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ABSTRACT

This paper uses detailed data on sequential offers from seven vastly different real-world bargaining settings to document a robust pattern: agents favor offers that split the difference between the two most recent offers on the table. Our settings include negotiations for used cars, insurance injury claims, a TV game show, auto rickshaw rides, housing, international trade tariffs, and online retail. We demonstrate that this pattern can arise in a perfect Bayesian equilibrium of an alternating-offer game with two-sided incomplete information, but this equilibrium is far from unique. We then provide a robust-inference argument to explain why agents may view the two most recent offers as corresponding to the potential surplus. Split-the-difference offers under this weaker, robust inference can then be viewed as fair. We present a number of other patterns in each data setting that point to split-the-difference offers as a strong social norm, whether in high-stakes or low-stakes negotiations.

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1 Introduction

The effects of fairness notions in bilateral bargaining have been widely explored in laboratory experiments. A number of studies document such influences, in particular demonstrating a bias toward an equal split of a known pie; see Camerer (2011) for a review. Little is known, however, about how these norms play out in the field, where assumptions of complete information in laboratory experiments are unlikely to hold. In this paper, we document a largely understudied fact: agents in real-world settings favor offers that split the difference between the two most recent offers on the table (the most recent offer of the proposer and the most recent offer of the counterparty). Such offers are "fair" only in that they lie halfway between the possible range of likely subsequent offers at the current offer history; they do not necessarily constitute a fair split of the actual surplus available to the agents. We offer a new robust-inference argument for how agents may nonetheless view these offers as "fair."

Our empirical evidence comes from novel, detailed data on sequential offers from seven vastly different bargaining contexts: business-to-business negotiations for used cars in the U.S. (using data overlapping that of Larsen 2021); pre-trial settlement bargaining on insurance injury claims in the U.S. (using a superset of the data studied in Prescott et al. 2014); street negotiations from a quirky TV game show in Spain (using data from Hernandez-Arenaz and Iriberri 2018); bargaining for auto rickshaw rides in India (using data from Keniston 2011); international trade tariff bargaining (using data from Bagwell et al. 2020); online retail negotiations from eBay.com (using data from Backus et al. 2020); and bargaining over housing through a real estate dealer (using a new dataset we have acquired). In each setting, we find strong evidence of split-the-difference offers—a clear mode at the 50/50 point between the two most recent offers.[1] To our knowledge, the widespread nature of this phenomenon—across very different bargaining settings—was previously unknown.

We then ask what model could possibly rationalize this behavior. We first demonstrate that split-the-difference offers can be sustained as a perfect Bayesian equilibrium (PBE) of

[1] The term *split-the-difference* appears in previous experimental research on bargaining with different meanings. Binmore et al. (1989), for example, use it to describe bargaining outcomes in which the players divide a known surplus net of their respective outside options. We emphasize that, in the present paper, split-the-difference offers refer to those that lie at the midpoint between the two most recent offers. As an example, to make these ideas concrete, suppose, in an alternating-offer game, at some point when it is the seller's turn, the seller proposes \$200, then the buyer proposes \$160, and then it is the seller's turn again. We refer to the \$200 and \$160 offers as the *two most recent offers*, and, if the seller next proposes \$180, we refer to this as a *split-the-difference* offer.

an alternating-offer bargaining game with two-sided private information, even with continuously distributed player valuations and overlap in the support of buyer and seller valuations, a result that is new to the literature.[2] Microfounding this behavior is quite involved because we must consider players' evolving beliefs in a two-sided signaling game. Analysis of such bargaining environments in the literature has largely been restricted to mechanism-design approaches rather than extensive-form solutions (e.g., Myerson and Satterthwaite 1983). As highlighted by Ausubel et al. (2002), there is no known complete characterization of equilibria in this setting, and this point is still true today.

While split offers can be sustained in a PBE, the equilibrium is far from unique. Thus, while the behavior is compatible with PBE, it is by no means *predicted* by it. Furthermore, PBE does not explain why, from a continuum of possible equilibria, we would observe the split-the-difference behavior to be so common. In particular, the PBE framework is incompatible with the standard "fairness-based" explanation for this behavior: since equilibrium offers do not correspond to actual values or costs, splitting the difference between offers does not yield an equal split of the surplus.[3]

We then present a robust-inference approach that explains why agents may indeed view an equal split of the two most recent offers as "fair." Our argument relies on agents making inferences about the support of their opponent's valuation based only on the fact that the opponent did not accept the agent's previous offer; we assume agents do not base inferences specifically on the *level* of an opponent's counteroffer. Consider a case where a seller initially proposes a price of $100. The buyer does not accept this offer but instead counters at $50.

[2]These features—a continuum of values, two-sided uncertainty, two-sided offers, and support overlap—have been notoriously complicated to analyze in theoretical models of bargaining. To our knowledge, the only equilibria analyzed in existing theoretical work that allows for these features are found in Perry (1986), where bargaining ends immediately in agreement or disagreement, and Cramton (1992), where at most two serious offers occur in equilibrium. Neither of these equilibria can rationalize the behavior we observe. Other theoretical models of bargaining with two-sided incomplete information consider two-type cases (e.g., Chatterjee and Samuelson 1988), cases where only one party is allowed to make offers (e.g., Cramton 1984), or cases where incomplete information is not about valuations but rather about obstinance (e.g., Abreu and Gul 2000) or about discount factors (e.g., Watson 1998). In these latter two cases, because players do not face incomplete information about their opponents' valuations, there is no uncertainty about whether gains from trade exist, and hence negotiating parties always agree in equilibrium. Our environment relaxes this constraint, allowing for disagreement in equilibrium.

[3]Indeed, in an alternating-offer game, the only way that an equal split between offers could correspond to an actual equal split of the surplus is if the seller's previous offer corresponds precisely to the buyer's value and vice versa. However, if agents have such precise knowledge of their opponents' values, we are in the classic complete-information Rubinstein (1982) game. In this type of game, the equilibrium cannot generate an outcome of two offers followed by a split-the-difference offer, because the unique subgame perfect Nash equilibrium involves a single offer that is immediately accepted by the counterparty.

What can the seller infer about the buyer's valuation from the fact alone that the buyer *rejected* \$100?

To answer this question, we rely on the concept of *sequential best-responses* (see Battigalli and Siniscalchi 2002), that imposes only weak assumptions about rationality. We show that, for all buyer types (i.e., buyers with some valuations) below \$100, rejecting the \$100 offer is a sequential best-response to *every* belief that the buyer may hold about the seller's type. And we show that, for all buyer types above \$100, accepting is a sequential best response to *some* belief a buyer could hold. In this sense, \$100 is the highest buyer type that the seller cannot rule out (1) on the basis alone of that buyer's rejection of \$100, and (2) under the assumption that the seller knows the buyer is behaving rationally according to some belief. A similar argument applies to the buyer's inference about the seller's valuation if the seller rejects the buyer's counteroffer of \$50. Together, these arguments offer an explanation for how a buyer and a seller might jointly view the gap between the two most recent offers—$[50, 100]$—as the *potential surplus*, or the *most optimistic* inference agents' could make about their opponents' type based on rational past-offer rejections. In this light, an offer that splits the difference between the two most recent offers—an offer of \$75 in this example—can be viewed as "fair," an equal split of the potential surplus.

We document several other patterns consistent with split-the-difference offers arising as a strong social norm. First, we show that split-the-difference offers are more likely to be accepted by the opposing party—more likely even than offers that are slightly *more favorable* to the opposing party. Second, we demonstrate that it is indeed the two most recent offers in a bargaining sequence to which players gravitate: proposing an offer at a later stage of the game that splits the difference between earlier offers (or between other potential anchor points specific to the bargaining setting) is less common than proposing to split the difference between the two most recent offers. Third, we find that split-the-difference offers are more likely to be followed by subsequent split-the-difference offers within a given bargaining sequence. We also show that certain agents are more likely to follow this norm than others. Fourth, we show that a seller is less likely to propose a 50/50 split if one of the two most recent offers is an extremely low buyer offer, and thus the 50/50 norm is constrained by the disparity between the two previous offers. Finally, we demonstrate that, in some settings, at histories of the game where only one seller offer has been made so far, buyers demonstrate a propensity to propose offers that split the difference between that offer and zero. These patterns are consistent with our robust-inference theoretical explanation.

We see our paper as demonstrating that there is a convention—not an ironclad convention, but a notable convention—that when an agent makes an offer in a real-world negotiation, they are inclined to split the difference between the two most recent offers and, further, that offers that abide by this convention are more likely to be accepted, ending the game. Moreover, our paper establishes *why* such behavior could be viewed as "fair" in some sense, even though the two most recent offers are themselves endogenous equilibrium objects and thus the halfway point does not actually correspond to an equal split of the pie.

While analysis of fairness in incomplete-information settings is rare, the prevalence of equal splits of a *commonly known surplus* has been widely documented in lab experiments. It occurs in relatively simple experiments, such as those involving the dictator and ultimatum games, as well as in less structured bargaining studies allowing the subjects to freely negotiate over the division of a pie. For excellent reviews of this vast literature, see Roth (1995) and Camerer (2011). Whereas previous research has mostly focused on the final outcomes of negotiations, a key feature of the datasets we analyze in this study is that they contain complete bargaining *sequences*—in some cases hundreds of thousands of them—with information on all of the back-and-forth offers within each sequence. Such information allows us to document the widespread nature of offers that split the difference between the two most recent offers on the table.[4] In that sense, our paper relates to the empirical evidence in Backus et al. (2020), who highlight a variety of patterns in the eBay bargaining setting, including a propensity of agents to make and accept split-the-difference offers. The eBay case is one of the seven settings we study herein, and we document a number of new dimensions of this behavior, in addition to offering a theoretical model.[5]

[4] To be clear, a large number of experiments in the lab involve alternating-offer bargaining; see, for example, Binmore et al. (1985), Ochs and Roth (1989)) and Binmore et al. (1989). These experiments have investigated issues such as time discounting and the relevance of outside offers in bargaining. Andreoni and Bernheim (2009) focus on bargaining with complete information and offer a model and experimental results demonstrating how an equal split of a known pie can arise from a preference to appear equitable (a concern for *social image*). Other related studies include Roth and Malouf (1979) and Roth (1985). We reiterate that, to the extent of our knowledge, the experimental literature has not analyzed the split-the-difference patterns that we study in this paper.

[5] This type of detailed bargaining data we study in our seven empirical settings—each containing the full back-and-forth sequence of endogenous offers—is relatively new. As such, split-the-difference offers have been naturally understudied thus far. Several other studies analyze bargaining settings outside of those

Our robust-inference argument is consistent with recent data from Huang et al. (2020), who study lab subjects in ultimatum games under incomplete information. These games have starkly different strategic incentives compared to alternating-offer bargaining. In one treatment, the proposer (buyer) is unaware of the receiver's (seller's) cost, but the receiver knows both the value and cost. In their data, the modal offer is exactly halfway between the proposer's value and the most optimistic belief that the proposer could hold about the receiver's cost (Huang et al., 2020, Figures B4.c and B4.d). Our study of field data offers a similar insight: agents in incomplete-information bargaining gravitate toward a notion of "fairness" that does not correspond to an equal split of the surplus. Our paper provides strong evidence that these behavioral norms are an important feature of negotiations that extend well beyond the lab, appearing in high-stakes and low-stakes negotiations, regardless of whether these negotiations involve consumers, large businesses, game-show participants, or nations.

The rest of the paper is organized as follows. Section 2 describes each of our seven data settings, and Section 3 contains our main empirical results documenting the prevalence of split-the-difference offers. Section 4 presents both our PBE derivation and our robust-inference argument. Section 5 provides further empirical results supporting the view that split-the-difference offers constitute a social norm, and Section 6 concludes.

2 Description of Field Settings

We now introduce the field settings from which we obtain our bargaining data. A benefit of the question we study in this paper—how the current offer in a sequential bargaining game relates to the two most recent offers—is that we can address the question in each of these field settings even though the products or outcomes over which agents negotiate differ drastically from setting to setting. In particular, in each setting, we observe data on many bargaining *sequences* (which we also refer to as *threads*) and, for each sequence, we observe the full set of sequential offers between negotiating parties. We consider an *observation* to

we study and also have access to sequence-level bargaining data, but do not focus on split-the-difference behavior. Examples include Byrne et al. (2019) (studying a field experiment for retail electricity service), Dunn et al. (2021) (studying medicare claim reimbursements), van Dolder et al. (2015) (studying the division of a game show jackpot), and Merlo and Ortalo-Magne (2004) and Mateen et al. (2021) (studying other housing markets).

be an offer triple: the current offer and two preceding offers.

We drop from every dataset any bargaining sequences in which there are fewer than three offers. This step is nuanced in some data settings, and we describe those nuances below. We drop any threads in which an agent makes an offer exactly equal to the opponent's previous offer (which logically should have ended the game in agreement) but additional actions are recorded. We also drop any sequences in which an offer lies outside the two most recent offers, or cases in which a seller's offer lies below a buyer's offer.[6] We describe additional cleaning steps for each dataset in Appendix B.

2.1 Business-to-Business Used-Car Bargaining

The first dataset comes from the U.S. wholesale used-car industry and consists of tens of thousands of bargaining sequences. In this market, owners of used-car dealerships buy vehicles from other dealerships as well as from large companies, such as Hertz (rental cars), Wheels (a fleet company), Bank of America (selling off-lease or repossessed vehicles), or Ford (selling lease buy-back cars). All negotiating agents are professionals or businesses experienced in these negotiations. This industry underlies the supply side of the used-car market in the U.S.; similar platforms exist internationally. About 15 million cars are up for sale through this market annually, totaling over $80 billion in sales. For each car, an auction house runs a secret-reserve-price ascending auction, followed by bilateral bargaining between the seller and the highest bidder if the auction price falls short of the reserve price. The data we use here comes from this post-auction bargaining stage.

The dataset comes from six auction houses from January 2007 to March 2010. The dataset records each distinct attempt to sell the vehicle through the mechanism, and, for each attempt, every alternating offer proposed by either the buyer or the seller, as well as the outcome of the bargaining. This data overlaps in part with the data used in Larsen (2021), but contains additional bargaining sequences that were dropped in that analysis. This new inclusion highlights a major benefit of our empirical approach: the structural exercise of Larsen (2021) required careful data cleaning and controlling for heterogeneity

[6] Such behavior likely corresponds to misrecorded data or to cases where some feature of the bargaining environment changes prior to the current proposed offer, such as the arrival of additional information or a new outside option for an agent. Dropping such threads eliminates fewer than 2% of observations in most data settings, but as many as 24% in some data settings where the arrival of new information or misrecorded offers may be more prevalent. We discuss this in Appendix B.

in the items over which the parties negotiated, whereas our approach only requires looking at split-the-difference patterns between offers in a given bargaining sequence, regardless of heterogeneity across items.

Descriptive statistics for this dataset are shown in the first column of Table 1. This dataset consists of 21,734 total bargaining sequences and 33,356 observations (offer triples). The first bargaining offer in this game is always the auction price: the bargaining begins with the auction house calling the seller over the phone to report that the auction price is below the reserve price, and this starts an alternating-offer bargaining game. The seller can choose to accept the auction price, propose a counteroffer, or quit (ending the game). The bargaining process is typically wrapped up within a day, with an average of several hours between each offer. The average first offer (auction price) is \$7,444, followed by an average counteroffer from the seller of \$8,918. The average number of offers in a sequence in the used-car sample is 3.53 and the average last price offered is \$8,072.[7] The negotiation ends in agreement 59% of the time, at an average accepted price of \$7,987. The γ_t objects reported in Table 1 are defined and discussed in Section 3.

2.2 Pre-trial Settlement Bargaining from Insurance Claims

The second dataset comes from the pre-trial settlement bargaining over injury claims made under U.S. auto and general liability insurance policies.[8] This dataset consists of extensive proprietary information about all claims made to a large national auto and general liability insurer that closed between January 1, 2004, and March 31, 2009. The data contains details about the underlying accident, the alleged injury, the involved parties, the insurance contract, and all attempts by the parties to resolve the associated dispute.

In these insurance cases, plaintiffs allege that injurers caused harm covered by the insurer's policies. If a plaintiff asserts damages within policy limits or declines to pursue the insured individually for any excess—or if the insurer agrees to cover any damages in excess of the insurance contract's policy limit, which effectively it must do to act in "good faith" if it turns down an offer by the plaintiff for the policy limit or less—the insurer effectively

[7] As highlighted at the beginning of Section 2, for every data setting, our analysis conditions on bargaining sequences that include at least three offers.

[8] Prescott et al. (2014) studies a small subset of this information, but the data we use in this paper—particularly the bargaining threads—remains largely unexplored.

