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Initiating Bargaining

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While there is an extensive literature on how economic agents bargain to divide an asset, little is known about the decision to initiate bargaining and how the initiation affects the outcome of bargaining. We address these questions in the context of high-stakes poker tournaments in which the last few players often negotiate the division of the remaining prize money rather than risk playing the tournament to the end. In 63% of the tournaments in our sample players enter into negotiations, and in 31%, they successfully reach an agreement. We find that the identity of the player who initiates bargaining affects whether a deal is completed but does not affect the terms of the eventual deal. The initiator tends to have a weaker than average position at the table, but the likelihood that a deal will be completed increases in the initiator's strength in the game and history of winning past tournaments. These findings indicate that initiating negotiations conveys information that is relevant to whether a deal will emerge. Nevertheless, initiating bargaining does not affect the initiator's pay-off in a completed deal. Lastly, we find strong evidence that bargaining tends to be initiated and is more likely to be successful when participants' stakes are about equal, consistent with the theoretical work of Cramton, Gibbons and Klemperer (1987, "Dissolving a Partnership Efficiently", *Econometrica*, **55**, 615–632).

Key words: Bargaining, Negotiations, Poker

JEL C78, C93, D7

1. INTRODUCTION

Bargaining and negotiations pervade many aspects of economic life and social interactions. Although this topic has received a great deal of attention in the economics literature, we have scarce empirical or experimental evidence on some of its most important facets. We know little about what determines when negotiations start, which agents are more likely to propose to start bargaining, if the identity of the party initiating bargaining influences whether an agreement is reached, or if the initiator's pay-off is systematically affected. Studying these topics empirically is challenging, as many contexts involve agency conflicts, private information, or pay-offs or other features that are difficult to quantify and analyse. At the same time, bargaining in experimental studies is rarely endogenous, which makes it difficult to investigate its initiation.

This paper is an empirical examination of bargaining that arises endogenously between parties that have uncertain claims on future pay-offs. We analyse the initiation of bargaining: when it occurs, who initiates it, and how the outcome of bargaining depends on the characteristics of the initiator. The setting has the advantage that the potential negotiators are principals, stakes are substantial, and the outside option and the pay-offs under a successful deal are clearly and unambiguously defined.

The context of our study is the negotiations that often occur near the end of high-stakes online poker tournaments (in which total prize money averages more than $80,000 per tournament). Players begin the tournament with an equal number of chips and are eliminated when they lose all their chips. Each tournament has a schedule of monetary prizes to be awarded on the basis of the final ranking of players. However, once the tournament is reduced to nine or fewer

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participants, any player can propose to end the tournament early and to distribute the remaining prize money among the surviving participants. The terms of such a division are the subject of negotiation, and the only constraints that players face are that the sum of the pay-offs be equal to the sum of the remaining prizes and that the agreement be unanimous. The terms of the deal may depend on the number of chips each player has, his past success, or anything else that affects bargaining power. Any player can veto a proposed division in which case the tournament continues.[1] The gains to trade from a deal stem from the elimination of risk inherent in playing the game out. In the absence of a deal, players face an uncertain outcome, although those who are currently leading in the tournament (*i.e.*, have more chips) have a greater likelihood of obtaining larger prizes.

This setting combines real-world bargaining with clarity usually found only in a laboratory. The and outside options (*i.e.*, that the game continues) are well defined and players in our sample are likely experienced enough to evaluate them meaningfully. Moreover, the stakes are substantial. In a typical deal, two or three players divide, on average, more than $37,000, which suggests that players take the negotiations seriously.

In our sample of 1246 online tournaments, 31% had a negotiated division of the prize money prior to the end of the tournament. A further 34% had negotiations that ultimately failed to reach an agreement. Of course, the fact that the agents in our sample often strike deals to reduce risk indicates that they are risk averse, but their decision to participate in poker tournaments in the first place implies that they also derive enjoyment from playing (or are risk seeking over smaller gambles, as in Friedman and Savage, 1948). Their preference for games of chance may make it less likely that they make a deal, but when examining the cross section of bargaining, there is no reason to expect them to systematically behave differently from managers, lawyers, or other economic agents who may initiate bargaining in other contexts.

Our results are striking both in what they show and in what they do not show. We find that the identity of the initiator affects whether a deal is completed but does not affect the terms of the deal. This is surprising because in simple models of bargaining, there is no role for the initiator. If there are gains to trade, a deal will be made regardless of who proposes it. There may be a role for the initiator in the presence of private information. In such a case, the player initiating bargaining may be revealing a weakness—perhaps that he does not believe he could win the tournament or that he has a high level of risk aversion. This could conceivably hurt the initiator, who would then receive a smaller pay-off in an agreed upon deal.[2] So either the initiator's identity should not matter, or, if it does matter, his pay-off in a completed deal should be systematically affected.

These two predictions, while intuitively plausible, are not supported by the data. First, when the initiator has a stronger position at the bargaining table (*e.g.*, if he has more chips than his opponents or if he has a successful track record in previous tournaments), then a deal is more likely to be successfully completed. The second central result, which deepens the puzzle, is that the initiator's pay-off in a completed deal is not affected. The estimated impact of being the initiator is not only statistically insignificant, it is also economically small over its entire 95% confidence interval.

We separate deals between two players and deals negotiated among three or more players. In either case, being the initiator does not affect a player's pay-off. But we find intriguing results

1. Bargaining here has similarities to the *n*-player, one-cake model of Binmore (1985), and the "unanimous game" of Krishna and Serrano (1996), Chatterjee and Sabourian (2000), and Ali (2006).

2. Although the first concrete proposal can act as an "anchor" on which counterproposals will be based (Tversky and Kahneman, 1974; Galinsky and Mussweiler, 2001), in our case, initiation of bargaining usually does not include a proposal with specific terms.

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regarding the pay-offs to the players with the most and the fewest chips at the table. In deals that are agreed to when only two people remain, the player with fewer chips receives a pay-off greater than his expected value at the expense of the player with more chips. In contrast, when deals are made among three or more players, both the player with the fewest chips and the player with the most chips extract value from those in the middle. As an implication for the experimental literature, this suggests that the results of two-person bargaining games may not generalize directly to games with more than two players.[3]

A very robust result is that the distribution of wealth is important for the initiation and success of bargaining.[4] Bargaining tends to be initiated when chip holdings are relatively equal and, given a proposal, a deal is more likely to be completed when there is less inequality. In the context of dissolving a partnership, Cramton, Gibbons and Klemperer (1987) argue that an efficient division of the partnership stakes can only occur when the claims of the parties are not too different from each other. We test that hypothesis against alternative explanations and provide strong empirical support for their previously untested theory.

This paper proceeds as follows. In the next section, we describe the bargaining environment and the data. Section 3 addresses the question of how the identity of the agent who initiates bargaining affects the outcome. Section 4 investigates whether the initiator's pay-off in a completed deal is affected. Section 5 discusses the empirical results in the context of bargaining theory and Section 6 concludes.

2. SETTING AND DATA

The data in our study are a sample of 1246 poker tournaments from one of the largest online poker sites. The prize pool averages more than \$80,000 per tournament, and the largest tournaments have prize pools of well over \$1 million. We first discuss the key features of the tournament structure and then we describe the data.

2.1. *Online poker tournaments*

The data come from tournaments of a popular variety of poker called no-limit hold'em. The mechanics and the strategies of hold'em poker are unimportant for this study. However, the tournament structure is crucial. To participate in a tournament, players must pay a "buy-in," which is set aside for the prize pool. The total prize pool of a tournament is, in general, the buy-in multiplied by the number of players participating.[5]

In the tournaments we consider, participants are assigned to virtual tables of nine players each. Players start the tournament with the same number of chips and bet with others at their table. When a player loses all of his chips, he is eliminated from the tournament. As players drop out, the number of tables is reduced and remaining players are reseated so that each table has nine or close to nine players. When a player is reseated, he takes his chips to the new table. Eventually, only nine players remain; they collectively possess all the original chips. They form the "final table." Our analysis starts at that stage.

3. There are few experimental papers studying multilateral bargaining. These include Knez and Camerer (1995) and Okada and Riedl (2005) who study three-person variations of the ultimatum game. Guth and van Damme (1998) and Kagel and Wolfe (2001) study a three-person ultimatum game in which one player is completely passive. Some other recent experiments have more than two-players bargaining, but with a majority voting rule (*e.g.*, Frechette, 2009; Battaglini and Palfrey, 2007).

4. Throughout this paper, we use the terms "wealth," "rich," and "poor" to refer to the number of chips each player has. These should not be confused with unobservable outside wealth.

5. In addition, each player pays a fee of up to 10% of the buy-in, which is kept by the "house."

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At the final table, players continue to bet until all but one are eliminated. The remaining player wins first prize, and all others are ranked in the reverse order in which they were eliminated. The prize structure varies, but in a typical tournament with 900 starting players, 81 players would be awarded prizes, with first prize receiving about 25% of the total prize pool, second prize about 14%, etc.

The most important feature for the purposes of our study is that at the final table, before the end of the tournament, players may make a deal in which they split the remaining prize money in any mutually agreeable way. For example, if three players remain and the top three prizes are $20,000, $10,000, and $6000, respectively, the players might agree to take $12,000 each, regardless of the final outcome of the tournament. The terms of the deal are entirely up to the players, so if Player A has more chips than Players B and C, and thus is likely to win the tournament, the split may be $18,000 for A and $9000 each for B and C. The key restriction is that all remaining players must agree to the terms of any deal (*i.e.*, each player has veto power).

We refer to the individual who starts the discussion about dividing the prize money as the "initiator" of bargaining. The initiator may propose specific terms, but generally the details do not arise until later in the negotiations. Often a deal is vetoed before any specific terms are proposed.

When bargaining commences, the tournament is paused between hands (when no cards are in play), so the specifics of any hand do not affect bargaining. After a deal is made, play continues until one player has all the chips, allowing players to compete for any nonmonetary benefits of winning the tournament. Thus, for the purposes of our analysis of bargaining, such nonmonetary benefits can be ignored.

The software used by the online casino presents all player communication in a "chat window" that is also visible to tournament observers.[6] Deal negotiations are conducted via this chat window and are finalized by the tournament support personnel. The support personnel do not suggest, encourage, or discourage any particular deal but merely ensure that all players agree and then execute the deal. No structure is imposed on the negotiation process in the sense that there are no a priori defined "rounds," no order in which players make offers and respond to them, etc. Thus, the only major differences between the bargaining process and negotiations in other contexts are that the players cannot see one another and that their information about one another is largely limited to what they can infer from the game played thus far. As in other contexts, bargaining here is multistage. Bargaining must first be initiated, and then all participants must agree to specific terms. In our empirical analysis, we will condition each stage on the outcome of the previous stage.

2.2. *Data*

We collected data over a period from April 2007 to July 2007. Because of the technological limitations of collecting data in real time over the Internet, we captured only a subset of available tournaments. We chose those with the largest prize pools. The data consist of all activity at the final table of each tournament, including hand-by-hand data on the number of chips each player has and the outcome of each hand, from the start of the final table until the completion of the tournament. The data also include all communication between players (or "chat"). We manually process the chat transcript to identify when proposals to negotiate are made, the bargaining process, and the terms of any agreed upon deal.

6. Communication among players via other channels is unlikely. Such communication during play is considered cheating and expressly forbidden by the online casino. Moreover, other than their on-line nicknames, players are anonymous and their contact information is unavailable.

