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By W. Güth, S. Kröger, E. Maug

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You May Have To Do It Again, Rocky!

– An Experimental Analysis of Bargaining with Risky Joint Profits^{–*}

Werner Güth,[†] Sabine Kröger[‡] and Ernst Maug[§]

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Abstract

We present an experimental study of a risky sequential bargaining to model negotiations in risky joint ventures that proceed through multiple stages. Our example is the production of a movie that may give rise to a sequel, so actors and producers negotiate sequentially. We compare the predictions of alternative theoretical approaches to understanding such a game. The game theoretic solution predicts (assuming risk neutrality) that actors are willing to accept wages below their outside option for first films in order to capture the gains from winning lucrative sequel contracts. This prediction is strongly rejected by the data. The data are better explained by either equity theory (equal splits) or by a game theoretic model where actors have uncertain risk aversion. The parameters of the game are calibrated to match data on 99 movies for 1989 available from a case study.

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[†]Max-Planck-Institute for Research into Economic Systems, Kahlaische Strasse, 07745 Jena, Germany, (email: gueth@mpiew-jena.mpg.de).

[‡]CentER, Tilburg University, Warandelaan 2, 5037 LE Tilburg, The Netherlands (email: S.Kroger@uvt.nl).

[§]Humboldt Universität zu Berlin, School of Business and Economics, Institute of Konzernmanagement, Spandauer Str. 1, D - 10178 Berlin, Germany (email: maug@wiwi.hu-berlin.de).

1 Introduction

How do negotiations develop in the presence of large risks? We analyze such a bargaining game between a producer of a movie and an actor. 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 "Rocky," Sylvester Stallone).¹ Clearly, the bargaining power of the actor is high when negotiating the contract for the sequel. 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 are indispensable to the success of a movie and make a take it or leave it offer to the studio. This setting has applications to situations outside the film industry where production leads to (1) a sequential resolution of uncertainty, (2) successive negotiations of contracts, and where (3) each round of negotiations carries the risk of terminating the relationship. The model structure therefore resembles risky partnerships and cooperations typical also for R&D joint ventures and venture capital.²

The two theories which we distinguish will later be tested experimentally. Standard game theory suggests that producers and actors both anticipate the potential of a sequel to the original film. Specifically, rational anticipation of a lucrative second contract should make actors inclined to accept offers *below* their outside opportunities at the first stage. Equity theory on the other hand would suggest to split the joint profit equally. Thereby offers below the equal split but also below the actor's outside opportunity are allowed when later, in case of a success, actors are compensated.

A controlled experiment allows us to actually test the theoretical predictions and learn about bargaining behavior in risky environments. The easiest way to capture such risks involved is to rely on parameters that

¹A notable exception are the James Bond-movies that led to a remarkable number of sequels, albeit with different actors.

²Venture 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. See Gompers (1995).

closely resemble those in the field. Parameter constellations, far off those in the field, may be interesting for their own sake but do not illuminate what happens in specific risky environments. We determine the parameters of the experiment so as to match the moments of an empirical distribution.³

We can summarize our experimental results as follows. Firstly, “actors” rarely accept offers below their first-stage opportunity costs.⁴ We hypothesize that this is the impact of 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 this potential reward is too risky to make subjects pay for this opportunity by foregoing a certain outside opportunity. Thereby “producers” either have to become the only risk taker or have no joint project at all. Secondly, actors hardly react at the second stage in accordance with one of the theories. Nevertheless, actor subjects seem to apply rules of thumb so that we can distinguish between constant proposers who do not react to the first stage offer, linear reciprocators who react to high (low) first stage offers by an increase (decrease) of second stage offers, and experimenters who try out different second stage offers in idiosyncratic ways.

The approach of the current study differs importantly from usual experimental papers. In order to capture the realism involved in such a risky bargaining environment we calibrated the parameters of the model. Parameter calibration based on empirical data has hardly been used in experimental economics although it is probably very much needed to overcome the parallelism problem questioning the reliability of experimental findings in the field.⁵ Mostly parameter constellations for experiments are chosen to distinguish between competing theories. As our emphasis lies on the parallelism to a naturally occurring environment, we do not have this freedom. We take this risk in order to keep the realism of the setting. We feel that results may not be completely independent of the parameters chosen in the experiment and our calibration makes us somewhat more confident about the relevance of our results. To the best of our knowledge, ours is the first experimental

³Our calibrations and the data for our study are based on a case study (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. Luehrmann bases his data on Variety Magazine and some other industry sources.

⁴Here and in the following we refer to our experimental roles as “actors” and “producers.” However, the instructions to our experimental subjects contain no reference to the movie industry or to any other real-life setting this game may reflect.

⁵We are only aware of two studies (Grether and Plott, 1984, and Hong and Plott, 1982) which try to capture parameters of the field.

study of such large risks in bargaining.