Table 1: Descriptive Statistics of Bargaining Settings

	Cars	Settlement	TV Show	Rides	Housing	Trade	eBay
# Threads	21,734	74,356	204	2,058	176	44,048	6,976,776
# Offer Triples	33,356	208,463	714	2,986	176	46,985	9,789,903
Rounds	3.53	4.80	5.50	4.32	3.00	3.07	3.40
Pr(Agree)	0.59	0.94	0.91	0.39	0.73	0.08	0.29
First Offer	$7,444	$36,391	€19.50	₹51.69	$460,849	0.00	$151.06
Second Offer	$8,918	$64,042	€124.27	₹36.73	$430,071	69.60	$88.71
Final Offer	$8,072	$24,728	€56.67	₹39.50	$451,248	38.30	$122.70
Accept Price	$7,897	$21,838	€55.37	₹42.54	$469,658	24.29	$91.40
γ_3	0.39	0.29	0.32	0.28	0.71	0.44	0.42
γ_4	0.18	0.43	0.31	0.24		0.26	0.38
γ_5	0.38	0.29	0.25	0.18		0.33	0.23
γ_6	0.14	0.39	0.28	0.16			0.31
γ_7	0.33	0.30	0.19	0.17			0.19
γ_8	0.12	0.38	0.34	0.27			
γ_9	0.45	0.32	0.09				
γ_{10}	0.00	0.38	0.38				

Notes: Table shows the number of sequences/threads and number of offer triples in each data setting, as well as averages for several variables in the data. For $t \geq 3$, the variable γ_t denotes the average concession weight in bargaining round t, as defined in Section 3. The units for the average first, second, final, and accept prices are euros for the TV Show and Indian rupees for the Rides setting. The trade setting combines offer sequences in which the units are percentages and sequences where the units are a currency. Units are unimportant for our analysis, which relies on the unit-less γ_t weights.

replaces the injurer as the defendant in any dispute, which occurs in virtually all cases. Under these circumstances, the plaintiff and the insurer bargain over the amount that should be paid by the insurer to the plaintiff. This process can take many months to reach a conclusion. If they cannot reach an agreement, the two parties will pursue litigation, with the injurer filing a complaint. The parties may also negotiate and settle the claim during litigation. Importantly, the insurer records the amount of each back-and-forth proposal made by either the insurer or the plaintiff and whether the parties reach an agreement in these negotiations.

After cleaning, our sample contains 74,356 bargaining threads and 208,463 offer triples. Table 1 shows that the average first offer is $36,391, followed by a counteroffer of $64,042 from the opposing party, and an average final offer of $24,728. The negotiations include 4.8 offers on average and end in agreement 94% of the time, at an average accepted price of $21,838. This number is not between the average first and second offers because of a feature of negotiations in this setting: the first offer may come from the plaintiff or from the insurer, and, in computing the average first and second offers, Table 1 pools over these two cases.[9] Appendix B discusses this point in more detail and describes how we clean the data to form alternating-offer sequences.

2.3 Street Bargaining from a TV Game Show in Spain

The third dataset comes from a TV game show in Spain titled *Negocia Como Puedas* (roughly, "Bargain However You Can") analyzed in Hernandez-Arenaz and Iriberri (2018).[10] This data was generated in the streets of several major Spanish cities in summer 2013. In a typical episode of the show, the host approaches individuals in the street and invites them to participate in the game. Upon acceptance, an individual (the *proposer*) is endowed with a potential pie of 100 euros and is asked an easy question. The proposer is not allowed to answer the question herself. Instead, she must, within a three-minute limit, (i) find a passer-by (the *responder*) able to provide an answer to the question that the proposer finds satisfactory, and (ii) negotiate a price that the proposer will pay the responder in order to be able to use that answer.

If the negotiations succeed and the responder's answer to the original question is correct (as determined by the host), the proposer pays the responder the agreed amount. The proposer then moves on to a new question, referred to as a new stage of the game, where the process is repeated. In the new stage, the size of the pie increases (by 200 euros in the second stage, 300 in the third, and 1,000 in the fourth). In any stage of the game, if the proposer does not reach an agreement within the three-minute time limit, the game ends, and the proposer gets nothing. Throughout the game, the size of the pie is only known to the proposer, not the responder. In any given stage of the game, the bargaining is unstructured, but the negotiations typically follow an alternating-offer structure, with the proposer making the first offer. We only keep those threads in which offers clearly alternate between parties. Additional details on the cleaning of the data are found in Appendix B.

In the data, we have 204 sequences and 714 offer triples. Table 1 shows that the average first offer is 19.5 euros, followed by an average second offer of 124.3 euros and an average final price of 56.7 euros. The game ends in agreement most of the time (91%), after an

[9]Examining these two cases separately, the average final offer is indeed between the average first and second offers.

[10]For an episode of this TV show, see https://www.cuatro.com/negocia-como-puedas/completos/Negocia_como_puedas_online_2_1652205034.html.

average of 5.5 rounds and at an average final price of 55.4 euros.

2.4 Auto Rickshaw Rides Bargaining in India

The fourth dataset comes from the local transportation market by auto rickshaw in Jaipur, India. An auto rickshaw is a form of three-wheeled mini-taxi, officially capable of carrying three passengers in a semi-enclosed back seat. Auto rickshaws are the primary means of rented transportation in Jaipur. During the period in which Keniston (2011) collected the data (January 2008 to January 2009), all prices were set by negotiation.

The data was collected by surveyors (whom we also refer to as buyers) who followed one of two possible protocols. In *real* bargaining, buyers were assigned to travel by auto rickshaw along fixed routes through the city, bargaining for the price of each ride. At the beginning of each route, buyers were paid a lump sum slightly higher than the expected cost of the route, and were allowed to keep any money not spent on autorickshaw fares. At the end of their assigned trip, they were free to return to their homes or alternate employment. Thus, their financial incentives and cost of time were similar to real trips taken for personal purposes. In *scripted* bargaining, buyers negotiated with sellers according to a written bargaining script (prepared by Keniston) consisting of a sequence of pre-determined counteroffers. Scripted surveyors were instructed to act as if they were bargaining in a realistic manner so that drivers (whom we also refer to as sellers) would respond as naturally as possible. After the conclusion of the bargaining, surveyors wrote down the series of offers made by the drivers and themselves. Drivers were not aware that they were part of a field experiment. The average negotiation took 55 seconds to complete.

In our analysis below, we exclude any offers or responses that come from scripted surveyors, as they do not represent actual reactions. Additional details on data cleaning are found in Appendix B. Our main sample consists of 2,058 bargaining threads and 2,986 offer triple observations. Table 1 demonstrates that the average first offer was 52 rupees, followed by an average counteroffer of 37 rupees and a final offer of 40 rupees. Negotiation ended after an average of 4.32 offers, ending in agreement 39% of the time at an average accepted price of 43 rupees.

2.5 Bargaining in Residential Real Estate

The fifth dataset we use is new to the literature and comes from a growing residential real-estate broker company that offers discounted agency fees of 2–3% rather than the traditional 6%. We collected this dataset in collaboration with the company, covering a number of houses on the market from 2015 to 2019 in Colorado. This dataset differs from the others we analyze in that we only observe offers placed by potential buyers, not by the seller. The company informs us that seller counteroffers are indeed quite rare in this market. Rather, the typical negotiation proceeds with a seller list price (which we treat as the first offer) followed by sequential offers from the buyer. For a given home, we observe the seller's list price and each offer placed by potential buyers. The time on the market for a given home can be several weeks or several months. In this setting, we consider split-the-difference behavior to be cases in which a buyer makes an offer and then, if that offer is rejected, subsequently makes an offer that splits the difference between the list price and the buyer's initial offer.

Table 1 shows that our sample has 176 threads and the same number of offer triples. This feature is by construction: our main object introduced in Section 3 cannot be defined in cases where one party makes three consecutive offers; thus, we only keep the seller's list price and the first two offers from the buyer, i.e., one offer triple for each bargaining sequence. These bargaining sequences end in agreement 73% of the time. Bargaining begins with an average list price of $460,849, followed by an average second offer of $430,071, and a final offer of $450,248. When parties agree, they end at an average price of $469,658. Additional details on data cleaning are found in Appendix B.

2.6 International Trade Tariff Bargaining

The sixth dataset contains detailed information on international trade negotiations recently declassified by the World Trade Organization (WTO). In these negotiations, countries bargain over commitments on their respective import tariffs. Despite the multilateral nature of both the WTO and its predecessor, the General Agreement on Tariffs and Trade (GATT), the negotiations are mostly bilateral, with individual country pairs making *requests* and *offers* over the tariff for a specific tariff-line (a product code).

We use the dataset of Bagwell et al. (2020), which comprises the Torquay Round (1950–1951). This data includes 298 bilateral bargaining pairs from 37 countries, negotiating tariffs over thousands of tariff-line products. A bargaining thread is defined as two countries (*proposer* and *target*) negotiating a tariff over a tariff-line product. In each thread, we observe all requests from the proposer and offers from the target. As documented in Bagwell et al. (2020), relatively few back-and-forth offers and counteroffers take place in any given thread. For our analysis below, we consider whether a proposer requests a tariff that splits the difference between a zero tariff and the existing tariff (the status quo before the negotiations). Thus, to map the zero-tariff and existing tariff possibilities into the same framework as the other data settings, Table 1 considers a zero tariff as the de facto initial request from the proposer (and, indeed, a zero tariff is frequently an actual request made in this setting). Similarly, Table 1 considers the existing tariff as the initial offer from the target (the "second offer" in Table 1). This point is discussed further in Section 5.4. All subsequent requests and offers are also recorded in the data.

Table 1 shows that the sample consists of 44,048 bargaining sequences and 46,985 offer triple observations. The game proceeds for 3.07 offers on average, ending in agreement 8% of the time. Note that here we combine sequences in which the units are percentages and sequences in which the units are a currency; thus, we provide no units on these averages of offers in Table 1 and their values are hard to interpret. However, units are unimportant for our analysis, which relies on the unit-less γ_t weights (described in Section 3). Additional details on data cleaning are found in Appendix B.

2.7 Bargaining on eBay's Best Offer Platform

Our final field setting comes from eBay's Best Offer negotiation platform. eBay is well known as a platform for buying and selling via auctions or fixed prices. Less well known is the bargaining mechanism on eBay, through which a buyer and seller negotiate via alternating offers (limited to three offers by each party). The game begins with the seller posting a list price. An interested buyer can pay this price or make an offer. Offers are sent through the eBay platform, and the receiving party has 48 hours to respond by either accepting, declining, or proposing a counteroffer. Our data comes from internal data collected by Larsen and coauthors for a separate project (Backus et al. 2020), and consists of all bargaining sequences placed on eBay (regardless of the product) from June 2012 through May 2013.

The sample consists of 6,976,776 bargaining sequences, comprising 9,789,903 offer triple observations. These sequences contain an average of 3.4 offers. The average list price is \$151, average second offer is \$89, and average final offer is \$123. When trade occurs (which happens 29% of the time), the final agreed-upon price is \$91.

3 Split-the-Difference Offers are Widespread

We now demonstrate a key empirical pattern: agents favor offers that split the difference between the two most recent offers. To show this, we first introduce some useful notation. For each data setting, we organize each sequential bargaining thread in the following way. For each round $t = 1, 2, ...$ in the bargaining thread j, we observe the proposed amount, $p_{j,t}$. This proposed amount is an offer made by the seller/buyer, insurer/plaintiff, proposer/respondent, driver/surveyor, proposer/target, etc. If $p_{j,t}$ comes from one player, $p_{j,t+1}$ must come from the opponent—with the exception of threads in the housing dataset, as we explain later in this section.

We can write the proposed amount in round $t \geq 3$ as a weighted average of the proposed amount in the previous two rounds: $p_{j,t} = \gamma_{j,t} p_{j,t-1} + (1 - \gamma_{j,t}) p_{j,t-2}$. Therefore, $\gamma_{j,t}$ represents, for bargaining thread j, the weight that the player in round t places upon the opponent's previous offer, and $1 - \gamma_{j,t}$ represents the weight the player places on her own previous offer. We can think of $\gamma_{j,t}$ as how much a player *concedes* to her opponent when she is making a counteroffer, or her *concession weight*. Rearranging to solve for $\gamma_{j,t}$ yields

$$\gamma_{j,t} = \frac{p_{j,t} - p_{j,t-2}}{p_{j,t-1} - p_{j,t-2}}.$$

As highlighted in Section 2, in the housing dataset, we observe a seller's list price and a given buyer's offers, and in no bargaining thread does the number of offers from the same buyer exceed two. In this setting, we only define the concession rate for the second buyer's offer. Specifically, we let

$$\gamma_{j,3} = \frac{p_{j,3} - p_{j,2}}{p_{j,1} - p_{j,2}},$$

where $p_{j,1}$ is the list price, $p_{j,2}$ is the first buyer's offer and $p_{j,3}$ is the second buyer's offer.

Thus, in the housing dataset, $\gamma_{j,3}$ represents the weight a buyer places on the list price, and $1 - \gamma_{j,3}$ the weight she places on her own initial offer.

The advantage of focusing on concession weights is that they are unit-less and do not require considering any heterogeneity across negotiation threads. We can easily calculate them in any of the settings we study, and we can then analyze whether patterns of concession weights are consistent across these diverse settings. The average $\gamma_{j,t}$ for each round of the game, beginning with $t = 3$, is shown in Table 1. We observe as many as ten $\gamma_{j,t}$'s in some settings,[11] and, as highlighted above, only the round-3 $\gamma_{j,t}$ in the housing setting. The average $\gamma_{j,t}$ in each round is below 0.5 (other than for housing, where it is 0.71), suggesting that most agents make offers closer to their own previous offers than to their opponent's. In the settlement data, the average $\gamma_{j,t}$ is roughly 0.3–0.4 in every round of the game, whereas in the cars setting, $\gamma_{j,t}$ tends to be much smaller in even rounds, which correspond to the seller's turn in this setting, suggesting that sellers generally concede less than buyers in this setting.

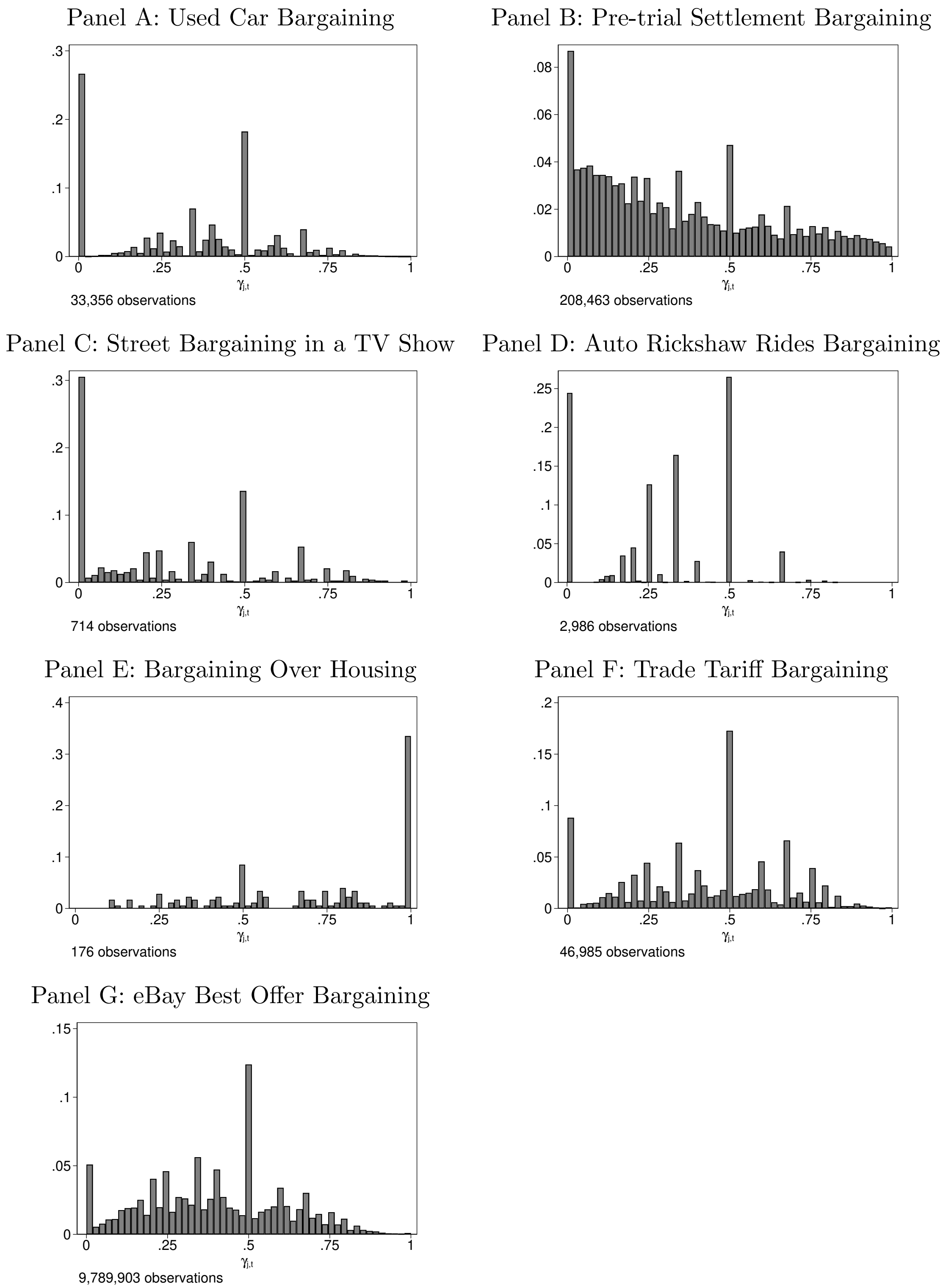
The main pattern we wish to examine is whether agents in each of these settings exhibit a tendency to make offers that lie halfway between the two most recent offers on the table (i.e., $\gamma_{j,t}$ close to 0.5). Figure 1 plots a histogram of these concession weights, with each panel corresponding to one data setting. To keep the number of figures manageable, we pool together $\gamma_{j,t}$ for all $t \geq 3$; our results are similar if we analyze $\gamma_{j,t}$ from each round t separately. Despite the drastic differences in the environments, products, outcomes, or agents, an interesting pattern stands out in all datasets: there is a mass point at 0.5—counteroffers that are halfway between the previous two offers, or split-the-difference offers.[12]

To our knowledge, the widespread nature of this split-the-difference pattern in negotiations in the field has not previously been documented. Existing evidence on split-the-difference behavior comes largely from laboratory experiments, and generally relates to the idea of players equally splitting a *commonly known* pie. This complete-information assumption would not hold in any of the settings we study: players are not splitting a known pie, because no player knows the full willingness to pay or willingness to sell of her opponent.

[11] Some settings have bargaining threads exceeding ten rounds, and we truncate them to the first ten rounds in Table 1.

