SEQUENTIAL BARGAINING IN THE FIELD: EVIDENCE FROM MILLIONS OF ONLINE BARGAINING INTERACTIONS*

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We study patterns of behavior in bilateral bargaining situations using a rich new data set describing back-and-forth sequential bargaining occurring in over 25 million listings from eBay's Best Offer platform. We compare observed behavior to predictions from the large theoretical bargaining literature. One-third of bargaining interactions end in immediate agreement, as predicted by complete-information models. The majority of sequences play out differently, ending in disagreement or delayed agreement, which have been rationalized by incomplete information models. We find that stronger bargaining power and better outside options improve agents' outcomes. Robust empirical findings that existing models cannot rationalize include reciprocal (and gradual) concession behavior and delayed disagreement. Another robust pattern at odds with existing theory is that players exhibit a preference for making and accepting offers that split the difference between the two most recent offers. These observations suggest that behavioral norms, which are neither incorporated nor explained by existing theories, play an important role in the success of bargaining outcomes. *JEL* Codes: C78, D82, D83, M21.

I. Introduction

Bilateral bargaining is one of the oldest and most common forms of trade. Nations negotiate trade deals, arms control, and climate change mitigation; legislators engage in horse-trading to build coalitions and pass legislation; business people haggle over contracts from corporate acquisitions to labor agreements; lawyers wrangle settlements both civil and criminal, and private individuals bargain over wages, real estate, and the allocation of

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household chores. Bargaining determines the allocation of surplus in these settings, as well as the likelihood of breakdown—the latter with real economic and human costs. Therefore, understanding how people bargain, and the institutions, norms, and practices that affect bargaining outcomes, is of first-order importance.

Over the past 60 years, a large body of literature in economics has examined various aspects of bargaining in theory and in laboratory experiments. The theoretical literature typically assumes a particular information structure and extensive form of the game, which can sometimes be implemented in a controlled laboratory setting. Bargaining in real-world settings, however, tends to be less structured, and as a consequence, little evidence has been presented about how people bargain in the field and how prices actually form in real-world negotiations. Indeed, Fudenberg, Levine, and Tirole (1985) explained that the "thorny issue" arising in much of the bargaining literature is that the researcher does not actually know the extensive form of real-world, often unstructured bargaining scenarios. For example, a street vendor bargaining over price might state an offer, watch the reaction of the buyer, and immediately state a lower price without waiting for a spoken response. It is unclear whether this situation should be modeled with alternating offers, one-sided offers, a concession game, or some other structure.

The advent of online marketplaces provides new opportunities to study negotiations in a real-world setting, where the extensive form of the game is similar to those studied in the theoretical and experimental literature, and where the data collected are on a massive scale. In this article, we use data from over 88 million listings on the eBay.com Best Offer platform, where sellers offer items at a listed price and invite buyers to engage in alternating, sequential-offer bargaining, very much in the spirit of Rubinstein (1982). In a large fraction of these listings, buyers chose to make an offer, initiating the alternating-offer game, resulting in over 25 million bargaining sequences. In this setting, we document a variety of facts on how bargaining proceeds and how prices form, and we find evidence consistent with the most salient predictions of economic theory. At the same time, we document robust patterns that suggest that behavioral factors based on reciprocal and equitable norms play a significant role in bargaining outcomes.

Although more widely known for its auctions and fixed-price listings, eBay has offered sales through alternating-offer bargaining for over a decade. Our data come from eBay's Best Offer platform, through which almost 10% of eBay transaction volume occurs as buyer-seller pairs engage in alternating-offer bargaining. Given the sheer volume of trade on eBay and the simple extensive form of the game, the Best Offer platform provides a useful setting for studying the determination of agreed-on prices in sequential bargaining situations. The bargaining in this setting is only over a single dimension (price), making it more straightforward to analyze than many other bargaining settings (such as procurement contracts; Bajari, McMillan, and Tadelis 2009), while still yielding the benefit of being a real-world setting. Furthermore, the data allow us to link buyers and sellers over time. Our data set is, to our knowledge, the largest offer-level negotiations data set to be analyzed in the literature.[1]

Section II describes background on the Best Offer platform and introduces our data set. Section III then documents how patterns observed in the data relate to a variety of game-theoretic models of bargaining. We provide a breakdown of how bargaining sequences unfold in practice and the frequency with which different responses and outcomes occur. We find that there are often few back-and-forth offers in a given bargaining pair, which is predicted by complete-information, common-priors models of bargaining, such as the classical Rubinstein (1982) model. Bargaining also frequently ends in disagreement early on, consistent with the incomplete information model of Perry (1986). Some interactions involve a delay and end in agreement, consistent with other models of incomplete information (Rubinstein 1985; Grossman and Perry 1986; Gul and Sonnenschein 1988). However, a number of sequences end in disagreement after a delay, a feature that is absent in nearly all existing bargaining models, with Cramton (1992) being the only exception we are aware of.

In Section IV we examine several conventional drivers of bargaining outcomes. Bargaining differs when players bargain over expensive versus inexpensive products in a way that is consistent with fixed costs of bargaining playing a role, as opposed to the more commonly modeled discount-factor approach. We examine several forms of bargaining strength. We find that

1. In cooperation with eBay, we anonymized the data set and made it publicly available for research purposes. The data can be accessed at http://www.nber.org/data/bargaining.html or by contacting the authors. We hope that it will further fuel the recent surge of empirical work studying bargaining in economics and stimulate additional work in the area, both empirical and theoretical.

buyers who are more experienced in bargaining on this platform (as measured by the number of previous Best Offer negotiations the buyer has participated in) also tend to achieve lower final prices, and experienced sellers achieve higher final prices. These results are consistent with common models of bargaining in which a player's bargaining power affects outcomes (Rubinstein 1982, 1985; Watson 1998); they are also consistent with laboratory evidence (Rapoport, Erev, and Zwick 1995) and survey data (Scott Morton, Silva-Risso, and Zettelmeyer 2011), but to our knowledge have not been previously confirmed with data from actual bargaining outcomes.[2] We also find evidence that bargaining games in which multiple buyers negotiate with the same seller—improving the seller's outside option with each buyer—yield higher prices for the seller, and vice versa. Furthermore, we document that listings containing more photos (a measure of reduced severity of adverse selection) tend to more quickly receive buyer offers and tend to yield higher negotiated prices.

In Section V we document some patterns unexplained by existing bargaining theories, which exhibit flavors of reciprocity. First, we find that bargaining offers tend to change gradually over the course of the bargaining interaction. This is in contrast to a number of existing bargaining models, in which any delay in bargaining is war-of-attrition-like delay: no information is revealed until one party concedes everything, completely revealing her valuation to the opponent. In contrast, the behavior we observe is consistent with a gradual revelation of information and a gradual concession of bargaining positions. We demonstrate furthermore that this gradualism is reciprocal: the opponent responds to stubbornness by not conceding and to concession by reciprocating with more concession.

We show that players often make offers lying halfway between their previous offer and their opponent's current offer. We further demonstrate that such "split-the-difference" offers have a higher likelihood of being accepted—higher even than some offers that would be even more favorable in money terms for the accepting party. Such behavior is not consistent with any existing theory of rational behavior, but it may be consistent with

2. One study documenting causal evidence on delay in bargaining from field data (but not actual offer data) is Ambrus, Chaney, and Salitsky (2018), studying delay induced by travel times of Spanish ransom teams negotiating with North African pirates in the 1600s.

behavioral norms; similar split-the-difference behavior is discussed throughout the experimental and theoretical behavioral bargaining literature, in which market participants may care about fairness and often favor a split-the-difference strategy (Roth and Malouf 1979; Roth 1985; Binmore, Shaked, and Sutton 1985; Bolton 1991; Bolton and Ockenfels 2000; Charness and Rabin 2002; Andreoni and Bernheim 2009). A distinction in the setting we study is that here players are splitting the difference between two previous price offers, not necessarily a known surplus.

Our article is related to a growing literature studying negotiated price settings. Many such papers have only data on final negotiated prices and only for cases in which trade occurs, such as in Crawford and Yurukoglu (2012). In contrast, we observe all back-and-forth offers, even for bargaining interactions that failed to reach an agreement. Similar data sets, although smaller than ours in size and scope, are analyzed in Keniston (2011), Bagwell, Staiger, and Yurukoglu (2017), Hernandez-Arenaz and Iriberri (2018), Larsen and Zhang (2018), Larsen (2019), and Backus, Blake, and Tadelis (2019a, 2019b). Several papers provide tests of implications of bargaining theory, as ours does, such as Scott Morton, Silva-Risso, and Zettelmeyer (2011) and Grennan and Swanson (2019).

