parenthesis and $R^2 = 0.80$.

[33] Estimation of Π_2 on W_1 $\left(\Pi_2^i = \alpha_0 + \alpha_1 \cdot W_1^i + \varepsilon^i\right)$ results in $\hat{\alpha}_0 = 9.3\ \ (0.4)\,, \hat{\alpha}_1 = -0.09\ \ (0.07)$ for the parameter estimates with standard errors in parentheses and $R^2 = 0.01$.

[34] There is a total of 36 actors. Two participants could not be classified. One subject had only once the chance to make an offer at the second stage. The other person received and offered the same amounts in both cases.

Nevertheless, this reaction is still different from ET, according to which parameter estimates should be close to $\alpha_0 = -2.5$, $\alpha_1 = 4.0$. Considering the regression results, a corresponding compensation to a deviation of the first stage offer from equal split seems to be dominated by the presence of the outside option of the producer also for reciprocators.

The idiosyncratic behavior of actors can partly be explained by directional learning. Directional learning (see, for instance, Selten and Buchta, 1998) predicts the direction of changing one's strategy by adapting it in the direction suggested by an ex-post-analysis of past choices in order to maximize profits. For an actor reaching the second stage directional learning theory would predict that if his offer was rejected last time it will be increased next time. Similarly, in case of an accepted offer last time one should not increase the offer (or keep it constant). 92% of all idiosyncratic offers confirm directional learning.[35]

Result 2 An analysis of the data at an individual level sheds light on what we can learn from the different approaches.

(i) Based on first stage offers which fall in the range of the GT, we model proposers' beliefs about actors' risk preferences. And based on responses to those offers we estimated actors' actual risk preferences. This analysis indicates that producers overestimate actors' risk preferences and therefore have to high expectations about the acceptance of low offers.

(ii) There is support for general reciprocation by some second stage offers in the spirit of ET: 26% of actors reciprocate with their second stage offers and 6% of all actors offered unconditionally the equal split. However, the majority of actors (68%) adjust their offers in a profit maximizing manner.

[35] The reciprocity analysis should be interpreted cautiously as we observe between 2 and 7 second stage responses per actor. Nevertheless, it shows, that the current theories are rather questionable in a more complex environment.

8 Summary

This paper has raised the question how bargaining processes evolve over time when large risks are involved. We investigate this question in an explorative experimental way. In order to capture risk involved in the field, we calibrate the experimental parameters using data from a field study on the motion picture industry. In particular, we look at a two period bargaining model, with alternating bargaining position and additive surplus at each stage. In terms of " movie production," the negotiation arises between a producer and an actor about how to share the uncertain proceeds from a first movie and in case of a sequel the profits of the second movie with alternating bargaining positions.

The model developed here differs from the existing literature in two aspects. First, the surplus at the first stage is stochastic and its realization revealed to both bargaining parties only after establishing a contract. This differs from the existing literature where at least one person is informed about the realization of the stochastic surplus. Second, the surplus generated at each stage is additive and the bargaining process can only continue if both parties accepted the contract in the previous stage, resembling continuation projects in risky joint ventures.

Our results indicate that despite the riskiness of the business, even in the laboratory there is "movie production" as some experimental participants in the role of producers are willing to take on risks. Moreover, according to our data, producers either have to become the only risk taker or there is no movie production at all. We analyze the data in light of two different behavioral approaches, one assuming decision making is influenced by outcome maximization and individual risk preferences, the other based on the decision makers' goal to share equally. Looking at the data from those two angles, we learn that often production of first films fails since producers underestimate the risk aversion of actors, who seem not to be willing to share the risk with the producer. Interestingly, we observe that at the second stage with the sure surplus, accepted offers are much lower than conventional studies on ultimatum bargaining report. This indicates that actors not only offer lower shares to the producer, but also that this behavior is accepted by the producer. Even though, actors in general behave rather opportunistically, reciprocity ideas can partly explain other aspects of observed behavior, some actors reciprocate to higher first stage offers by higher second stage offers or share the second stage surplus equally.