Our paper presents innovations relative to several strands of literature in economics. Relative to the literature on *two period alternating offer bargaining games*, the main differences are that parties do not bargain whether and how they share the first period-pie or the second period-pie, or more.⁶ In the game at hand not only the first period-pie can be negative, it also depends on the stochastic realization of the first period-pie whether there is an additive second period-pie. Here parties may end up in sharing neither pie, only the first period-pie but also both pies.

When comparing our study to experiments exploring the *distribution of random pies* the main difference is that such studies typically rely on private information.⁷ Usually the proposer knows the size of the pie and uncertainty reflects the responder's incomplete information how large the pie is. In our study the pie size is extremely (since it may turn negative) stochastic, too. But there is no private information since initially both parties (the producer and the actor) do not know whether it will become a flop or a success movie. Other studies allow parties to allocate chips rather than money directly where the monetary reward may depend on how the chips are allocated.⁸ Our setting assumes transferable utility, as measured by monetary rewards, since producer and actor can share freely what ever they earn from cooperating.

Finally, one possible comparison is to view the strategic game as a *hold-up-problem*. In a typical hold-up-game (e.g., Malcomson, 1997) an investor can generate a positive surplus which, however, would be partly appropriated by another party what results in under (i.e., less than efficient) investment. In the game at hand the investor would be the producer who, however, would generate an uncertain surplus which might be even negative. Furthermore, not only the investment can be vetoed by the other party but also appropriation of the possible positive surplus (in case of a success movie) can be vetoed by the investor, i.e., the producer. This compared to unusual hold-up-problems we study a more complex situation where not only the surplus is highly stochastic but where also the investment and the expropriation depends on how parties interact strategically.

In the following Section 2 the model is introduced and solved. Section

⁶See Binmore, Shaked, and Sutton, 1985, Güth and Tietz, 1990, and partly, Ochs and Roth, 1989, for experimental studies.

⁷See Mitzkewitz and Nagel, 1993, Rapoport, Sundali, and Potter, 1992, Güth, Huck, and Ockenfels, 1996.

⁸E.g., Nydegger and Owen, 1975, Kagel, Kim and Moser, 1995, Gneezy and Güth, 2003.

3 explains the procedure we followed for calibrating the parameters of the model. Section 4 is devoted to developing a solution based on game theory and an alternative prediction based on equity theory. Additionally, we compare the implications of game and equity theory using the parameterized model. Section 5 describes the details of the experimental design. Section 6 presents the major regularities of the experimentally observed behavior. Section 7 concludes.

2 The Model

We model a bargaining game between a single actor, denoted by A and a producer, denoted by P . 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. We explicitly permit $W_1 < O_1^A$ to allow the producer to offer a lower wage than the actor's outside option.

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 or "pie" 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 always given by $\Pi_1^s = C_1^s - W_1$. Note that we do not allow for output-contingent contracts. However, we do not model effort-incentives, so the usual reasons for output-related pay do not apply.⁹

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 producing the sequel is known to be C_2 . 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 is much larger than before, so $O_2^A > O_1^A$.

⁹See 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.

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.

Altogether, the parameters are the probability ω for the “hit,” the four outside option payoffs O_1^A, O_2^A, O_1^P and O_2^P , and the three pie sizes C_1^f, C_1^h , and C_2 . In light of the qualitative facts reported in the case study we assume

$$C_1^f < 0 < C_2 < C_1^h \quad .$$

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”

(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:¹⁰

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

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.

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

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

¹⁰The discount rate of 12% is suggested by the case writer.

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

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 sequels 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 2.¹¹ 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 Model Predictions

In this section we present two approaches to analyzing the model, one based on game and the other based on equity theory.

4.1 Game Theory

Risk-Neutral Agents We first develop the game by assuming risk neutrality of procedures and actors. This solution serves as a benchmark and yields sharp, testable predictions. To render bargaining at all profitable we

¹¹The full calibration results for the parameters are listed in table 9 in appendix A.

also stipulate

$$E(C_1^s) > O_1^A + O_2^P , \quad (2)$$

$$C_2 > O_2^A + O_2^P , \quad (3)$$

where $E(\cdot)$ denotes the expectation operator.