The large scale of our data and the variation across several measures of heterogeneity help paint a useful and comprehensive picture of sequential bargaining in the real world that adds great detail to the existing literature. The patterns we uncover confirm some of the most basic insights of bargaining theory, yet reveal behaviors that are not explained by conventional theoretical approaches. As such, the patterns we uncover suggest that further developments in the theory of bargaining are warranted, especially those that more seriously consider aspects of reciprocity and fairness. In turn, such new theoretical insights can shed light on how to better design platforms that increase gains from trade.

II. eBay's Best Offer Mechanism: Facts and Data

eBay is one of the world's largest online marketplaces for consumer-to-consumer transactions. It began in 1995 using second-price-like auctions as the sole format for transacting on its platform. The site eventually allowed users the option of selling goods through a single posted fixed price. In 2005, the site began to allow sellers to sell through an alternating-offer

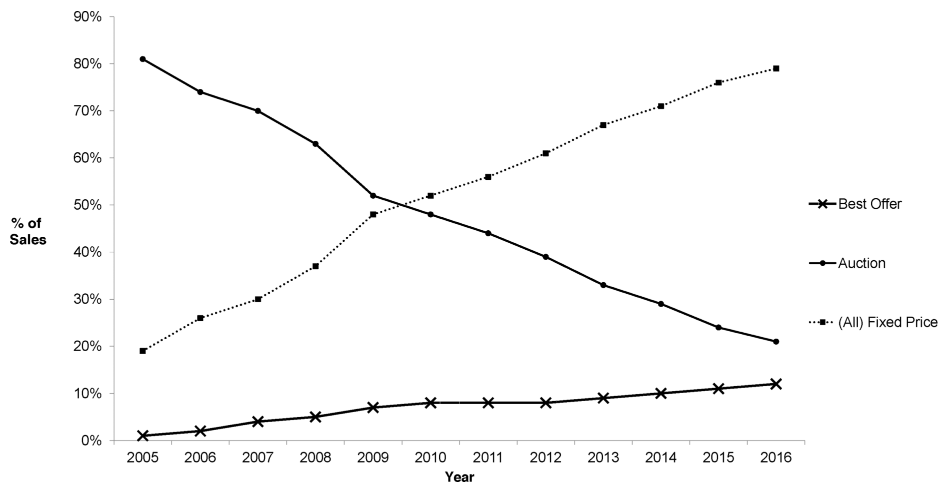

FIGURE I

Growth of Best Offer

This figure depicts the percentage of gross market value made up by three mechanisms on the eBay platform—Best Offer, auctions, and fixed-price listings—from 2005 to 2016, computed from internal eBay data. The calculation for fixed-price listings includes Best Offer sales. The calculation for Best Offer includes only listings that were bargained; it does not include Best-Offer-enabled listings that sold at the listing price.

protocol referred to as Best Offer. This feature can be enabled (at no cost) by the seller at the creation of the listing and is only available for fixed-price listings—there is no equivalent mechanism for auctions.

The Best Offer platform is currently a fast-growing sales format on eBay. Figure I shows the growth of this format relative to auctions and fixed-price listings over the past 10 years. In 2005, when the format was first rolled out, only a tiny fraction of listings were Best Offer listings, less than 1% of all eBay transactions occurred through a buyer actually placing an offer (rather than accepting the Buy It Now price). By 2012, that fraction had grown to just under 9%.

Goods offered for sale under the Best Offer format are listed as “accepts Best Offer” in eBay search results.[3] Throughout, we refer to these postings as Best Offer listings. A buyer viewing a Best Offer listing sees similar information to a buyer viewing a fixed-price listing (referred to as a Buy-It-Now listing), including

3. Potential buyers may filter search results to display only those listings that accept offers.

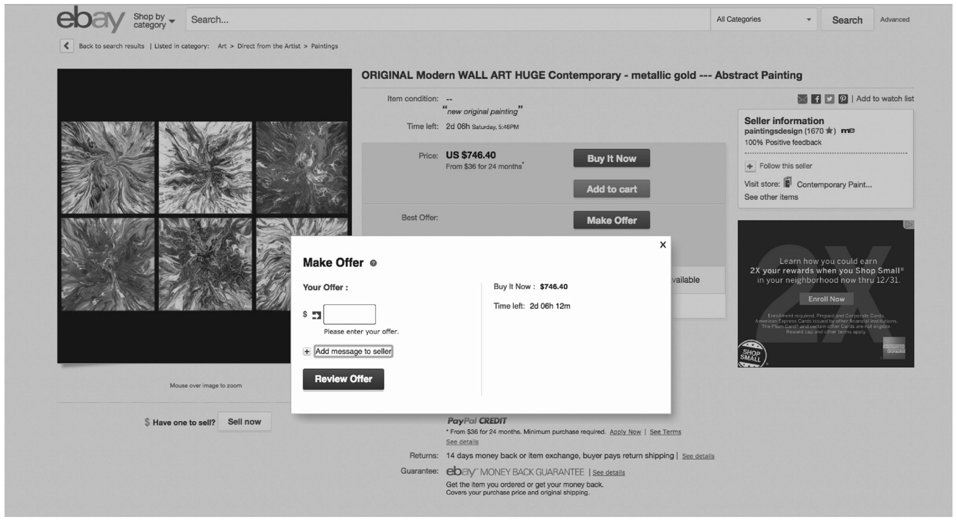

FIGURE II

Best Offer User Interface

This figure depicts the “view item” page for a listing with Best Offer enabled. The potential buyer may click on “Buy It Now” to purchase the painting at the listed price of $746.40—or they may click on “Make Offer” and be prompted to propose a price.

the listing title, seller ID and feedback score, at least one picture of the item, and any other information about the item that the seller decides to display.[4] The buyer sees the Buy-It-Now price, as in a standard fixed-price listing, but also sees an additional option, a button labeled “Make Offer,” as illustrated in Figure II. Selecting the Make Offer button allows the buyer to send an offer to the seller. As such, we treat the Buy-It-Now price (equivalently, “listing price”) as the seller’s first offer to any buyer who wished to bargain.[5]

Upon receiving this offer, the seller may accept the offer, make a counteroffer, or decline the offer (without making a

4. Throughout, we use the term “buyer” to refer to the user interested in potentially buying the item whether or not the transaction actually occurs.

5. The observant reader will notice the “Add a message to seller” option in Figure II. The data set accompanying this article includes a dummy variable for whether a message was sent along with an offer, but does not include the text of that message for risk of deanonymizing users. In Backus, Blake, and Tadelis (2019a), the authors identify a natural experiment in the availability of this text communication (on the German version of eBay’s Best Offer mechanism). They find that communication substantially improves the probability that a bargaining interaction leads to a transaction.

counteroffer).[6] If the seller makes a counteroffer, the buyer can accept, decline, or counter in response. Play continues until either party accepts or until the buyer declines. If the seller declines, the buyer may still respond with a counteroffer or can, at any time, purchase at the Buy-It-Now price. Each party is limited to three offers (not including the listing price), and each offer expires 48 hours after being placed.[7] We refer to a sequence of back-and-forth offers—a given buyer and seller pair bargaining over a given item—as a thread.

To form our primary data set, we obtain internal eBay data from all Best-Offer-enabled, single-unit listings created in May 31, 2012–June 1, 2013 from the US eBay site. This consists of over 90 million Best-Offer-enabled listings. This data set, anonymized to remove all identifiable information, constitutes the data set that we have arranged to have released publicly for research purposes. For the primary analysis in this article, we restrict attention to listings with Buy-It-Now prices between \$0.99 and \$1,000.00, and eliminate listings with apparent data errors (e.g., cases where we could not locate the original offer corresponding to a counteroffer). Details on our sample construction criteria appear in Online Appendix B.[8] Our final data set analyzed in this article contains approximately 88.4 million listings. Of these, 18 million receive an offer, in some cases multiple offers, generating 25.5 million bargaining threads (defined as a listing-buyer pair). These bargaining threads involve 1.2 million sellers and 4.7 million buyers.

Table I presents descriptive statistics for our sample. The top panel contains statistics at the level of the listing. The average list price (Buy-It-Now) is \$95, and the average sale price is 83% of the list price. Sales include Buy-It-Now choices as well—conditional on bargaining occurring, the average sale price comes down to 73% of the list price. We note that almost 80% of listings never receive an offer. Of the listings, 54.8% are for used goods, and 26.3% have

6. As a time-saving device for sellers, the platform offers sellers the option to specify an "auto-accept" price, which is unobserved to buyers and which, if exceeded by the buyer's offer, will result in the platform accepting the offer on behalf of the seller. Sellers can similarly specify an "auto-decline" price.

7. In 2017 this maximum limit was changed to five offers. In our sample, approximately 1.1 percent of interactions reach the binding limit, and most of these fail; see Figure III later. The limit was extended in an attempt to encourage these negotiators to succeed. The time frame of our data does not permit us to evaluate this policy change.