Altogether there appears to be some variety in what motivates behavior in such risky bargaining environments, which can neither be captured by assuming pure outcome maximization of decision makers allowing for risk preferences nor by assuming that their choices are solely motivated by equity theory. It seems that different motives are competing in such extreme environments. To which extend fairness considerations survive or are crowded out and what drives the impact of different motives in risky environments remain future research questions.

9 Appendix

A Parameter Calibration

Calibrating Model Parameters. We estimate the profitability of sequels (in present value terms) estimating NPVs on the basis of projected revenues and costs. Note that the calculations are similar to those above, but for the first films we used actual data, whereas we use projected profitability for sequels based on the stylized facts reported above. Hence, this procedure reflects the expected and not the actual profitability of sequels. For example, it would never predict that a sequel is more profitable than its first film (like Batman 2). Also, while no studio would ever make a sequel with a negative NPV, sequels can turn out to make losses even after a successful first film. ("Look who is Talking 2" was a disaster.) We can then estimate the value of a sequel right, that is the economic value of the right of the movie studio to produce a sequel after observing the success of the first film. While only a small number of first film gives rise to profitable sequels, the movie studio does not have to produce sequels to flops. Table 6 gives the relevant data.

Studio	Profitable Sequels	Value of sequel right	Sequel/First film
MCA Universal	9	\$6.69	30%
Paramount	3	\$2.68	32%
Sony	4	\$2.89	35%
20^{th} Century Fox	2	\$1.78	30%
Warner Brothers	3	\$7.33	42%
Disney	5	\$10.29	36%
Total/Average	26	\$4.96	34%

Table 6: *Values of Sequels*

Hence, based on this model we would project that of 99 films, 26 would generate profitable sequels. Note that even Sony, which had a negative profit for its first films, would have expected positive profits for its sequels, since it would only make sequels of 4 of its 34 films. These data are volatile and can be driven by a small number of outliers. In the case of Sony, a large fraction of projected sequel profits comes from the successful "Look who is talking," that generates about 80% of its

Parameter	Symbol	Value
Probability of hit	ω	0.25
Profit of hit	Π_1^h	66
Profit of flop	Π_1^f	-12
Exp. profit of sequel	Π_2	20

Table 7: *Parameters*

projected sequel profits.[36] For our purposes, we now define a "hit" as a film that could give rise to a profitable sequel, hence our hit rate here would be 26/99 or 26.3%. Note that this hit rate probably overestimates the likelihood of a sequel being made, since it includes some movies where the script of the first movie would hardly give rise to a sequel (e.g., "Driving Miss Daisy").

We reduce the empirical distribution of movies to a binary distribution as follows. A film in our model is either a "hit" and produces a payoff of Π_1^h, or a "flop" with a payoff of Π_1^f, where $\Pi_1^h > \Pi_1^f$. A film is a hit with probability ω, hence the expected profitability of a film is:

$$\mu = \omega \Pi_1^h + (1-\omega)\, \Pi_1^f \quad . \tag{14}$$

The standard deviation of the binary distribution is:

$$\sigma = \left(\Pi_1^h - \Pi_1^f\right) \sqrt{\omega\,(1-\omega)} \quad . \tag{15}$$

The value of a sequel after a successful first film is denoted by Π_2, hence the value of the *sequel right* is $\omega\Pi_2$. We chose the parameters in table 7.

Table 8 compares the actual values in the data, the calibrated values, and the errors between actual and calibrated values. The calibration captures the mean and standard deviation of the data very accurately. The profitability of the sequel and the value of a sequel right is also captured. The typical ratio of the expected profitability of a sequel to a successful first film is 30% for the model values, and 34.1% in the sample.

[36]Two sequels to this film were made, but their economic success was far lower than expected on the basis of the first film.