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

$$W_2^* = C_2 - O_2^P , \quad (4)$$

$$\Pi_2 = O_2^P . \quad (5)$$

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,

$$W_1^* = O_1^A - \omega W_2^* , \quad (6)$$

$$\Pi_1^s = C_1^s - O_1^A + \omega W_2^* . \quad (7)$$

Equations (4), (5), (6), and (7) 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 (4) and (6) still represent the solution to the second stage. Then we require:

$$U(O_1^A) \leq \omega U(W_1 + W_2^*) + (1 - \omega) U(W_1) \quad (8)$$

for any acceptable W_1 , where W_2^* is still given from (4). 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 (6). Also, it follows directly from (8) that any wage offer $W_1 \geq O_1^A$ will be accepted, even by an infinitely risk-averse agent. Hence, we have:

$$O_1^A - \omega W_2^* \leq \widehat{W}_1 \leq O_1^A \quad . \quad (9)$$

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 (9). Hence, the producer's expected payoff as a function of her wage offer is:

$$\begin{aligned} E(\Pi(W_1)) &= [E(C_1^s) - W_1 + E(O_2^P)] F(W_1) + (1 - F(W_1)) O_2^P \\ &= [E(C_1^s + O_2^P) - W_1] F(W_1) + (1 - F(W_1)) O_2^P \end{aligned} \quad (10)$$

where according to our model $E(C_1^s) = \omega \cdot C_1^h + (1 - \omega) \cdot C_1^f$. Solving first order conditions $\frac{\partial E(\Pi(W_1))}{\partial W_1} = 0$ yields:¹²

$$W_1^* + \frac{F(W_1^*)}{f(W_1^*)} = E(C_1^s + O_2^P) - O_1^P \quad . \quad (11)$$

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

¹²The second order condition for payoff maximization is $f'(W_1^*) F(W_1^*) > 2(f(W_1^*))^2$.

not pre-select producers in the experiment according to their risk preferences, we relax the assumption of risk neutrality also for producers. This will expand the range of possible first stage offers the model can explain.

The producer chooses W_1 in order to maximize

$$\omega F(W_1) U(C_1^h + O_2^P - W_1) - (1 - \omega) F(W_1) U(C_1^f - W_1) + (1 - F(W_1)) U(O_2^P) \quad (12)$$

A risk-neutral producer would offer at maximum $W_1 = O_2^A$, 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 (6)). Therefore, offers with $W_1 < O_1^A - \omega W_2^*$ are interpreted as being reluctant to get engaged into the project, which might be explained by risk aversion. 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 (9) or to take the outside option by offering a wage

$$W_1 < O_1^A - \omega W_2^*. \quad (13)$$

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 (4), (5), and (9) represent the game-theoretic solution (GT) of the game allowing for risk-averse actors, whereas equation (13) captures the self-selection of producers.

4.2 Equity Theory

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.¹³

Equity theory (Homans, 1961) predicts equal sharing but leaves open *what* is shared equally.¹⁴ This can, for instance, be the total of the expected pie $E(C) = E(C_1^s + C_2) = [\omega(C_1^h + C_2) + (1 - \omega)C_1^f]$. Sharing the expected stage pie separately at each stage would result in $W_1 = E(C_1^s) / 2$

¹³See Güth (1995) and Roth (1995) for surveys.

¹⁴See Güth (1988) for an attempt to add specificity to this concept.

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.¹⁵ We therefore allow, more generally,

$$W_1 = E(C_1^s)/2 - \omega\Delta \quad , \quad (14)$$

$$\Pi_2 = C_2/2 - \Delta \quad , \quad -\frac{C_2}{2} \leq \Delta \leq \frac{C_2}{2}. \quad (15)$$

In this respect, equation (15) essentially predict (positive and negative) reciprocity. Lower offers W_1 are followed by lower offers Π_2 such that Π_2 depends positively on W_1 .¹⁶ Nevertheless, if both agents follow equity considerations, too meager offers, i.e., $W_1 < E(C_1^s)/2 - \omega\frac{C_2}{2}$ and $\Pi_2 < C_2/2 - \frac{1}{\omega}(E(C_1^s)/2 - W_1)$, will be rejected. Equations (14) and (15) represent the equity-theoretic solution (ET) of the game.

On the basis of table 2 we can now be more specific about the model predictions. We distinguish between two theoretical approaches:

- the game-theoretic solution allowing for risk-averse agents (GT) with equations (4)-(7), (9), and (13),
- the equity-theoretic solution based on the total expected profit (ET) with equations (14) - (15).

Using the calibration above, we obtain the predictions in table 3.

Clearly, given our calibrated parameters game theory and equity theory provide quite different forecasts (see table 3). According to which W_1 would lie either in the interval of $[-10, 2.0]$ or $[0.625, 8.875]$, respectively. Together, both theories cover 24% of the total action space $[-10, 68]$, which can be decomposed in 15% for GT, 11% for ET, and 2% for an overlapping range at $[0.625, 2]$. Interestingly, game theory would predict the actor to accept wage offers in the range $[-4.5, 2.0]$, i.e., also negative offers.¹⁷

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 an indirect wage-claim (W_2) of 26. Whereas according

¹⁵The actor will accept the lower offer and not be compensated with probability $(1 - \omega)$. If the producer offers $E(C_1^s)/2 - \omega\Delta$ 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 .

¹⁶Equity theory would predict $\Pi_2(W_1) = C_2/2 - \frac{1}{\omega}E(C_1^s)/2 + \frac{1}{\omega}W_1$.