[12] Another common mass point in these histograms is at zero, representing cases where a player does not budge at all. In the housing dataset, a mass point at 1 is also common, representing that an agent fully concedes to the seller's list price.

Figure 1: Distribution of Concession Weights $\gamma_{j,t}$



Notes: Each panel shows a histogram of $\gamma_{j,t}$ in a given data setting.

Rather, our settings—and, arguably, most real-world negotiations—involve private information, and players in our settings are therefore proposing offers that split the difference between endogenous *offers*, not offers that split the actual surplus equitably.

4 What Model Could Generate This Behavior?

We now turn to the question of what theoretical model of bargaining might generate this type of behavior. In doing so, we take two approaches. First, we consider whether such behavior can arise in a standard game theoretic framework—perfect Bayesian equilibrium (PBE). We prove that there exists a PBE with split-the-difference behavior, but there are many other equilibria without it. Hence, while PBE is not falsified by splitting the difference, it neither explains nor predicts the behavior. In response to this critique, we then propose an alternative, robust argument that, without imposing a complete equilibrium model, explains how agents might view an equal split of the difference between the last two offers as a fair outcome, even though in reality it does not correspond to realized surplus.

We consider an alternating-offer game with two-sided incomplete information: neither the buyer nor the seller knows the other party's valuation for the good. The buyer has a value b and the seller a value s, each of which are in $[0, 1]$, drawn independently according to CDFs $F_b : [0, 1] \to [0, 1]$ and $F_s : [0, 1] \to [0, 1]$. Time is discrete, and the discount factor for both players is $\delta \in (0, 1)$. If an offer of price p is accepted at time t, the buyer's present discounted utility is $\delta^{t-1}(b - p)$ and the seller's is $\delta^{t-1}(p - s)$. Without loss of generality, we focus on a game in which the seller is the first proposer.

4.1 A PBE with Split-the-Difference Behavior

We construct a PBE of the game that has split-the-difference behavior at every history on the path of play. For ease of construction, we assume that both values are uniformly distributed, $F_s(v) = F_b(v) = v$. We study the "no-gap" case (Fudenberg and Tirole 1991) in which F_b and F_s have overlapping support, which introduces a number of challenges for analysis.

The following preliminary lemma first establishes an equivalent way to represent sequences of split-the-difference offers. The proof for this lemma, and all other proofs, are found in Appendix A.

Lemma 1. *Consider any sequence* $\{x_t\}_{t=1}^{\infty}$*, such that for* $t \geq 3$*,* $x_t = 0.5x_{t-2} + 0.5x_{t-1}$*. This is equal to the sequence* $\{y_t\}_{t=1}^{\infty}$*, defined by* $y_t = \overline{x} + \left(-\frac{1}{2}\right)^{t-1}\alpha$*, where* $\overline{x} = \frac{1}{3}x_1 + \frac{2}{3}x_2 = \lim_{t\to\infty} x_t$ *and* $\alpha = x_1 - \overline{x}$*.*

We now argue that, for δ close enough to 1, there exists a PBE in which every on-path offer is

$$p_t = \frac{1}{3} + \left(-\frac{1}{2}\right)^{t-1}\alpha, \tag{1}$$

where $\alpha = \frac{2(1-\delta)}{3(4-\delta)}$. We construct an equilibrium such that proposers are deterred from making offers not equal to equation (1) on the path of play.

For convenience, we will represent the game so that no player is called to play twice in a row; at each point, the receiver either accepts the current offer, chooses a counteroffer, or quits. This simplifies the application of the one-stage deviation principle, and has no substantial effect on the results.[13] The game proceeds as follows:

1. At $t = 0$, the **seller** makes an offer $p_1 \in \mathbb{R}$ or quits.
2. For all $t \in \{1, 3, 5, \ldots\}$, the **buyer** either accepts the offer p_t, chooses a counteroffer $p_{t+1} \in \mathbb{R}$, or quits.
3. For all $t \in \{2, 4, 6, \ldots\}$, the **seller** either accepts the offer p_t, chooses a counteroffer $p_{t+1} \in \mathbb{R}$, or quits.

We construct an equilibrium with the following path of play, in which we denote $\phi = \frac{4-\delta}{4(1-\delta)}$:

1. For all t, on the path of play, the offer p_t is as in equation (1).
2. At $t = 0$, the seller offers p_1 if $s \leq p_1$ and quits otherwise.
3. For all $t \in \{1, 3, 5, \ldots\}$, the buyer accepts if $b > \frac{1}{3} + \phi(p_t - \frac{1}{3})$, quits if $b < p_{t+1}$, and counters with p_{t+1} otherwise.

[13] Collapsing these two adjacent decisions into one means that the one-stage deviation principle licenses us to directly compare the payoff from making any counteroffer p_{t+1} to the payoff from accepting p_t.

4. For all $t \in \{2, 4, 6, \ldots\}$, the seller accepts if $s < \frac{1}{3} - \phi(\frac{1}{3} - p_t)$, quits if $s > p_{t+1}$, and counters with p_{t+1} otherwise.

5. Whenever a player observes any off-path behavior, she believes her opponent is the weakest possible type ($b = 1$ or $s = 0$, respectively).

Proposition 1. *There exists a PBE of the bargaining game with the path of play and beliefs described in steps 1–5.*

Several points are worth noting. One point is that $\phi > 1$ for $\delta \in (0, 1)$. This means that, in this particular equilibrium, the last rejected offer is not an upper bound on the buyer's value. Conditional on the buyer rejecting a price $p_t = \frac{1}{3} + \left(\frac{1}{2}\right)^{t-1} \alpha$, the highest possible type for the buyer is $b = \frac{1}{3} + \phi \left(\frac{1}{2}\right)^{t-1} \alpha > p_t$. Also note that $\phi = 1$ for $\delta = 0$, indicating that (in the limit) myopic players treat the current offer as a take-it-or-leave-it offer. The proof is quite involved, requiring that we separately handle possible deviations at the first offer and those at later offers, and that we construct an appropriate punishment scheme to prevent such deviations for buyers or sellers.

Proposition 1 demonstrates that it is indeed a PBE for players to make bargaining offers lying halfway between the two most recent offers on the table. This equilibrium has several interesting features. First, it is particularly the two most recent offers that agents divide 50/50—the equal split is not between any other pair of prices in the offer history, nor any combination of actual valuations and offers. Second, and relatedly, split offers, once accepted, generically do not result in an equal split of the underlying *surplus* (either in ex-ante or ex-post terms); one player inevitably takes home more of the surplus than the other. Third, split-the-difference offers follow previous split-the-difference offers, leading to a shift in *which player* gets more expected surplus depending on which round the game ends at when it ends in agreement.[14] Finally, split-the-difference offers are more likely to be accepted than nearby offers, even those that are slightly *more favorable* for the opposing party. This is because a non-split offer leads to adverse inference by the receiver.

[14] Suppose that the bargaining ends in agreement at round t, for $t \geq 3$, given the behavior specified by Proposition 1. The expected surplus of the offering player is $\frac{1}{2^{t-1}} \left(\frac{1}{6} + \frac{\alpha}{2}\right)$, and the expected surplus of the receiving player is $\frac{1}{2^{t-1}} \left(\frac{5}{12} - \alpha\right)$. For $\delta > 0$, the receiving player has strictly more expected surplus, and the inequality is strict even in the limit as $\delta \to 1$.

4.2 A Robust Inference Argument: How Could Agents Possibly View Splitting the Two Most Recent Offers as "Fair"?

Our results thus far demonstrate that split-the-difference behavior is indeed consistent with classical game theory. The construction in Section 4.1, however, is somewhat *post hoc*: the behavior is built in, with no explanation of *why* agents might gravitate toward this behavior. Splitting the difference is by no means the unique PBE prediction; the equilibrium we have constructed is one of infinitely many. For bargaining under incomplete information, it is widely acknowledged that even sequential equilibrium has only weak implications for on-path behavior. Gul and Sonnenschein (1988) write that, with one-sided incomplete information, "almost any pair of strategies that is sequentially rational *along the equilibrium path* can be supported as a sequential equilibrium." The equilibrium we have constructed is instead for the case of two-sided incomplete information, but the same point applies: the construction can be easily modified to support on-path offers that are *unequal* splits between the most recent two.

It seems plausible that, rather than some equilibrium notion, split-the-difference offers are supported by *fairness norms*, but such an explanation is less straightforward than it appears. Evidence from laboratory experiments indicating that subjects often favor equal divisions of a *known* pie helped motivate the development of theoretical models involving social preferences, which account for agents' concerns for issues such as equity, social welfare, reciprocity, or social image (Bolton, 1991; Rabin, 1993; Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Andreoni and Miller, 2002; Andreoni and Bernheim, 2009). However, when bargaining under incomplete information, the buyer's last offer need not be equal to the seller's value, and vice versa, so splitting the last two offers does not in general split the surplus; thus, the behavior also does not correspond to any previous notion of fairness. Moreover, in the equilibrium constructed in Section 4.1, splitting the last two offers does not even split the *expected* surplus equally, even though both buyer and seller values are independently and identically distributed.

How, then, could agents view splitting the two most recent offers as fair? We suggest that the last offer that the buyer rejects is a *robust* upper bound for the buyer's value. For example, suppose that the buyer has just received an offer of \$100. If the buyer's value is strictly less than \$100, rationality alone implies that the buyer will reject the offer. If the buyer's value is strictly above \$100, then rationality alone does not imply the buyer will reject. That is, there exist buyer beliefs about the seller's strategy that would rationalize accepting an offer of \$100. Hence, if the seller believes that the buyer is rational, she cannot rule out that she is facing a buyer with a value below \$100. But, depending on which rational strategy the seller believes the buyer is playing, she might be able to rule out values above \$100. So \$100 is the highest buyer value that the seller *robustly cannot rule out* on the basis of the buyer's past rejection behavior.

The preceding argument applies symmetrically to the inferences that the buyer can make when the seller rejects an offer. Hence, the last offer that the buyer rejects is a *robust* upper bound for his value, and the last offer that the seller rejects is a *robust* lower bound for her value. Equal splits can then be explained as a fairness norm applied to these bounds on the *potential surplus*.[15]

To formalize this argument, we introduce a few definitions. A **narrow strategy** σ_i for player $i \in \{s, b\}$ is a function from public histories to i's available actions.[16] A **belief system** for player i is a conditional probability system defined on $H \times \Sigma_{-i} \times \Theta_{-i}$, where H is the set of public histories, Σ_{-i} the set of opponent narrow strategies, and Θ_{-i} the set of opponent types. A pair (σ_i, θ_i) is **rational** if there exists a belief system μ such that σ_i is a sequential best reply to μ for type θ_i.[17] An offer sequence $\{p_t\}_{t=1}^{T}$ is **monotone** if the buyer's offers are strictly increasing, the seller's offers are strictly decreasing, and the highest buyer offer is no more than the lowest seller offer.[18]

Proposition 2. *Let h be a history with a monotone offer sequence $\{p_t^*\}_{t=1}^{T}$, with the seller*

[15]Note that bounds on values based on the most recent offer an agent *proposes*, rather than rejects, cannot rationalize split-the-difference behavior in the same way. Consider a seller proposing a price of \$100, and then a buyer countering at \$50. Assuming that no player makes an offer that would be unprofitable if accepted, the seller must value the item weakly less than \$100 and the buyer weakly more than \$50. But these arguments provide no upper bound on the potential surplus—it could be that the seller's value is \$0 and the buyer's value is \$500—and a split-the-difference offer (\$75) would not be at the midpoint of potential surplus.

[16]We call this *narrow* because it does not depend on i's type.

[17]Rationality is a weaker condition than extensive-form *rationalizability* (Pearce, 1984). Rationality only requires that agents play sequential best responses to some belief system. But we could require more strategic sophistication, stipulating that each agent believes that his opponent is rational, and believes that his opponent believes that he is rational, and so on. Extensive-form rationalizability requires *strong belief* in rationality, meaning that, at every history, each agent attributes to her opponent the highest level of strategic sophistication consistent with what has already occurred. See Battigalli and Siniscalchi (2002) for details.

[18]Our restriction to monotone sequences simplifies the theory. Appendix B demonstrates that sequences violating a weak version of monotonicity are not common empirically.

making the latest offer $p_T \in (0, 1)$.

1. *For all buyer values* $b < p_T^*$, *for any buyer strategy* $\sigma_B \in \Sigma_B(h)$ *such that* (σ_B, b) *is rational,* σ_B *rejects* p_T^* *at* h.

2. *There exists* $\underline{\delta} < 1$ *such that for all discount factors* $\delta \geq \underline{\delta}$, *for all buyer values* $b > p_T^*$, *there exists* $\sigma_B \in \Sigma_B(h)$ *such that* (σ_B, b) *is rational and* σ_B *accepts* p_T^* *at* h.[19]

And symmetrically for histories at which the buyer makes the latest offer.

The importance of Proposition 2 is that it provides an explanation for why largely rational—although somewhat cognitively limited—agents could gravitate toward offers that are halfway between the two most recent offers. We take as given, from the vast evidence in the literature, that agents value fairness, and in Proposition 2, we describe how split-the-difference offers could be viewed as fair. The cognitive limitation is that we consider agents making inferences about an opponent's value based only on the history of offers the opponent has *rejected*, not proposed. We believe this is a realistic limitation to impose: inference based on an opponent's binary decision to accept or reject a given offer is much less computationally intensive than the process of conditioning on the full history of the game and attempting to invert an opponent's continuously valued offer.[20]

Proposition 2 shows that, under this offer-rejection inference, a seller cannot rule out the possibility that the buyer's value is equal to (or less than) the most recent offer the buyer rejected, as any rational buyer would not have accepted an offer below his value. And for buyers with higher valuations, there exist rational strategies under which these buyers would have accepted that most recent offer of the seller. Therefore, the largest buyer type that the seller could not possibly rule out is a buyer with a value equal to the most recent offer rejected by the buyer, and analogously for the buyer's inference about the seller rejecting the most recent offer. Thus, an agreement to split this difference equally can be thought of as a fair division of the potential surplus.

[19]It is natural to ask whether the beliefs supporting σ_B are reasonable. With small modifications, our proof can be strengthened to show that there exists a common prior on values and costs, and a PBE of the bargaining game with that common prior, such that type b plays σ_B under the PBE.

[20]The idea of agents only making inference based on rejections of previous offers, and not the levels of those offers, also arises in a number of previous theoretical analyses of incomplete-information bargaining, such as Chatterjee and Samuelson (1988), Gul and Sonnenschein (1988), and Ausubel and Deneckere (1992). They examine cases in which the level of the offer made by a privately informed party is not informative to the counterparty; only the fact that the previous offer was rejected is informative.

By this reasoning, a hypothetical buyer who has just rejected an offer of $100 might make the following statement: "I just told you (the seller) that I won't pay $100 for the item. You and I both know that, after such an action, I would never admit to really valuing it at more than $100 (even if that were true), because I could always argue that if I valued it at more than $100 I would have accepted. But we also know that I would certainly have rejected your offer if my value was $100 or less." Under this argument, both agents know that $100 is the *most optimistic* belief the seller could have about the buyer's value that the buyer could not claim is inconsistent with rational rejection behavior. Because each player could make such statements about the other's valuation, a split-the-difference offer could emerge as a "fair" resolution of these claims.

We view this robust-inference argument as a more compelling explanation of split-the-difference offers than the PBE construction. The PBE is only one of infinitely many, qualitatively different equilibria. While a preference for fairness could certainly be invoked as an *equilibrium selection* argument, the PBE framework does not offer any direct explanation of how split-the-difference offers could relate to equity. In contrast, the robust-inference argument directly addresses how the two most recent offers may be seen as representing a notion of surplus. It aims only to explain one key conundrum: why a 50/50 split of the two most recent offers could be seen as equitable, and why anything else might therefore be seen as generous or greedy.

5 Further Empirical Evidence of Splitting the Difference

We now return to our seven empirical settings to examine a number of empirical patterns offering further insight into split-the-difference offers.

5.1 Split-the-Difference Offers Are More Likely to be Accepted

In this section, we explore how agents *respond* when they receive split-the-difference offers compared to when they do not. We show that split offers are discontinuously more likely to be accepted than non-split offers, suggesting that splitting the difference is not merely a heuristic used by the *offering* party, but rather that it is viewed as preferable (arguably fair) behavior by both the offerer and the receiver.

Specifically, we examine how a player's choice of offer, as measured by the concession weight, $\gamma_{j,t}$, relates to the probability that the offer is accepted. We create a measure for whether the offer is a "split" offer by creating an indicator $Split_{j,t}$ that is equal to one if $\gamma_{j,t}$ is equal to 0.5 (after being rounded to the nearest hundredth, or $\gamma_{j,t} \in [0.495, 0.505]$) for each $t \geq 3$. We then estimate the following linear probability regression:

$$Accept_{j,t} = \beta Split_{j,t} + f(\gamma_{j,t}) + \tau_t + \epsilon_{j,t}, \tag{2}$$

where $Accept_{j,t}$ is an indicator for whether the offer is accepted, τ_t is a round fixed effect, and $f(\gamma_{j,t})$ is a flexible function of $\gamma_{j,t}$. We specify $f(\gamma_{j,t})$ as a third-order polynomial of $\gamma_{j,t}$.[21] The results are reported in Table 2, where each column corresponds to one dataset. We also report the frequency of acceptance and split offers. The acceptance rate varies across settings from 7% to 73%, and the fraction of split offers ranges from 4% to 19%. We see a positive coefficient before the "split" offer indicator in all of our datasets, and this is statistically significant in all columns except the auto rickshaw rides and housing cases (columns 4 and 5). This means that an offer in bargaining is more likely to be accepted if it is a split offer than if it is not. This effect is surprisingly large in magnitude, varying from 5.7% to 21.9%.