8. This and all other appendix material is found in the Online Appendix.

TABLE I
DESCRIPTIVE STATISTICS FOR THE MAIN SAMPLE

	Mean	Std. dev.	Min	Median	Max
Listing-level data					
Listing price	94.6	164	0.01	30	1,000
Used	0.548	0.498	0	1	1
Revised	0.263	0.44	0	0	1
Sold	0.215	0.411	0	0	1
Sold by Best Offer	0.132	0.338	0	0	1
Received an offer	0.206	0.404	0	0	1
No. photos	2.69	2.68	0	1	12
Sale price	69.7	119	0.01	25	1,000
Sale price / list price	0.832	0.175	0.00099	0.857	1
Bargained price	74.1	121	0.99	28	1,000
Bargained price / list price	0.727	0.146	0.00099	0.75	1
No. listings	88,386,471				
Seller-level data					
Feedback positive percent	99.4	5.3	0	100	100
No. listings	73.8	1,941	1	3	1,084,709
No. sales	15.9	158	0	1	66,977
No. sales by Best Offer	9.71	101	0	1	56,473
No. sellers	1,197,397				
Buyer-level data					
No. bargaining threads	5.12	17.9	1	2	5,697
No. offers	8.48	30	1	3	7,823
No. purchases	3.21	9.27	1	1	4,095
No. bargained purchases	2.47	7.39	0	1	3,329
No. buyers	4,701,301				
Thread-level data					
No. offers	1.66	0.942	1	1	6
No. offers if sold	1.48	0.891	1	1	6
Agreement reached	0.454	0.498	0	0	1
Seller experience	3,883	18,350	1	450	385,419
Buyer experience	129	598	1	26	32,909
First buyer offer	86.6	126	0	35	1,000
First buyer offer / list price	0.608	0.193	0	0.626	1
No. threads	25,453,072				

Notes. This table presents summary statistics for the main data set. Note that indicator "Used" (for used versus new status of item) is missing for 27,678,157 listings, and the feedback variable in the seller panel is missing for 51,992 sellers. See Online Appendix A for an extensive discussion of exclusion criteria.

the Buy-It-Now price revised at some point by the seller during the listing life.

Table I also includes detailed information on market participants. On average, sellers have a 99.4% positive feedback score. Although there are many one-time sellers, the market is skewed toward experienced sellers: the average number of listings per seller is 74, 16 of which sell through Best Offer or Buy-It-Now and 10 of which sell specifically through Best Offer. Most of the sales in our data set are made by a relatively small fraction of the sellers. The population of buyers is skewed, but less so: on average, buyers in our sample are observed in 5 bargaining threads, make 8 offers, and purchase 3 items (2.5 of these coming through bargaining). Finally, at the thread level, Table I shows that most bargaining threads are short (only 1.66 offers, on average, where the first offer is always made by the buyer). Seller and buyer experience in this table are counts, at the time of the current thread, of the number of bargaining threads including the current thread in which the player has ever participated since the inception of the Best Offer mechanism. The average thread includes a seller having several thousand previous negotiations and buyer with over 100, again reflected a skew toward experienced players. On average, buyers offer \$86.60, which represents 61% of the list price. Bargaining is ultimately successful 45% of the time.

Table II contains means of several variables at the listing and thread level for the main sample and for broad category subsamples: collectibles, electronics, fashion, media, toys, business and industrial, and other. Table II demonstrates that the majority of listings are for items that could reasonably be characterized as idiosyncratic or one-of-a-kind inventory, such as collectibles or fashion. Categories with more well-defined, frequently sold products, such as media products or electronics, make up a smaller fraction of the data. Interestingly, Table II reveals that collectibles are less likely to receive offers or sell through bargaining, than are electronics, but when they do sell through bargaining they do so at a smaller fraction of the list price (the ratio of the bargained price to the list price is 0.70 in the former and 0.79 in the latter). The probability of agreement is highest in bargaining threads over media listings (0.596) and least likely for electronics (0.317). Sellers are most experienced at bargaining in fashion, and buyers are most experienced in the business category. A number of statistics are remarkably stable across categories, such as the number of offers per thread (1.54–1.7) and the ratio of the first buyer offer to the list price (0.575–0.660).[9]

9. It would be tempting to use cross-category comparisons to learn about bargaining on the assumption that some will intuitively manifest more asymmetric information than others (e.g., we intuit that collectibles might have more

TABLE II

MEANS BY CATEGORY

	Full sample	Collectibles	Electronics	Fashion	Media	Toys	Business	Others
Listing-level data								
Listing price	94.6	75.7	146	122	31.6	73.7	200	126
Used	0.548	0.56	0.639	0.466	0.724	0.503	0.613	0.413
Revised	0.263	0.236	0.242	0.31	0.296	0.238	0.208	0.269
Sold	0.215	0.177	0.372	0.222	0.148	0.287	0.213	0.273
Sold by Best Offer	0.132	0.115	0.194	0.15	0.0714	0.164	0.128	0.151
Received an offer	0.206	0.176	0.345	0.229	0.102	0.268	0.186	0.24
No. photos	2.69	2.47	2.67	3.36	1.69	2.9	2.72	2.57
Sale price	69.7	54.8	124	65.9	22.6	62.5	143	77.4
Sale price / list price	0.832	0.805	0.89	0.814	0.855	0.858	0.827	0.858
Bargained price	74.1	60.7	135	68.9	25.8	68.2	145	81.7
Bargained price / list price	0.727	0.701	0.791	0.728	0.703	0.753	0.714	0.747
No. listings	88,386,471	34,809,404	6,796,662	23,416,322	9,350,356	7,760,006	3,060,080	3,193,641
Thread-level data								
No. offers	1.66	1.64	1.7	1.66	1.54	1.68	1.61	1.66
No. offers if sold	1.48	1.46	1.58	1.46	1.37	1.53	1.45	1.48
Agreement reached	0.454	0.491	0.317	0.474	0.596	0.424	0.543	0.451
Seller experience	3,883	3,248	2,227	6,671	2,177	2,650	2,329	2,174
Buyer experience	129	200	121	75.2	79.6	58.7	377	65.1
First buyer offer	86.6	67.6	150	79	26.9	77.1	138	92.2
First buyer offer / list price	0.608	0.575	0.66	0.607	0.602	0.624	0.596	0.625
No. threads	25,453,072	8,106,675	4,126,466	7,348,818	1,113,603	2,976,443	719,044	1,062,023

Notes. This table presents means for variables in the main data set in the first column and in a mutually exclusive and exhaustive set of broad category subsamples in the remaining columns.

TABLE III
LISTINGS RECEIVING AN OFFER VERSUS NOT

	Full sample	Received at least one offer	Never received any offer
Listing-level data			
Listing price	94.6	119	88.3
Used	0.548	0.558	0.545
Revised	0.263	0.263	0.263
Sold	0.215	0.739	0.0789
No. photos	2.69	3.26	2.54
Sale price	69.6	78.7	47.6
Sale price / list price	0.832	0.765	0.996
No. listings	88,350,383	18,214,827	70,135,556
Seller-level data			
Feedback postitive percent	99.4	99.4	99.4
No. listings	73.8	21.1	71.9
No. sales	15.9	15.6	5.67
No. sellers	1,196,955	861,757	975,772
Buyer-level data			
No. purchases	3.21	2.82	2.19
No. buyers	4,698,748	4,481,259	1,116,258

Notes. This table presents summary statistics for the listings in our data that ever receive an offer compared to those listings that never receive an offer.

Much of our analysis in the remainder of the article focuses on the subsample of listings in which bargaining takes place. These listings, and the buyers and sellers involved in them, may differ from those in which no bargaining offer is ever observed. In the top panel of Table III, we compare the full sample and these two subsamples of listings. We find that listings that received at least one offer were much more likely to sell, and at a higher price. (Note that this finding would not have been a foregone conclusion: listings that receive no offers can still sell through the Buy-It-Now option.) We find that listings bargained over and those not bargained over are equally likely to be used items and to have the Buy-It-Now price revised at some point. In the bottom two panels of Table III, we compare the buyers and seller involved in listings

idiosyncratic inventory than electronics). This is undermined by the stability of the statistics. We contend, and our casual browsing confirms, that there is substantial heterogeneity in all categories, and that conditional on using the Best Offer mechanism, which is an endogenous decision of the seller, these intuitive preconceptions often do not hold.

with no bargaining and those with bargaining. In the sample of listings that receive offers, sellers post fewer listings on average and sell more listings but have similar feedback ratings. Buyers in this sample tend to make more purchases than those who are not.[10]

III. Bargaining Theories and Empirical Evidence

In this section, we walk through a number of existing theoretical models of bargaining, examine their empirical implications, and study how much of the observed data each model might be able to explain. Models are abstractions from reality, and as such cannot be expected to explain all features of real-world negotiations. We use these models simply as a framework for highlighting features of real-world bargaining that existing theory can or cannot explain well. We focus our discussion in this section on three features that have played a prominent role in motivating existing theory: (i) whether agreement or disagreement occurs, (ii) when agreement or disagreement occurs (immediately or after a delay), and (iii) how the final negotiated price is reached (suddenly or gradually).