¹⁷A negative first stage wage might be a reasonable result as unknown actors might become engaged in rather costly actions to get the chance of their life and become a movie star.

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

Table 3: Predictions of game theory (eqs. (4)-(5), (9), (13)) and equity theory (eqs. (14)-(15))

[‡]Self-selection of risk-averse producers. [‡]Allowing for risk-averse actors, assuming risk-neutral producers.

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 .

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.¹⁸ It predicts a certain relation of the deviation from stage-wise equal split.

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. As the outside options can not be deduced from the empirical data, we had to choose them from a reasonable range (see appendix A). 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.

¹⁸Note, that 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 $i \in \{A, P\}$.

5 Experimental Design and Procedure

Our experimental design exactly matches the sequential game. In order to analyze bargaining behavior and to investigate the presented theories we rely on the estimated parameters from the case study. The easiest way to capture risks involved in naturally occurring settings is to rely on parameters that closely resemble those of the field study. Parameter constellations, far off those in the field, may be interesting but do not illuminate what happens in specific risky environments.

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 ran six sessions, each consisting of two matching groups. To allow for learning, participants played 18 rounds of the two-stage bargaining game. Participants first read the instructions and were then privately informed about their role.¹⁹ 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 every round new actor-producer-pairs were formed randomly.²⁰

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 on 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).²¹ Participants were paid their average payoff of all 18 rounds which was on average DM 21. More precisely,

¹⁹See appendix D for a shortened and translated version of the instructions.

²⁰Rematching 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.

²¹DM 1 \approx EUR 0.51.

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.

6 Results

6.1 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.

	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 4: Offers: number of observations, median, mean, and standard deviation

Table 4 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

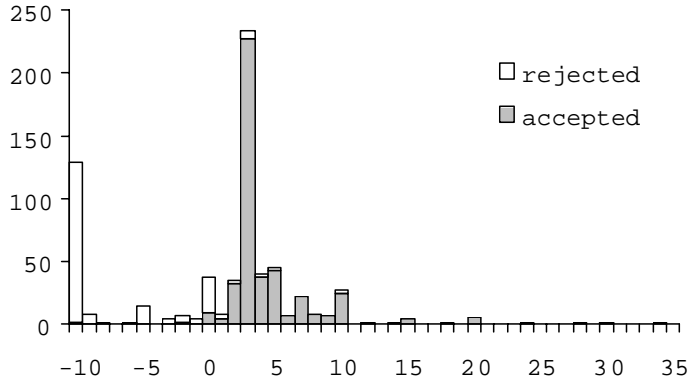


Figure 1: Frequencies and acceptance/rejection of stage 1 offers (N=648)

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 -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. 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 address the

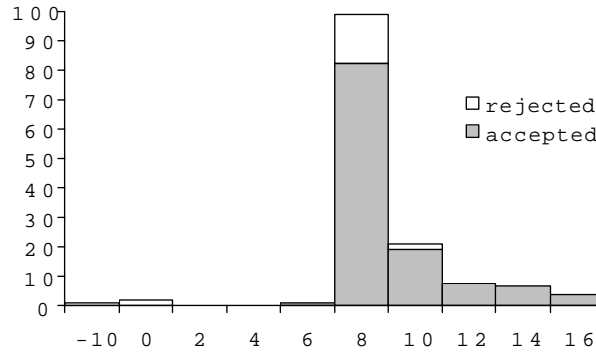


Figure 2: Frequencies and acceptance/rejection of stage 2 offers (N=143)

question how well the two theories explain the observed behavior in the experiment.

6.2 Contrasting 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 4), which fall into the range of the equity prediction (see table 3) 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 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.²² The probability estimates and their 95% confidence bounds are reported in table 5. The estimates

²²The 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 $\widehat{Pr} = \widehat{Pr}(W_{1,i} \in [b_l, b_u]) = \frac{1}{N} \sum_{i=1}^N \mathbb{1}(W_{1,i} \in [b_l, b_u])$ with $\mathbb{1}(\cdot)$ denoting the indicator function. The confidence bounds are estimated as $\widehat{Pr} \pm 1.96 * \sqrt{\frac{\widehat{Pr}(1-\widehat{Pr})}{N}}$.