Table 2: Probability of a Split Offer Being Accepted

	(1) Cars	(2) Settlement	(3) TV Show	(4) Rides	(5) Housing	(6) Trade	(7) eBay
Split	0.120***	0.219***	0.151**	0.0569	0.158	0.0676***	0.0849***
	(0.00830)	(0.00555)	(0.0615)	(0.0354)	(0.119)	(0.00341)	(0.000484)
N	33356	204141	714	3010	176	46985	9789903
Order of $\gamma_{j,t}$	3	3	3	3	3	3	3
Round FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Accept rate	0.38	0.34	0.26	0.20	0.73	0.07	0.20
Split rate	0.18	0.04	0.14	0.19	0.08	0.17	0.12
R^2	0.0605	0.0566	0.114	0.123	0.0412	0.195	0.125

Notes: Table shows the estimated coefficient on the split indicator from the regression described by equation (2). Each column corresponds to a separate data setting. The accept rate is the mean of the dependent variable and the split rate is the mean of the split indicator. Standard errors are shown in parentheses. The number of observations for the rides setting differs from that in Table 1 because some scripted bargaining acceptance must be dropped and some scripted bargaining offers can be included here. The number of observations for the settlement settting differs from that in Table 1 because some sequences end at round 10, and we have no data on whether round 10 offers were accepted or not. See Appendix B for details. $*: p < 0.10$, **: $p < 0.05$, and ***: $p < 0.01$

[21] The results are not sensitive to this choice; we find similar results with second-, fourth-, or fifth-order polynomial approximations. We also find similar results defining "split" offers using other bandwidths, including 0.01 (i.e., $\gamma_{j,t} \in [0.49, 0.51]$) and 0.05 (i.e., $\gamma_{j,t} \in [0.45, 0.55]$).

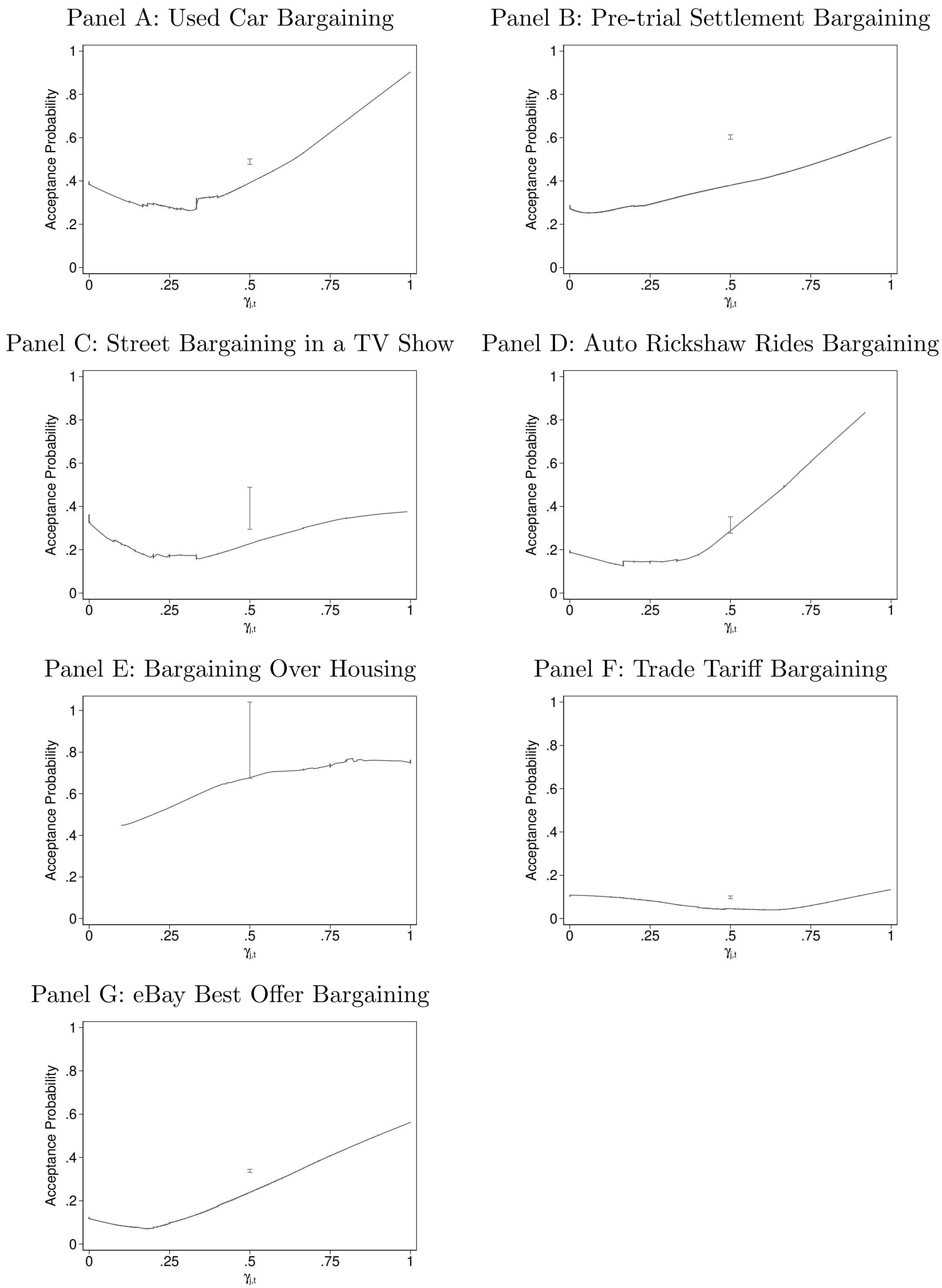
Our results in the housing setting are likely insignificant due to the small sample size (176 offer triples). One possible explanation for the lack of a significant effect in the auto rickshaw ride setting is that this specification compares the acceptance rate of a split offer with nearby offers and, as shown Figure 1, the nearby offers in this dataset are quite sparse. This is also reflected in the high split offer rate in the fourth column (19%). We therefore likely lack power to detect a significant effect in this dataset. This dataset, however, has a unique subset—the scripted bargaining offers—in which we can obtain estimates that are closer to a *causal* effect of split offers on acceptance rates. As highlighted in Section 2.4, buyers in these scripted sequences make offers that are assigned by the experiment designer rather than arising endogenously.[22] When we estimate equation (2) in this subset of the data, shown in columns 4–5 of Appendix Table A2, we find positive point estimates, and a particularly large, positive effect in those sequences that begin with a buyer offer.

In Figure 2, we offer an even more flexible approach to this question, plotting a weighted local linear fit of acceptance and $\gamma_{j,t}$ using observations where $\gamma_{j,t}$ is not a split offer. The fitted values are estimated using locally weighted least squares with a tricube weighting function. We also plot in Figure 2 the average acceptance probability for observations that *are* split offers, along with the 95% confidence bound about this mean. We find that the underlying relationship between the acceptance and $\gamma_{j,t}$ is monotonic in most regions and split offers are substantially more likely to be accepted than nearby offers with similar $\gamma_{j,t}$ in all datasets except the auto rickshaw case (where we again lack power locally around 0.5) and the housing case (where the number of observations is small). In the latter two cases, the point estimate is still higher at split offers.

The striking implication overall is that, even across these widely varying field settings, split-the-difference offers are more likely to be accepted than even a slightly *more favorable* offer. This suggests that a preference toward splitting the difference between the two most recent offers is a norm followed not only by the proposer of these offers but also by the receiver, consistent with the notion we model in Section 4.2. These results are reminiscent of findings in a wide range of laboratory ultimatum games (e.g. Roth et al. 1991), which show receivers frequently rejecting offers of less than half of the surplus, but accepting "fair" offers of a 50-50 split of the surplus nearly 100% of the time.

[22] Even though the offer sequence of the surveyor is assigned exogenously, the event that an offer is a "split" offer is not entirely exogenous, as this depends on the previous offer of the driver as well.

Figure 2: Probability of an Offer Being Accepted



Notes: Each panel shows a local linear fit of the acceptance probability as a function of $\gamma_{j,t}$ along with the acceptance probability of split offers (plus the 95% confidence interval around this point). To facilitate computation of the local linear estimator in the eBay setting, we use a random sample of 100,000 threads.

Table 3: Repeat Split-the-Difference Behavior

	(1) Cars	(2) Settlement	(3) TV Show	(4) Rides	(5) Trade	(6) eBay
	A: Effect of Opponent's Split Offer					
$Split_{j,t-1}$	0.00304	0.144***	0.117**	0.00358	0.0928***	0.125***
	(0.00763)	(0.00672)	(0.0591)	(0.0193)	(0.0188)	(0.000840)
N	11622	134107	510	2714	2937	2813127
	B: Effect of Agent's Own Split Offer					
$Split_{j,t-2}$	0.0440	0.0807***	0.0203	0.0708*	-0.000644	0.0699***
	(0.0276)	(0.00991)	(0.0724)	(0.0382)	(0.0519)	(0.00137)
N	2155	83296	343	1121	250	1100490

Notes: Panel A shows the estimated coefficient on the one-period-lagged split indicator from the regression described by equation (3). Panel B shows results instead using the two-period-lagged split indicator. Each column corresponds to a separate data setting. The housing data setting is omitted because no sequence contains more than three offers. $*: p < 0.10$, **: $p < 0.05$, and ***: $p < 0.01$

5.2 Split Offers Are Frequently Followed by Split Offers

In this section, we address two empirical questions. First, do split offers in period t by one party tend to be followed by the *opponent* proposing a split offer in period $t+1$? Second, do split offers in period t tend to be followed by split offers by the *same* party in period $t+2$? Both of these points speak to the question of whether splitting the difference between the two most recent offers is a social norm that is perhaps followed more consistently by some agents than others and that, when invoked by one agent, tends to be adopted by the opponent.

To examine this question, we analyze the following linear probability model:

$$Split_{j,t} = \beta Split_{j,t-1} + \epsilon_{j,t} \tag{3}$$

Thus, we regress the indicator of whether, in period t, an agent proposes a split offer, $Split_{j,t}$, on the indicator of whether the most recent offer, $Split_{j,t-1}$ (which naturally comes from the opponent), also corresponds to a split offer.

Panel A in Table 3 shows the results.[23] We observe positive point estimates in each setting, and these estimates are significant in most columns, suggesting that agents are more likely to propose a split offer when the opponent has done the same. In panel B,

[23] We cannot examine this question in the housing dataset as we only observe a single offer triple in each sequence in that setting.

we consider a version of equation (3) in which we use $t-2$ actions on the right-hand side rather than $t-1$, allowing us to examine whether agents who make split-the-difference offers earlier in the game are more likely to do so again. We find evidence of this effect for the case of settlement and eBay negotiations, and a marginally significant effect in the case of auto rickshaw rides.

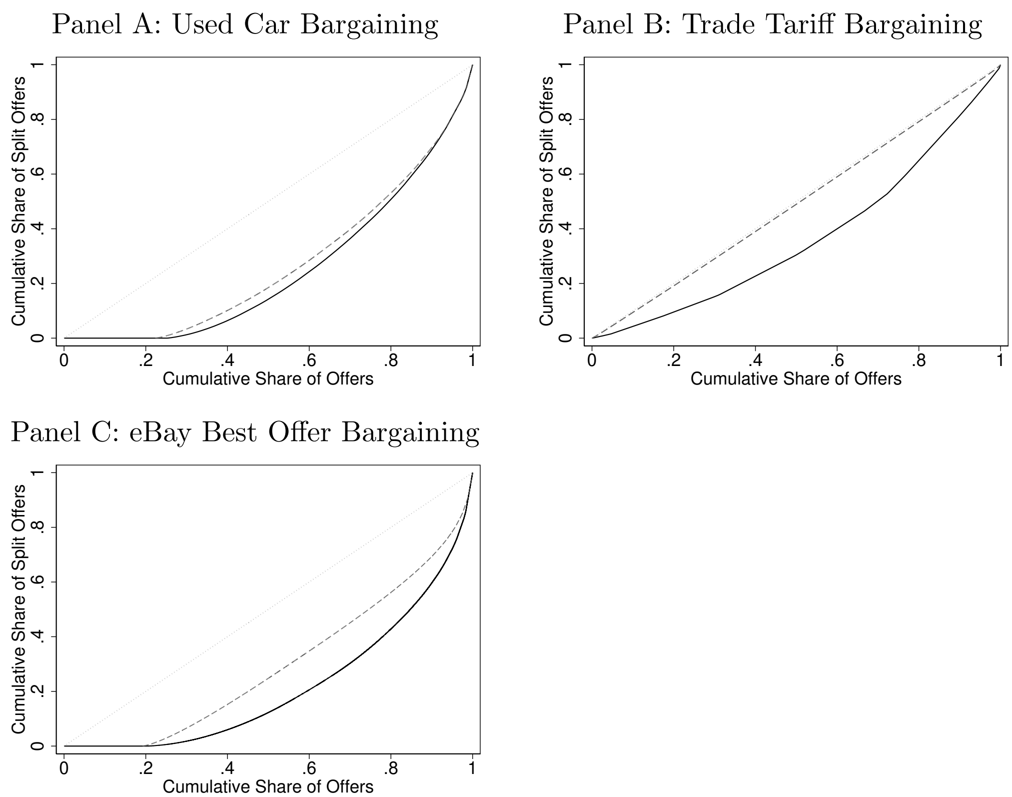
We examine this latter effect further by exploring whether splitting the difference is a norm followed by certain agents more than by others. To do so, we take advantage of agent identifiers, which we observe in the used car, trade, and eBay bargaining settings.[24] In a given dataset, we sort agents by the fraction of split offers among all offers they make. We then plot, on the horizontal axis in each panel of Figure 3, the cumulative share of offers made by agents. The solid line corresponds to the cumulative share of offers by these agents that are *split* offers. If the propensity to propose split offers is roughly equal across all agents, and if each agent makes a large number of offers, the solid line should be close to the 45-degree line (the dotted one). This comparison can thus be considered a modified Lorenz curve that measures the "inequality" of split offers among agents.

Figure 3 indeed shows a gap between the solid and dotted lines in each panel. In reality, however, we only observe a few offers made by a given agent, and hence a large part of the area between the solid line and the 45-degree line is due to sampling noise.[25] To construct a more meaningful benchmark, we consider a case where each agent has the same probability to propose a split offer, with this probability given by the split rate reported in Table 2. Using this split rate, we simulate a fake split indicator for each observation following a Bernoulli distribution. We plot our cumulative share of split offers based on these fake indicators using the dashed line in Figure 3, which should lie between the 45-degree line and the curve plotted using the real data. Comparing the dashed and solid lines in Figure 3, we find evidence that some agents have a stronger proclivity toward split-the-difference than others. This is particularly the case in the eBay and trade settings, where the dashed line is farther from the solid line. In the used-car setting, the solid and dashed lines are close, indicating that the propensity to make split-the-difference offers is roughly uniform

[24]In our other data settings, we have no consistent means of tracking an agent across different bargaining sequences.

[25]For example, suppose every agent has the *same* propensity q to propose a split offer, but each agent only ever proposes one offer in the data. We would observe roughly a fraction of q players proposing one split offer and a fraction of $1-q$ players proposing no split offers, and the curve will be far off the 45-degree line.

Figure 3: Some Agents More Likely to Make Split Offers



Notes: Each panel ranks agents by the fraction of split offers among all offers they make and plots their cumulative share of total offers on the x-axis and the cumulative share split offers on the y-axis. The solid lines use the real data. The dashed lines use simulated split indicators assuming every agent has the same propensity to propose split offers. The dotted line indicates the 45-degree line.

across agents.