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TABLE 1
Summary statistics

Panel A: Summary of tournaments

	Average	Standard	5th percentile	Median	95th percentile
Number of tournaments	1246				
Prize pool ($000)	82·0	171·3	17·2	47·9	206·4
1st prize ($000)	17·6	26·9	4·1	11·3	48·7
2nd prize ($000)	10·3	14·1	2·4	6·2	27·8
Buy-in + fee ($)	77·5	107·2	5·5	55·0	215·0
Number of players	947·1	1295·0	154	750	2104
Tournament duration (h)	6·4	1·3	4·7	6·3	8·5
Final table duration (m)	70	23	38	67	112

Panel B: By deal outcome (averages)

	All tournaments	Completed deals	Unsuccessful bargaining	No bargaining
Number of tournaments	1246	386	429	431
Fraction of all	100%	31%	34·4%	34·6%
Prize pool ($000)	82·0	109·1	74·4	65·4
Prize1–Prize2 ($)	7,355	9,294	6,985	5,988
Prize skewness	1·338	1·375	1·341	1·300
Buy-in + fee ($)	77·5	75·4	78·2	78·8
Number of players	947·1	1, 256·4	930·9	686·2
Ranked players at final table	0·7	0·5	0·7	0·8
$1 - R_i / R_{\max}$	0·38	0·35	0·39	0·40
Repeat finalists at final table	4·8	4·5	4·8	5·1
Number of negotiations	1·2	1·8	1·7	0

This table presents summary statistics for the tournaments in our sample. Prize pool is the total value of all prizes awarded in the tournament. Buy-in + fee is the amount paid by each player to participate in the tournament. Number of players is the total number of tournament participants. Tournament duration is the time, measured in hours, from the start of the tournament until the finish. Final table time is measured in minutes from the start of the final table until the end of the tournament. Panel B is broken down by tournaments in which deals were successfully negotiated, those in which negotiations occurred but did not lead to a completed deal, and those in which bargaining was not even attempted. Skewness is measured over the top nine prizes. Ranked players are those among the top 200 based on performance in previous tournaments, the continuous ranking $1 - R_i / R_{\max}$ is defined in footnote 8, and repeat finalists are players who appear in more than one final table in our sample. Number of negotiations is the number of times a deal was attempted in a given tournament.

In Table 1, Panel A, we display the summary statistics of our data set. The total prize pool averages $82,034 per tournament (and the median is $47,855). The largest 5% of tournaments in our sample boast prize pools of $200,000 and up, and the very largest prize pools exceed $1 million. On average, almost 950 players start in a tournament, and a tournament lasts more than 6 h. The price to play (buy-in plus fee paid to the online casino) averages $77·50.

In all tournaments in our sample, all nine players at the final table get monetary prizes, but the prize structures are heavily skewed towards top finishers. First prize averages $17,628, and second averages $10,273. Therefore, if there are only two players left in the game, they can negotiate over the $7000 difference, on average. When n players remain in the game, they effectively negotiate over the sum of the top n prizes minus n times the nth highest prize since each remaining participant is already guaranteed to receive at least the nth highest prize.

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The point of dividing the remaining prizes before the end of a tournament is to reduce the risk inherent in playing the game out until the end. For example, suppose that two player remain in a tournament, each with an equal probability of winning and each with log utility, who agree to divide first and second prizes equally. The gain to each player from this deal is the difference between the negotiated pay-off and the certainty equivalent of continuing to play. The sample averages for first and second prizes imply a per player value creation of

$$\text{CE(equal split)} - \text{CE(no deal)} = \frac{17,628 + 10,273}{2} - e^{0\cdot5(\ln(17,628)+\ln(10,273))} = \$493\cdot44.$$

Of course, the value created varies depending on the actual prize structure, the number of players involved, their utility functions, and so forth, reduced by the value that each player puts on his enjoyment of the game.

We argue that the value created by successful negotiations in the tournaments in our sample is economically interesting and compares favourably to the stakes in typical bargaining experiments. Moreover, the substantial variation in the prize pools in our sample helps us determine the importance of stakes in starting negotiations and closing deals.

Finally, although players are anonymous and can only be recognized via their on-screen pseudonyms, we use a ranking of player nicknames, computed by a third-party website, based on players' previous tournament success. Of the 50,000 nicknames recorded as having positive profits, we classify the top 200 as "highly ranked" (or "famous") players.[7] As a second proxy for reputation, we identify players (or, more specifically, player nicknames) who reach the final table multiple times in our sample. We conjecture that such "repeat finalists" are famous or perhaps skilled players.

3. THE INITIATOR AND THE SUCCESS OF NEGOTIATIONS

3.1. *When does bargaining occur?*

Before we carry out a detailed analysis of the impact of the initiator, we study when bargaining occurs and when it is successfully leads to a deal.

The second panel of Table 1 breaks down tournaments in our sample by the outcome of bargaining. In 386 tournaments (31%), players agreed to split the prize money before the end of the tournament; in 429 (34%), there were negotiations, but no agreements were reached; and in 431 tournaments (35%), no bargaining occurred.

The average amount of money at stake, as measured by the total prize pool, is considerably higher for the tournaments with a deal than for those without one. Moreover, the average decreases from tournaments with a deal to tournaments with some negotiations (albeit not successful) to tournaments in which a deal is not even mentioned. However, the prize pool may not be the best measure of the potential gains of making a deal. As we discuss below, deals typically occur when only two or three players remain at the final table. Thus, a better measure may be the difference between first and second prize, *i.e.*, the amount the last two players could bargain over. We obtain the same result with this measure: the average difference between the top two prizes is highest for tournaments with a successful deal and lowest for those without any bargaining at all.

7. This ranking was recorded before our main tournament data and is not influenced by players' performance in our sample. The rankings are roughly based on the dollar winnings and the number of tournaments played. Unfortunately, we could not obtain the exact algorithm used for computing the rankings. Apart from "top 200 players," we consider a continuous variable based on ranking in the paper; in unreported analysis, we experimented with other ranking-based variables with very similar results.

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Skewness of the prize structure is correlated with whether a deal occurs. We apply the usual skewness estimator to the top nine prizes to measure how much the top winners of the tournament get relative to players who are eliminated earlier. Skewness is highest for tournaments with a deal and lowest for tournaments without any bargaining. This suggests that in our setting risk aversion plays a larger role than any preference for skewness that players may have (as in, *e.g.*, Alderfer and Bierman, 1970). The more the tournament looks like a lottery with highly skewed pay-offs, the more likely making a deal becomes.

Successful deals are more likely in tournaments with more players and with smaller buy-ins (which may be related to players' utility from playing high-stakes tournaments or to their risk aversion). Of course, these two variables are mechanically tied to the size of the prize pool, which may drive the relation.

The next three variables are the number of players with a top 200 ranking, a continuous variable that measures how highly ranked players are,[8] and the number of "repeat finalists" (players who appear multiple times at final tables in our sample). All these variables indicate that there are fewer skilled (or perhaps famous) players in tournaments with a deal. Finally, the last variable summarizes the number of times negotiations occur in each tournament. The first attempt at negotiations typically fails to result in an agreement; the per-tournament average is 1·84 negotiations and the (unreported) median is 2.

Table 2 refines our analysis in a multivariate set-up. We use logit specifications to model the probability that a deal occurs (Panel A) and that bargaining takes place regardless of whether it results in a completed deal (Panel B). We compute standard errors using White's (1980) method to control for potential heteroscedasticity. We report the estimation results in the form of marginal effects as they are easier to interpret.

Panel A explains the probability of a completed deal. We begin with the stakes, proxied by the logarithm of the dollar difference between the top two prizes. The estimated coefficient of this variable is positive and statistically significant, which suggests that the larger the stakes, the easier it is to achieve a deal. However, the economic impact of the stakes is rather limited. If the difference between the first and the second prize doubles, the estimates in regression (1) imply that the probability of reaching an agreement increases by approximately $0{\cdot}073 \times \ln(2) = 5{\cdot}1\%$.

The amount players pay to participate in the tournament is negatively related to the likelihood of making a deal. When it doubles, the probability of a deal is reduced by about 3%. Skewness of the prize schedule has a positive coefficient, but it is not always statistically significant. The next three variables in Table 2 proxy for fame and skill of the final table platers. Deals are less likely when many players have a high ranking; the number of repeat finalists has a negative coefficient as well, but it is not statistically significant. We speculate that ranked players believe that they are highly skilled and only agree to a deal if they receive a disproportionately large portion of the prize pool. If other players disagree with the ranked player's assessment of his skill, a deal is less likely to materialize. We come back to this issue in our subsequent analysis.

The last variable in Table 2, Gini coefficient, measures the inequality in the distribution of chips among players at the beginning of the final table. The Gini coefficient, which is often employed in other contexts to capture income or wealth inequality, is defined as

$$\frac{n}{n-1}\frac{\sum_{i=1}^{n}\sum_{j=1}^{n}|s_i - s_j|}{2n^2\bar{s}},$$

8. Each player with a ranking is assigned the score of one minus the player's position in the ranking divided by one plus the number of all players on the ranking list. Players who do not have a ranking are assigned a score of zero. Thus, the score varies from one for the top-ranked player to zero for players who are not on the ranking list.

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TABLE 2

Probability of a deal (or bargaining) as a function of tournament characteristics

	Panel A: Probability of a successful deal (logit)					
	All tournaments					Prize pool <\$100K
	(1)	(2)	(3)	(4)	(5)	(6)
log(1st Prize–2nd Prize)	0·07***	0·10***	0·09***	0·08***	0·10***	0·04
	(2·70)	(3·36)	(3·17)	(2·88)	(3·42)	(0·86)
Log(buy-in + fee)	−0·04**	−0·04**	−0·04**	−0·04**	−0·05**	−0·05**
	(−2·21)	(−2·26)	(−2·28)	(−2·20)	(−2·38)	(−2·42)
Prize skewness	0·48***	0·29*	0·35**	0·40**	0·29*	0·39**
	(2·97)	(1·68)	(2·00)	(2·19)	(1·67)	(2·00)
Number of ranked players		−0·05***			−0·05***	−0·05**
At final table		(−2·95)			(−2·98)	(−2·29)
Avg $(1 - R_i/R_{\max})$			−0·22***			
At start final table			(−2·81)			
Number of repeat finalists				−0·01		
At final table				(−0·98)		
Gini coefficient					−0·35**	−0·36**
At start of final table					(−2·14)	(−2·08)
Observations	1246	1246	1246	1246	1246	1045
Pseudo R^2	0·0393	0·0450	0·0442	0·0400	0·0479	0·0544

	Panel B: Probability of bargaining (logit)					
	All tournaments					Prize pool <\$100K
	(1)	(2)	(3)	(4)	(5)	(6)
Log(1st Prize–2nd Prize)	0·08***	0·09***	0·09***	0·08***	0·09***	0·05
	(2·68)	(2·94)	(3·00)	(2·75)	(2·96)	(1·16)
Log(buy-in + fee)	−0·04*	−0·04*	−0·04*	−0·04*	−0·04*	−0·04*
	(−1·81)	(−1·85)	(−1·87)	(−1·82)	(−1·91)	(−1·85)
Prize skewness	0·62***	0·53***	0·54***	0·56***	0·53***	0·63***
	(3·79)	(2·99)	(3·13)	(2·97)	(3·00)	(3·09)
Number of ranked players		−0·02			−0·02	−0·02
At final table		(−1·53)			(−1·55)	(−1·05)
Avg $(1 - R_i/R_{\max})$			−0·14*			
At final table			(−1·73)			
Number of repeat finalists				−0·01		
At final table				(−0·74)		
Gini coefficient					−0·27	−0·28
At start of final table					(−1·61)	(−1·50)
Observations	1246	1246	1246	1246	1246	1045
Pseudo R^2	0·0438	0·0453	0·0457	0·0442	0·0469	0·0484

This table presents the estimated marginal effects of a logit model that relates the probability of achieving a deal (Panel A) or initiation of negotiations regardless of whether a deal is ultimately achieved (Panel B) to tournament characteristics. Each panel presents full sample estimation results as well as results for the subsample of tournaments with prize pools below \$100,000. The last row reports the fraction of tournaments that resulted in a deal (Panel A) or which had bargaining (Panel B). Independent variables are as defined in Tables 1 and 2, and the Gini coefficient is computed based on the number of chips held by each player at the beginning of the final table. *T*-statistics are obtained using robust standard errors and are reported in parentheses. ***, **, and * denote that an estimate is significant at the 1%, 5%, and 10% level, respectively.