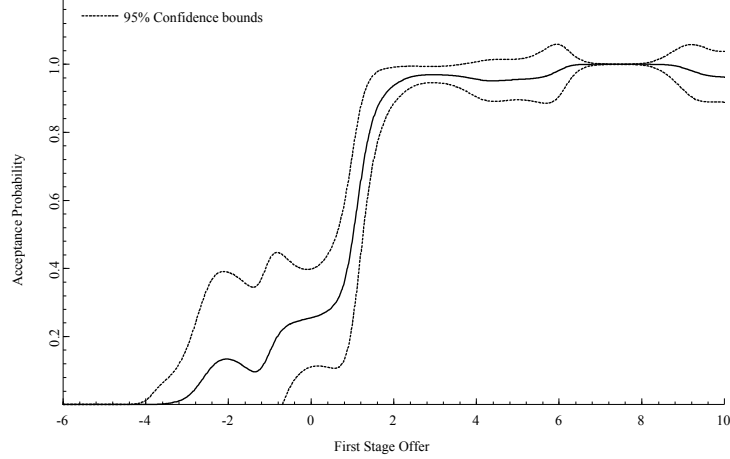


Figure 3: Acceptance probability of first stage offers

indicate the likelihood that W_1 is offered within the predicted interval of GT to be 38%, whereas with 61% probability the offer lies in the ET interval. The 95% confidence bounds are 34% and 42% as well as 57% and 64% for the GT and ET probability estimates, respectively, which emphasizes this result. The overlapping range of ET and GT comprises 6% of all first stage offers.

Second stage offers are compared to the prediction of GT and ET by a Sign test.²³ 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 $H_1 : \Pi_2 \neq 7$, ($p = .006$).²⁴ 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 (14)

²³The 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.

²⁴This result holds on the individual level at ($p = .000$).

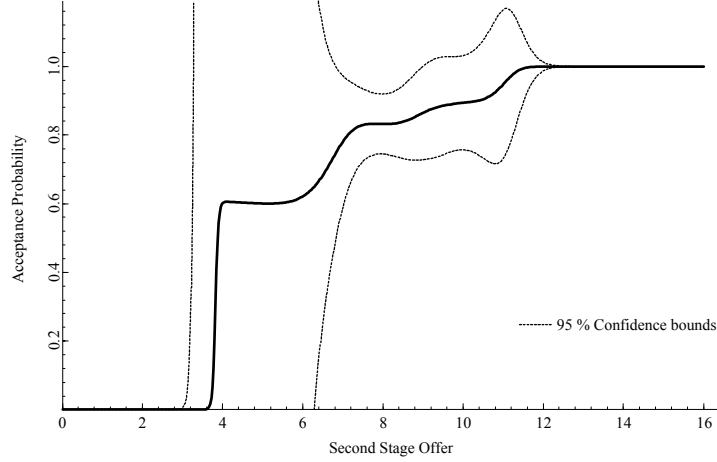


Figure 4: Acceptance probability of second stage offers

we know that this deviation is: $E(C_1^s)/2 - W_1 = \omega\Delta$. 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 $\frac{E(C_1^s)/2 - W_1}{C_2/2 - \Pi_2} = \frac{\omega\Delta}{\Delta} = \omega$. Figure 5 plots the density of this “deviation ratio” ($\hat{\omega}$) for all second stage offers and additionally in a separate graph of the 118 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.²⁵ Acceptance of producers is rather independent of the deviation ratio which is illustrated in Figure 4.

We can summarize our results so far:

Regularity 1

(i) Producers frequently offer negative wages W_1 which are almost never

²⁵In only 3 out of 12 sessions average earnings of actors are higher than average earnings of producers.

W_1 (N = 648)	\widehat{Pr}	c_l	c_u
GT [‡] (N = 247)	38.1	34.4	41.9
GT [‡] (N = 92)	14.2	11.5	16.9
ET (N = 393)	60.6	56.9	64.4
ET & GT (N = 41)	6.0	4.4	8.2
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.

Predictions according to the calibrated parameters are GT: $W_1 = [-4.5, 2.00]$, $\Pi_2 = 7$ and ET: $W_1 = 4.75 - \omega\Delta$ with $\Delta \in [-16.5, 16.5]$ and $\omega = 0.25$ such that $W_1 \in [0.625, 8.875]$, $\Pi_2 = 16.50 - \Delta$.

[‡]Allowing for risk-averse agents. [‡]Allowing for risk-averse actors, assuming risk-neutral producers.

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 when considering only the overlapping range). This also 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.

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

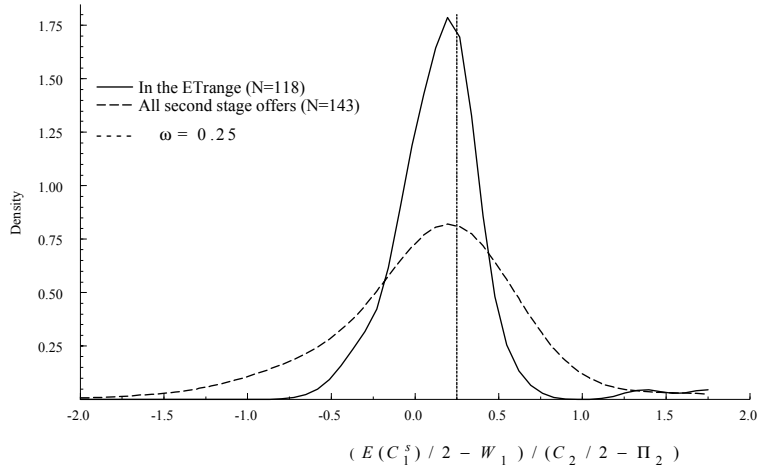


Figure 5: Density estimate: Ratio of first and second stage deviations according to equity theory

predicted range of GT (equation (9)) will 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 theories 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, in the following two sub-sections we will summarize results on an analysis and estimation of risk parameters as well as classification of different individual reactions in case of a continuation at stage two.