5.3 When are Split-the-Difference Offers Made?

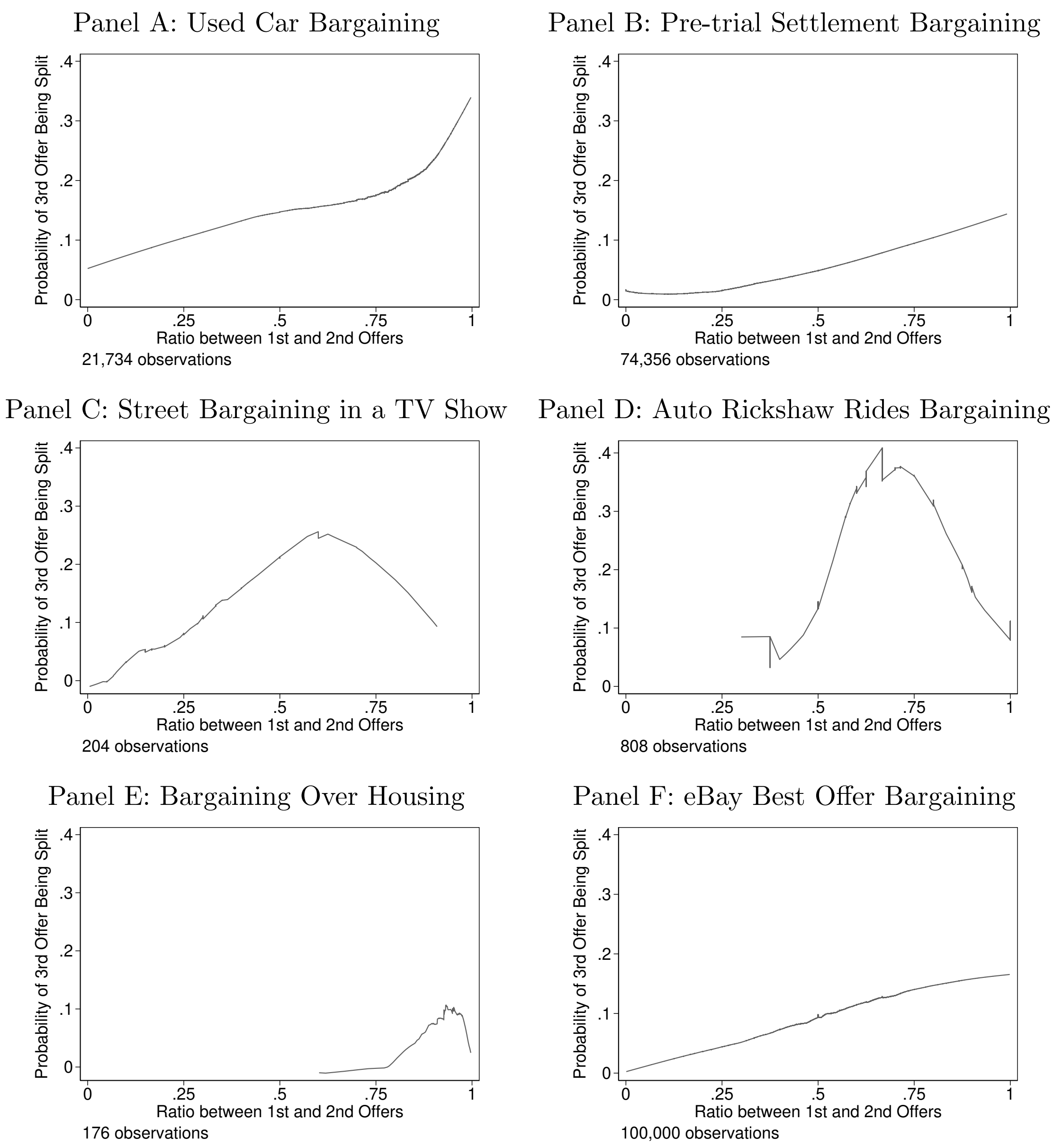
The robust-bargaining theory developed in Section 4.2 suggests that agents make split-the-difference offers when these constitute a "fair" split of the potential surplus, defined in a sense that is robust to any possible beliefs of either player. Yet, the set of cases in which split-the-difference offers might occur remains constrained, either because the mid-point between the two previous offers might be lower than the seller's true value or higher than the buyer's, or because a very demanding offer from the opponent might be seen as "unfair" and thus not deserving of a "good faith" split-the-difference counteroffer. Both of these arguments suggest that when a buyer's offer is only a small fraction of the seller's initial offer, we are unlikely to observe a subsequent split-the-difference offer, with the same being true for relatively high seller offers. Conversely, when the difference between previous offers is very small, for instance within a few percentage points, the size of potential surplus may be small, and fairness concerns may be less relevant.

Figure 4 examines these patterns in the data, showing the probability that an agent makes a split offer in round three as a function of the ratio of the first two offers. In sequences that begin with seller offers, this is the ratio of the buyer's first offer to the seller's first offer, and the reverse is true in sequences that begin with buyer offers; thus, the ratio is always between zero and one. We cannot examine this in the trade setting, where the first offer is zero. In all six datasets in Figure 4, we find that the probability of a split offer is lower when the buyer's offer is a very small fraction of the seller's (that is, when the gap is relatively large), and then increases initially. When the buyer and seller's previous offers are relatively close, the chance of a split counteroffer decreases again in the TV, rides, and housing cases. In these cases, split offers are most likely when the previous offer ratio lies in the 60%-90% range. For these values, where the opponent's offer is not too "unreasonable," but the gains from bargaining may still be substantial, agents are most likely to adopt the fairness norm. For the other three settings—cars, settlement, and eBay, which also correspond to the cases where we have the most data—we see the frequency of split offers increase globally as the ratio increases.

5.4 Splitting When There is Only One Previous Offer

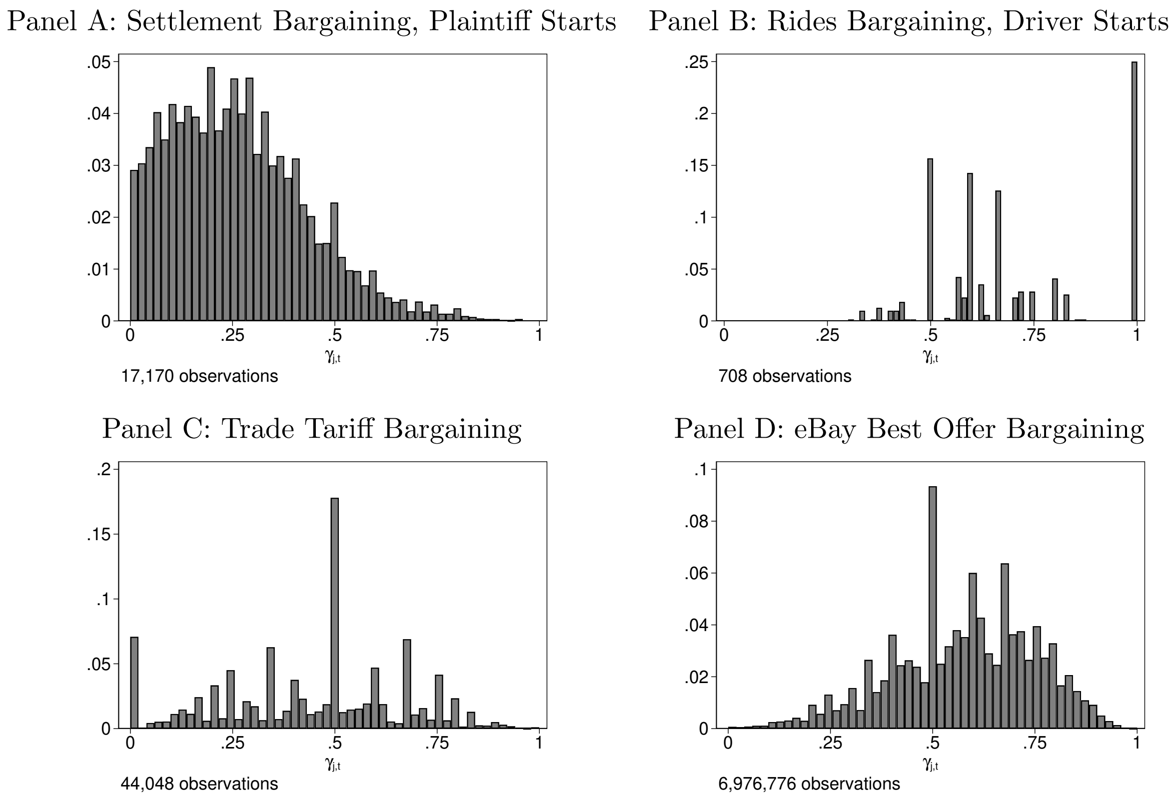
In this section, we present a further test of the idea that negotiating agents' behavior is consistent with the potential surplus-split argument we propose in Section 4.2. We consider here settings in which the seller makes the first offer. When it is the buyer's turn to make the first counteroffer, there is only one previous offer to which agents can apply an optimistic-inference potential-surplus view. The most optimistic lower bound on the seller's value in such cases is a lower bound of zero. For example, in the eBay setting, suppose a seller posts a list price of $100. If the buyer rejects this offer, the history of rejected offers from which the players can make inference will consist only of the rejected list price. What, then, should be the notion of fairness toward which agents gravitate? In the spirit of our robust argument, the potential surplus at this stage of the game is the range from $0 to $100, an

Figure 4: Split Probability as a Function of Ratio of First Two Offers



Notes: Each panel shows, on the vertical axis, the probability that the third offer in the sequence is a split offer. On the horizontal axis is the ratio previous buyer offer and previous seller offer, regardless of order. The line in each plot is a weighted local linear fit. To facilitate computation of the local linear estimator in the eBay setting, we use a random sample of 100,000 threads.

Figure 5: Splitting the Difference Between Zero and the First Proposal



Notes: Histograms of concession weights defined as where the second offer in a thread lies relative to the first offer and zero, where the first offer is from a seller-like agent, meaning the agent who wants the price higher. Thus, panel A uses only settlement threads starting with the plaintiff in panel A and rides threads starting with the driver in panel B. In panel D—eBay bargaining—all threads start with a seller. In panel C—trade bargaining—we already treat zero as the first offer throughout the paper.

equal split of which is an offer of $50.

This same argument can be applied to any of our settings in which the seller moves first.[26] Among our data settings, these include the subset of settlement bargaining where the plaintiff starts, the subset of rides bargaining where the driver starts, and eBay bargaining. We also examine the trade bargaining case here, where, as explained in Section 2.6, we set zero as the first bargaining offer throughout the paper. In Figure 5, we examine where the buyer's offer in these settings lies relative to zero and relative to the seller's first offer. In the rides, trade, and eBay settings, we observe a mass point at 0.5 (although the mass point

[26]Note that cases in which a buyer moves first do not offer a zero lower bound: suppose the buyer first offers $200, and then it is the seller's turn. If the seller counters she will clearly counter at a price above $200, but there is no natural upper bound that the agent's would assume about the buyer's value.

at 0.5 in the rides case is similar in size to that at about 0.6 or 0.7). These mass points are consistent with agents focusing on the halfway point of the potential surplus even at this early stage of the game when that potential surplus is defined by zero and the first seller offer.

Pre-trail settlement bargaining in panel A is the one setting in Figure 5 in which the first offer is *not* frequently a 50/50 split between 0 and the first offer. There we observe a slight uptick at 0.5 relative to surrounding points, but the contrast is much smaller than in the other panels. This finding gives some insight into the limits of split-the-difference behavior. In this setting, the plaintiff's initial offer is often exorbitant relative to where the bargaining eventually ends; thus, a halfway offer on the part of the buyer (i.e., the insurer) would typically be overly generous (and might often be higher than the insurer's valuation, i.e., the expected court ruling). Housing bargaining would exhibit a similar result: it would be unheard of for a buyer to counter at a price that is 50% of the seller's list price. Such an offer would undoubtedly give surplus to the buyer, but it would surely not be seen as "fair" by the seller, and panel E of Figure 4 demonstrates that indeed buyers do not make such low-ball offers. These potential constraints on split offers may drive the broader patterns observed in Section 5.3.

5.5 The Two Most Recent Offers Are Special

Our analysis in Section 3 demonstrates robust evidence across a wide spectrum of settings that a modal strategy in real-world bargaining is to make offers that split the difference between the two most recent offers. This is consistent with our robust explanation in 4.2 that players may treat the gap between these two most recent offers as representing some notion of potential surplus, which they agree to split equally. Here, we explore whether it is indeed the two most recent offers that serve as the most prominent anchor points in players' formation of a notion of *the potential pie* to split fairly. For example, it is possible that offers splitting the difference between *earlier offers* in the game (prior to the two most recent) are also common. In a sequence (beginning with a seller offer) $\{100, 50, 90, 70\}$, a subsequent offer splitting the difference between the two most recent offers would be 80, but it may be that 75 (which splits the difference between the *first two* offers) is also a focal point for players in this game.

To examine this possibility, we define *placebo concession* by treating the proposed amount in round t as a convex combination of offers from *earlier* rounds of the game. For example, for $t = 4$, we can treat the proposed amount as a convex combination of offers from the first and second rounds, which we define as $\gamma_{j,4}^{3} = \frac{p_{j,4} - p_{j,1}}{p_{j,2} - p_{j,1}}$. In general, for $t \geq 4$ and $s < t$, the placebo concession is defined as follows:

$$\gamma_{j,t}^{s} = \frac{p_{j,t} - p_{j,s-2}}{p_{j,s-1} - p_{j,s-2}}, t \geq 4, 3 \leq s < t,$$

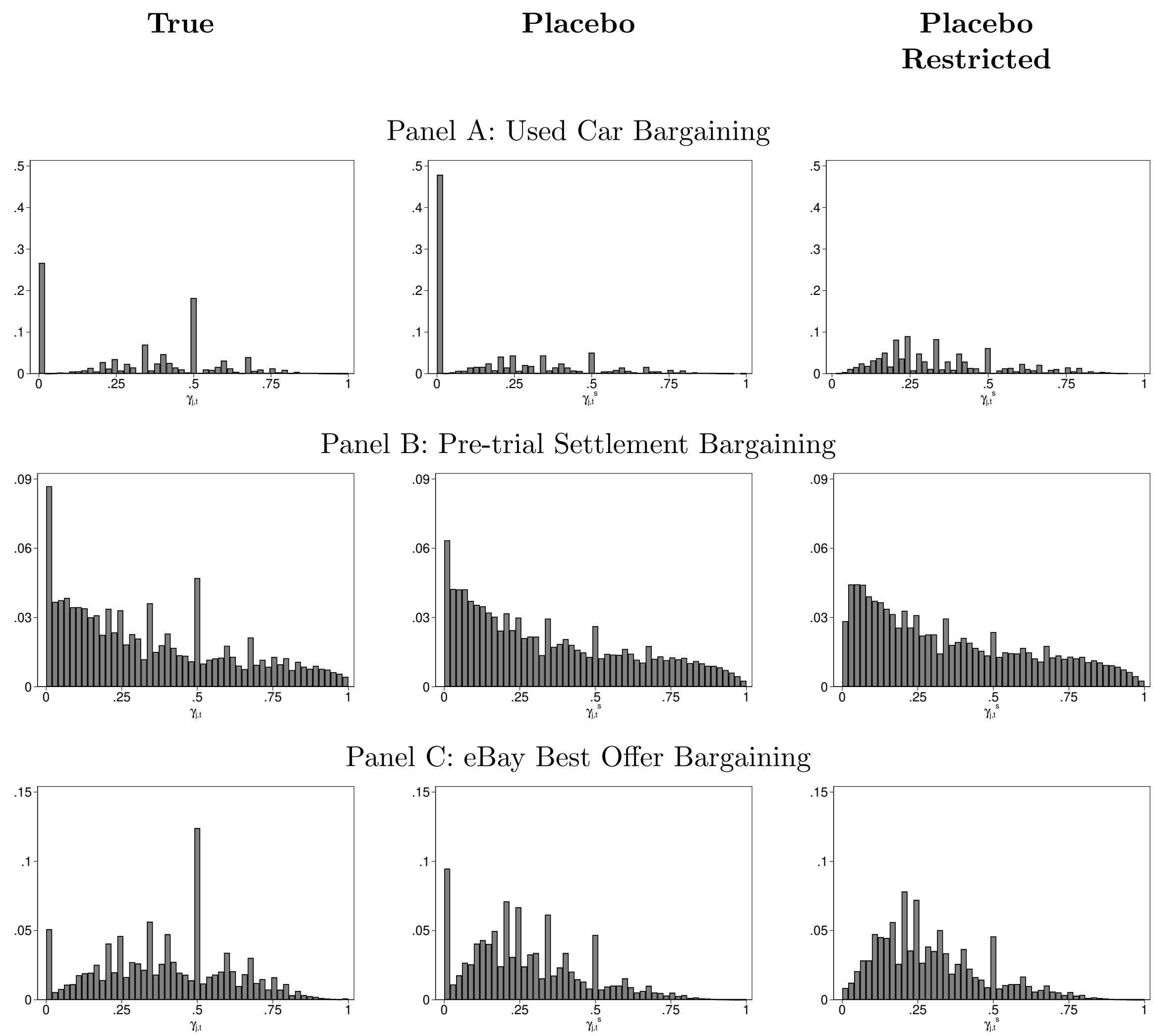
where t is the round in which the current offer is evaluated, and $s < t$ is the round in which offers from rounds $s - 1$ and $s - 2$ actually were the most recent offers. If negotiating agents care most about fairness as defined by an equal split of the two most recent offers, we expect less mass at 0.5 for the placebo concession than in our main results from Section 3.

For this analysis, we focus on the three datasets for which we have the longest sequences, as they allow us to construct the placebo concession metric: business-to-business used car bargaining, pre-trial settlement bargaining, and eBay bargaining. Figure 6 plots the distribution of true concession and placebo concession in these three datasets. In the left column, we replicate the true concession weight histograms from Figure 1. In the middle column, we plot histograms of the placebo concession weights based on earlier-round bargaining offers: $\gamma_{j,t}^{s}, t \geq 4, 3 \leq s < t$.

In the third column of Figure 6, we focus on a restricted sample in which we drop cases that can mechanically lead to mass points at 0.5 even in the placebo concession. As an example, consider an offer sequence with the first four offers being $\{100, 60, 90, 70\}$. A split-the-difference offer at the fifth round would be 80, but this offer would also represent splitting the difference between the earlier offers of 100 and 60. Our restricted sample excludes and placebo concession weights that are exactly equal to the true concession weights for a given round.

Panels A and C of Figure 6 demonstrate that counteroffers occur halfway between *earlier* offers of the game (the middle and right columns) less frequently than between the two most recent offers (the left column). In panel B, the pre-trial settlement bargaining, placebo split-the-difference offers are also frequent. However, in both the middle and right figures in panel B, the mass is more uniformly distributed across concession weights in the placebo cases than in the left column, suggesting that the *relative* likelihood of split-the-difference offers

Figure 6: Distribution of True Concession and Placebo Concession



Notes: Figure shows, in left plots, histograms of true concession weights ($\gamma_{j,t}$) as in Figure 1 for the cars (panel A), settlement (panel B), and eBay (panel C) settings. In the middle plots, we show histograms of the placebo concession weights. In the right plots, we show histograms of the placebo concession weights restricting the sample to exclude observations that are mechanically equal to 0.5.

is the highest when considering the two most recent offers.

To formally test whether the masses at 0.5 are different in the true vs. placebo concession, we calculate the fraction of split-the-difference offers (as in Section 5.1) for the true concession weights, placebo concession weights, and their difference, as well as standard errors on each of these means.[27] We also compute the fraction of split offers among placebo concession weights in the restricted sample. Table 4 presents the results. In each dataset, we detect a (statistically significantly) larger fraction of split offers using the true concession weights than the placebos, suggesting that players indeed rely more strongly on the two most recent offers than on earlier offers in determining a 50/50 split.