Points (i) and (ii) relate to how bargaining ends. To visualize how bargaining ends in the actual data, we display a tree in Figure III representing the extensive form of the bargaining game. Square boxes represent the identity of the player (B for buyer and S for seller). At the right of each box, we display the number of observations that reach the node. Below each node are edges representing the player's decision to make an initial offer (O), accept (A), decline (D), or counter (C). Each edge shows the percent of observations passing through that edge corresponding to a given action being chosen.[11] We refer to these percentages as we explore

10. Note that unlike the top panel of Table III, the comparison of sellers involved in listings that never receive an offer and sellers involved in listings that do receive an offer is not a comparison of mutually exclusive samples. This is also true for the buyer comparison in the bottom panel. Note also that the sale/list price ratio in the "never received an offer" column is not exactly equal to 1; this appears to be due to a small fraction of listings in which the Buy-It-Now price was revised by the seller and the sale price variable was not updated in eBay's database to reflect this change.

11. For the sake of visual clarity, Figure III does not display the buyer's option to buy at the Buy-It-Now price later in the bargaining sequence, which is always an option buyers have available.

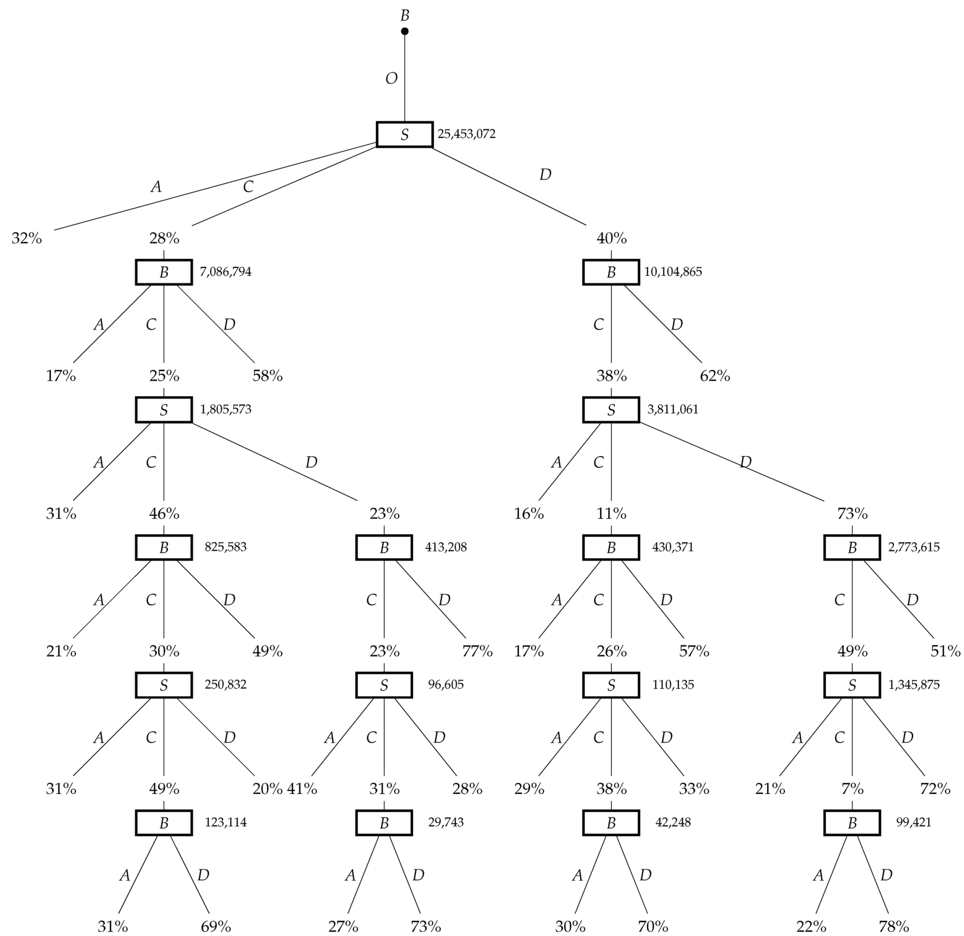

FIGURE III

Bargaining Sequence Patterns

This figure summarizes the offer-level data in terms of the game tree of bargaining. See text for detailed discussion.

what fraction of the data existing models could potentially explain. Throughout the discussion that follows, we attempt to be generous in attributing what fraction of observations can be explained by a given model. In particular, each observation in the data is a sequence of offers corresponding to some game-tree-path from Figure III; if a given model can generate this path—and in some cases a particular rate of concession of players' counteroffers—we state that this model could have plausibly generated this observation.

We emphasize that the discussion is not meant to suggest that any of these theoretical models are "wrong" in any sense—each is entirely accurate if its corresponding assumptions are satisfied. Rather, by pointing out empirical regularities that some models fail to generate, this discussion highlights that the assumptions of these models (such as complete information of one or both parties) may not be satisfied in real-life settings.

We also note that existing game theoretic models of bargaining focus on particular, interesting equilibria, that satisfy some reasonable equilibrium selection restrictions. Indeed, the patterns we observe that do not arise in existing equilibrium models can be trivially supported as equilibria in some cases, but these trivial equilibria are neither meaningful nor interesting. For example, an equilibrium in which players' counteroffers gradually concede at a given rate can be sustained by a perfect Bayes equilibrium in which any off-equilibrium deviation from this prespecified concession rate leads the opposing player to believe she is facing the weakest bargaining type. In this sense, it isn't necessarily that existing theory cannot explain patterns we document below, but that it has very little predictive power, in that it can trivially generate nearly any type of behavior in a sequential bargaining game.

III.A. Immediate Agreement: Rubinstein (1982)

Perhaps the two most influential bargaining models that come to an economist's mind are those of Nash (1950) and Rubinstein (1982). The model of Rubinstein (1982) consists of two players who sequentially alternate their offers. Each player has some cost of bargaining, such as a per period discount factor or a per offer cost applied to each time period of the game, and players have complete information about their opponents' valuations. The unique subgame perfect Nash equilibrium (SPNE) of this game is related to the axiomatic, cooperative solution proposed in Nash (1950), in which players choose a division of surplus that maximizes a weighted, joint payoff of the two bargaining parties, with each party's weight depending on a "bargaining power" parameter. When this bargaining power is given by players' discount factors in Rubinstein's model, the Nash solution corresponds precisely to the unique SPNE of the Rubinstein game.

This model has several immediate empirical restrictions. First, all bargaining interactions should end in agreement. Second, the player who moves first makes an offer that is immediately accepted by the second mover.[12] These two restrictions imply that for an observed interaction to be rationalized by the Rubinstein model, it must be the case that the game ends with the first offer being accepted immediately by the opponent. As shown in Figure III, immediate agreement occurs in 32% of our observations. The remaining 68% of observations are inconsistent with Rubinstein's strategic model or Nash's axiomatic model.[13] Below we discuss a number of theoretical approaches that could explain some of these outcomes.

III.B. Immediate Disagreement: Perry (1986)

A salient feature of real-world bargaining is that some negotiations end in impasse, and this cannot be explained by the complete-information models of Nash (1950) and Rubinstein (1982). A number of studies explain such impasse by relaxing the complete information assumption and incorporating incomplete information into a sequential bargaining game or a mechanism design framework. For example, incomplete information is the key to the seminal theorem of Myerson and Satterthwaite (1983). An important contribution to modeling an extensive-form, alternating-offer bargaining game with incomplete information is that of Perry (1986), in which both the buyer and seller have private valuations that are not commonly known to the parties. Buyers face a cost (common to all buyers) of making each offer and the seller faces a per offer cost common to all sellers. The unique sequential equilibrium of this game is that the side with the lowest bargaining cost makes an offer and the other party accepts or rejects, but never makes a counteroffer. Figure III implies that this model can rationalize 57% of the observed bargaining sequences; this includes a large percentage that cannot be rationalized by the Rubinstein (1982) or Nash (1950) models.[14] The Perry (1986)

12. A third implication of the Rubinstein and Nash bargaining models is that a player who has more "bargaining power" (or lower bargaining costs) should get a better deal. Testing this implication is not simple, as bargaining power and bargaining costs are not tangible or well-defined objects and are difficult to measure in data. We provide one approach to such an analysis in Section IV.

13. Note that for the purposes of these calculations we consider the buyer's first offer, rather than the Buy-It-Now price, to be the first bargaining offer.

14. This 57% includes the 32% of immediate-agreement observations and an additional 25% of observations—cases where the seller immediately declines (40%) followed by the buyer declining (62%): that is, 40% $\times$ 62% $=$ 25%.

model cannot rationalize cases in which multiple offers or delays occur in equilibrium. A number of other bargaining models of incomplete information share this feature, such as the "k-double auction" of Chatterjee and Samuelson (1983): bargaining can end in agreement or in disagreement, but it always ends immediately (in this case because the game is assumed to be static).