Parameter	Symbol	Value	Data	Error
Prob. of hit	ω	0.25	0.263	-4.8%
Expected profit	μ	$\$7.50m$	$\$7.44m$	0.8%
Std. dev.	σ	$\$33.77m$	$\$34.16m$	-1.1%
Exp. prof. of sequel	Π_2	$\$20.00m$	$\$18.88m$	-5.6%
Sequel/first film	Π_2/Π_1^h	30%	34.1%	12.4%
Sequel right	$\omega\Pi_2$	$\$5.00m$	$\$4.96m$	-0.8%

Table 8: *Error statistics*

Calibrating Sequel Costs. With the calibrated parameters we adjust the values of the experiment the following way: If the company produces the movie it earns the revenue R and has to bear production costs, consisting of the actor's wages W and remaining production costs PC. The producer's profits Π_1 in the first stage for the "hit" (Π_1^h) and for the "flop" (Π_1^f) as well as profit for a sequel Π_2 can be written as:

$$\Pi_i^k = R_i^k - (W_i + PC_i)\,,\ \text{for } i = 1, k \in \{f, h\}\,, \text{and } i = 2 \text{ (without } k). \tag{16}$$

For calibrating R_2 we use the stylized facts as in the case study for the relation of the revenues of a successful film to a sequel, namely

$$R_2 \approx \frac{7}{10} R_1^h. \tag{17}$$

Furthermore, we assume that the additional production costs are the same in the film and its sequel, $PC_1 = PC_2$. With this system of equations and the calibrated values of $\Pi_1^h = 66$ (in case of a "hit"), of $\Pi_1^f = -12$ (in case of a "flop"), and $\Pi_2 = 20$ we chose the parameters according to the game with one modification as follows. The field study does not give any evidence for W_1 but indicates that the relation of total wage costs to cumulative costs (so called "negative costs" plus distribution expenses) is approximately one to five for a typical film, i.e., $\frac{1}{4}PC_1 > W_1$. That is why we choose for the calibration of the first stage revenue $W_1 = O_1^A = 2$.

The actor and the producer negotiate about the remaining surplus, $C^j = \Pi_1^j + O_1^A = R_1^j - PC_1$, $j \in \{l, h\}$ before the movie is going to be produced. The two possible pie sizes are therefore $C_1^h = 68$ and $C_1^f = -10$ for the hit and the flop movie, respectively. In case of a successful first movie the actor and producer negotiate

Parameter	Symbol	Value
Profit: hit	Π_1^h	66
Profit: flop	Π_1^f	-12
Profit: sequel	Π_2	20
Revenue: hit	R_1^h	116
Revenue: flop	R_1^f	38
Revenue: sequel	R_2	81
Additional costs hit/flop	PC_1	48
Additional costs sequel	PC_2	48
Wage costs hit/flop	W_1	2
Pie in case of a hit	C_1^h	68
Pie in case of a flop	C_1^f	-10
Pie in case of the sequel	C_2	33
Outside option actor both stages	O^A	2
Outside option producer both stages	O^P	7

Table 9: *Experimental parameters*

about the remaining share of the sequel's revenue which is $C_2 = R_2 - PC_2 = \frac{7}{10}R_1 - PC_2 = 33$, according to equation (17) and the assumption $PC_1 = PC_2$.

The outside option for the actor was chosen in order to resemble the outside opportunity for the actor. It additionally separates from offers around "zero" as a natural barrier between positive and negative offers at stage one. At the same time the outside opportunity should not exceed the expected first stage profit nor the equal split prediction described in Section 6. The producer's outside option should prevent from total bankruptcy but was chosen to be below the expected size of the first stage pie.

As the outside options cannot be deduced from the empirical data, we had to choose them from a reasonable range. To render bargaining at all profitable we had to respect $E(C_1^s) > O_1^A + O_1^P$ and $C_2 > O_2^A + O_2^P$ where $E(\cdot)$ denotes the expectation operator. In order to keep the whole game simple, both players' outside options are kept constant at both stages, i.e., $O_1^A = O_2^A = 2$ and $O_1^P = O_2^P = 7$. The action space of offers was bound at first stage to the minimum and maximum joint profits, i.e., $[-10, 68]$. At the second stage we kept the lower bound constant and adjusted the upper bound to the joint profit at the second stage, i.e, $[-10, 33]$. Table 9 displays all calibrated parameters.