Table 4: Fraction of Split Offers in True vs. Placebo Concession Weights

	True	Placebo	Difference	Placebo Restricted	Difference
			Panel A: Used Car Bargaining		
Split	0.1823	0.0503	0.1319	0.0614	0.1208
	(0.0019)	(0.0020)	(0.0023)	(0.0033)	(0.0034)
N	33,356	14,721		6,674	
			Panel B: Pre-trial Settlement Bargaining		
Split	0.0435	0.0218	0.0217	0.0190	0.0245
	(0.0004)	(0.0003)	(0.0005)	(0.0003)	(0.0005)
N	208,463	313,216		292,470	
			Panel C: eBay Best Offer Bargaining		
Split	0.1176	0.0437	0.0739	0.0424	0.0753
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
N	9,789,903	4,353,489		3,880,706	

Notes: Table shows the fraction of split offers among the true concession weights (first column) vs. the placebo concession weights (second column), as well as the difference of these means (third column). The fourth column shows the fraction of split offers among the placebo concession weights in the restricted sample, and the fifth column shows the difference between this mean and the true concession weight fraction. Standard errors are shown in parentheses. Panel A shows this analysis for the cars sample, panel B for the pre-trial settlement sample, and panel C for the eBay sample.

[27] Standard errors on the difference are constructed from 100 nonparametric bootstrap-sample estimates of the true and placebo rates, sampling at the thread level.

5.6 Splitting Based on Private Information

We also analyze whether agents tend to propose offers that split the difference between a publicly known threshold (a previous offer) and a *privately* known quantity that relate to agents' values. For this analysis, we exploit a number of privately known variables specific to several of our settings, including the secret reserve price known only to the seller in the used-car setting; the reserve/loss estimate known only to the "buyer" (the insurer) in the settlement negotiation setting; and the auto-accept or auto-decline prices that are known only to the seller in the eBay setting. The importance of these variables is that they are each privately known to only one side; thus, these variables allow us to examine whether agents' behavior is more consistent with equally splitting a potential surplus based on public information (as in our robust argument in Section 4.2), or whether instead agents appear to offer prices that are actually *fair* relative to their own private information.

For this analysis, we follow our construction of *placebo* concession weights from Section 5.5, replacing some offer information with these privately known quantities. We describe this analysis and results in detail in Appendix C. The bulk of the evidence from this exercise suggests that split-the-difference behavior is less related to such privately known values and more related to the potential surplus based on the two most recent offers.

5.7 Alternative Causes of Split-the-Difference Offers

In this section, we consider two alternative theories for why a 50/50 split between offers is a modal outcome in real-world settings. First, rather than being driven by an equitable split of potential surplus, agents' split-the-difference behavior may arise simply because it is *easier* (cognitively) to select the midpoint between the past two offers than to compute the optimal (surplus-maximizing) offer. While this may be one reason why 50/50 offers are selected, this argument alone fails to explain much of the empirical patterns surrounding split offers. In particular, it cannot explain why split offers are *accepted* more frequently, nor would it explain why split offers are frequently followed by other split offers. Furthermore, in high-stakes negotiations—some of which involve highly experienced professionals, such as insurance companies, car dealers, or trade negotiators—one would suppose that computational constraints are relatively less important.[28] Yet our results show that split offers are common in each of these settings.

A second alternative explanation is that split offers are a signal of a player's "best and final" offer, explaining their higher likelihood of acceptance. Yet to rationalize a split-the-difference offer as the *optimal* final offer, an agent must believe that her opponent's value is uniformly distributed between the last two offers, a knife-edge case that seems somewhat theoretically ad-hoc.[29] Empirically, the most straightforward version of the split-offer-as-final-offer theory is clearly rejected by the data, where we frequently see players continuing to negotiate after a split offer is rejected.

While we cannot totally reject these alternative mechanisms, we argue that the consistent patterns of behavior surrounding split-the-difference offers suggest a strong role played by a fairness norm as defined above.

6 Conclusion

Our study provides extensive evidence from seven unique empirical settings—cars, insurance claims, entertainment, transportation, housing, trade, and eBay—that negotiating agents gravitate toward offers that split the difference between the two most recent offers. Split offers are more likely to be accepted by the receiver, and are more likely to be followed by subsequent split offers. We also show that it is the two most recent offers in particular that agents are most likely to favor splitting equally, and that split-the-difference behavior is constrained by the disparity between the two previous offers. Finally, we demonstrate that some agents are more likely than others to follow split-the-difference patterns of behavior.

From prior experimental work on ultimatum games and bargaining with complete information, it is reasonable to believe that 50/50 surplus-sharing is supported by fairness norms. But in our settings, where agents have *incomplete information*, it is not obvious *a*

[28]Conversely, we do not necessarily expect fairness considerations, which are at the center of our potential surplus split argument from Section 4.2, to scale down with negotiation stakes. In fact, complete-information lab-in-the-field ultimatum game experiments involving large sums (from the subjects' perspective) mostly reproduce the typical results from the lab, suggesting that concerns about fairness persist when stakes are high (Slonim and Roth, 1998; Cameron, 1999).

[29]Specifically, suppose an agent offering at period t has a value of 0 and believes her opponent's value is uniformly distributed between the two most recent offers. The optimal take-it-or-leave-it offer for this agent is the halfway point, $p_t = 0.5(p_{t-2} + p_{t-1})$.

priori how they could possibly view a 50/50 split of the two most recent offers as a "fair" outcome. We first demonstrate that this behavior can arise in a PBE. But such behavior does not actually represent an equal split of surplus between agents, and the equilibrium is far from unique. For instance, there are PBEs in which only one player makes serious offers. Or, as another example, we could easily modify our construction to support 60/40 splits of the last two offers if players are sufficiently patient. Thus, while split-the-difference behavior is compatible with a PBE, it is not uniquely predicted by it.

We then offer a new, robust-inference argument rationalizing split-the-difference behavior: the two most recent offers constitute bounds on potential surplus corresponding to the most optimistic inference that agents could make about one another when those inferences are based only on previous *rejections* and on the common knowledge that each agent is rational. While we cannot rule out other explanations of split-the-difference behavior, other explanations do not appear fully consistent with our findings. An interesting avenue for future research would be to explore the welfare implications of these norms, which may be feasible given the richness of many of these datasets.

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A Proofs

A.1 Proof of Lemma 1

The first two terms are identical, since $y_1 = \overline{x} + x_1 - \overline{x} = x_1$ and $y_2 = \overline{x} - \frac{1}{2}(x_1 - \overline{x}) = \frac{3}{2}\overline{x} - \frac{1}{2}x_1 = x_2$. For any $t \geq 3$,

$$\frac{1}{2}y_{t-2} + \frac{1}{2}y_{t-1} = \overline{x} + \frac{1}{2}\left(-\frac{1}{2}\right)^{t-3}\alpha + \frac{1}{2}\left(-\frac{1}{2}\right)^{t-2}\alpha = \overline{x} + \left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right)^{t-2}\alpha = y_t. \quad (4)$$

□

A.2 Proof of Proposition 1

We proceed by the one-stage deviation principle, showing that no one-stage deviation is profitable in expectation for any type.

A.2.1 Deviations that do not involve off-path offers

We start by proving that at any public history such that all previous offers are as specified by Equation (1), the active player cannot profitably deviate by accepting, quitting, or making the next offer specified by (1).

Consider the position of a buyer who receives an offer p_t in an odd period (a symmetric argument works for a seller who receives an offer in an even period). The seller made an offer of p_t, so the buyer can infer $s \leq p_t = \frac{1}{3} + \left(\frac{1}{2}\right)^{t-1}\alpha$. The seller rejected an offer of p_{t-1}, so the buyer can infer $s \geq \frac{1}{3} - \phi(\frac{1}{3} - p_t) = \frac{1}{3} - \phi\left(\frac{1}{2}\right)^{t-2}\alpha$. If both these bounds hold with equality, we have that $s \sim U[\frac{1}{3} - \phi\left(\frac{1}{2}\right)^{t-2}\alpha, \frac{1}{3} + \left(\frac{1}{2}\right)^{t-1}\alpha]$.

Consider the threshold type $\underline{b}$ that is indifferent between accepting and rejecting. This threshold type satisfies $\underline{b} - \frac{1}{3} = \phi(p_t - \frac{1}{3}) = \phi\left(\frac{1}{2}\right)^{t-1}\alpha$. The threshold type's payoff from accepting at t is

$$\underline{b} - p_t = \underline{b} - \left(\frac{1}{3} + \left(\frac{1}{2}\right)^{t-1}\alpha\right) = (\phi - 1)\left(\frac{1}{2}\right)^{t-1}\alpha. \quad (5)$$

The threshold type will make the counteroffer at $t+1$, since $\underline{b} > \frac{1}{3} > p_{t+1}$, and if that offer is rejected, will accept the seller's offer at $t+2$, since $\underline{b}-\frac{1}{3} > \phi(p_{t+2}-\frac{1}{3})$. Given the assigned strategy profile, the expected utility from rejection is

$$\begin{aligned}
&\frac{\frac{3\phi}{4}}{\phi+\frac{1}{2}}\delta\left(\underline{b}-p_{t+1}\right)+\frac{\frac{\phi}{4}+\frac{1}{8}}{\phi+\frac{1}{2}}\delta^2\left(\underline{b}-p_{t+2}\right)\\
&\quad=\frac{\frac{3\phi}{4}}{\phi+\frac{1}{2}}\delta\left(\phi\left(\frac{1}{2}\right)^{t-1}\alpha+\left(\frac{1}{2}\right)^{t}\alpha\right)+\frac{\frac{\phi}{4}+\frac{1}{8}}{\phi+\frac{1}{2}}\delta^2\left(\phi\left(\frac{1}{2}\right)^{t-1}\alpha-\left(\frac{1}{2}\right)^{t+1}\alpha\right)\\
&\qquad=\left(\frac{1}{2}\right)^{t-1}\alpha\left[\frac{\frac{3\phi}{4}}{\phi+\frac{1}{2}}\delta\left(\phi+\frac{1}{2}\right)+\frac{\frac{\phi}{4}+\frac{1}{8}}{\phi+\frac{1}{2}}\delta^2\left(\phi-\frac{1}{4}\right)\right]. \qquad (6)
\end{aligned}$$

Equating (5) and (6) yields

$$\phi-1=\frac{\frac{3\phi}{4}}{\phi+\frac{1}{2}}\delta\left(\phi+\frac{1}{2}\right)+\frac{\frac{\phi}{4}+\frac{1}{8}}{\phi+\frac{1}{2}}\delta^2\left(\phi-\frac{1}{4}\right) \tag{7}$$

which implies

$$\phi=\frac{4-\delta}{4(1-\delta)}. \tag{8}$$

To make the stationary argument above work even for $t=1$, we have chosen α so that, conditional on the seller making the offer instead of quitting at $t=0$, we have $s\sim U[\frac{1}{3}-\phi\left(\frac{1}{2}\right)^{t-2}\alpha, \frac{1}{3}+\left(\frac{1}{2}\right)^{t-1}\alpha]$. This is true if $\phi\alpha=\frac{1}{6}$, that is, $\alpha=\frac{2(1-\delta)}{3(4-\delta)}$.

Take any $t\in\{1,3,5,\ldots\}$. For a seller with $s>p_t$, quitting yields a payoff of 0, and making the offer yields no more than 0. For a seller with $s\leq p_t$, quitting yields a payoff of 0, and making the offer yields at least 0. For a buyer receiving an offer of p_t, the payoff from accepting minus the payoff from rejecting is non-decreasing in b; since the threshold type is indifferent, no type can benefit from deviating. A symmetric argument holds for $t\in\{2,4,6,\ldots\}$.

A.2.2 Deviations at histories involving off-path offers

We now construct beliefs and strategies that yield the path of play in Proposition 1, and prove these are a PBE. It is sufficient to specify, for each t and each offer not equal to $\frac{1}{3}+\left(-\frac{1}{2}\right)^{t-1}\alpha$, beliefs and continuation strategies such that:

1. Those beliefs and continuation strategies form a PBE of the subgame that follows from the deviation.

2. On the path of play, no type of the player called to play at t has a profitable one-stage deviation to a counteroffer of $p_{t+1} \neq \frac{1}{3} + \left(-\frac{1}{2}\right)^t \alpha$.

We will deal with two cases separately: deviations at the first offer p_1 and deviations at any subsequent offer.

Deviations at the first offer

If the seller chooses $p_1 \neq \frac{1}{3} + \alpha$, then we specify the beliefs $s = 0$ and $b \sim U[0, 1]$.[30] This corresponds to the "no-gap" case in models of bargaining with one-sided incomplete information.[31]

There exists a PBE of this bargaining game such that, if the buyer has not deviated previously, the following holds:

1. In even periods t, the lowest-cost seller $s = 0$ offers $p_{t+1} = \frac{\sqrt{1-\delta^2}}{1+\sqrt{1-\delta^2}} \bar{b}_t$, where $\bar{b}_t$ is the highest buyer type that has not yet accepted.

2. In odd periods t, the buyer accepts p_t if $b\sqrt{1 - \delta^2} > p_t$ and counteroffers with $p_{t+1} = 0$ otherwise.

The seller's behavior in even periods is constructed as in Example 1 of Gul et al. (1986), which is due to Stokey (1981). For δ close enough to 1, the buyer's behavior in odd periods can be enforced by specifying the belief $b = 1$ for any deviating offer $p_{t+1} \neq 1$ (Gul and Sonnenschein, 1988, p. 610).

We specify that if the seller chooses $p_1 \neq \frac{1}{2} + \alpha$, then continuation play is as in the above equilibrium. Now we prove that, for δ close enough to 1, no type of s profits by deviating in this way.

After a first-offer deviation, no seller strategy results in an accepted price greater than $\sqrt{1 - \delta^2}$. Consequently, an upper bound for the seller's payoff after a first-offer deviation is $\max\{\sqrt{1 - \delta^2} - s, 0\}$.

[30] $b \sim U[0, 1]$ is implied by the usual requirement that the seller's actions cannot be informative about the buyer's type.

[31] This gap vs. no-gap language appears frequently in the incomplete-information bargaining literature. See, for example, Ausubel et al. (2002).

Case 1: Suppose $s \leq \frac{1}{6}$. The buyer accepts an offer of $p_1 = \frac{1}{3} + \alpha$ if $b > \frac{1}{3} + \phi\alpha = \frac{1}{2}$. Thus a lower bound for the seller's payoff from this offer is $\frac{1}{2}\left(\frac{1}{3} + \alpha - s\right) \geq \frac{1}{2}(\frac{1}{6} + \alpha)$. An upper bound for the seller's payoff from deviating is $\sqrt{1-\delta^2}$.

$$\lim_{\delta \to 1} \frac{1}{2}(\frac{1}{6} + \alpha) = \frac{1}{12} > 0 = \lim_{\delta \to 1} \sqrt{1-\delta^2}. \tag{9}$$

Thus, for δ close enough to 1, the seller cannot gain by deviating at the first offer.

Case 2: Suppose $s > \frac{1}{6}$. The seller's payoff in the constrained game is at least 0. The seller's payoff from the deviation is no more than $\max\{\sqrt{1-\delta^2} - \frac{1}{6}, 0\}$, and for δ close enough to 1, $\sqrt{1-\delta^2} - \frac{1}{6} < 0$, so the seller cannot gain by deviating at the first offer.

Deviations at later offers by the seller

Suppose that at $t \in \{2, 4, 6, \ldots\}$, the seller facing offer $p_t = \frac{1}{3} + \left(-\frac{1}{2}\right)^{t-1} \alpha$ makes an off-path counteroffer $p_{t+1} \neq \frac{1}{3} + \left(-\frac{1}{2}\right)^{t} \alpha$.

Upon this deviation, we specify the optimistic belief $s = 0$. At t, we have that $b \sim U\left[\frac{1}{3} - \frac{1}{2^{t-1}}\alpha, \frac{1}{3} + \frac{1}{2^{t-2}}\phi\alpha\right]$. This is the "gap" case.

Seller punishment construction

We now construct a PBE of the alternating-offers bargaining game starting from a deviating offer by the seller, such that as δ goes to 1, the transaction price converges to strictly less than the lower bound on b. We denote that lower bound as $\underline{b} \equiv \frac{1}{3} - \frac{1}{2^{t-1}}\alpha$. The strategies are as follows:

1. If all the buyer's previous offers (since the deviation) are equal to $p_B \equiv \underline{b}\frac{\delta}{1+\delta}$, then the buyer of type b accepts an offer of p if

$$b - p \geq \delta(b - p_B) \tag{10}$$

   and counteroffers with p_B otherwise.

2. If the seller of type 0 receives an offer of p_B, then he accepts.

3. If the seller of type 0 receives an offer not equal to p_B, then he believes that $b = 1$, and types $b = 1$ and $s = 0$ proceed to play as in the full-information alternating-offers

bargaining game.

We now verify that this is an equilibrium via the one-stage deviation principle. By inspection, the assigned strategies are optimal if the buyer makes an offer not equal to p_B.

We now check histories at which the buyer has only made offers equal to p_B. Suppose the buyer receives an offer of p. Accepting p yields payoff $b-p$ and making a counter offer of p_B yields $\delta(b-p_B)$. Thus, he prefers accepting p to making a counteroffer of p_B if and only if $b-p \geq \delta(b-p_B)$. If he makes any counteroffer other than p_B, then the lowest price the seller will later accept is $\frac{\delta}{1+\delta}$, so his payoff is at most $\max\{\delta(b-\frac{\delta}{1+\delta}), 0\}$, which is strictly less than his payoff from counteroffering p_B.