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where s_i denotes player i's chip holdings, $\bar{s}$ is the average chip holdings, and n is the number of players remaining.[9] The virtue of this variable is its appealing interpretation. It measures the expected difference in wealth between two randomly selected players, normalized by the average wealth of all players. Gini coefficients are between zero and one and are increasing in inequality.

We find that deals are significantly less likely when inequality between players' chip holdings increases. We consider other measures of inequality in Section 5, where we analyse the impact of inequality in more detail.

The impact of stakes implied by regressions (1) through (5) is perhaps surprisingly low. To investigate it further, we estimate regression (6) on the subsample of tournaments with total prize pools below \$100,000 (84% of our sample). Even these smaller tournaments involve large sums of money across a wide range. The total prize pool in this subsample varies from just under \$12,000 to almost \$100,000 (average of \$43,433), and the difference between the two top prizes ranges from roughly \$1000 to \$10,000 (average of \$4225).

The results are striking. In the restricted sample, the magnitude of prizes is statistically insignificant. Moreover, even if we take the point estimate at face value, its economic significance is tiny. In the univariate specification (not reported in the table), the estimate on the size of the prize pool is even lower: 0·015 (t-statistic of 0·56). This result is consistent with the existing literature, which generally finds that stakes have little effect on bargaining behaviour in an experimental framework (see Camerer and Hogarth, 1999). However, our earlier results show that the size of the stakes does have an effect when we include tournaments with truly large prizes.

Panel B of Table 2 uses similar specifications to explain the probability of observing bargaining, regardless of whether a deal is ultimately reached. The results are broadly similar to those from Panel A. In the full sample, negotiations are more likely when the stakes are larger, the buy-in is lower, and the prize structure is more skewed. As in the case of completed deals, the probability of bargaining is affected by the amount of money at stake—the size of the tournament—only when the prize pool is very large.

A weakness of Table 2 is that it only considers variables observable at the beginning of the final table. These variables may dramatically change as the game develops, and hence their impact may be better estimated using hand-by-hand data. To do that, we employ hazard specifications, designed to model the occurrence of bargaining, serious negotiations (a proposal being discussed rather than being ignored) and sealing a deal. To implement these models, we need to measure the time until the above events occur. We choose to measure time as the number of hands played until an event.[10]

Hazard models illustrate how changes in the game environment affect the outcomes. In addition to the variables we included in Table 2 (the stakes, the skewness of the prize structure, the presence of ranked players, and the inequality in chip holdings), we also control for the number of players remaining in the tournament and the number of players eliminated in the previous 10 hands. All these variables are measured at the beginning of each hand and hence their impact can be estimated more precisely than in Table 2. For example, the stakes can now reflect the number of remaining players and their chip holdings.

We use a simple model to estimate each player's probability of taking each place if the tournament continues. The model and the probability calculations are described in the appendix, where we also present evidence that the model fits the data on tournament outcomes well. Our model assumes away the strategic elements of the game, such as the ability to vary bets depending on the cards dealt or on other players' actions. However, it enables us to compute a player's

9. We multiply the usual formula for the Gini coefficient by $n/(n-1)$ to correct for bias.

10. When we estimate hazard models based on time measured in minutes, the results are very similar.

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probability of winning each of the remaining prizes and the expected pay-off as a function of the number of chips each player has.

Our measure of the stakes is the logarithm of the average (across players) of the standard deviation of the pay-offs from continuing the play. This variable captures both the dollar prizes and the risk of continued play. We have also experimented with other variables (*e.g.*, the total amount of money to be divided in a deal) with very similar results.

The estimation results, presented in the form of odds ratios[11] are summarized in Table 3. The results are broadly similar to those from Table 2. Players respond to the stakes: Bargaining and closing a deal are more likely when the pay-off standard deviations are higher. The skewness of the prize structure, which captures the disparity between the top and the remaining prizes, is also positively related to bargaining. Buy-in, or the "ticket price," has a negative impact but is not significant when modelling the probability of completing the deal. Inequality of chip stacks is strongly negatively related to all aspects of bargaining (initiation of bargaining, discussing a deal, and sealing a deal). Finally, the presence of ranked players tends to discourage discussing or sealing the deal, but of the two variables that we used in Table 2, only the fraction of top 200 players is significant.

The last variable we consider in Table 3 is based on the minimum bet size (known as the "big blind"). While we try to abstract from poker-specific terms in this paper, it is important to document that the specifics of our context do not influence our results. For example, as tournaments progress, the minimum bet size increases and continued play may become more risky. To check whether this relates to our results, we explicitly control for the bet size in specifications (4), (8), and (12) in Table 3. This variable is not significant and its inclusion hardly changes the signs, significance, and magnitude of the remaining variables.[12]

3.2. *Who initiates bargaining?*

Table 4 provides a summary of the state of the game at the onset of bargaining. The first column of Panel A is a snapshot of the "typical" state of the game, computed by averaging over all hands played at all final tables in tournaments that did not have any bargaining. This serves as a benchmark for comparison with the initiation of bargaining. The variables in Panel B, which measure the characteristics of the initiator (or rejector for proposals that were vetoed) are normalized to have a benchmark of zero.

Panel A supports the findings from the hazard models. Bargaining occurs relatively late in the game, as measured by time and by the number of remaining players. On average, only 3·66 players remain when bargaining is initiated, compared to nine players at the beginning of the final table and to an average of 4·89 players across hands drawn randomly from tournaments without any negotiations.[13] Moreover, on average, just over one player is eliminated in the 10 hands preceding bargaining. In fact, 33% of the time, bargaining is initiated immediately (*i.e.* within one hand) after a player loses all his chips and is eliminated from the tournament. In 67% of cases at least one player is eliminated in the 10 hands prior to bargaining. Negotiations

11. An odds ratio higher (lower) than one indicates that a variable positively (negatively) affects the probability of an event happening. The *t*-statistics reflect that relationship and are positive (negative) when the odds ratios are above (below) one.

12. In unreported analysis, we find that when deals are completed, the average player's chip holdings are about 25 times larger than the minimum bet size. This fairly large value indicates that even when deals are completed, the importance of the minimum bet size is not overwhelming.

13. Reported *t*-statistics of differences are based on standard errors robust to heteroscedasticity and clustered at the tournament level, which allow for dependence between hands played in the same tournament.

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TABLE 3

Probability of a deal (or bargaining) as a function of tournament and hand-level characteristics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Failure = making a deal				Failure = discussing a deal				Failure = initiation of bargaining			
$\log\left(\sum \sigma_i / n\right)$	1·20*	1·34**	1·28**	1·34**	1·31***	1·36***	1·33***	1·36***	1·27***	1·27***	1·25***	1·28***
	(1·76)	(2·54)	(2·16)	(2·56)	(4·39)	(4·55)	(4·30)	(4·54)	(4·70)	(4·48)	(4·28)	(4·52)
Prize skewness	8·26***	8·02***	10·26***	8·03***	5·11***	4·73***	5·56***	4·73***	4·23***	4·29***	4·82***	4·31***
	(3·44)	(3·25)	(3·58)	(3·25)	(4·51)	(4·09)	(4·61)	(4·10)	(4·82)	(4·78)	(5·23)	(4·79)
Log (buy-in + fee)	0·90	0·89	0·89	0·89	0·91**	0·89**	0·90**	0·90**	0·91**	0·91**	0·91**	0·91**
	(−1·38)	(−1·53)	(−1·50)	(−1·43)	(−2·10)	(−2·25)	(−2·19)	(−2·24)	(−2·30)	(−2·34)	(−2·29)	(−2·30)
Log (number of remaining players)		0·03***	0·03***	0·02***		0·22***	0·22***	0·21***		0·31***	0·32***	0·29***
		(−9·14)	(−9·10)	(−9·50)		(−6·65)	(−6·63)	(−6·72)		(−6·20)	(−6·18)	(−6·41)
Number of players recently eliminated		1·74***	1·74***	1·75***		1·79***	1·79***	1·79***		1·68***	1·68***	1·68***
		(8·19)	(8·16)	(8·27)		(14·40)	(14·39)	(14·39)		(16·45)	(16·44)	(16·44)
Gini coefficient		0·001***	0·001***	0·001***		0·04***	0·04***	0·04***		0·06***	0·06***	0·07***
		(−7·29)	(−7·30)	(−7·10)		(−5·19)	(−5·24)	(−5·06)		(−5·41)	(−5·44)	(−5·18)
Number of ranked players/n		0·16***		0·16***		0·56**		0·56**		0·69		0·69
		(−3·37)		(−3·37)		(−2·12)		(−2·12)		(−1·62)		(−1·61)
Avg $(1 - R_i / R_{max})$			0·72*				0·98				1·01	
			(−1·75)				(−0·18)				(0·09)	
Avg (s_i/big blind)				1·00				1·00				1·00
				(−1·62)				(−0·51)				(−1·14)
Observations	147390	134930	134930	134930	155309	142849	142849	142849	155309	142849	142849	142849
Number of subjects	1246	1246	1246	1246	1246	1246	1246	1246	1246	1246	1246	1246
Number of failures	384	384	384	384	882	873	873	873	1440	1396	1396	1396
Pseudo R^2	0·00923	0·0484	0·0460	0·0489	0·00757	0·0271	0·0268	0·0271	0·00575	0·0200	0·0199	0·0201
Wald χ^2	45·85	231·8	226·3	238·3	99·74	410·7	409·8	410·3	110·6	478·0	478·7	476·8

This table presents the estimated odds ratios from hazard specifications that model achieving a deal (Columns 1–4), engaging in negotiations (*i.e.*, discussing a proposal, Columns 5–8), and initiation of bargaining (Columns 9—12). The hazard models are estimated using all hands played in 1246 tournaments in our sample. $\sum \sigma_i / n$ is the average dollar standard deviation of remaining players' pay-offs, computed using the model described in the appendix, Avg (s_i/big blind) is the average chip stack divided by the minimum bet size in a given hand, Gini coefficient is based on player's chip holdings at the beginning of each hand, and other independent variables are defined as in previous tables. *t*-statistics, based on robust standard errors clustered at the tournament level, are reported in parentheses. ***,**, and * denote that an estimate is significant at the 1%, 5%, and 10% level, respectively.