B Parametric Example

Producers Assume producers have outside wealth Π_0 and constant relative risk aversion (CRRA) with parameter ρ. Then

$$U(\Pi_1) = \frac{(\Pi_0 + \Pi_1)^{1-\rho}}{1-\rho} \tag{18}$$

with $\Pi_1 = f(W_1)$. The risk aversion parameter for producers who do not want to get engaged into the risky joint venture at all even when facing a risk neutral agent who would accept W_1^*, have a risk aversion parameter $\overline{\rho}$ such that

$$U(W_1^*) \leq U\left(O_1^P\right)$$

$$\omega \frac{(\Pi_0 + C_1^h + O_2^P - W_1^*)^{1-\overline{\rho}}}{1-\overline{\rho}} - (1-\omega)\frac{(\Pi_0 + C_1^f - W_1^*)^{1-\overline{\rho}}}{1-\overline{\rho}} \leq \frac{(\Pi_0 + O_1^P)^{1-\overline{\rho}}}{1-\overline{\rho}}.$$

Actors Assume actors have outside wealth W_0 and constant relative risk aversion (CRRA) with parameter ρ. Then

$$U(W_1) = \frac{(W_0 + W_1)^{1-\rho}}{1-\rho} \quad . \tag{19}$$

This expression can be used directly in (6) and solved for $\widehat{W}_1$ (at least numerically) in terms of the parameters of the model.

Producers Define the lower and upper bound of the interval (7) by $\underline{W}$ and $\overline{W}$ respectively:

$$\underline{W}_1^A - \omega\left(C_2 - O_2^P\right) \quad , \tag{20}$$

$$\overline{W}_1^A \quad . \tag{21}$$

Then choose the following parametric family of distribution functions:

$$F(W_1) = \left(\frac{W_1 - \underline{W}}{\overline{W} - \underline{W}}\right)^{\gamma+1} \text{ with } \gamma \in [-1, \infty], \tag{22}$$

which have density

$$f(W_1) = \frac{(\gamma+1)(W_1 - \underline{W})^{\gamma}}{(\overline{W} - \underline{W})^{\gamma+1}} \tag{23}$$

so that the second order condition becomes

$$\gamma (W_1 - \underline{W}) > 2(\gamma+1) \quad . \tag{24}$$

Note that for $\gamma (W_1 - \underline{W}) > 2(\gamma+1)$ this family of distribution functions is sufficiently flexible for our example. For $\gamma = -1$ we obtain the uniform distribution, for $-1 < \gamma < 0$ we obtain distribution functions with the probability mass shifted to the left, and for $\gamma > 0$ we obtain distributions with the probability mass shifted to the right. Substituting these into the example above and solving (9) gives:

$$W_1^* = \min\left\{\overline{W},\ \frac{\gamma+1}{\gamma+2}\left(E\left(C_1^s + O_2^P\right) - O_1^P\right) + \frac{1}{\gamma+2}\underline{W}\right\} \quad . \tag{25}$$

We have to guarantee that the solution lies in the interval (7), so the Min-operator makes sure that the expression does not exceed the upper bound $\overline{W}$. Hence, for interior solutions W_1^* is a weighted average of the minimum $\underline{W}$ (the reservation wage for a risk-neutral actor) and the producer's maximum willingness to pay, $E\left(C_1^s + O_2^P\right) - O_1^P$. Paying this amount would reduce the producer's expected payoff to his outside option. The solution is intuitive. Observe that

$$\frac{\partial W_1^*}{\partial \gamma} = \frac{E\left(C_1^s + O_2^P\right) - O_1^P - \underline{W}}{(\gamma+2)^2} > 2 \tag{26}$$

for all solutions. Hence, a distribution that assigns higher probabilities to higher reservation wages also leads to higher equilibrium wage offers. Note also that:

$$\lim_{\gamma\to\infty} W_1^* = \min\left\{\overline{W}, E\left(C_1^s + O_2^P\right) - O_1^P\right\} = \overline{W} \tag{27}$$

$$\lim_{\gamma\to-1} W_1^* = \underline{W} \tag{28}$$

Here, the first result follows from the definition of (20) and (4). Hence, if we choose γ small enough, then the probability distribution degenerates and all probability mass is put on the event where the actor is risk-neutral ($W_1^* = \underline{W}$ for all $\gamma + 1 < 0$). Hence, for $\gamma = -1$ we recover the original problem and the solution (4), (5). Conversely, for large γ, all actors are deemed to be infinitely risk averse and judge the payoffs from the maximin criterion, so

$$\widehat{W}_1 = O_1^A\left(W_1^* = \overline{W} \text{ for } \gamma + 1 > \frac{\overline{W} - \underline{W}}{E\left(C_1^s + O_2^P\right) - O_1^P - \overline{W}}\right).$$

Equation (25) extends our game theoretic solution to risk averse actors. Its importance lies in the fact that we can always find a probability distribution characterized by some parameter γ that would rationalize the behavior of producers as an outcome of this game, where producers are uncertain about the actor's reservation utility. Conversely, offers outside the interval (7) cannot be rationalized at all.

C Modelling Uncertainty about Risk-Aversion

We model the uncertainty about actors' risk aversion by choosing a parametric family of probability functions $F\left(\widehat{W}\right) = \left(\frac{\widehat{W}-\underline{W}}{\overline{W}-\underline{W}}\right)^{\gamma+1}$ in (9) in Section 2 (p. 14) above. We apply two ways to estimate γ. Our first approach uses the arithmetic mean of all offers in the range $[-4.5, 2]$. In appendix B we showed that (9) then becomes:

$$W_1^* = \min\left\{\overline{W},\ \frac{\gamma+1}{\gamma+2}\left(E\left(C_1^s + O_2^P\right) - O_1^P\right) + \frac{1}{\gamma+2}\underline{W}\right\} \quad . \tag{29}$$

We can calculate γ with the offers observed. For this, we insert the experimental parameters and the mean offer in equation (29):

$$E\left(C_1^s + O_2^P\right) - O_1^P = \frac{17}{4}$$

$$\underline{W}_1^A - \omega\left(C_2 - O_2^P\right) = -\frac{9}{2}$$

Then equation (29) reads:

$$W_1^* = \min\left\{2,\ \frac{\gamma+1}{\gamma+2}\left(\frac{17}{4}\right) + \frac{1}{\gamma+2}\left(-\frac{9}{2}\right)\right\} \quad . \tag{30}$$

with γ as the only unknown parameter. The mean (median) offer in the range $[-4.5, 2]$ is 0.52 (0.00) and yields $\gamma = 0.34$ (0.06) from direct substitution into (29).

Our second approach to estimate γ is maximum likelihood estimation. We assume that the first stage offer W_1 is accepted ($a = 1$) when the threshold parameter $\widehat{W}$ is reached, i.e.,

$$a = \begin{cases} 1 & \text{if } W_1 \geq \widehat{W}, \\ 0 & \text{if } W_1 < \widehat{W}. \end{cases}$$

hence, the probability of accepting W_1 is

$$\Pr(a = 1) = \Pr\left(W_1 \geq \widehat{W}\right) = F(W_1).$$

We assume that the unknown threshold parameter $\widehat{W}$ follows the distribution $F\left(\widehat{W}\right) = \left(\frac{\widehat{W}-\underline{W}}{\overline{W}-\underline{W}}\right)^{\gamma+1}$, with $\underline{W} = -4.5$ and $\overline{W} = 2$. The log-likelihood function

$$l\left(\gamma|W_1\right) = \sum_{i=1}^{N}\left(a_i \cdot \log\left(\frac{W_{1i}-\underline{W}}{\overline{W}-\underline{W}}\right)^{\gamma+1} + (1-a_i)\log\left(1-\left(\frac{W_{1i}-\underline{W}}{\overline{W}-\underline{W}}\right)^{\gamma+1}\right)\right) \tag{31}$$