Suppose the seller receives an offer of p_B at t. We now check that it is not profitable to deviate to any counter offer p. A one-stage deviation to p is accepted by the buyer at $t+1$ if equation (10) is satisfied, and otherwise the buyer counteroffers with p_B and is accepted at $t+2$.

Given the buyer's strategy, the seller believes that b is uniformly distributed between $\underline{b}$ and $\overline{b}$, for some $\overline{b} \leq \frac{1}{3} + \frac{1}{2^{t-2}}\phi\alpha$. Thus, the buyer's acceptance threshold is uniformly distributed between $\underline{\tau}$ and $\overline{\tau}$, where $\underline{\tau} = \underline{b}(1-\delta+\frac{\delta^2}{1+\delta}) = \underline{b}\frac{1}{1+\delta}$ and $\overline{\tau} = \overline{b}(1-\delta) + \underline{b}\frac{\delta^2}{1+\delta}$

Thus, making an offer of $p \in [\underline{\tau}, \overline{\tau}]$ yields payoff

$$\frac{\overline{\tau}-p}{\overline{\tau}-\underline{\tau}}\delta p + \frac{p-\underline{\tau}}{\overline{\tau}-\underline{\tau}}\underline{b}\frac{\delta^3}{1+\delta} \tag{11}$$

Note that $\overline{b} \leq 2\underline{b}$, since

$$\overline{b} \leq \frac{1}{3} + \frac{1}{2^{t-2}}\frac{1}{6} \leq \frac{1}{2} \leq 2\left(\frac{1}{3} - \frac{1}{2^{t-1}}\frac{2(1-\delta)}{3(4-\delta)}\right) = 2\underline{b} \tag{12}$$

$\overline{b} \leq 2\underline{b}$ implies that $\overline{\tau} - 2\underline{\tau} + \delta^2\underline{\tau} \leq 0$, which implies that equation (11) is maximized at $p = \underline{\tau}$. Thus, the seller's maximum payoff from any counteroffer is $\delta\underline{\tau} = \underline{b}\frac{\delta}{1+\delta} = p_B$, so the seller cannot profit by rejecting an offer of p_B.

No profitable deviations by the seller

Suppose that the history of the game thus far is such that every offer has been consistent with equation (1). The seller faces an offer of $p_t = \frac{1}{3} - \frac{1}{2^{t-1}}\alpha$. Given the above punishment strategies, any one-stage deviation to a counteroffer $p_{t+1} \neq \frac{1}{3} + \frac{1}{2^t}\alpha$ is accepted only if

$p_{t+1} \leq (1-\delta) + p_t \frac{\delta}{1+\delta}$, and otherwise leads to a transaction at price $p_t \frac{\delta}{1+\delta}$.

Since $p_t = \frac{1}{3} - \frac{1}{2^{t-1}}\alpha$ is bounded away from 0 for all $t \in \{2,4,6,\ldots\}$, we can pick δ close enough to 1 so that for all $t \in \{2,4,6,\ldots\}$, $\delta > \sqrt{1-p_t}$, which implies that $(1-\delta)+p_t\frac{\delta}{1+\delta} < p_t$, and the seller cannot profitably deviate to an off-path offer.

Deviations at later offers by the buyer

Suppose that at $t \in \{1,3,5,\ldots\}$, the buyer facing offer $p_t = \frac{1}{3}+\left(-\frac{1}{2}\right)^{t-1}\alpha$ makes an off-path counteroffer $p_{t+1} \neq \frac{1}{3}+\left(-\frac{1}{2}\right)^{t}\alpha$. Upon this deviation, we specify the optimistic belief $b=1$. At t, we have that $s \sim U\left[\frac{1}{3} - \frac{1}{2^{t-2}}\phi\alpha, \frac{1}{3} + \frac{1}{2^{t-1}}\alpha\right]$.

Buyer punishment construction

We now construct a PBE of the alternating-offers bargaining game starting from a deviating offer by the buyer. The construction is essentially symmetric. We denote $\overline{s} \equiv \frac{1}{3} + \frac{1}{2^{t-1}}\alpha$. The strategies are as follows:

1. If all the seller's previous offers (since the deviation) are equal to $p_S = \overline{s} + (1-\overline{s})\frac{1}{1+\delta}$, then the seller of type s accepts an offer of p if

$$p - s \geq \delta(p_S - s) \tag{13}$$

   and counteroffers with p_S otherwise.

2. If the buyer of type 1 receives an offer of p_S, then he accepts.

3. If the buyer of type 1 receives an offer not equal to p_S, then he believes that $s=0$, and types $b=1$ and $s=0$ proceed to play as in the full-information alternating-offers bargaining game.

The argument proceeds as before. The only non-trivial part is checking one-stage deviations by the buyer of type 1 after receiving an offer of p_S.

As before, the seller's type is uniformly distributed between some $\underline{s} \geq \frac{1}{3} - \frac{1}{2^{t-2}}\phi\alpha$ and $\overline{s}$, so the seller's acceptance threshold for a counteroffer p is distributed uniformly between $\underline{\tau} \equiv (1-\delta)\underline{s} + \delta p_S$ and $\overline{\tau} \equiv (1-\delta)\overline{s} + \delta p_S = \overline{s} + (1-\overline{s})\frac{\delta}{1+\delta}$. The buyer's payoff from an offer of $p \in [\underline{\tau}, \overline{\tau}]$ is

$$\frac{p - \underline{\tau}}{\overline{\tau} - \underline{\tau}}\delta(1 - p) + \frac{\overline{\tau} - p}{\overline{\tau} - \underline{\tau}}\delta^2(1 - p_S) \tag{14}$$

Equation 14 is maximized at $p = \overline{\tau}$ if

$$1 - 2\overline{\tau} + \underline{\tau} - \delta(1 - p_S) \geq 0. \tag{15}$$

Some algebra reduces this to

$$2(1 - \overline{s}) \geq 1 - \underline{s} \tag{16}$$

which holds since $2(1 - \overline{s}) \geq 1 \geq 1 - \underline{s}$.

Substituting into equation (14), the buyer of type 1 has a payoff of no more than $(1 - \overline{s})\frac{\delta}{1+\delta} = 1 - p_S$ from making a counteroffer, so he cannot profit by rejecting an offer of p_S.

No profitable deviations by the buyer Suppose that, so far, every offer has been consistent with equation (1). The buyer faces an offer of $p_t = \frac{1}{3} + \frac{1}{2^{t-1}}\alpha$. Given the above punishment strategies, any one-stage deviation to a counteroffer $p_{t+1} \neq \frac{1}{3} - \frac{1}{2^t}\alpha$ is accepted only if $p_{t+1} \geq \delta p_S = \delta(p_t + (1 - p_t)\frac{1}{1+\delta})$, and otherwise leads to a transaction at price $p_t + (1 - p_t)\frac{1}{1+\delta}$. Since p_t is bounded away from 1 for all $t \in \{1, 3, 5, \ldots\}$, we can pick δ close enough to 1 so that for all $t \in \{1, 3, 5, \ldots\}$, $p_t < \delta(p_t + (1 - p_t)\frac{1}{1+\delta})$, so the buyer cannot profitably deviate to an off-path offer. □

A.3 Proof of Proposition 2

Suppose $b < p_T^*$. Any σ_B that accepts p_T^* at h yields negative utility conditional on h, whereas rejecting at h and at all subsequent histories yields 0 utility. Hence, any σ_B that accepts p_T^* at h is not a sequential best reply to any conditional probability system, which proves Clause 1.

Suppose $b > p_T^*$. Let σ_B^* be the buyer strategy such that:

1. If all previous offers have been consistent with the sequence $\{p_t^*\}_{t=1}^T$ and equal to p_T^* for $t > T$, then the buyer makes the next offer in the sequence if proposing, and accepts any offer weakly less than p_T^* if receiving.

2. Else, if the first inconsistent offer was by the seller, then the buyer plays the full-information subgame-perfect equilibrium with buyer value p_T^* and seller cost 0.

3. Else, the buyer offers p_T^* and accepts an offer if and only if it is no more than p_T^*.

Symmetrically, let σ_S^* be the seller strategy such that:

1. If all previous offers have been consistent with the sequence $\{p_t^*\}_{t=1}^T$ and equal to p_T^* for $t > T$, then the seller makes the next offer in the sequence if proposing, and accepts any offer weakly more than p_T^* if receiving.

2. Else, if the first inconsistent offer was buy the buyer, then the seller plays the full-information subgame-perfect equilibrium with buyer value 1 and seller cost p_T^*.

3. Else, the seller offers p_T^* and accepts an offer if and only if it exceeds p_T^*.

Observe that $\sigma_B^* \in \Sigma_B(h)$ and $\sigma_S^* \in \Sigma_S(h)$.

We now specify beliefs for both buyer and seller: on the path of play of (σ_B^*, σ_S^*), the buyer believes that the seller's strategy is σ_S^* and her cost $s = p_T^*$, and the seller believes that the buyer's strategy is σ_B^* and her value is $b = p_T^*$. Following a deviation by the seller, the buyer believes that the seller's cost is 0 and that she will henceforth play the full-information subgame-perfect equilibrium with buyer value p_T^* and seller cost 0. Symmetrically, following a deviation by the buyer, the seller believes that the buyer's value is 1 and that he will play the full information SPE with buyer value 1 and seller cost p_T^*.

For δ close enough to 1, σ_B^* is a sequential best reply to the specified beliefs for a buyer with value $b > p_T^*$. For any history at which the seller made the first deviating offer, σ_B^* is a sequential best reply by construction, since it specifies that the buyer plays his part in the full-information SPE with buyer value p_T^* and seller cost 0. For any history consistent with (σ_B^*, σ_S^*), playing according to σ_B^* yields utility $\delta^{T-1}(b - p_T^*)$. By contrast, if the buyer deviates to an off-path offer, then the seller will henceforth only offer $\frac{\delta p_T^* + 1}{1+\delta}$ and will only accept offers that exceed $\frac{p_T^* + \delta}{1+\delta}$. Hence the buyer's utility following a deviating offer is upper bounded by $b - \frac{p_T^* + \delta}{1+\delta}$. Similarly, the buyer's utility from deviating to accept an earlier offer is upper bounded by $b - \min_{t \in \mathbb{T}_S} p_t^*$, where $\mathbb{T}_S$ denotes the periods strictly before T in which the seller made offers. Hence the buyer's gain from deviating first is upper bounded by the expression

$$\max\left\{b-\frac{p_T^*+\delta}{1+\delta}, b-\min_{t\in\mathbb{T}_S} p_t^*\right\}-\delta^{T-1}(b-p_T^*) \tag{17}$$

which, as $\delta \to 1$, converges (uniformly in b) to

$$\max\left\{\frac{p_T^*-1}{2}, p_T^*-\min_{t\in\mathbb{T}_S} p_t^*\right\}<0. \tag{18}$$

where the inequality follows since the offer sequence $\{p_t^*\}_{t=1}^T$ is monotone. This argument yields Clause 2 of Proposition 2. A symmetric argument applies to the seller. □

B Additional Cleaning Steps of Datasets

In this section, we describe additional details about our cleaning procedure for each dataset.[32] Before describing each dataset in more detail, we first show the number of observations that are dropped due to our final restrictions described at the beginning of Section 2. First, we drop any threads in which an agent's offer is an exact repeat the opponent's previous offer (which logically should have led the game ending in agreement), but additional offers are recorded afterward (Restriction 1 in Appendix Table A1). Second, we drop any threads in which the seller makes an offer that is strictly below a buyer's offer (Restriction 2). Third, we drop any threads in which a buyer makes an offer that is strictly below her own previous offer or a seller makes an offer that is strictly above her own previous offer (Restriction 3). Appendix Table A1 shows that fewer than 2% of observations are dropped in most settings. In the settlement, TV show, and housing cases, 19%, 24%, and 16%, respectively, are dropped. In these settings, changes to the bargaining environment during the game (such as the arrival of new information), or simply misrecorded offers, may be more prevalent.

B.1 Used Car Bargaining in the U.S.

In this data setting, when the auction price falls short of the seller's secret reserve price, the typical next step is for the seller and the highest bidder to engage in bargaining. In some cases, this negotiation may end quickly, with the seller deciding on the spot to not accept the auction price and to not negotiate further. In these cases, a buyer who is not

[32] We do not describe any additional details for the eBay dataset, as we use the same cleaning steps as Backus et al. (2020).

Table A1: Observations Dropped

	(1) Cars	(2) Settlement	(3) TV Show	(4) Rides	(5) Housing	(6) Trade	(7) eBay
# Threads $\geq$ 3 rounds	22,134	91,617	268	2,058	210	44,893	7,057,219
Restriction 1	22,069	87,390	264	2,058	198	44,732	7,048,997
Restriction 2	21,955	80,576	258	2,058	198	44,732	7,029110
Restriction 3	21,734	74,356	204	2,058	176	44,048	6,976,776
% Dropped	1.81%	18.84%	23.89%	0%	16.19%	1.88%	1.14%

Notes: Table shows the number of sequences/threads dropped due to the restrictions described at the beginning of Section 2.

the highest bidder may, on occasion, approach the auction house salesperson and make an offer on the car, asking the auction house to call the seller to notify her. We include such sequences in our main analysis. Another possibility in cases when the auction price falls below the reserve price is that the seller and the highest bidder may engage in bargaining and, at the same time, a buyer who is not the highest bidder may approach the auction house and make a "back-up offer," which the auction house can turn to if the negotiation between the seller and the highest bidder breaks down. As these back-up offers are more complicated to interpret in our alternating-offer framework, we drop any sequences that contain back-up offers. We also drop any inexplicable sequences, such as those that end with a counteroffer or end with a party accepting an offer after an opponent had already supposedly ended the negotiations. Neither of these restrictions exclude a large fraction of sequences.

B.2 Pre-trial Settlement Bargaining from Insurance Claims in the U.S.

The dataset contains multiple proposed offers (an *offer* here means it is a proposal from the insurer) or *demands* (meaning a proposal from the plaintiff) on the same day with no exact timestamp. Sometimes consecutive proposals from the same party are recorded, a pattern that does not satisfy the alternating-offer feature of the bargaining we are analyzing. To construct the bargaining sequences for analysis, we rearrange all bargaining sequences following the rules described below.

1. In each claim, we order all the offers and demands by date.
2. If there are multiple offers on the same day, we order them in the *increasing* amount.
3. If there are multiple demands on the same day, we order them in the *decreasing* amount.
4. If there are both offers and demands on the same day, we assume within the same day, demands and offers should be alternating.
5. If there are both offers and demands on the same day, whether this day starts with a demand or an offer follows the following rule:
    (a) If the date is the first date in a claim, we assume *offers* come first.
    (b) If the date is not the first date in a claim
        i. If the most recent date before this day ends with an offer, we assume this day starts with a demand.
        ii. If the most recent date before this day ends with a demand, we assume this day starts with an offer.
6. After we arrange all offers and demands in this way, if there are consecutive offers or demands, we keep the last offer or demand and drop others.

Our main analysis pools together sequences that begin with an offer and those that begin with a demand. When we examine these separately, we find a similar mass point at 0.5. We also find that split offers are more likely to be accepted regardless of whether the sequence begins with a proposal from the insurer or the plaintiff. These results are shown in the first two columns of Appendix Table A2. Note that some sequences end at round 10, and we have no data on whether round 10 offers were accepted or not. This leads to the total number of observations in Table 1 being slightly larger than that in analysis that examines acceptance, such as Table 2 and Appendix Table A2.

B.3 Street Bargaining from a TV Game Show in Spain

The bargaining sequences in the dataset are not necessarily alternating. Sometimes the proposer or the respondent can make consecutive offers. In such cases, we only keep the last offer in consecutive offers made by the same party. We also drop a small number of sequences that start from the respondent, so all remaining sequences start from the proposer.

B.4 Auto Rickshaw Rides Bargaining in India

As described in the paper, there are two broad types of bargaining: "real" bargaining and "scripted" bargaining. We keep all real bargaining sequences. For scripted sequences, we exclude offers and acceptance decision from surveyors, as these are not actual decisions made by negotiating agents. This point leads to the total number of observations for the rides setting differing in analysis where we examine offers made (such as Table 1 and Figure 1) vs. analysis where we examine offers accepted (such as Table 2 or Appendix Table A2), because, in acceptance analysis, some scripted bargaining acceptances must be dropped, and yet some scripted bargaining offers can be included.

In columns 3–5 of Appendix Table A2, we repeat our analysis of the likelihood that split offers are accepted, doing so separately for real bargaining data, the scripted bargaining sequences that begin with a driver offer, and the scripted bargaining sequences that begin with a surveyor offer. As highlighted in Section 5.1, these scripted bargaining offers are the most interesting for this analysis, as these give something closer to a causal estimate of the effect of split offer because surveyor's offers are assigned by the experiment designer (Keniston) rather than arising endogenously.[33] In this subset of the data, shown in columns 4–5, we find positive point estimates, and a particularly large and marginally significant positive point estimate in those sequences that begin with a surveyor offer. When we examine histograms of concession weights separately for these three subsamples, we also find a large mass point at 0.5 and sparse data at other points, as in the main sample.

B.5 Bargaining Over Housing

In this dataset, we observe a seller identifier (which is simply the address of the home), but we do not observe the buyer identifier. This means that when we observe multiple offers for the same house, these could come from the same buyer or different buyers. We are therefore required to make some assumptions to identify a distinct bargaining thread

[33] Even though the offer sequence of the surveyor is assigned exogenously, the event that an offer is a "split" offer is not entirely exogenous, as this depends on the offer of the driver as well.

(i.e., a negotiation between a given seller and given buyer). For each observation, we can observe the agent commission type (call it AgentType), which is either a fixed amount (e.g., $5,000) or a percentage (e.g., 2%). We assume if two observations have different AgentType, they must be different buyers. If two observations have the same AgentType, they are not necessarily the same buyer. For all offers in each house-AgentType pair, we sort them by their submitted timestamp.