III.C. Delayed Agreement: Gul and Sonnenschein (1988) and Others

A large branch of the theoretical bargaining literature includes models in which parties may delay reaching an agreement, but nonetheless always agree. Models that generate delayed agreement differ widely in how delay is generated. Rubinstein (1985) studies an alternating-offer game in which there may be two offers in equilibrium before agreement occurs: if the offer of the player moving first is not accepted, the player who rejected that offer then makes an offer that is accepted immediately. Grossman and Perry (1986) and Gul and Sonnenschein (1988) provide a model where an informed buyer (with a private valuation) alternates offers with an uninformed seller (with a known valuation). In the equilibria they study, parties always agree, and that agreement may occur immediately or after several back-and-forth offers. Interpreted generously, these last two models could explain any bargaining sequences ending in agreement, which occurs 45.4% of the time (Table I). However, Gul and Sonnenschein (1988) demonstrate that a Coase conjecture result (Gul, Sonnenschein, and Wilson 1986) holds: as the time between offers decreases, agreement takes place immediately.[15]

Two separate models that can also generate delayed agreement in alternating-offer bargaining are Cramton (1992) and Abreu and Gul (2000). We discuss these below, as they also provide testable predictions of how offers themselves change over the course of the bargaining.

15. The authors also demonstrate that the equilibria they study have the property that all unaccepted offers made by buyers in a given period of the game must be the same for all buyers. The class of equilibria they study nests that of Grossman and Perry (1986). There are a number of other theories of delayed agreement—too many to treat here. For example, Feinberg and Skrzypacz (2005) obtain delayed agreement in a model in which one party has private information about her valuation and the other has private information about his beliefs about the other party's valuation.

III.D. Delayed Disagreement: Cramton (1992)

The models discussed above cannot generate delayed disagreement—cases where a buyer and seller exchange multiple offers and then walk away without trading. This is another salient feature of the data shown in Figure III. The one model of alternating offers of which we are aware that allows for delayed disagreement is Cramton (1992), in which both parties have private information about their valuations and may discover at some point that there are no gains from trade and will then walk away.[16] In the model, parties effectively play a war-of-attrition game: once a party makes an offer, the offer itself and the timing of the offer completely reveal the offering party's valuation. The model can be augmented to allow for multiple back-and-forth offers as long as any early offers (offers other than the last two) are nonserious (that is, offers that would not be accepted by any opponent type and that are only intended to inform the opposing party of the offerer's unwillingness to budge yet). Assuming that early offers are nonserious, the Cramton (1992) model could potentially explain all sequences in the data. We provide evidence that offers tend to change gradually, suggesting that they are indeed serious. Assuming offers are serious, the model can potentially rationalize any cases in which, after an offer is made, the opposing party (i) immediately accepts or declines it or (ii) makes a counteroffer that is immediately accepted.

The empirical prevalence of these Cramton (1992) cases can be computed in a number of ways. First, if the Buy-It-Now price is viewed as not fully revealing of the seller's valuation, and the buyer's first offer (and its timing) is viewed as arising from the Cramton separating equilibrium, then the seller should respond to this first buyer offer by immediately accepting, declining, or making an offer that is guaranteed to be accepted. Such cases make up 62% of bargaining sequences in Figure III.[17] If instead the first bargaining offer is viewed as uninformative to the seller (and simply as a signal that the buyer wishes to enter negotiations), then the first offer with the potential to fully reveal a player's valuation is the seller's first counteroffer. The buyer should respond to this

16. The model of Cramton (1992) is a two-sided-offer, continuous-types extension of the one-sided offer game of Admati and Perry (1987).

17. This quantity comes from 32% immediate agreement, 40% $\times$ 62% immediate disagreement, as in the Perry (1986) model, plus an additional 28% $\times$ 17% of cases where the seller counters at a price that the buyer then accepts.

by accepting or rejecting or by countering at a price acceptable to the seller. This behavior is consistent with 83% of the observations in which the seller makes a counteroffer in response to the buyer's first offer (which occurs 28% of the time).[18] In either scenario, a significant fraction of bargaining sequences in the data are too long to be explained fully by the Cramton (1992) equilibrium. Moreover, the war-of-attrition nature of the Cramton model does not match the actual protocol used in the data; the protocol dictates whose turn is next, which in and of itself poses some difficulty for this model in explaining patterns of behavior in our game.

III.E. What Theory Struggles to Explain: Gradual Offers

A salient feature of the data that existing theories fail to replicate is that counteroffers on both sides tend to gradually be more and more favorable to the opposing party with each subsequent offer. This is illustrated in Figure IV. In each panel, the vertical axis shows the average amount of the offer and, on the horizontal axis, the period of the game in which the offer is made, with the $t = 0$ offer representing the list (Buy-It-Now) price. Panels on the left include sequences ending in agreement, and panels on the right include those ending in disagreement. We analyze separately those sequences that end in period 6, where the seller declines (and the buyer takes no further action) or the seller accepts, and those that end in period 7, with the buyer accepting or declining. Each panel also displays the average change in offer price the seller makes from one offer to the next, averaged across all periods of the game, and similarly for the buyer.[19]

This gradualism of offers seems quite intuitive to anyone who has engaged in bargaining in practice—it is exactly how one would expect bargaining offers/counteroffers to evolve over the course of negotiations. However, theoretical models generating this type of pattern are almost nonexistent. As highlighted already, most models can rationalize only immediate disagreement or immediate agreement. The equilibria of Grossman and Perry (1986) or Gul and Sonnenschein (1988) can generate gradually

18. This 83% figure can be seen in Figure III, following the seller's first counteroffer, as the sum of 17% + 58% + 25% $\times$ 31%.

19. In creating these figures, we include only sequences from the left side of the game tree (Figure III); this excludes sequences that involve a seller's decline followed by additional action on the buyer's part.

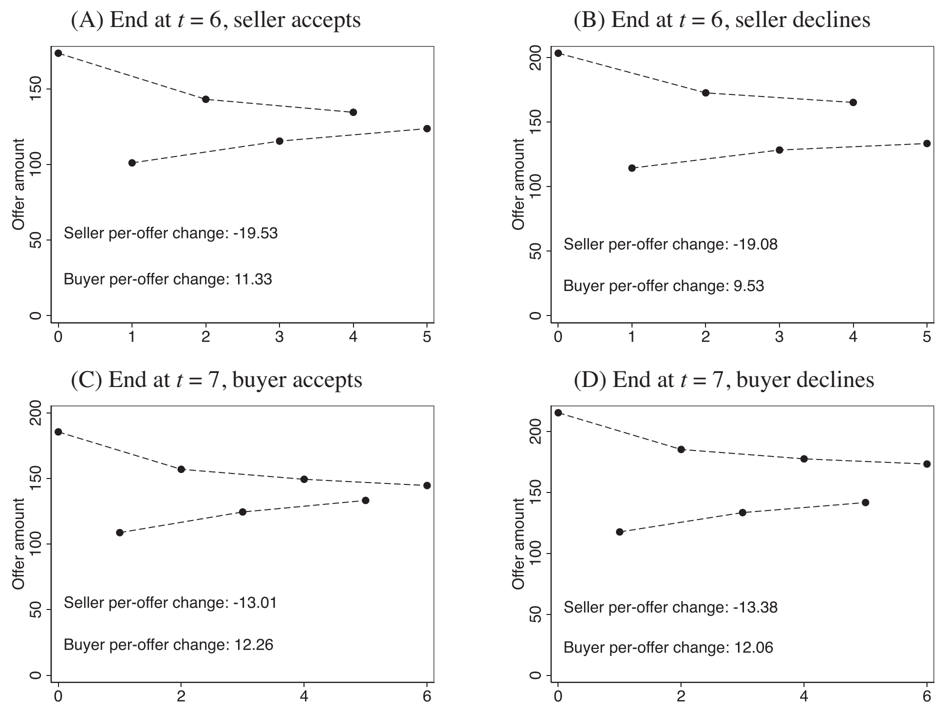

FIGURE IV

Average Offers over the Duration of Bargaining ($t = 6, 7$)

Figure displays the average first offer (Buy-It-Now price), average second offer, and so on for bargaining sequences that ended in six (Panels A and B) or seven (Panels C and D) periods. Panels on the left ended in acceptance, and panels on the right ended in decline. Units are U.S. dollars.

changing offers by one party (the uninformed party) but not by both parties. As highlighted, the model of Cramton (1992) can accommodate many offers by each party in equilibrium, but only if all offers (other than the last offer made by each party) are completely uninformative, nonserious offers; offers cannot gradually become more favorable to the opposing party.[20] Indeed, in the model of Cramton (1992), when a player concedes to the opposing player, the concession must be a precipitous jump.