6.3 Risk Preferences

Producers Assuming risk-neutral producers and allowing for risk-averse actors, GT can account for 14% of all first stage offers (see tables 3 and 5).²⁶ Taking the probability estimate of GT (allowing for risk aversion of all agents) of 38% into account, approximately one-quarter of all first stage disagreements are caused by producers' risk preferences. In Section

²⁶The 95% confidence bounds of this probability estimate are: 11.5% and 16.9%.

2 (p. 10) 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 takes only offers in the interval $[-4.5, 2]$ (equation (9)) 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 the offers rejected and accepted. 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.²⁷ We are left with only 15 out of 36 experimental subjects with usable results for estimating risk aversion. Estimating risk aversion²⁸ $\rho(\widehat{W}_1)$ by the highest rejected offer we obtain individual risk parameters in the range $[\.69, 7.13]$.²⁹

Uncertainty about risk aversion We model the 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 (11) 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 0.34 for approach 1 and 2.70 for approach 2. This result seems to indicate that producers might underestimate actors' risk aversion.

²⁷In 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.

²⁸We estimate risk aversion by stipulating that $W_0 = 20$ (approximately equal to average experimental earnings) and solve equation (21) in appendix B for \widehat{W}_1 .

²⁹Assuming that the acceptance threshold lies in the middle of the interval of the highest rejected and the lowest accepted offer, we can estimate \widehat{W}_1 by averaging the highest rejected and the lowest accepted offer. Then we obtain a larger range of risk parameters $[\.21, 26.17]$.

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 γ -parameter of the threshold density function cannot account for all data. It considers only offers in the interval $[-4.5, 2]$ which comprises only 14% of all first stage offers.

6.4 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, at the second stage actors hardly seem to respond in a way that conforms to the predictions of equity theory. Regressing Π_2 on W_1 indicates a constant second stage offer around 9 and no reaction towards the offer at the first stage.³⁰ 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:³¹

- 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) (**Linear Reciprocators**), and

³⁰Regressing Π_2 on W_1 ($\Pi_2^i = \alpha_0 + \alpha_1 \cdot W_1^i + \varepsilon^i$) gives $\hat{\alpha}_0 = 9.3$ (0.4), $\hat{\alpha}_1 = -0.09$ (0.07) for the estimates with standard errors in parentheses and $R^2 = 0.01$.

³¹There 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.

- 19 participants, who neither relied on the same Π_2 nor reciprocated (in the above sense) (**Experimenters**, who try out different offers Π_2 in idiosyncratic ways).

Four of the first type actors 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 ($\Pi_2^i = \alpha_0 + \alpha_1 \cdot W_1^i + \varepsilon^i$) for those participants results in $\alpha_0 = 6.9$ (0.2), $\alpha_1 = .41$ (0.04) for the estimates with standard errors in parenthesis and $R^2 = 0.80$. Nevertheless, this reaction is still very different from ET, which would have predicted the parameter estimates to be $\alpha_0 = -2.5$, $\alpha_1 = 4$. 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 behavior of the ‘experimenting’ 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. 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 ‘experimentator’-offers confirm directional learning (43% are constant offers mainly at 7.5 or 8, i.e., when the producer’s outside option has been reached). Only 8% of the ‘experimentator’-offers contradict directional learning.

Also 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 challenged in a more complex environment.

Regularity 2 An analysis of individual behavior allowed us to estimate individual preference parameters. This investigation disclosed some weaknesses in the explanatory power of the theories investigated here.

- (i) Estimates of individual risk parameters could only be based on information of 44% of all actor subjects as other subjects’ behavior violates basic behavioral assumptions of GT.

- (ii) We modelled the producer’s uncertainty about actors’ risk preferences based on 14% of all first stage offers with and without taking actors’ reaction to those first stage offers into account. From the comparison of both estimates we conclude that producers seem to underestimate the risk aversion of their bargaining partners.
- (iii) There is no support for general reciprocation by actors in the spirit of ET. We can distinguish different types of behavior amongst actor subjects: constant proposers, linear reciprocators, and adjusting in an experimental manner.