In the main sample, we only keep those house-AgentType pairs where all offers always weakly increase over time. Among these pairs, if the last offer is accepted or no offer is accepted, we assume all these offers belong to the same buyer. If some middle offer is accepted, we assume all offers up to the accepted offer belong to the same buyer and all offers after the accepted offer belong to another buyer.

For pairs where not all offers weakly increase over time, we follow the rules below to identify distinct buyers:

- When an offer is higher than the previous offer and the previous offer is not accepted, then the two offers come from the same buyer.
- When an offer is higher than the previous offer and the previous offer is accepted, then the second offer is made by a new buyer.
- When an offer is lower than the previous offer, then the second offer is made by a new buyer.

In doing so, we assume that the seller only bargains with one buyer at the same time. We are less confident in this assumption, and thus in the main sample, we exclude these observations. When these observations are included, we find a similar mass point at 0.5 in the concession weights, and find a positive (but insignificant) point estimate of the effect of a split offer on the probability of acceptance. These latter results are shown in column 6 of Appendix Table A2.

B.6 International Trade Tariff Bargaining

This dataset is publicly available on the journal website. We define one bargaining round as a combination of Proposer-Target-Stage-Date. A stage can be "request", "offer", "final offer", or “modification.” An example of one bargaining round is the following: Australia makes requests to India on 10/16/1950. To create product-level concordances across negotiations, Bagwell et al. (2020) connect product-level descriptions to HS 1988 6-digit (HS6) codes. A product-level description can involve multiple tariff items. We refer to a combination of HS6 and tariff item as one product. If multiple observations exist for one product in one bargaining round, we use their average tariffs. A bargaining thread contains two counties negotiating over the tariffs for a certain product in a certain direction.

In the raw dataset, there are two types of tariffs: “Specific” means the request/offer is in dollars and “Ad Valorem” means the tariff is quoted as a fraction of prices. In most threads, only one type of tariff is used. In some rare cases, both types can exist. For each thread, if all observations have Ad Valorem tariff terms, we use this variable as the price variable. If not all observations involve Ad Valorem tariff terms, but all observations involve Specific tariff terms, we use this variable as the price variable. We drop threads with no consistent tariff types. We also drop observations with missing stage variable and with inconsistent country names.

Within each thread, we sort all observations by date. In a few cases, there are multiple observations on the same day, which come from modifications of offers/requests/final offers. We treat these modifications as having come after their corresponding proposals. For each thread, if there is a “final offer” or “modification of final offer” stage, we assume the price in this round is the final price. If there is no such stage, we assume this bargaining thread does not reach an agreement. For each round, if the price is equal to the final price, we assume this offer or request is accepted. Otherwise, it is rejected/countered. By construction, the price in the “final offer” or “modification of final offer” stage is accepted.

In all threads, 66.5% start with a request, 14.1% start with an offer, and the rest start a final offer. We drop threads that start with a final offer. We further restrict to threads with the following patterns: threads that start with a request (which includes items labeled “request,” “request-offer,” “request-final offer,” and “request-offer-final offer”) and threads that start with an offer (which includes items labeled “offer” and “offer-final offer”). These threads account for more than 80% of total threads.

For purposes of examining split-the-difference behavior, we consider two benchmarks as though they are default bargaining offers at the beginning of any given thread. These are a zero tariff, which can be seen as the initial request from any proposer, and a the status quo tariff before the negotiations, which can be seen as the initial offer from the target. For threads that start with an offer and for the last round in threads with the pattern "request-offer-final offer", we replace $\gamma_{j,t}$ with $1-\gamma_{j,t}$, so that $\gamma_{j,t}$ still measures the extent of concession in two consecutive offers from the target. We exclude the last round in threads with the pattern "offer-final offer", as this implies three consecutive offers and we cannot define concession in this case.

In our main analysis, we pool together sequences that begin with an a request and those that begin with an offer. When we examine these two subsets of the data separately, we find a similar mass point at 0.5 in the concession weights, and a similarly strong positive and significant effect of split offers on the acceptance probability. These latter results are shown in the last two columns of Appendix Table A2. The effect of a split offer is especially large for sequences that begin with an offer.

C Additional Placebo Concession Analysis

C.1 Alternative Placebo Analysis in Used Car Bargaining

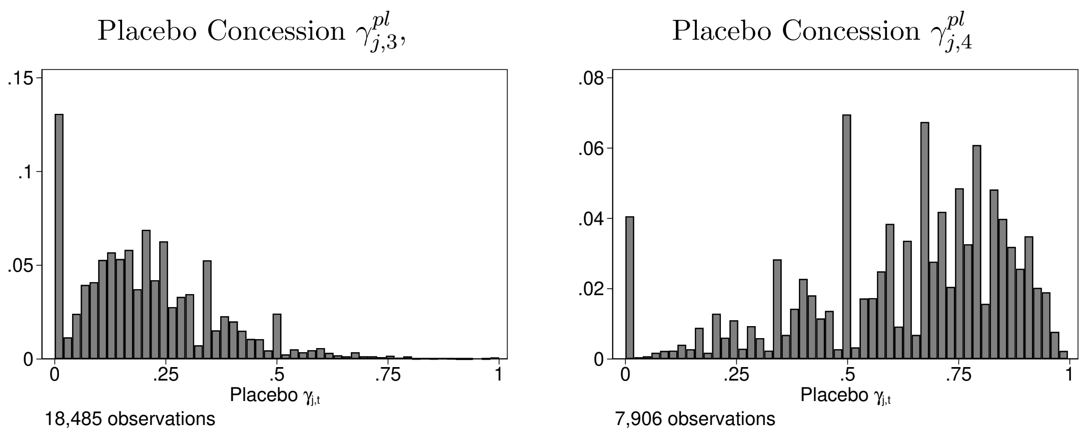
In the used car bargaining data, we can observe the reserve price the seller reports to the auction house. This is a *secret* reserve price, in that it is not announced to the buyer. If the auction price is above this secret reserve price, the highest bidder is awarded the car. Otherwise, the seller and the buyer can bargain. The bargaining starts with the auction price from the buyer, $p_{j,1}$, and then alternates between the seller and buyer.

Below are two placebo concession weights we construct that rely on sellers' secret reserve prices:

- In round 3, the true concession of the buyer is $\gamma_{j,3} = \dfrac{p_{j,3} - p_{j,1}}{p_{j,2} - p_{j,1}}$. The placebo concession $\gamma^{pl}_{j,3}$ replaces the offer of the seller, $p_{j,2}$, with the reserve price.
- In round 4, the true concession of the seller is $\gamma_{j,4} = \dfrac{p_{j,4} - p_{j,2}}{p_{j,3} - p_{j,2}}$. The placebo concession $\gamma^{pl}_{j,4}$ replaces the offer of the seller, $p_{j,2}$, with the reserve price.

In many cases, the placebo concession is out of the range $[0, 1]$. Appendix Figure A1 plots the distribution of these placebo concession weights in round 3 and 4, where we limit to cases where the weight lies in $[0, 1]$. In the right panel of Appendix Figure A1, we observe a spike at 0.5, suggesting that some sellers do propose offers that split the difference between the buyer's most recent offer and the seller's secret reserve price. This tendency to splitting the difference is much weaker here, however, than in the main sample histogram shown in Figure 1. The spike at 0.5, for example, is similar to those at other levels of $\gamma_{j,4}^{pl}$ (such as those around 0.7 or 0.8), suggesting that a stronger norm for splitting the difference between the two most recent offers than between an offer and a privately known quantity.

Figure A1: Distribution of Placebo Concession, Used Car Bargaining



Notes: Each panel shows a histogram of the placebo concession weights in the used-car bargaining data where the seller's round 2 offer is replaced with the seller's secret reserve price. The left panel uses the round 3 placebo concession and the right panel uses the round 4 placebo concession.

C.2 Alternative Placebo Analysis in Pre-trial Settlement Bargaining

In the pre-trial settlement data, we can observe the insurer's "reserve price," which is an estimate known only to the insurer of how much the insurer expects the case to cost the company. There are two types of bargaining sequences: those that start with a demand and those that start with an offer.

- If the sequence starts with a demand, in round 3, the true concession of the plaintiff is $\gamma_{j,3} = \dfrac{p_{j,3} - p_{j,1}}{p_{j,2} - p_{j,1}}$. The placebo concession replaces the offer of the insurer in round 2, $p_{j,2}$, with the reserve.

- If the sequence starts with an offer, in round 3, the true concession of the insurer is $\gamma_{j,3} = \dfrac{p_{j,3} - p_{j,1}}{p_{j,2} - p_{j,1}}$. The placebo concession replaces the offer of the insurer in round 1,

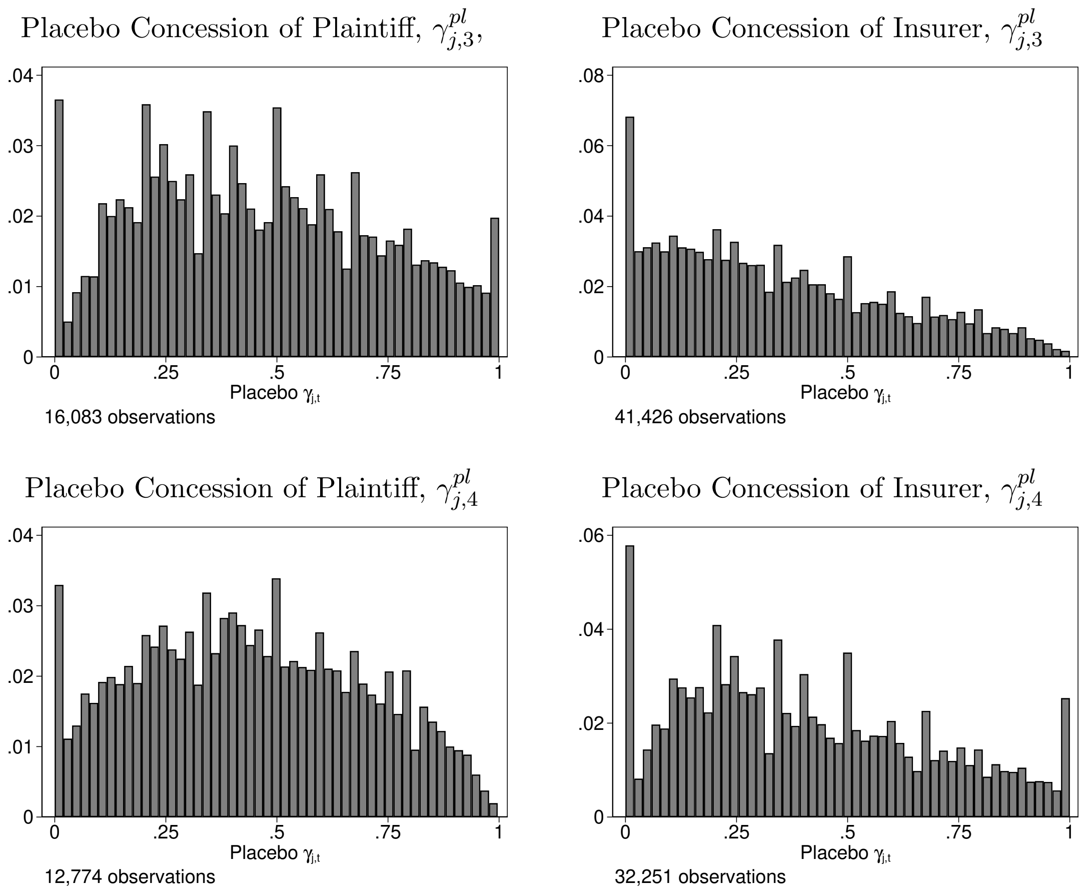
$p_{j,1}$, with the reserve.

- If the sequence starts with a demand, in round 4, the true concession of the insurer is $\gamma_{j,4} = \frac{p_{j,4} - p_{j,2}}{p_{j,3} - p_{j,2}}$. The placebo concession replaces the offer of the insurer in round 2, $p_{j,2}$, with the reserve.

- If the sequence starts with an offer, in round 4, the true concession of the plaintiff is $\gamma_{j,4} = \frac{p_{j,4} - p_{j,2}}{p_{j,3} - p_{j,2}}$. The placebo concession replaces the offer of the insurer in round 3, $p_{j,3}$, with the reserve.

In many cases, the placebo concession is out of the range $[0, 1]$. Appendix Figure A2 plots the distribution of placebo concession in round 3 and 4 for sequences that start with a demand and start with an offer separately, limiting to those with concession weights in $[0, 1]$. We do not observe strong support for agents favoring offers that split the difference between the privately known reserve and the most recent public offer.

Figure A2: Distribution of Placebo Concession, Pre-trial Settlement Bargaining



Notes: Each panel shows a histogram of the placebo concession weights in the settlement bargaining where an insurer offer is replaced with the insurer's privately known reserve amount.

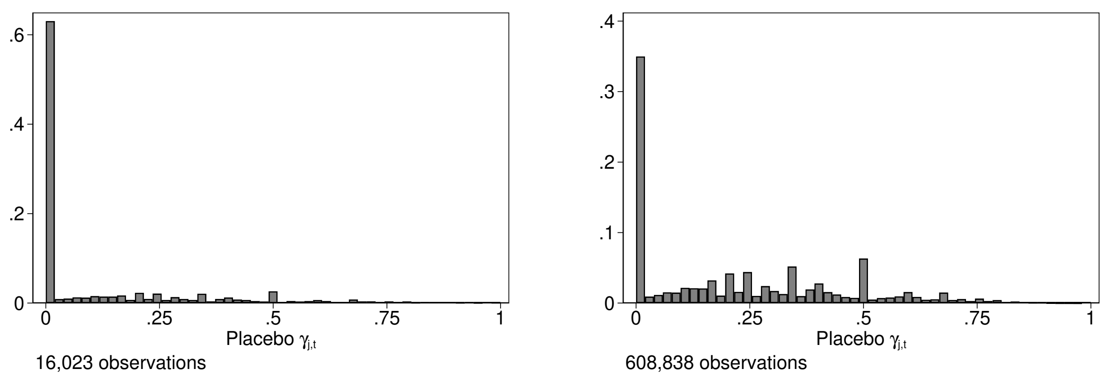
C.3 Alternative Placebo Analysis in eBay Best Offer Bargaining

In the eBay data, we can observe a seller's *auto-accept* and *auto-decline* prices. Reporting these price thresholds is optional for a seller. When reported, these prices serve a similar role to proxy bids in an eBay auction. If buyer makes an offer above the auto-accept price, the platform automatically accepts the offer on the buyer's behalf. If the buyer makes an offer below the auto-decline price, the platform declines. These prices are known only to the seller.

In the eBay setting, a bargaining sequence starts with the seller's list price and alternates between the buyer and seller. The list price is $p_{j,1}$, the initial offer from the buyer is $p_{j,2}$, and the first offer from the seller is $p_{j,3}$. In round 3, the true concession of the seller is $\gamma_{j,3} = \dfrac{p_{j,3} - p_{j,1}}{p_{j,2} - p_{j,1}}$. The placebo concession replaces the list price $p_{j,1}$ with the auto-accept or auto-decline price. In many cases, the placebo concession is out of the range $[0, 1]$. Appendix Figure A3 plots the distribution of placebo concession using auto-decline and auto-decline prices separately, limiting to those cases with concession weights in $[0, 1]$. We observe some mass at 0.5, but far less than in the main sample (Figure 1), suggesting again a stronger norm for splitting the difference between the two most recent offers than between an offer and a quantity known only to one party.

Figure A3: Distribution of Placebo Concession, eBay Best Offer Bargaining

Placebo Concession $\gamma^{pl}_{j,3}$, Auto-Decline Price　Placebo Concession $\gamma^{pl}_{j,3}$, Auto-Accept Price



Notes: Each panel shows a histogram of the placebo concession weights in the eBay bargaining. In each case, the list price of the seller ($p_{j,1}$) is replaced with either the auto-decline (left panel) or auto-accept (right panel) price of the seller.

Table A2: Probability of a Split Offer Being Accepted

	Pre-trial Settlement Bargaining		Auto Rickshaw Rides Bargaining			Housing	Trade Tariff Bargaining	
	Insurer First	Plaintiff First	Real	Driver	Surveyor	Full	Request First	Offer First
Split	0.170***	0.165***	-0.0485	0.0333	0.165*	0.0983	0.0224***	0.341***
	(0.00602)	(0.00991)	(0.0458)	(0.0567)	(0.0944)	(0.114)	(0.00235)	(0.0218)
N	148173	55968	1224	1050	736	338	41473	5512
Order of $\gamma_{j,t}$	3	3	3	3	3	3	3	3
Round FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Accept rate	0.37	0.28	0.30	0.13	0.16	0.60	0.05	0.25
Split rate	0.04	0.04	0.31	0.13	0.09	0.07	0.17	0.17
R^2	0.128	0.183	0.264	0.108	0.0932	0.0163	0.349	0.0814

Notes: Table shows the estimated coefficient on the split indicator from the regression described by equation (2), as in Table 2, using different subsamples in several of the data settings. Columns 1 and 2 correspond to settlement bargaining sequences that begin with a plaintiff or insurer proposing, respectively. Columns 3–5 correspond to the auto rickshaw rides data, with the real bargaining only in column 3, scripted bargaining beginning with a driver moving first in column 4, and scripted bargaining with a surveyor moving first in column 5. Column 6 uses the housing data, without excluding less trustworthy observations, as described in Appendix B.5. Columns 7–8 use the trade data, with sequences beginning with a *request* in column 7 and those beginning with an *offer* in column 8. The accept rate is the mean of the dependent variable and the split rate is the mean of the split indicator. Standard errors are shown in parentheses. $*: p < 0.10$, **: $p < 0.05$, and ***: $p < 0.01$