20. In the equilibrium of Cramton (1992), the timing of offers is endogenous. This feature can be viewed as literally allowing a player to signal her valuation when she first makes an offer—and that is the interpretation we adopt in Section III.D—or instead allowing the player to delay through making nonserious offers whenever it is her turn, and then finally making a serious offer and signaling her valuation through the cumulative total time passed since the game began until the serious offer is made.

Other models have a similar war-of-attrition flavor to the Cramton (1992) model and can thus explain sudden, but not gradual, offer changes. One example includes Abreu and Gul (2000). Their model applies reputational game theory concepts (Kreps et al. 1982) to bargaining, as suggested by Myerson (1991), where with some probability an opponent is a "crazy" or "obstinate" type who will never budge from her initial offer. Rational types find it profitable to mimic obstinate types until the game ends, at which point they concede. This model yields sudden offer changes when a rational player does concede, but no gradual changes along the way.[21] We are aware of only two previous models generating gradually changing offers on both sides: Abreu and Pearce (2003) and Compte and Jehiel (2004). In the first paper, the authors model behavioral types who, for exogenous reasons, concede differently than rational agents. The model shares an unrealistic feature of many of the above models in that it only allows for equilibrium agreement, not disagreement. In the second paper, the authors model a setting in which both parties have complete information, but by making offers, parties can influence the outside-option payoff to the opposing party. Disagreement can occur in a special case of the Compte and Jehiel (2004) model, but that special case involves no gradual offers. We explore the gradualism behavior that we observe in more detail in Section V.A.

IV. Conventional Drivers of Bargaining Outcomes

In this section we analyze three features that play important roles and drive outcomes in a number of bargaining models: costs of bargaining, bargaining power, and players' outside options. Each feature can be related to the others and are not necessarily distinct in their empirical implications. We also explore

21. A gradual change in offers is the equilibrium outcome of several models of one-sided bargaining, where only one party gets to make offers to the opposing party, and the opposing party only gets to accept or reject these offers. For example, Fudenberg, Levine, and Tirole (1985) and Gul, Sonnenschein, and Wilson (1986) allow for a seller (with no private valuation for the good) to screen a buyer (who does have a privately known valuation) by making successively decreasing offers. This generates gradual offers, but only through the constraint that only one party is allowed to make offers, which is perhaps not a realistic constraint for many bargaining settings (and clearly not for ours). Other papers with similar assumptions and gradualism include Deneckere and Liang (2006), Fuchs and Skrzypacz (2013), and Gerardi, Hörner, and Maestric (2014).

a fourth dimension of analysis: examining the effect of reducing adverse selection on bargaining outcomes. Online Appendix C contains additional analysis of bargaining outcomes, demonstrating that variation in bargaining outcomes is explained more by variation in who is bargaining than what is being bargained over.

IV.A. Bargaining Costs

Rubinstein (1982) proposed two models of bargaining costs: one in which the surplus at stake is discounted exponentially, as if the primary cost of bargaining were delayed consumption, and a second in which there is a fixed cost of making offers. In the first case, bargaining costs scale up with the value of the transaction, whereas in the latter they are fixed. Many subsequent bargaining models have also adopted one or the other (or both) of these types of costs (e.g., Cramton 1991). Because these types of bargaining costs differ in how they relate to the value of the transaction, in this section we search for evidence of such costs by examining how bargaining outcomes differ at different levels of the listing price.

Figures V and VI present smoothed (weighted local linear regressions, LOWESS) plots of expected outcomes against the listing price for our sample. To construct these plots, we used a stratified subsampling approach, sampling 10,000 listings each from 20 bins of \$50 in length (inclusive on the upper extreme).[22] The distribution of listing prices is presented in Figure V, Panel A, where we see that the vast majority of listings fall in the \$0.99 to \$100 range. While average first offers relative to list price are decreasing throughout the range (Panel B), bargained prices are initially rising and then fall (Panel C), and the slope of the expected sale prices flips from negative to positive and back again (Panel D). Figure VI provides some insight into this pattern. For very cheap items, more buyers exercise the Buy-It-Now option and forgo bargaining (Panels B and C). Moreover, sellers who do receive offers on cheaper items tend to accept them immediately (Panel D).

We interpret these outcomes as informative about the costs of bargaining. Assuming higher listing prices correspond to settings

22. For the LOWESS plots in Figures V and VI, as well as those in Figure IX later, we use default Stata options for LOWESS plots: tricube weighting, and centered subsets of size $0.8{*}N$ (where N is the number of observations in a given plot) to construct a smoothed prediction about each point. For endpoints, smaller, uncentered subsets are used as described in Stata documentation.

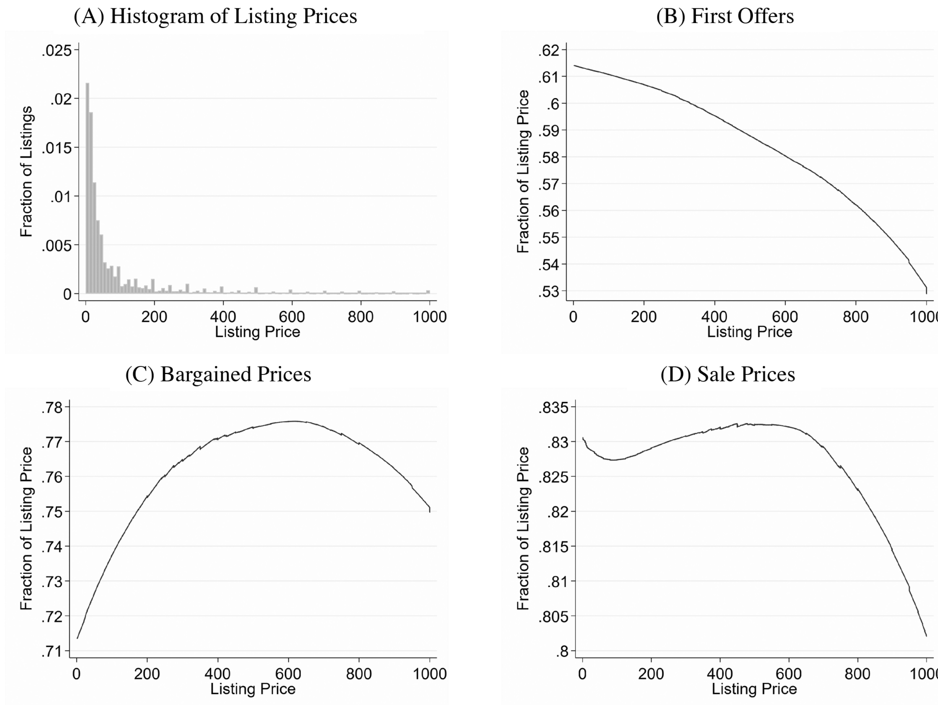

FIGURE V

Bargaining Outcomes by Listing Price

Panel A depicts a histogram of the listing prices for the full sample of listings. The remaining panels depict LOWESS plots of the outcome variables in terms of the listing price. In Panel B the variable of interest is the mean first offer of bargaining threads; in Panel C it is the bargained price, conditional on sale and the buyer not executing the Buy-It-Now option; and in Panel D we are interested in the sale price, conditional on sale.

with a larger surplus on the table, our data are consistent with the existence of fixed costs of bargaining: when the listing price is greater and the amount of surplus to be negotiated is large, parties are more willing to engage in the back and forth of negotiation; when the listing price is low and there is little surplus on the table, bargaining power tends to sit with whoever makes the current offer. This model of costs is consistent with the findings of Jindal and Newberry (2018) in the setting of negotiation over retail appliances; it is also consistent casual empiricism: bargaining in street markets is less frequent in developed economies with higher incomes—it is in some sense an inferior good—but bargaining remains prevalent among high-value transactions, for example, salary negotiations, plea bargaining, terms of a merger, and trade deals; or even big-ticket consumer transactions, such as