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TABLE 4

State of the game and initiator/rejector characteristics at the time of bargaining

	Benchmark (no bargaining)	Initiation of bargaining	Bargaining minus benchmark
Number of remaining players (n)	4·89	3·66	−1·23***
			(−18·89)
Gini coefficient	0·35	0·27	−0·08***
			(−12·81)
Number of players recently eliminated (previous 10 hands)	0·58	1·04	0·45***
			(17·98)
Number of ranked players$/n$	0·10	0·06	−0·04***
			(−3·83)
Number of repeat finalists$/n$	0·60	0·53	−0·06***
			(−3·50)
Time since start of final table (m)	38·00	48·16	10·14***
			(9·332)

	Benchmark	Initiator	Initiator minus benchmark	Rejector	Rejector minus benchmark
Chip leader dummy - $1/n$	0	−0·072	−0·07***	0·113	0·11***
			(−6·28)		(4·80)
$s_i/S - 1/n$	0	−0·024	−0·02***	0·031	0·03***
			(−6·68)		(4·59)
$\Delta s_i/S$ (previous 10 hands)	0	0·052	0·05***	0·050	0·05***
			(16·17)		(8·57)
$\Delta(s_i/S - 1/n)$ (previous 10 hands)	0	−0·033	−0·03***	−0·036	−0·04***
			(−9·94)		(−6·13)
$\mathrm{HW}_i/\sum_j \mathrm{HW}_j - 1/n$ (previous 10 hands)	0	−0·004	−0·004	0·016	0·02**
			(−0·96)		(2·20)
Ranked player dummy – Number ranked/n	0	−0·016	−0·02***	0·047	0·05***
			(−2·90)		(4·28)
Repeat finalist dummy – Number of repeat finalist/n	0	−0·013	−0·01	0·070	0·07***
			(−1·08)		(3·61)

Panel A compares the state of the game at the initiation of bargaining to a benchmark (average over all hands of tournaments without bargaining). Panel B compares the initiator and the player who rejects a proposal to the benchmark at the time of the proposal or rejection, respectively. t-statistics are based on robust standard errors clustered at the tournament level and are reported in parentheses. The Gini coefficient is computed using the number of chips held by each remaining player. The number of ranked players and repeat finalists are normalized by dividing by the number of remaining players (n). "Chip leader dummy" is a dummy for whether a given player has the most chips at the table and is normalized by subtracting $1/n$. s_i is the number of chips a player has and is normalized by dividing by the total number of chips at the table (S) and by subtracting $1/n$. Δs_i is the increase in a player's chip holdings over the previous 10 hands and is normalized in two different ways. HW_i is the number of hands won by a player in the previous 10 hands, and is normalized by the average number of hands won by all remaining players and by subtracting $1/n$. Ranked player (repeat finalist) dummy is normalized by subtracting the proportion of ranked players (repeat finalists) at a given time. ***, **, and * denote that an estimate is significant at the 1%, 5%, and 10% level, respectively.

occur when the distribution of chips is relatively equal; the average Gini coefficient at the time of the initiation of bargaining is significantly below the benchmark. Lastly, bargaining is more likely when there are few highly ranked players left at the table. As a benchmark, just over

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10% of players at final tables are highly ranked at any given time,[14] but when bargaining occurs, only 6·3% of remaining players are ranked. Similarly, there are fewer repeat finalists than in the benchmark at the time of bargaining.

Panel B presents characteristics of the player who initiates bargaining. These variables capture wealth (in chips), recent performance, and ranking. For player wealth, the first variable we consider is a dummy that takes the value one when the player has the most chips at the table and zero otherwise. If players were to initiate bargaining at random, the expected value of this variable would depend on the number of players. Therefore, we subtract the inverse of the number of remaining players from the chip leader dummy so that its expected value is equal to zero regardless of the number of players.[15] The second measure of wealth is simply the number of chips the player has divided by the total number of chips at the table. We also normalize this variable by subtracting one divided by the number of remaining participants.

We find that the initiator of bargaining tends to have fewer chips than his opponents. The normalized chip leader dummy averages −0·072, corresponding to the initiator being the chip leader only 42·8% of the time in two-person negotiations. Similarly, the initiator has fewer chips than would otherwise be expected. In contrast, in proposals that were vetoed the player who refuses the deal is in a stronger than average position.

It is not clear why the player in the weaker position first suggests deal making. It might be understandable if deals were always an equal split of the prize money. But, as we will discuss later, the terms of completed deals tend to be closely related to each player's expected value. Similarly, it is not clear why the richer player vetoes—he could always suggest terms that compensate him for his strong position rather than dismiss bargaining out of hand.

For recent performance, we measure the change in a player's chip holdings over the past 10 hands, divided by the total number of chips outstanding. We find that on average, both the initiator and the rejector have increased their wealth by about 5% of all outstanding chips. When interpreting this measure, one should recall that in a large percentage of cases, one or more participants would have been eliminated within the previous 10 hands. Thus, simply by remaining alive and winning the chips of the eliminated player(s), the remaining participants should be expected to have increased wealth. Therefore, we also use a second measure in which we take the change in wealth and subtract the change in the inverse of the number of players remaining, to correct for any reduction in the number of players. Under this measure, we find that the initiator (as well as the rejector) has reduced wealth.[16] In other words, the initiator of bargaining tends to have increased his wealth recently, but not as much as one would expect given that another player may have been recently eliminated. Both measures indicate that the initiator's and the rejector's change in wealth are similar.

Another measure of recent performance is the number of hands recently won (divided by the number of hands won by all surviving players and normalized for the number of players). With this measure, we find no evidence of abnormal performance by the initiator, but the rejector is likely to be someone who has recently won more hands than his opponents.

The last two variables in Table 4 are the ranked player and repeat finalist indicators, normalized by subtracting the fraction of remaining players who are ranked or are repeat finalists. Ranked players are significantly less likely to initiate bargaining and are more likely to reject

14. The percentage of ranked players may be high because of their higher skill but also because they participate in many more tournaments than do other players.

15. We disregard situations when more than one player holds the highest number of chips. These situations are rare; in our entire sample of 177,663 hands played, in only three cases (0·002%) did two players have equal chip holdings.

16. The adjustment term in this measure implicitly assumes that any eliminated players previously had $1/n$th of all chips.

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deals proposed by others. The results are similar for repeat finalists, but the tendency not to initiate bargaining is statistically insignificant.

To summarize, while in principle bargaining could occur at any time at the final table and could be initiated by any player, in practice, it occurs late in the game, when there are few players remaining, often immediately after one or more participants are eliminated. The initiator of bargaining is likely to be poorer than his opponents and less likely to be highly ranked. When deals are refused, the rejector is likely to be richer and more likely to be a highly ranked player.

3.3. *Does the initiator affect the success of negotiations?*

We are now ready to investigate the circumstances under which negotiations lead to an agreed deal. In Table 5, we use the logit framework to estimate the probability of reaching a deal given the initiation of bargaining. As in Table 2, we report marginal effects rather than logit coefficients. Robust standard errors are clustered at the tournament level to control for the dependence between multiple proposals made in the same tournament.[17]

According to the univariate results of regressions (1) through (6), a deal is more likely when the initiator is wealthier (as measured by his share of the chips) and better known (*i.e.*, is highly ranked or is a repeat finalist; surprisingly, the continuous ranking variable is not significant). The economic impact of these variables can be substantial. For example, when two players remain and the initiator has twice as many chips as his opponent, the probability of reaching agreement increases by 5·4%. If the initiator is a ranked player, the likelihood of a successful bargain goes up by 7%.

These findings are important. Although the results may seem intuitive, it is difficult to explain them in a traditional modelling framework. Note that the terms of the deal are entirely up to the players and could—and, as we show in Section 4, indeed do—compensate richer or ranked players regardless of who starts the negotiations. Some of the findings could be explained if information is asymmetric. For example, experienced players could have a higher probability of winning the tournament and could rationally demand higher pay-offs in the deal. If other players are not aware of their opponent's skill, they may not consent and bargaining may break down. However, this mechanism cannot explain all our results. Chip holdings are apparent to all players, so it is unlikely that a player would reject a deal because he is unaware of his opponent's chip count. Yet, the number of chips the initiator has is important for the outcome of bargaining.

Regressions (7) through (12) add additional explanatory variables. In line with the earlier results, the probability of coming to an agreement strongly depends on the number of players remaining in the game. When the number of players decreases from three to two, the probability of reaching agreement increases by about 15%.[18] The presence of players with a top 200 ranking discourages deals. The impact of this variable is almost as high as that of the number of players. For example, if there are two (four) players left and one of them is highly ranked, the probability of reaching agreement drops by approximately 16% (8%). Equality of chip holdings is also important. When the Gini coefficient drops from its average value by one standard deviation (0·164 measured across all negotiations), the probability of reaching agreement increases by about 9%.

17. In unreported analysis, we experiment with other specifications designed to capture this dependence. For example, we introduce dummy variables for the second, third, and more-than-third proposal in a given tournament without qualitatively changing the results.

18. Further illustrating this result, about 58% of two-person negotiations in our sample culminate in a deal, whereas only 16% of four-player negotiations result in a deal.

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TABLE 5

Probability of success of bargaining as a function of the initiator's characteristics and the state of the game

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
							Characteristics of the initiator:						
$s_i/S-1/n$	0·32***						0·27***						0·34**
	(3·70)						(2·83)						(2·13)
$\Delta(s_i/S-1/n)$		0·04						0·14					0·03
		(0·41)						(1·43)					(0·32)
Chip leader dummy minus $1/n$			0·03						0·04				−0·03
			(1·16)						(1·60)				(−0·81)
Ranked player dummy minus number of ranked/n				0·14**						0·14**			0·13*
				(2·21)						(2·03)			(1·90)
1-$R_i/R_{\max}$					0·01						0·04		
					(0·56)						(1·35)		
Repeat finalist dummy minus number of repeat finalist/n						0·07**						0·04	0·04
						(2·25)						(1·39)	(1·11)
							Characteristics of the environment:						
Log(# remain· players)							−0·40***	−0·40***	−0·40***	−0·39***	−0·40***	−0·40***	−0·40***
							(−10·86)	(−10·89)	(−10·88)	(−10·76)	(−10·95)	(−10·83)	(−10·77)
Number of ranked players /n							−0·35***	−0·36***	−0·36***	−0·33***		−0·35***	−0·32***
							(−4·00)	(−4·06)	(−4·06)	(−3·78)		(−3·97)	(−3·68)
Avg $(1-R/R_{max})$											−0·15***		
											(−2·68)		
Gini coefficient							−0·54***	−0·56***	−0·57***	−0·58***	−0·57***	−0·57***	−0·54***
							(−7·11)	(−7·41)	(−7·66)	(−7·88)	(−7·75)	(−7·79)	(−7·06)
Number of players eliminated·							0·02	0·03*	0·02	0·02	0·02	0·02	0·02
(previous 10 hands)							(1·53)	(1·70)	(1·43)	(1·48)	(1·44)	(1·34)	(1·60)
$\text{Log}\left(\sum\sigma_i/n\right)$							0·01	0·01	0·01	0·01	0·005	0·01	0·01
							(0·96)	(0·93)	(0·99)	(0·91)	(0·30)	(0·94)	(0·88)
Avg (s_i/big blind)							−0·001	−0·001	−0·001	−0·001	−0·001	−0·001	−0·001
							(−1·34)	(−1·40)	(−1·40)	(−1·31)	(−1·37)	(−1·43)	(−1·23)
Observations	1451	1399	1451	1451	1441	1451	1399	1399	1399	1399	1399	1399	1399
Pseudo R^2	0·007	0·000	0·001	0·003	0·000	0·003	0·168	0·164	0·165	0·166	0·156	0·164	0·172

This table presents estimated marginal effects of a logit model that relates the probability of achieving a deal to the state of the game and initiator characteristics. *t*-statistics, based on robust standard errors and clustered at the tournament level are reported in parentheses. Explanatory variables in the top (bottom) half of each panel refer to the initiator of bargaining (to the state of the game at the initiation of bargaining). The independent variables are as defined in previous tables. The number of observations varies for different specifications because some of the variables cannot be computed for all proposals (*e.g.*, if bargaining begins within the first 10 hands of the final table). ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

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The next control variable measures the gains to trade. Recall that the gains to trade stem from the elimination of risk. We use the simple model introduced in Section 3.1 (and formally presented in the appendix) to calculate the expected value and standard deviation of each player's pay-offs if the game continues, given the number of chips each player holds and the monetary prizes of taking each place. We proxy for the gains to trade by taking the logarithm of the average standard deviation across remaining players. While this variable has a positive coefficient, it is not significant with a t-statistics of about 0·7–0·8. In unreported analysis, we experimented with other measures of gains to trade (*e.g.*, the dollar amount to be divided in a deal) with similarly insignificant results. Finally, the last variable, the average chip holdings divided by the minimum bet size, is not statistically significant either.