7 Discussion

Our paper has been inspired by a field study (Luehrmann, 1992) to which we refer as the sequel project. A producer and an actor negotiate how to share the uncertain proceeds from a first movie and in case of a sequel the profits of the second movie in an alternating offer-way. Additionally, we provide experimental evidence. An innovative aspect of our study is that we rely on calibrated parameters. Our experiment which uses parameters calibrated from the field study, should imply more reliable insights and should avoid the missing parallelism of usual experiments.

Actually, the data of the sequel project suggest such extreme parameters that we were first reluctant to use them. With hindsight we find our results encouraging: Although “movie production” is risky, even in the laboratory there is “movie production” as some experimental subjects in the role of producers are willing to take on risks.

Other related experiments³² did not include such dramatic risks which seem crucial for the analysis of risky ventures. In our view, these qualitative and quantitative differences to former experiments are too dramatic to expect similar results as in previous studies (Güth and Tietz, 1990, for instance, report much lower conflict rates in their review).

Moreover, according to our data producers either have to become the only risk taker or there is no movie production at all. Risk-aversion can partly account for actors’ behavior. Often production of first films fails since producers underestimate actors’ acceptance threshold. Reciprocity ideas seem to explain other aspects of observed behavior, although some actors behave rather opportunistically. More generally, we could distinguish three types of actor behavior, namely, constant, reciprocal and experimenter with

³²See Roth (1995) for a survey of simpler experiments.

the latter adjusting in a learning direction–mode. Altogether there seems to be some variety in what motivates behavior in such complex and risky bargaining environments.

8 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

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

talking,” that generates about 80% of its projected sequel profits.³³ 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:

$$\mu = \omega\Pi_1^h + (1 - \omega)\Pi_1^f \quad . \quad (16)$$

The standard deviation of the binary distribution is:

$$\sigma = \left(\Pi_1^h - \Pi_1^f\right) \sqrt{\omega(1 - \omega)} \quad . \quad (17)$$

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.

³³Two 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:

$$\Pi_i^k = R_i^k - (W_i + PC_i), \text{ for } i = 1, k \in \{f, h\}, \text{ and } i = 2 \text{ (without } k). \quad (18)$$

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

$$R_2 \approx \frac{7}{10} R_1^h. \quad (19)$$

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

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

and producer negotiate 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 (19) 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 4. The producer’s outside option should prevent from total bankruptcy but was chosen to be below the expected size of the first stage pie.

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 the calibrated parameters.³⁴

³⁴In our model we assumed the outside option of a movie star to be larger than before becoming famous, so $O_2^A > O_1^A$. However, to distinguish between the proposer position

B Parametric Example

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

$$U(\Pi_1) = \frac{(\Pi_0 + \Pi_1)^{1-\rho}}{1-\rho} \quad (20)$$

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 $\bar{\rho}$ such that

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

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

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

$$U(W_1) = \frac{(W_0 + W_1)^{1-\rho}}{1-\rho} . \quad (21)$$

This expression can be used directly in (8) 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 (9) by \underline{W} and \overline{W} respectively:

$$\underline{W} = O_1^A - \omega (C_2 - O_2^P) \quad , \quad (22)$$

$$\overline{W} = O_1^A \quad . \quad (23)$$

Then choose the following parametric family of distribution functions:

$$F(W_1) = \left(\frac{W_1 - \underline{W}}{\overline{W} - \underline{W}} \right)^{\gamma+1} \quad \text{with } \gamma \in [-1, \infty], \quad (24)$$

and the outside portion as source of bargaining power, we decided to keep the outside option constant at both stages in the experiment.

which have density

$$f(W_1) = \frac{(\gamma + 1)(W_1 - \underline{W})^\gamma}{(\overline{W} - \underline{W})^{\gamma+1}} \quad (25)$$

so that the second order condition becomes

$$\gamma(W_1 - \underline{W}) > 2(\gamma + 1) \quad . \quad (26)$$

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 (11) gives:

$$W_1^* = \min \left\{ \overline{W}, \frac{\gamma + 1}{\gamma + 2} (E(C_1^s + O_2^P) - O_1^P) + \frac{1}{\gamma + 2} \underline{W} \right\} \quad . \quad (27)$$

We have to guarantee that the solution lies in the interval (9), 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, $E(C_1^s + O_2^P) - O_1^P$. Paying this amount would reduce the producer's expected payoff to his outside option. The solution is intuitive. Observe that

$$\frac{\partial W_1^*}{\partial \gamma} = \frac{E(C_1^s + O_2^P) - O_1^P - \underline{W}}{(\gamma + 2)^2} > 2 \quad (28)$$

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

$$\lim_{\gamma \rightarrow \infty} W_1^* = \min \{ \overline{W}, E(C_1^s + O_2^P) - O_1^P \} = \overline{W} \quad (29)$$

$$\lim_{\gamma \rightarrow -1} W_1^* = \underline{W} \quad (30)$$

Here, the first result follows from the definition of (22) and (6). 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 (6), (7). Conversely, for large γ , all actors are

deemed to be infinitely risk averse and judge the payoffs from the maximin criterion, so $\widehat{W}_1 = O_1^A \left(W_1^* = \overline{W} \text{ for } \gamma + 1 > \frac{\overline{W} - W}{E(C_1^s + O_2^P) - O_1^P - \overline{W}} \right)$.