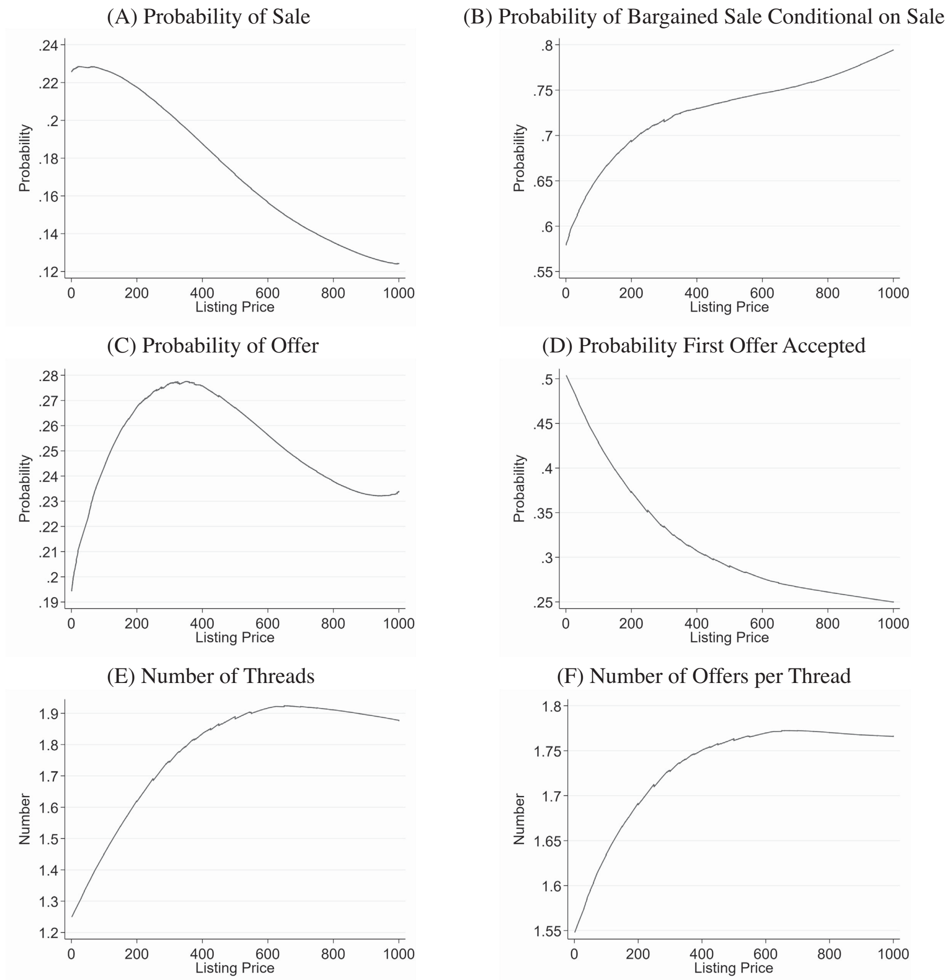

FIGURE VI

More Bargaining Outcomes by Listing Price

These panels depict LOWESS plots of bargaining outcomes in terms of the listing price. Panel A concerns the probability of sale for all listings; Panel B restricts attention to successful listings and plots the likelihood that the price was bargained (as opposed to a buyer executing the Buy-it-Now option); Panel C concerns the empirical likelihood of receiving any offer; Panel D concerns the likelihood that, conditional on such an offer arriving, it is immediately accepted; Panel E concerns the number of bargaining threads per listing; and Panel F measures the number of offers associated with each thread, not including the listing price as an offer.

cars, large appliances, or homes. Fixed costs of bargaining are not the only possible explanation for the findings; another possible explanation would be that the types of players or the equilibrium of the game differs markedly between high- and low-listing price sequences.

These findings are especially important insofar as most testing of theoretical models of bargaining has been primarily done in the lab. For reasons of feabsility, experimental work focuses on low-stakes bargaining. If players behave differently when the stakes are high—because there are fixed costs of bargaining or because of some other reason—then this implies an important caveat to the external validity of those findings. It also highlights the importance of complementing this experimental testing in the lab with evidence from the field.

IV.B. Bargaining Power

An additional feature of many theoretical models of bargaining is that players with more bargaining power obtain a greater share of the surplus. This "bargaining power" is captured differently in different contexts. In some models, such as Rubinstein (1982) and Rubinstein (1985), bargaining power is explicitly represented by a player's patience (discount factor). In other bargaining models, in particular many recent models applied in empirical research in bargaining settings (e.g., Crawford and Yurukoglu 2012; Grennan 2013), bargaining power is instead a reduced-form feature of the model rather than an underlying primitive, with a direct correspondence to the share of the surplus the player would receive in a static Nash bargaining game, where both players agree to maximize the total surplus weighted by the bargaining power weights (see Binmore, Rubinstein, and Wolinsky 1986). In these models, bargaining power can represent concepts such as a bargaining party's negotiation skill or experience.

Here we use a simple approach to identify buyers who may have a greater degree of patience than others. In particular, we identify patient buyers as those who, ex post (after the bargaining ends), choose the slowest shipping option when multiple options are available. Namely, at checkout, a buyer can sometimes choose between several shipping options, where faster shipping is more expensive than slower shipping. Hence, by revealed preference, buyers who choose a slower shipping method reveal that they are willing to wait rather than spend more money, and are thus more patient than buyers who opt for faster shipping at a higher price. We also construct a measure of experience for buyers and sellers using their accumulated number of previous bargaining threads participated in (summary statistics for this measure are shown in Table I).

For this analysis, we rely on a subsample of the data for which we can compute a reference price for each good. We construct these reference prices by limiting to listings of products that can be linked to third-party catalogs. For each such product and item condition pair (where condition is used versus new), we construct a reference price by taking the average Buy-It-Now price for all listings of this product and condition sold during our sample through Buy-It-Now listings that did not have the bargaining mechanism enabled; thus, reference prices are constructed using listings outside of our data but during the same sample period. See Online Appendix B for a discussion of and summary statistics for this sample. In Table IV, the dependent variable in each regression is the final price from a bargaining transaction in which agreement occurred, divided by the reference price for that item. All regressions include fixed effects at the finest category level available in the eBay data (referred to as leaf category).

Table IV shows the results of regressing the normalized price on our measures of buyer patience (controlling for whether multiple shipping options are available) and on both parties' experience. We find negative point estimates for the slowest shipping variable in each column. This sign is consistent with more patient buyers receiving lower final prices in bargaining, as in many theoretical models; however, none of these estimates are statistically significant.[23] We find stronger evidence for bargaining power being captured by players' experience. Table IV demonstrates that more experienced sellers tend to obtain higher prices (statistically significantly so for new goods) and more experienced buyers tend to obtain lower prices (statistically significantly so for used goods). For both buyers and sellers, the results suggest a relative

23. This insignificance is likely due to the fact that our measure of patience is imperfect and to the specification we adopt here by including leaf category fixed effects. When we remove leaf category fixed effects, we find negative and significant estimates for used goods of approximately -0.07, suggesting that more patient buyers obtain prices that are lower by 7 percentage points of the reference price. It is important to note that while this evidence is consistent with a role for patience, these regressions may also simply be capturing an effect of willingness or ability to pay: buyers who are willing/able to pay less for the item may also be willing/able to pay less for fast shipping, and hence the better deal obtained by buyers whom we label as "patient" may actually be due to those buyers' low willingness/ability to pay. This highlights an important point: a player's patience, willingness/ability to pay, bargaining costs (from the previous section), or outside options (discussed in the following section) can all affect the strength of a player's bargaining position and the surplus the player obtains.

TABLE IV

NEGOTIATED PRICES REGRESSED ON BARGAINING POWER MEASURES

	(1)	(2)	(3)	(4)	(5)	(6)
Slowest shipping	−0.0188		−0.0164	−0.0205		−0.0213
	(0.0314)		(0.0314)	(0.0124)		(0.0124)
Multiple shipping options	0.214***		0.202***	0.102***		0.100***
	(0.0220)		(0.0217)	(0.00977)		(0.00984)
Log(seller experience)		0.0192***	0.0158***		0.00262**	0.000119
		(0.00174)	(0.00165)		(0.000926)	(0.000952)
Log(buyer experience)		−0.00401	−0.00289		−0.0220***	−0.0216***
		(0.00251)	(0.00251)		(0.00134)	(0.00134)
Constant	0.989***	0.942***	0.924***	1.115***	1.179***	1.175***
	(0.00362)	(0.0110)	(0.0112)	(0.00247)	(0.00667)	(0.00667)
Condition	New	New	New	Used	Used	Used
R^2	0.0300	0.0282	0.0306	0.0452	0.0453	0.0459
No. leaf FE	404	404	404	398	398	398
N	125,418	125,418	125,418	328,029	328,029	328,029

Notes. This table presents results from regressions where the dependent variable is the normalized price (see text for a discussion of the construction of reference prices) and the regressors are buyer and seller attributes. All regressions include leaf category fixed effects. Robust standard errors are presented in parentheses. *: $\alpha = 0.10$, **: $\alpha = 0.05$, and ***: $\alpha = 0.01$.

improvement in prices of about 2 percentage points given a 1 log point increase in experience. We show additional evidence in Online Appendix D (Table A-4) that buyers' and sellers' counteroffer behavior follows a similar pattern: players concede more in nearly every round of the game when facing a more experienced opponent and concede less when they are more experienced themselves.