When we control for the above variables, two characteristics of the initiator—wealth and the status of being a ranked player—remain significant. They are still significant in regression (13), where we include all characteristics and all other variables at the same time.

We repeat the analysis (unreported) for the probability that players at the table will discuss a deal once bargaining is initiated (*i.e.*, that the initiation of bargaining will not be ignored). The results are very similar except that the gains to trade through the elimination of risk is related to the probability that a deal will be discussed, even though it is unrelated to the probability that a deal will be completed.

4. THE PAY-OFF TO THE INITIATOR

The previous sections analyse whether negotiations lead to a successful deal. Here, we condition on a deal being made and analyse the determinants of how the money is divided. Our goal is to complement the previous findings by testing whether the initiator's pay-off is affected and to learn how players' characteristics influence their shares in a completed deal.[19]

There are two focal equilibria for the division of surplus, each occurring in about a third of completed deals. The first is an equal division in which each remaining player gets the same amount. The second focal equilibrium is a proportional split: each player first receives the lowest prize remaining in the tournament, and the remaining prize money is then divided proportionally to the number of chips each player has. Although this second focal point is a traditional way to split prizes in both online tournaments and physical casinos, it is not supported by any theoretical construction. Indeed, a proportional split can lead to bizarre outcomes that players would never agree to.[20]

Neither of the above two types of division is a default option or is suggested by the online casino. However, players are comfortable enough with them to choose one of them in about two-thirds of all deals in our sample. In the remaining one-third of cases, players might start by considering one of the two focal points, and then one player may try to increase his share at the expense of other players. Sometimes, the division terms are *ad hoc*, *e.g.*, a player may demand $10,000 and suggest that the other players split the remainder equally.

To meaningfully compare the amounts players obtain in different tournaments, we use the model mentioned in Section 3.1 (and fully described in the appendix) to estimate expected pay-offs. Table 6 relates the amount obtained in a deal to each player's expected value and to his characteristics. We standardize the amount a player gets by the average amount awarded in a

19. For recent studies on the effect of individuals' characteristics on bargaining power, see Harding, Rosenthal and Sirmans (2003) and Scott Morton, Zettelmeyer and Silva-Risso (2004).

20. For example, in one of the tournaments in our sample, a proportional split was discussed and it turned out that such a division would have given more than the first prize money to the chip leader. This proposal was quickly renegotiated.

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TABLE 6

Terms of the deal as a function of player characteristics

	All deals					Two-player deals				3+ player deals				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Initiator	−0·005	−0·003	−0·002	−0·001	−0·001	0·002	−0·003	−0·003	−0·004	−0·010	−0·000	0·001	0·002	0·002
	(−0·48)	(−0·70)	(−0·44)	(−0·30)	(−0·33)	(0·21)	(−0·95)	(−1·08)	(−1·09)	(−0·61)	(−0·02)	(0·24)	(0·42)	(0·39)
$\mathrm{EV}_i/\bar{\mathrm{EV}}$		1·15***	1·24***	1·22***	1·22***		0·83***	0·91***	0·91***		1·20***	1·27***	1·22***	1·22***
		(30·75)	(25·40)	(23·22)	(23·19)		(23·53)	(22·40)	(22·32)		(28·85)	(22·84)	(17·28)	(17·30)
$\Delta s_i/S$			−0·02*	−0·02*	−0·02**			−0·01	−0·01			−0·02	−0·02	−0·02
			(−1·81)	(−1·96)	(−1·99)			(−0·81)	(−0·84)			(−0·81)	(−0·94)	(−0·93)
Ranked player			0·02**	0·02**	0·02**			0·02*	0·02*			0·02	0·03**	0·03**
			(2·26)	(2·54)	(2·51)			(1·69)	(1·69)			(1·61)	(2·42)	(2·33)
Repeat finalist					0·003				0·003					0·003
					(0·68)				(0·51)					(0·49)
Small stack			0·03***	0·04***	0·04***			0·01***	0·01***			0·03***	0·03***	0·03***
			(6·12)	(7·46)	(7·53)			(4·67)	(4·54)			(3·99)	(4·05)	(4·14)
Chip leader				0·01**	0·01**								0·02**	0·02**
				(2·22)	(2·25)								(2·13)	(2·11)
Observations	1019	1019	1019	1019	1019	426	426	426	426	593	593	593	593	593
R^2	0·000	0·890	0·901	0·902	0·902	0·000	0·824	0·833	0·834	0·001	0·907	0·912	0·914	0·914

This table reports regression coefficients relating each player's share (amount awarded in a deal divided by the average pay-off) to player characteristics. To ensure that fitted values within each tournament sum up to the value of the dependent variable, each variable is demeaned at the tournament level and the regressions are estimated without a constant term. *t*-statistics, based on robust standard errors clustered at the tournament level, are reported in parentheses. $\mathrm{EV}_i/\bar{\mathrm{EV}}$ is the ratio of player i's expected value of continuing the tournament (in the absence of a deal) to the average expected value computed over all remaining players. $\Delta s_i/S$ is a player's increase in chips over the past 10 hands as a fraction of all chips on the table. The initiator (ranked player, small stack, chip leader) dummy is equal to 1 if a given player initiated the bargaining that led to the deal (is among the top 200 ranked players, has the fewest chips, has the most chips). ***, **, and * denote that an estimate is significant at the 1%, 5%, and 10% level, respectively.

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given deal. Each observation corresponds to a pay-off in a deal, so the total number of observations (1019) is equal to the total number of players who participated in all deals in our sample.[21] Therefore, in each tournament with a division of prizes, there is a dependence between observations corresponding to different players. For example, if we know the share of a player in a two-person deal, we can infer the share of the other player as well. Thus, the effective number of observations we have is lower than 1019. To correct the standard errors accordingly, we cluster them at the tournament level. To make sure that the fitted values from the regression are logically consistent (*i.e.*, that the predicted shares sum to one in each tournament), we demean both left- and right-hand side variables within each tournament and estimate the regression without an intercept. This way, for each tournament, the fitted values sum up to zero regardless of the estimated parameters and thus coincide with the sum of the (demeaned) dependent variables.[22] [23]

The main variable in all regressions is the initiator indicator. In all cases, the point estimates of the initiator's coefficient are close to zero. The signs of the estimates differ across specifications. Moreover, the estimates are not statistically significant in any of the regressions; in all cases, they are less than 1·1 standard error away from zero. Even if the point estimates are taken at face value, their economic impact is limited compared to the effect of other characteristics (being a highly ranked player, the chip leader, etc.). For example, regression (4) indicates that initiators' shares are, on average, 0·1% lower than the average share. In contrast, ranked players (chip leaders) get 2·3% (1·3%) more of the pie than the average player. To put these numbers into perspective, 2·3% (1·3%) corresponds to an additional \$325 (\$184) in the average deal. Compared to this, the penalty for being the initiator is inconsequential: just \$14 in the average deal (in other specifications, *e.g.*, (6), the initiator gets a premium of a similar magnitude). Thus, an initiator's share in a completed deal is not different, statistically or economically, from shares of other players.

This finding goes against the hypothesis that initiating bargaining signals a high level of risk aversion, low skill, or impatience that could be penalized by other players. Recall that we previously found that the identity of the initiator affects whether a deal will occur (*e.g.*, a deal is more likely when the initiator has more chips). In our view, that first result can only be fully rationalized if the decision to initiate bargaining reveals some private information. However, the revealed information should then be accounted for in the terms of the deal and the initiator's pay-off should be systematically affected. Puzzlingly, we find that it is not.

To ensure that the finding above is not driven by the way we model the expected values, we carried out additional model-free analysis. As described at the beginning of this section, players in our sample often choose an equal or a proportional division. For the initiator's outcome to be systematically affected, the type of division chosen would need to be correlated with the characteristics of the initiator. For example, if initiators were systematically hurt, we would

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21. We lose one deal observation because we could not meaningfully identify the time the proposal was made; thus, we cannot identify the exact chip holdings on which the deal is based.

22. We also estimated all regressions from Table 6 without demeaning the variables and with a constant term. This specification does not constrain the fitted values. All results are very similar to those from the constrained model.

23. Another approach would be to jointly estimate all stages of the game, including the terms of the deal regressions. This approach is complicated by the fact that the residuals from the earlier stages are univariate, but the last stage residual is multivariate (since each player who participates in a deal has a separate residual). Moreover, the last stage residuals are negatively correlated within each tournament (a player can increase his share only at the remaining players' expense). Thus, any dependence between the division of surplus and the previous stages of bargaining would affect some residuals positively, but other residuals negatively. Given these complications, we decided to model the terms of the division separately from the earlier stages, conditioning the analysis on there being a deal. To correct for within-tournament error correlation, we cluster standard errors at the tournament level.

observe that the average wealth of the proposing player is lower in proportional divisions (which favour richer players) than in equal divisions (which hurt richer players). In fact, the average wealth of the initiator is almost exactly the same for these two types of divisions. In equal (proportional) divisions, the initiator holds 98·9% (98·7%) of the average number of chips per player.

The terms of the deal are strongly related to the expected pay-offs (normalized by the average expected pay-off of remaining players). This variable alone explains about 89% of the variation in our sample. However, its coefficient is significantly greater than one, which indicates that having many chips, and hence higher expected winnings, gives the player extra bargaining power to extract more value from the deal. Of course, this extra value comes at the expense of players with smaller chip holdings.[24]

We find positive coefficients on indicator variables both for the chip leader and for the player with the fewest chips. (Recall that the regressions already control for the number of chips via the expected pay-off variable.) Thus, players at both extremes of the chip distribution receive more in the deal, at the expense of players with medium holdings. One possible explanation for the premium to the small stack player is that he may find it relatively inexpensive to hold up the deal and use his veto power to extract rents. There is also some evidence that recent increases in chips (over previous 10 hands) have a negative effect on a player's negotiated pay-off. The total number of chips is already captured in the expected value variable, but the regression suggests that the parties to the negotiation discount the value of the recently acquired chips of the "nouveau riche." This finding contrasts with the "hot hands" phenomenon (Gilovich, Vallone and Tversky, 1985; Croson and Sundali, 2005), which predicts an overweighing of recently acquired chips. It is, however, consistent with a disposition effect: players may be eager to lock in recent chip gains and are willing to bear a small penalty to convince other players to agree to a deal.

Ranked players achieve better outcomes in the deal. Controlling for other factors, they get an extra 2·4% of the average award. Combined with the results from previous tables, this finding suggests that ranked players may be somewhat less likely to propose a deal and, when somebody else initiates bargaining, they demand a larger fraction of the pie. This is frequently not acceptable to other players (hence the high number of rejections with highly ranked players at the table). In the deals that eventually get made, highly ranked players extract sizable premiums for their (perceived) skill and fame. Interestingly, once we control for ranked player status, it turns out that repeat finalists do not obtain any premium.