Equation (27) extends our game theoretic solution to risk averse actors. The importance of (27) 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 (9) 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 $F(\widehat{W}) = \left(\frac{\widehat{W} - W}{\overline{W} - W} \right)^{\gamma+1}$ in (11) in Section 2 (p. 9) 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 (11) then becomes:

$$W_1^* = \min \left\{ \overline{W}, \frac{\gamma + 1}{\gamma + 2} (E(C_1^s + O_2^P) - O_1^P) + \frac{1}{\gamma + 2} W \right\} . \quad (31)$$

We can calculate γ with the offers observed. For this, we insert the experimental parameters and the mean offer in equation (31):

$$\begin{aligned} E(C_1^s + O_2^P) - O_1^P &= \frac{17}{4} \\ \underline{W} &= O_1^A - \omega(C_2 - O_2^P) = -\frac{9}{2} \end{aligned}$$

Then equation (31) reads:

$$W_1^* = \min \left\{ 2, \frac{\gamma + 1}{\gamma + 2} \left(\frac{17}{4} \right) + \frac{1}{\gamma + 2} \left(-\frac{9}{2} \right) \right\} . \quad (32)$$

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 (31).

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

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

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

$$l(\gamma|W_1) = \sum_{i=1}^N \left(a_i \cdot \log \left(\frac{W_{1i} - \underline{W}}{\overline{W} - \underline{W}} \right)^{\gamma+1} + (1 - a_i) \log \left(1 - \left(\frac{W_{1i} - \underline{W}}{\overline{W} - \underline{W}} \right)^{\gamma+1} \right) \right) \quad (33)$$

The log-likelihood function is maximized for $\gamma = 2.7$.³⁵

D Instructions (Translation)

The experiment was conducted in German and the original experimental instructions were also in German. This is a shortened³⁶ 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 program 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 .

³⁵The likelihood function is $L(\gamma|W_{11} \dots W_{1N}) = \prod_{i=1}^N F(W_{1i})^{a_i} (1 - F(W_{1i}))^{1-a_i}$. Substituting for $F(\widehat{W})$ and taking logs gives (33).

³⁶The complete German instructions are available at request.

⇒ In case of rejection you receive:

as A : 2 and

as B : 7.

The interaction is finished.

⇒ 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 .

⇒ In case of rejection you receive additionally to the previous profit:

as A : 2 and

as B : 7.

The interaction is finished.

⇒ 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

- AMNON RAPOPORT, J. A. S., AND R. E. POTTER (1992): "Ultimatum games with incomplete information: Effects on the variability of the pie size," .
- BINMORE, K., A. SHAKED, AND J. SUTTON (1985): "Testing Noncooperative Bargaining Theory: A Preliminary Study," *American Economic Review*, 75, 1178–1180.
- FISCHBACHER, U. (1999): "Z-Tree. Toolbox for Readymade Economic Experiments," IEW Working Paper 21, University of Zurich.
- GNEEZY, U., AND W. GÜTH (2003): "On competing rewards standards - An experimental study of ultimatum bargaining," *The Journal of Socio-Economics*, 31, 599–607.
- GOMPERS, P. A. (1995): "Optimal Investment, Monitoring, and the Staging of Venture Capital," *Journal of Finance*, 50, 1461–1489.
- GREYER, 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., S. HUCK, AND P. OCKENFELS (1996): "Two level-ultimatum bargaining with incomplete information - An experimental study," *The Economic Journal*, 106, 593–604.
- GÜTH, W., AND E. MAUG (2002): "Who Volunteers? A Theory of Charities as Firms," Humboldt Universität zu Berlin, Working Paper.
- 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 (1995): "Fairness in Ultimatum Games with asymmetric information and asymmetric payoff," *Games and Economic Behavior*, 11(1), 100–110.
- LUEHRMAN, T. A. (1992): "Arundel Partners: The Sequel Project," Discussion Paper 9-292-140, Harvard Business School.
- MALCOMSON, J. (1997): "Contracts, Hold-Up, and Labor Markets," *Journal of Economic Literature*, 35(4).
- MITZKEWITZ, M., AND R. NAGEL (1993): "Experimental Results on Ultimatum Games with Incomplete Information," *International Journal of Game Theory*, 22, 171–198.
- NYDEGGER, R. V., AND G. OWEN (1975): "Two person bargaining: An experimental test of the Nash axioms," *International Journal of Game Theory*, 3, 239–349.
- OCHS, J., AND A. E. ROTH (1989): "An experimental study of sequential bargaining," *American Economic Review*, 79, 355–384.
- 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.