The log-likelihood function is maximized for $\gamma = 2.7$.[37]

D Instructions (Translation)

The experiment was conducted in German and the original experimental instructions were also in German. This is a shortened[38] *translated version of the instructions. Participants read the paper instructions before the computerized experiment started. In the beginning of the instructions, subjects were informed that the instructions are the same for every participant, they receive an initial endowment of DM 10, that the payoff is according to the average earnings – wins and losses from all periods would be added, the exchange rate from ECU (Experimental Currency Unit) to DM: ECU 1 = DM 2, that communication was not allowed and questions would be answered privately and that all decisions will be treated anonymously. Then the main instructions started. Before the programm started participants were informed that they will interact in this way 18 periods and that their bargaining partner is randomly selected after each period.*

Two parties, two persons A and B negotiate in each period about how to share up to two amounts of money (all in ECU). Whether you act as A or B is determined randomly at the beginning of the experiment. You will keep your role for the whole experiment. The schedule of the decision making is as follows:

First B offers an amount v_1 , with $-10 \leq v_1 \leq 68$, to participant A of a later randomly determined amount G_1. Participant A decided whether he accepts or rejects offer v_1 of B.

$\Rightarrow$ In case of rejection you receive:

as A : 2 and

[37]The likelihood function is $L\left(\gamma\,|W_{11}...W_{1N}\right) = \prod_{i=1}^{i=N} F\left(W_{1i}\right)^{a_i}\left(1-F\left(W_{1i}\right)\right)^{1-a_i}$. Substituting for $F(\widehat{W})$ and taking logs gives (31).

[38]The complete German instructions are available at request.

as B : 7.

The interaction is finished.

$\Rightarrow$ In case of acceptance you receive:

as A : v_1

as B : $G_1 - v_1$

If A accepted the offer v_1 the amount G_1 which is to be shared is determined randomly. Thereby with a probability of 75% the amount has the value of -10 and with probability 25% the value of 68. Please note, that $G_1 = -10$ causes a loss for player B.

If $G_1 = -10$ the interaction is finished.

Otherwise (after $G_1 = 68$) the interaction proceeds and A offers B a share v_2 , with $-10 \leq v_2 \leq 33$, about an additional amount G_2 of 33. Participant B decides whether he accepts or rejects the offer v_2 of A.

$\Rightarrow$ In case of rejection you receive additionally to the previous profit:

as A : 2 and

as B : 7.

The interaction is finished.

$\Rightarrow$ In case of acceptance you receive additionally to the previous profit:

as A : $G_2 - v_2$ $(= 33 - v_2)$

as B : v_2

The interaction is finished.

At the end you will be informed again about the decisions of your interaction partner and your corresponding payoffs. Please note, that losses are possible.

References

BINMORE, K., A. SHAKED, AND J. SUTTON (1985): "Testing Noncooperative Bargaining Theory: A Preliminary Study," *American Economic Review*, 75, 1178–1180.

BOLTON, G., AND A. OCKENFELS (2000): "ERC - A Theory of Equity, Reciprocity and Competition," *American Economic Review*, 90(1), 166–193.

CAMERER, C. (2003): *Behavioral Game Theory: Experiments on Strategic Interaction*. Princeton University Press, Princeton.

CHARNESS, G., AND M. RABIN (2002): "Understanding Social Preferences with Simple Tests," *Quarterly Journal of Economics*, 117, 817–869.

CHISHOLM, D. C. (1997): "Profit-Sharing versus fixed-payment contracts: evidence from the motion pictures industry," *The Journal of Law, Economics, & Organization*, 13(1), 169–201.

FEHR, E., AND K. SCHMIDT (1999): "A Theory of Fairness, Competition and Cooperation," *Quarterly journal of Economics*, 114, 817–868.

FISCHBACHER, U. (1999): "Z-Tree. Toolbox for Readymade Economic Experiments," IEW Working Paper 21, University of Zurich.