In regressions (6) through (14), we break up the analysis into two subsamples: deals between two players and deals between three or more players.[25] (Of course, we cannot have dummies for both fewest chips and chip leaders in the regressions limited to two-player deals.)

The most striking result is that for two-player deals, the coefficient of expected value is significantly lower than one, whereas in deals with three or more players, it is significantly greater than one. Furthermore, in the two-player regression (8), the coefficient of the fewest chips dummy suggests that the poorer player extracts an additional 1·3% from his counterparty. Thus, when bargaining occurs between two players, the richer player sacrifices some wealth in favour of his opponent. This finding is reminiscent of the well-known result in two-person ultimatum games: more powerful players willingly deviate from the Nash equilibrium and cede

24. In an unreported analysis, we find the same result when we use the fraction of chips a player has instead of expected value. Interestingly, when both enter the regression, only expected value is important and the number of chips becomes insignificant.

25. In unreported analysis, we estimated the main regressions separately for tournaments with high and low level of inequality, with high and low prize pools, and high and low number of ranked players. In all cases, the results are very similar to those we discuss here.

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part of the surplus to their partners. (See Roth, 1995, for a review of these results.) The situation changes when more than two players remain in the game. In this case, the richest player extracts an additional 2% from the other players. At the same time, the player with the fewest chips also receives a premium, again meaning that players at both extremes of the wealth distribution are financed by the people in the middle.

The fact that the richest player loses some of his bargaining power in two-person negotiations suggests that the hold-up problem changes between two- and more-than-two-player bargaining. This finding is particularly interesting and deserving of further study, especially because most of the existing experimental evidence is limited to two-player bargaining games.

5. THEORETICAL FRAMEWORK OF BARGAINING

To interpret the empirical results, it is instructive to relate them to bargaining theories and the hypotheses implied by those theories. In Section 5.1, we address the delay in bargaining, the role of the initiator, and the terms of the deal. In Section 5.2, we interpret our results on the role of equality within the context of theoretical literature on bargaining.

5.1. *Relation to existing theories*

When a number of parties negotiate the division of an asset, the terms of the deal depend on the outside option of each player and the surplus is divided according to each party's relative bargaining power (Nash, 1950). The surplus in our setting stems from risk aversion. If all players were risk neutral, then the value of the outside option to a player would be the expected value of the prize to be won by that player. Under risk neutrality, there is no net gain to the system if a deal is struck, so there would be no reason for a deal to occur.

However, in the presence of risk aversion, deals should occur. In this case, the value of the outside option is the certainty equivalent of the possible outcomes faced by the player. The surplus that can be divided in bargaining is the difference between the sum of the remaining prizes and the sum of the certainty equivalents. When there is no structure on the bargaining process, any distribution of this surplus can be an equilibrium (Edgeworth, 1881).

In the seminal model of multi-period full information bargaining, Rubinstein (1982) applies a per-period discount factor to reflect the deadweight cost of delaying the deal. In our case, the cost of a delayed deal, as well as the cost of not completing a deal at all, is the risk of continuing the tournament with an uncertain outcome.

In the full information setting, without any forces encouraging continued play, deals should be made at the first possible time allowed. This is not what we observe. Instead, we observe significant delays until deals are made, if they are made at all. In fact, if we take the model literally, allowing for risk aversion, players should not play at all (which is equivalent to making a deal at the very beginning of the entire tournament.) Clearly, there must be some reason for playing, such as risk-seeking preferences over some range of pay-offs and risk aversion over others (*e.g.*, Friedman and Savage, 1948) or simply enjoyment of the game. Our observation that deals do occur suggests that at some point risk aversion becomes the more important force. Thus, the observed delay until bargaining occurs may mean that risk aversion does not overcome the benefits of playing until late in the game.

The full information model does not predict any special role for the initiator of bargaining. Indeed, in the structured setting of Rubinstein (1982), the model predicts that bargaining will be initiated by the first party that is allowed to make an offer. This contrasts with our finding that there are regularities in who initiates bargaining and how the identity of the initiator affects the likelihood of a successful deal.

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A variation of the complete information framework is one with learning.[26] In our setting, players may need time to understand the value of reaching a deal and to learn how to bargain effectively. This could rationalize the delay in bargaining. Since unanimity is required, all participants must understand the benefit of bargaining, which also might explain why bargaining tends to occur with fewer remaining players.

However, much of the evidence contradicts the learning hypothesis. Since bargaining may only take place during the final table, one could identify repeated finalists as those who are more likely to be experienced. Similarly, highly ranked players are more likely to have the experience to bargain. However, we find that deals are *less* likely to occur when there are more repeated finalists or highly ranked players at the table. Moreover, if experience helps, one might expect that repeated finalists would extract more value in a deal, but we found no such effect in Table 6. Highly ranked players do receive a higher pay-out but that could be explained by a higher probability of winning the tournament due to skill.

Overconfidence in one's bargaining power has been studied by Yildiz (2003), Ali (2006), and Galasso (2010), among others. Theory shows that overconfidence can delay the onset of bargaining for a multilateral deal, although Yildiz (2003) argues that such a delay is less likely in two-person bargaining. Thus, overconfidence could rationalize our observed delay in bargaining, and the higher frequency of bargaining with two remaining players. A related argument is that of self-serving biases in Babcock and Loewenstein (1997). Agents with self-serving biases inhibit completion of deals because they have different notions of fairness. In our setting, there are two focal point divisions (equal and proportional divisions) and participants may disagree in a self-serving manner about which type is fair. However, contrary to our findings, these theories do not make any prediction that the success of bargaining should depend on who initiates it.

The most common approach to explaining delay in bargaining is incomplete information (*e.g.*, Cramton, 1992; Kennan and Wilson, 1993). In our context, the private information that each player has may include his skill level (which relates to the expected pay-off absent a deal) or his level of risk aversion (which relates to the cost of delay). Such incomplete information can lead to bargaining delays or even preclude deals. For example, skilled players may assess their own skill higher than other players at the final table do. If this is the case, they will demand a bigger slice of the pie than the other players find acceptable. This will make bargaining more difficult or perhaps even impossible.

The incomplete information approach opens the door for a role for the initiator. When one party initiates bargaining, it could signal information. Similarly, any response, agreement or disagreement by the other parties could likewise reveal information. In a more formal experiment, in which one party would make a specific proposal, and the next party would accept the proposal or make a counter proposal, it might be possible to identify the information revealed. But in our context, where bargaining is more natural and unstructured, the initiator only suggests that a deal is worth discussing and usually does not specify any numbers at first. Still, it seems reasonable to hypothesize that initiating bargaining signals a weak position (*e.g.* a relatively higher level of risk aversion). If a deal is reached, the other players are similarly signalling a degree of risk aversion, but nevertheless, the initiator, by choosing to move first might be revealing relatively more weakness. The fact that highly ranked players initiate bargaining less frequently is in line with the notion that initiation is a sign of weakness.

The above signalling argument would allow for our findings that the success of the deal depends on who the initiator is. However, it would also imply that the initiator should obtain a

26. See, *e.g.*, Roth and Erev (1995), Fudenberg and Levine (1997), Erev and Roth (1998), and Slonim and Roth (1998), for discussions on how learning can affect the outcomes of experimental games.

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smaller pay-off in completed deals. We find no evidence that this occurs. Thus, it is unlikely that standard asymmetric information models can fully describe our results.

The contrast between our two main results, that players in a stronger position are more likely to initiate bargaining, but that the initiator's pay-off is unaffected, is difficult to interpret given existing theories of bargaining. As a result, these findings suggest that there may be behavioural forces at play. Indeed, it appears as if participants are considering the decision to enter negotiations and the decision to agree to particular terms separately, analogous to narrow framing in which people view investment decisions individually and not based on the total effect. Since the terms of the deal indicate that initiators are not revealing information, it appears that by virtue of experience or being chip leader, a player can take a leadership role and successfully encourage others to negotiate. However, when agreeing to the terms of the deal, the initiator no longer has a special role, and players focus on expected values (based on chip stacks) while also showing a tendency to anchor on one of the two focal points—equal division and proportional division.

All in all, while the theories are consistent with some of our findings, they are either refuted by or do not explain other findings. We illustrate this in Table 7, which summarizes the theoretical approaches discussed above, their empirical implications, and the empirical evidence in favour or against them. Certain aspects of bargaining, *e.g.* the delay that often precedes it, are well documented, leading to a theoretical literature that proposes a variety of explanations. However, there has been little empirical research on the role of the initiator, which may explain why the theoretical literature does not directly address it. (As we explain above, existing theories cannot simultaneously explain the importance of the initiator together with the fact that the initiator's pay-off is not systematically affected). We hope that our paper will help change that.

5.2. *Equality and the success of negotiations*

The evidence in Tables 2–5 indicates that equality in the distribution of chips across players is an important determinant of when negotiations are initiated and when they lead to a completed deal. In this section, we take a closer look at this result and show that it is strong and robust to the measure of inequality used.

The previous tables used, the Gini coefficient to measure inequality. To ensure that the results are not driven by that choice, we replicate the main analysis using other variables: the Herfindhal index (often used to measure industry concentration) and the Theil (1967) index T_0.[27] The former is defined as

$$\text{Normalized Herfindhal index} = \frac{\sum_{i=1}^{n} \frac{s_i^2}{S^2} - \frac{1}{n}}{1 - \frac{1}{n}},$$

where S is the sum of all chips, s_i is the number of chips player i holds, and n is the number of remaining players. Note that this formula normalizes the measure so that it is always between 0 and 1, regardless of the number of players.[28] Theil's index T_0 is defined as

$$T_0 = \frac{1}{n} \sum_{i=1}^{n} \ln\left(\frac{S}{n\, s_i}\right).$$

27. We have experimented with additional proxies for inequality, such as Theil's index T_1 (see Theil, 1967) or the sum of absolute deviations of each player's share of all chips from the average share (one over the number of players). All results are equally strong when these alternative measures are used.

28. When the Herfindhal measure is defined as the sum of squared shares, it can take values between $1/n$ and 0. In our case n is small, so the correction in the formula is necessary.

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TABLE 7
Summary of related theories

	Delay in bargaining	Identity of initiator	Initiator's effect on completion of bargaining	Initiator's effect on terms of deal	Characteristics of the environment conducive to bargaining
Empirical results	Bargaining occurs with a significant delay or not at all	Initiator typically in weaker position; Initiator less likely to be experienced or highly ranked	Deals more likely when initiator in stronger position or experienced/ highly ranked	No effect	Larger gains to trade; high risk; equality of outside options; few remaining players; few experienced players
Complete information bargaining	Immediate bargaining (delay requires other benefits of continued play)	Irrelevant	No effect. Deal always completed	No effect	Large gains to trade; high risk
Complete information bargaining with learning	Delay possible	Players with more experience more likely to initiate	?	?	Large gains to trade; high risk; more experienced players
Complete information with biases (overconfidence)	Delay possible, especially in multilateral bargaining	Players who are more overconfident in bargaining and less confident in playing	?	?	Large gains to trade; high risk; few (two) players
Incomplete information	Delay possible	Players who are privately informed of low skill or high risk aversion	Initiating may signal larger gains to trade	Initiator likely disadvantaged	Large gains to trade; high risk
Dissolving a partnership (Cramton *et al.*, 1987)	N/A	N/A	N/A	N/A	Equality of outside options

This table summarizes the central empirical results of the present paper and contrasts them with the implications of large classes of theoretical models. The detailed discussions of these results, as well as relevant references, can be found in Section 5.

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TABLE 8
Bargaining and inequality

	# of remaining players	Gini coefficient	Normalized Herfindhal	Theil's index T_0
Panel A:				
Benchmark (no bargaining)	4·89	0·35	0·10	0·16
Initiation of bargaining	3·66	0·27	0·08	0·10
Difference	1·23***	0·08***	0·02***	0·06***
	(18·89)	(12·81)	(5·57)	(11·99)
Panel B:				
Unsuccessful bargaining	4·02	0·30	0·09	0·12
Successful deals	2·69	0·20	0·06	0·05
Difference	1·33***	0·10***	0·03***	0·07***
	(16·19)	(10·28)	(6·05)	(10·716)
Panel C:				
Successful deals excluding equal divisions	2·89	0·25	0·07	0·07
Benchmark minus unequal divisions	2·00***	0·10***	0·03***	0·09***
	(27·18)	(10·27)	(4·73)	(14·94)
Unsuccessful deals minus unequal divisions	1·127***	0·05***	0·01**	0·05***
	(12·28)	(4·42)	(2·36)	(7·20)

This table presents measures of inequality in chip holdings across players. The three measures of inequality (Gini, Herfindahl, and Theil's index T_0) are described in Section 5.2 The benchmark is the average value across all hands in a tournament, averaged across all tournaments without bargaining. "Initiation of bargaining" is the average value of inequality when bargaining commences. "Unsuccessful bargaining" and "Successful deals" are the average values at the initiation of bargaining separated into those that failed to lead to a deal and those that successfully lead to a deal. Panel C excludes bargaining that lead to equal divisions of the remaining prize pool.

When all chip holdings are equal, the index takes the value of zero and is increasing in inequality.

Table 8 presents the measures of inequality as well as the number of players remaining in the game. Panel A corresponds to Table 4 and compares the initiation of bargaining to typical situations in tournaments without negotiations. For all measures, initiations are associated with a lower than usual level of inequality. Moreover, unreported analysis indicates that the inequality tends to decrease before the initiation of bargaining. This effect is quite pronounced in that only 31% of the time does bargaining commence after an increase in the Gini coefficient. This contrasts with the typical dynamics of the game: inequality tends to increase as the game progresses, *e.g.*, the average change in the Gini coefficient over 10 sequential hands is positive for the benchmark tournaments.

Panel B of Table 8 compares the outcome of negotiations, given that bargaining was initiated. Again, for all measures, the more equal the chip distribution, the more likely it is that bargaining will culminate in a successful deal.

Thus, equality fosters initiation of bargaining, and, once bargaining is in progress, makes a completed deal more likely. It is not immediately clear why this phenomenon occurs. Recall that players can agree to any division of the surplus and could easily address any differences in chip holdings in the terms of the deal. In our view, the best explanation for the role of equality is that of Cramton, Gibbons and Klemperer (1987),[29] who argue from a mechanism design

29. While this theory fits our findings on the role of equality, it is mute on the initiation of bargaining and the role of the initiator.

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perspective that bargaining is more likely to succeed when parties' stakes in an enterprise are close to equal. However, before we discuss this theory, we analyse alternative explanations for why chip distribution may matter. First, the risk of continuing the game, measured as the sum of the standard deviations of future pay-offs, is highest when chip holdings are equal (assuming equal skill across players). Because the benefit of agreeing to a deal is a reduction in risk, the total gains to trade (assuming equal weight on each player's risk reduction) are highest when all chip counts are the same. Second, when players have a similar number of chips, the terms of the deal may gravitate towards the equal division, which, as discussed in Section 4, is a natural focal point. Thus, it may simply be easier to reach agreeable terms when there is more equality. Moreover, if players have a natural preference for equal divisions out of a sense of fairness (as discussed in Roth, 1995 and modelled by Fehr and Schmidt, 1999 and Bolton and Ockenfels, 2000), inequality might make a player disadvantaged enough by an equal split to veto the deal.[30]

These alternative hypotheses fit the data poorly. It is unlikely that the level of equality simply proxies for the gains to trade. In Tables 3 and 5, we control for gains to trade using estimated standard deviations of players' pay-offs. In unreported analysis, we also experimented with other measures, such as the prize pool, total amount of money to be distributed in a deal and its per-player average, etc. Measures of inequality remain important (with similar coefficients) also after the addition of these variables.

Moreover, while equal splits are undoubtedly more frequent when chip holdings are about equal, chip equality makes it easier to reach a deal even excluding equal divisions. In Panel C of Table 8, we consider only completed deals that had an unequal division of the prize money. By focusing on those deals that were ex-post unequal, we are biasing the analysis against finding a relationship between equality of chips and the success of bargaining. Excluding equal splits, the average value of the Gini coefficient at the time of bargaining is 0·251. This value is still significantly below the benchmark Gini coefficient of 0·349. Moreover, it is also statistically significantly smaller than the average Gini for unsuccessful negotiations (0·298).[31]

Given that these alternative hypotheses do not fit the data, we now come back to our favoured explanation, taken from Cramton, Gibbons and Klemperer (1987). The context of their theory is dividing a partnership. In their model, a number of partners jointly own a partnership, each with a potentially different share of ownership, and each having private information about his valuation. Using a mechanism design approach, they show that efficient dissolution is only possible when the partners' claims center around equality. When their claims are very unequal, no agreement is possible. The intuition for this result is that for a mechanism to be incentive compatible, extra value must be left for agents who truthfully reveal their private information. If the claims on the partnership are very unequal, it may be impossible to transfer enough value from those with small claims to induce truthful revelation by the partner with a large claim.

In the context of our tournaments, the remaining players can be viewed as partners in an enterprise that will pay-out the prize pool. At a given time, each player has expected winnings based on the number of chips he possesses. These expected values can be interpreted as the players' shares in the partnership. The private information that each player has can be his risk aversion, skill level, etc. Dissolving the partnership consists of finding a set of pay-offs for each player, *i.e.*, a negotiated division of the prize money. We argue that this constitutes a close

30. Arguably, players who self-select to play in poker tournaments are perhaps less likely to exhibit inequality aversion. Regardless, as we show below, the data does not support the preference for equality argument.

31. As an alternative to this test, we also re-estimated the logit regressions from Table 5 excluding equal splits. The Gini coefficient's estimate is still negative and statistically significant (depending on the specification, it ranges from $-0{\cdot}188$ to $-0{\cdot}247$, with t-statistics between $-2{\cdot}785$ and $-3{\cdot}880$).

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mapping between our setting and the Cramton, Gibbons and Klemperer (1987) model and we view our results that successful deals are strongly negatively related to inequality in chips as important evidence supporting their theoretical arguments. To our knowledge, there has not been empirical confirmation of Cramton *et al.* until now, in spite of that paper's influential contribution to economic theory.

6. CONCLUSION

We use a unique data set to investigate the start and outcome of bargaining. We consider high-stakes poker tournaments in which players can agree to a negotiated division of the prizes instead of playing until the end. The force driving the gains to trade is risk aversion, and our observation that deals occur indicates that at some point, risk aversion is stronger than the pleasure of continuing the game.

Our main result is that the identity of the initiator of bargaining matters. While most negotiations are initiated by relatively poorer agents, the more chips the initiator has, the more likely it is that a negotiations will lead to a deal. A similar effect occurs when the initiator has had success in previous tournaments. These effects, while perhaps in line with common wisdom, are difficult to explain. The terms of the deal are entirely up to the bargaining agents who can compensate rich or well-known players regardless of who originally proposed the division. Indeed, we find that the terms of the deal compensate players with more chips and highly ranked players. In contrast, there is no evidence that the initiator's share in a completed deal is affected, which means that opening negotiations are not a signal of weakness. We are not aware of any theoretical work that would generate this set of predictions, and we hope that our paper will spur investigations in this direction.

Although the data in this paper come from poker tournaments, there are many other contexts in which similar bargaining arises. For example, in litigation, parties can choose to come to a negotiated settlement rather than risk the ruling of a court. More generally, in any commercial transaction, parties can negotiate a deal or, as an outside option, face the uncertainty of finding another counterparty. Economic agents who appear in our sample are obviously not representative of the population at large. Their preference for games of chance (revealed by paying to participate in tournaments) may be behind some of our findings, such as the relatively low frequency of deals. However, our main results on the identity of the initiator, determinants of the division in deals that do occur, etc., are unlikely to be driven by such preferences. Moreover, agents in other situations also frequently display a tendency to disregard risks and "keep playing:" managers may take excessive risks rather than negotiate with their creditors, plaintiffs may insist on excessive pay-outs that make out-of-court settlement less likely, and so forth. All in all, our results should not be viewed in the narrow context of poker tournaments but instead as providing insights into when and how economic agents negotiate.

APPENDIX: EXPECTED VALUE OF THE TOURNAMENT

We use the independent chip model (ICM) to measure the expected value of continuing the tournament. ICM is used by more sophisticated players to estimate the marginal value of a chip when making strategic decisions. While imperfect, it is considered the best available model that can be applied to general situations.[32] Below we present the model and compare its predictions to the empirically observed outcomes of tournaments that did not end prematurely with a deal.

32. See Nelson, Streib and Lee (2007) for a more in-depth discussion of ICM and comparisons to other models.

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Suppose that there are n players remaining and that player i has s_i chips. The total number of chips in the game is $S = \sum_i s_i$. Each chip is viewed as a lottery ticket to win the tournament. Thus, the probability of player i winning first place is s_i/S. (In the two-player game, this is the solution to the well-known gambler's ruin problem.) After first prize is drawn, second prize is drawn from the remaining lottery tickets (excluding those of the first prize winner), so that the probability of winning second prize is the number of chips a player has divided by the total number of remaining chips. Lower-ranked prizes are sequentially awarded in the same manner. This leads to the following probabilities:

$$\begin{aligned}
\Pr(i \text{ wins first}) &= \frac{s_i}{S}.\\
\Pr(i \text{ wins second}) &= \sum_{j \neq i} \Pr(j \text{ wins first}) \times \Pr(i \text{ wins second} | j \text{ first})\\
&= \sum_{j \neq i} \frac{s_j}{S} \times \frac{s_i}{S - s_j}.\\
\Pr(i \text{ wins third}) &= \sum_{j \neq i} \sum_{k \neq i, j} \Pr(j \text{ wins first}) \times \Pr(k \text{ wins second} | j \text{ first})\\
&\quad \times \Pr(i \text{ wins third} | j \text{ first}, k \text{ second})\\
&= \sum_{j \neq i} \sum_{k \neq i, j} \frac{s_j}{S} \times \frac{s_k}{S - s_j} \times \frac{s_i}{S - s_j - s_k}.
\end{aligned}$$

The probabilities of fourth and lower places are computed similarly. The expected value (and standard deviation) can be calculated using these probabilities and the tournament prizes.

Even though the model abstracts away from the detailed features of poker, it fits the data well. Figure 1 presents the comparison between the model's predictions of a player's final rank in a tournament and empirically observed frequencies. We consider all tournaments without a deal and compute model-implied probabilities of a particular outcome using the chip holdings observed the first time only two players remain (top row) or only three players remain in the tournament (two bottom rows). We divide theoretical probabilities into 20 bins, each covering 5% of possible values. The left column of Figure 1 presents a histogram summarizing the number of tournaments that fall within each bin.[33] Graphs in the right column plot the theoretical probability of taking first place (or one of the top two places) against the empirical frequency of that event, computed using tournaments within each bin. Overall, Figure 1 indicates that the model describes the empirical frequencies well.