GOMPERS, P. A. (1995): "Optimal Investment, Monitoring, and the Staging of Venture Capital," *Journal of Finance*, 50, 1461–1489.

GRETHER, D. M., AND C. R. PLOTT (1984): "The Effects of Market Practices in Oligopolistic Markets: An Experimental Examination of the Ethyl Case," *Economic Inquiry*, 22, 479–507.

GROSSMAN, S., AND O. D. HART (1983): "An Analysis of the Principal-Agent Problem," *Econometrica*, 51, 7–45.

GÜTH, W. (1988): *On the Behavioral Approach to Distributive Justice - A Theoretical and Experimental Investigation*pp. 703–717. Brighton.

——— (1995): "On Ultimatum Bargaining Games - A Personal Review," *Journal of Economic Behavior and Organization*, 27, 329–344.

GÜTH, W., AND E. MAUG (2002): "Who Volunteers? A Theory of Charities as Firms," Humboldt Universität zu Berlin, Working Paper.

GÜTH, W., R. SCHMITTBERGER, AND B. SCHWARZE (1982): "An experimental analysis of ultimatum bargaining," *Journal of Economic Behavior and Organization*, 3(4), 367–388.

GÜTH, W., AND R. TIETZ (1990): "Ultimatum Bargaining Behavior - A Survey and and Comparison of Experimental Results," *Journal of Economic Psychology*, 11, 477–449.

HOLSTROM, B. (1979): "Moral Hazard and Observability," *Bell Journal of Economics*, 10(1), 74–91.

HOMANS, G. C. (1961): *Social Behavior*. New York: Harcourt, Brace, and World.

HONG, J. T., AND C. R. PLOTT (1982): "Rate Filing Policies for Inland Water Transportation: An Experimental Approach," *The Bell Journal of Economics*, 12, 1–19.

KAGEL, J. H., C. KIM, AND D. MOSER (1996): "Fairness in Ultimatum Games with asymmetric information and asymmetric payoff," *Games and Economic Behavior*, 13, 100–110.

MITZKEWITZ, M., AND R. NAGEL (1993): "Experimental Results on Ultimatum Games with Incomplete Information," *International Journal of Game Theory*, 22, 171–198.

OCHS, J., AND A. E. ROTH (1989): "An experimental study of sequential bargaining," *American Economic Review*, 79, 355–384.

PRAG, J., AND J. CASAVANT (1994): "An empirical study of the determinants of revenues and marketing expenditures om tje ,pdtion picture industry," *Journal of Cultural Economics*, 18, 217–235.

RAPOPORT, A., J. A. SUNDALI, AND D. A. SEALE (1996a): "Ultimatums in two-person bargaining with one-sided uncertainty: Demand games," *International Journal of Game Theory*, 25.

——— (1996b): "Ultimatums in two-person bargaining with one-sided uncertainty: Demand games," *Journal of Economic Behavior & Organization*, 30.

ROTH, A. E. (1995): *Bargaining Experiments*chap. 4, pp. 253–348. Princeton University Press.

SELTEN, R., AND J. BUCHTA (1998): *Experimental Sealed Bid First Price Auctions with Directly Observed Bid Functions*pp. 79–102. Mahwah NJ: Lawrence Erlbaum Associates, Inc.

STRAUB, P. G., AND J. K. MURNIGHAM (1995): "An experimental investigation of ultimatum games: information, fairness, expectations and lowest acceptable offers," *Journal of Economic Behavior and Organization*, 27.

TEICHNER, W. A., AND T. A. LUEHRMAN (1992): "Arundel Partners: The Sequel Project," Harvard Business School Case no. 9-292-140, Harvard Business School Pub.

VANY, A. D., AND W. D. WALLS (2002): "Does Hollywood make too many R-rated movies? Risk, stochstic dominance, and the illusion of expectation," *Journal of Business*, 75(3), 425–451.

WEINSTEIN, M. (1998): "Profit-sharing contracts in Hollywood: evolution and analysis," *Journal of Legal Studies*, 27, 67–112.