To further investigate this result, we considered the following test. Let y_i be a binary variable that takes value 1 if a given player takes first place (or one of the top two places). For each tournament, we compute squared deviations of that variable from model-implied probabilities. The average squared deviation is a measure of how well our model describes the data. Under the null hypothesis that the model holds, we calculate the expected value and variance of each squared deviation and standardize it accordingly. By the central limit theorem, the average of the standardized quantities is asymptotically standard normal.[34] For two players and for the

33. The bimodality of the histogram obtained for two players is driven by deal making. Players tend to make deals when their chip holdings and hence the probabilities of winning the tournament are similar. Tournaments with deals are not included in the analysis here.

34. We compute the test statistic using one player from each tournament (the player with the lowest seat number; seat numbers are assigned randomly).

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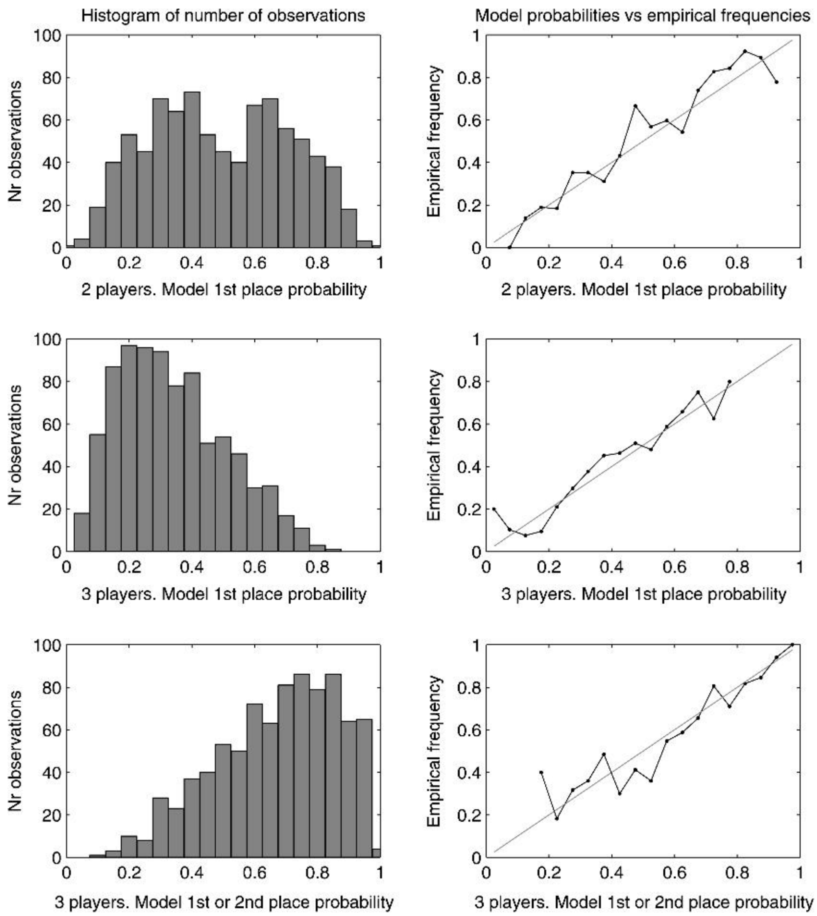

FIGURE 1

Model probabilities vs empirical frequencies. The graphs compare the theoretical probabilities of tournament outcomes implied by the model in the appendix to empirically observed frequencies. The first row presents the probability of finishing in first place when there are two players remaining, and the second (third) row presents the probability of finishing in first (first or second) place when there are three players remaining. Empirical frequencies are based on all tournaments that did not have a deal. In the first (second and third) row, model probabilities are computed using chip stacks right after a third (fourth) player is eliminated and are divided into 20 bins. Histograms in the first column depict the number of tournaments with model probabilities that fall within each bin. The second column plots theoretical probabilities against the empirical frequencies computed using tournaments from each bin that contains at least five tournaments. A 45-degree line is superimposed on the graphs for comparison.

probability of taking first place, the test statistic is $-0{\cdot}497$. For three players remaining and the probability of taking first place (or one of the top two places), the test statistic is $-0{\cdot}247$ ($0{\cdot}156$). Hence, we cannot reject the null hypothesis that the ICM model proposed here holds.

A different model (a generalization of the gambler's ruin problem) could be as follows: With n players remaining, each wins a hand with probability $1/n$. The winning player increases his chips by $n-1$, and all others lose one chip. When a player's chip holdings are reduced to zero he is eliminated, and the game continues with $n-1$ players. This process is repeated until only one

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player remains. Unfortunately, to the best of our knowledge, this well-known model has not been solved for the general case of n players.[35] For this reason, we use the first model to calculate expected values. Luckily, simulations show that the two models give similar probabilities, and in the two-player game, their predictions are identical.

An alternative approach would be to use the empirical probabilities of outcomes as a benchmark. However, the probability of a player finishing in any particular position potentially depends on the entire vector of chip holdings of all remaining players. For more than two players, meaningful estimates of the probabilities of finishing in each position would require far more data than we presently have.

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REFERENCES

ALDERFER, C. P. and BIERMAN, H. (1970), "Choices with Risk: Beyond the Mean and Variance", *Journal of Business*, **43**, 341–353.

ALI, S. N. M. (2006), "Waiting to Settle: Multilateral Bargaining with Subjective Biases", *Journal of Economic Theory*, **130**, 109–137.

BABCOCK, L. and LOEWENSTEIN, G. (1997), "Explaining Bargaining Impasse: The Role of Self-Serving Bias", *Journal of Economic Perspectives*, **11**, 109–126.

BATTAGLINI, M. and PALFREY, T. R. (2007), "The Dynamics of Distributive Politics, *Economic Theory*, forthcoming.

BINMORE, K. (1985), "Bargaining and Coalitions", in Roth A. E. (ed) *Game-Theoretic Models of Bargaining* (Cambridge: Cambridge University Press) 269–304.

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

BRUSS, F. T., LOUCHARD, G. and TURNER, J. (2003), "On the N-Tower Problem and Related Problems", *Advances in Applied Probability*, **35**, 278–294.

CAMERER, C. F. and HOGARTH, R. M. (1999), "The Effects of Financial Incentives in Experiments: A Review and Capital-Labor-Production Framework", *Journal of Risk and Uncertainty*, **19**, 7–42.

CHATTERJEE, K. and SABOURIAN, H. (2000), "Multiperson Bargaining and Strategic Complexity", *Econometrica*, **68**, 1491–1509.

CRAMTON, P. (1992), "Strategic Delay in Bargaining with Two-Sided Uncertainty", *Review of Economic Studies*, **59**, 205–225.

CRAMTON, P., GIBBONS, R. and KLEMPERER, P. (1987), "Dissolving a Partnership Efficiently", *Econometrica*, **55**, 615–632.

CROSON, R. and SUNDALI, J. (2005), "The Gambler's Fallacy and the Hot Hand: Empirical Data from Casinos", *Journal of Risk and Uncertainty*, **30**, 195–209.

EDGEWORTH, F. Y. (1881), *Mathematical Psychics: An Essay on the Application of Mathematics in Moral Sciences* (London: Paul).

EREV, I. and ROTH, A. E. (1998), "Predicting How People Play Games: Reinforcement Learning in Experimental Games with Unique, Mixed strategy Equilibria", *American Economic Review*, **88**, 848–881.

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

FRECHETTE, G. (2009), "Learning in a Multilateral Bargaining Experiment" (Working Paper, New York University).

FRIEDMAN, M. and SAVAGE, L. (1948), "The Utility Analysis of Choices Involving Risk", *Journal of Political Economy*, **56**, 279–304.

FUDENBERG, D. and LEVINE, D. K. (1997), "Measuring Player's Losses in Experimental Games", *Quarterly Journal of Economics*, **112**, 479–506.

GALASSO, A. (2010), "Over-Confidence May Reduce Negotiation Delay, *Journal of Economic Behavior and Organization*, **76**, 716–733.

35. See Bruss, Louchard and Turner (2003). Swan and Bruss (2006) propose a solution for the probability that a player is the first eliminated but not for the probabilities of finishing in any other position.

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GALINSKY, A. D. and MUSSWEILER, T. (2001), "First Offers as Anchors: The Role of Perspective-Taking and Negotiator Focus", *Journal of Personality and Social Psychology*, **81**, 657–669.

GILOVICH, T., VALLONE, R. and TVERSKY, A. (1985), "The Hot Hand in Basketball: On the Misperceptions of Random Sequences", *Cognitive Psychology*, **17**, 295–314.

GUTH, W. and VAN DAMME, E. (1998), "Information, Strategic Behavior and Fairness in Ultimatum Bargaining: An Experimental Study", *Journal of Mathematical Psychology*, **42**, 227–247.

HARDING, J. P., ROSENTHAL, S. S. and SIRMANS, C. F. (2003), "Estimating Bargaining Power in the Market for Existing Homes", *Review of Economics and Statistics*, **85**, 178–188.

KAGEL, J. H. and WOLFE, K. W. (2001), "Tests of Fairness Models Based on Equity Considerations in a Three-Person Ultimatum Game", *Experimental Economics*, **4**, 203–219.

KENNAN, J. and WILSON, R. (1993), "Bargaining with Private Information", *Journal of Economic Literature*, **31**, 45–105.

KNEZ, M. J. and CAMERER, C. F. (1995), "Outside Options and Social Comparison in Three-Player Ultimatum Game Experiments", *Games and Economic Behavior*, **10**, 65–94.

KRISHNA, V. and SERRANO, R. (1996), "Multilateral Bargaining", *Review of Economic Studies*, **63**, 61–80.

NASH, J. F. (1950), "The Bargaining Problem", *Econometrica*, **21**, 128–140.

NELSON, L., STREIB, T. and LEE, K. (2007), *Kill Everyone* (Las Vegas: Huntington Press).

OKADA, A. and RIEDL, A. (2005), "Inefficiency and Social Exclusion in a Coalition Formation Game: Experimental Evidence", *Games and Economic Behavior*, **50**, 278–311.

ROTH, A. E. (1995), "Bargaining Experiments", in Kagel J. H. and Roth A. E. (eds) *The Handbook of Experimental Economics* (Princeton, NJ: Princeton University Press) 171–202.

ROTH, A. E. and EREV, I. (1995), "Learning in Extensive-Form Games: Experimental Data and Simple Dynamic Models in the Intermediate Term", *Games and Economic Behavior*, **8**, 164–212.

RUBINSTEIN, A. (1982), "Perfect Equilibrium in a Bargaining Model", *Econometrica*, **50**, 97–110.

SCOTT MORTON, F., ZETTELMEYER, F. and SILVA-RISSO, J. (2004), "A Test of Bargaining Theory in the Auto Retailing Industry" (Working Paper, Yale University).

SLONIM, R. and ROTH, A. E. (1998), "Learning in High Stakes Ultimatum Games: An Experiment in the Slovak Republic", *Econometrica*, **66**, 569–596.

SWAN, Y. and BRUSS, F. T. (2006), "A Matrix-Analytic Approach to the N-Player Ruin Problem", *Journal of Applied Probability*, **43**, 755–766.

THEIL, H. (1967), *"Economics and Information Theory"* (Amsterdam, The Netherlands: North-Holland).

TVERSKY, A. and KAHNEMAN, D. (1974), "Judgment Under Uncertainty: Heuristics and Biases", *Science*, **27**, 1124–1131.

WHITE, H. (1980), "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity", *Econometrica*, **48**, 817–830.

YILDIZ, M. (2003), "Bargaining Without a Common Prior—An Immediate Agreement Theorem", *Econometrica*, **71**, 793–811.

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