IV.C. Outside Options

Another feature that can affect outcomes is the outside option of a negotiator. In our setting, the outside option of a seller is to exit and search for another player with whom to negotiate (or to leave the platform). In some cases, a player may even be engaged in bargaining simultaneously with multiple parties at the same time. Of the listings in our data, 7.8% have at least two buyers whose bargaining threads overlap in time with the same seller, and these threads make up 14.2% of all bargaining threads. In 2% of threads, a seller's decision to accept a buyer offer results in the seller declining an outstanding offer from a competing buyer. On the buyer side, in the subset of our data containing cataloged product identifiers, we see that 2.1% of listings involve a given buyer bargaining with more than one seller of the same cataloged product at the same time, and these threads make up 4.8% of all cataloged product threads. When a buyer fails to reach agreement with a seller of a given cataloged product, in 2.9% of threads the buyer trades with another seller of the same product within a day's time.[24]

The option of a player to end negotiations with one player and engage with another can affect prices and other bargaining outcomes. To examine this, we run regressions of the final price (normalized by the reference price, as in Table IV) on several measures of competition and outside options, including the log of the number of buyers with whom the current seller is bargaining simultaneously for this item (labeled "competing buyers" in Table V), the log of the number of sellers (selling the same

24. A related interesting statistic is the fraction of repeat interactions by the same buyer and seller pair. We find that 9% of buyer-seller pairs meet in at least two separate bargaining threads. Together, these repeat buyer-seller pairs constitute 23.5% of the interactions in the data. This feature is another interesting aspect that could be exploited in future research with our public data set, studying, for example, reputation-building and learning in bargaining.

TABLE V

NEGOTIATED PRICES REGRESSED ON COMPETITION MEASURES

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log(competing buyers + 1)	−0.00175			−0.00631	0.0193***			0.0208***
	(0.00767)			(0.00802)	(0.00473)			(0.00481)
Log(competing sellers + 1)		0.0202		−0.0123		−0.0619***		−0.0566***
		(0.0610)		(0.0589)		(0.00603)		(0.00626)
Log(competing listings + 1)			0.0369***	0.0374***			−0.00734***	−0.00577**
			(0.00735)	(0.00671)			(0.00173)	(0.00182)
Constant	1.023***	1.022***	0.991***	0.992***	1.128***	1.134***	1.141***	1.137***
	(0.00433)	(0.00389)	(0.00616)	(0.00585)	(0.00233)	(0.00237)	(0.00319)	(0.00312)
Condition	New	New	New	New	Used	Used	Used	Used
R^2	0.0272	0.0272	0.0276	0.0276	0.0446	0.0446	0.0446	0.0447
No. leaf FE	404	404	404	404	398	398	398	398
N	125,418	125,418	125,418	125,418	328,029	328,029	328,029	328,029

Notes. This table presents results from regressions where the dependent variable is the normalized price (see text for a discussion of the construction of reference prices) and the regressors are the (log of) the number of overlapping buyers competing on the same thread for a given product, the number of sellers offering a given product, and the number of listings of the same product live on the site at the same time as a given listing. All regressions include leaf category fixed effects. Robust standard errors are presented in parentheses. *: $\alpha = 0.10$, **: $\alpha = 0.05$, and ***: $\alpha = 0.01$.

cataloged product) with whom the current buyer is bargaining simultaneously (labeled "competing sellers"), and the log of the number of other listings available at the same time as the current listing offering the same product as the current listings (labeled "competing listings"). In these regressions, we also include leaf-category fixed effects.

The results are displayed in Table V. The first four columns display results for new items, and the last four columns display results for used items. For new goods we do not detect any significant effects of competition and outside options on the final price except for a significant and positive coefficient on the number of competing listings, suggesting that prices are actually higher when more listings of a particular product are available; this likely reflects an equilibrium response of supply. Among used items, we see a positive and significant increase in price (2% of the reference price) when the number of competing buyers on a given listing increases by 1 log point. Conversely, we see a negative and significant drop of 6% of the reference price when the number of competing sellers increases by 1 log point, and a drop of 0.6% when the number of competing products increases by 1 log point. These results for used goods are consistent with the role one would expect for market thickness and outside options of one side of the market or the other.

This simple analysis only touches the surface of possible effects of outside options on bargaining outcomes in dynamic marketplaces. For example, eBay is a marketplace that is constantly changing, with goods continuously arriving and exiting from inventory. Indeed, there is no reason to expect that the outside options of two bargaining parties will stay constant even during the short window of negotiation over which we observe them (and outside options of negotiators off the eBay platform may be changing as well). In this light, dynamic outside options may be an additional explanation for the delayed agreement and delayed disagreement documented in Section III.

IV.D. Adverse Selection

Another area of interest in the theory literature on bargaining is adverse selection (Evans 1989; Vincent 1989; Deneckere and Liang 2006). We do not attempt a full survey of the implications of adverse selection for bargaining here, but we do present several salient facts that may help guide future theoretical and empirical

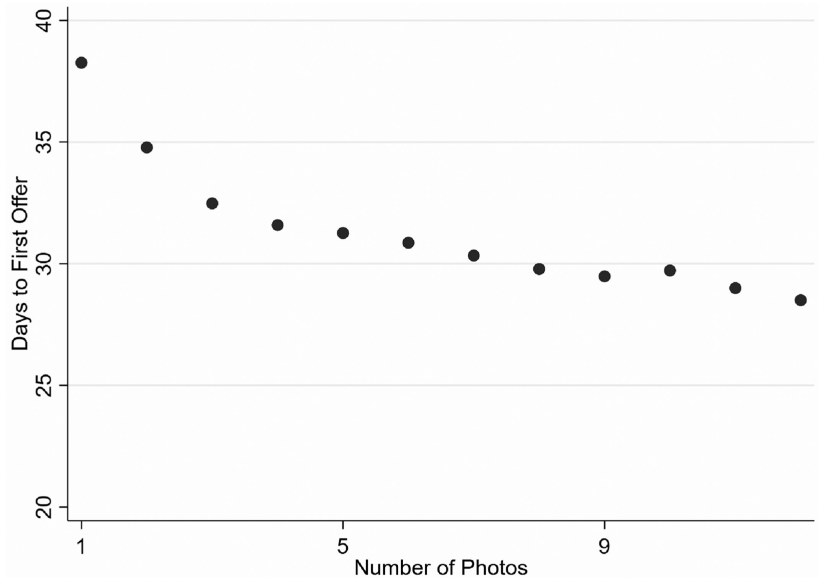

FIGURE VII

Time to First Offer by Number of Photos

Figure displays the average time (in days) from when the listing is posted until the first offer arrives conditional on the number of photos.

work, in particular related to information disclosure by sellers. In previous work studying online fixed-price and auction markets on eBay Motors (a marketplace for vehicles), Lewis (2011) demonstrated that the number of photos included in a listing serves as a useful measure of the amount of information revealed by sellers about an item's quality.[25] Here we examine how bargaining outcomes differ with the number of photos.[26]

In Figure VII, we examine how many days it takes for the first bargaining offer to arrive as a function of the number of photos in a listing. We find that conditional on having at least one photo, the larger the photo count, the quicker the first offer arrives. This suggests that buyers may be more willing to engage in bargaining

25. Note that our data does not include data from eBay Motors, which is a platform primarily used by sellers as a classified advertising mechanism and not as a setting for negotiating over or selling cars.

26. Note an important distinction between the type of information revelation that can be captured in the number of photos and the private information modeled in Myerson and Satterthwaite (1983), Perry (1986), and others (see Section III.B): in those models, each bargaining party has private information about her own valuation, but no private information about factors affecting her opponent's valuation.

TABLE VI

Bargaining Outcomes by Number of Photos

	Received offer (1)	Received offer (2)	Sold by Best Offer (3)	Sold by Best Offer (4)	Norm. price (5)	Norm. price (6)
Log(photos + 1)	0.0611***	0.0353***	0.0344***	0.0259***	0.193***	0.225***
	(0.000610)	(0.00106)	(0.000574)	(0.000971)	(0.00494)	(0.00975)
Constant	0.368***	0.414***	0.194***	0.204***	0.908***	0.860***
	(0.000662)	(0.000899)	(0.000603)	(0.000793)	(0.00470)	(0.00516)
Condition	Used	New	Used	New	Used	New
R^2	0.214	0.124	0.0735	0.0264	0.0530	0.0367
No. leaf FE	494	492	494	492	398	404
N	1,469,560	574,560	1,469,560	574,560	328,029	125,418

Notes. This table presents results from regressions where the dependent variable is the normalized price (see text for a discussion of the construction of reference prices) and the right-hand-side variable of interest is the log of 1 plus the number of photos of the listing. All regressions include leaf category fixed effects. Robust standard errors are presented in parentheses. *: $\alpha = 0.10$, **: $\alpha = 0.05$, and ***: $\alpha = 0.01$.

when there is less asymmetric information; however, the choice to disclose that information may itself be endogenous to the content. Table VI presents regressions of bargaining outcomes on the log of the number of photos included with the listing. These regressions use our reference price sample, as in Tables IV and V. We find that the more photos a listing has, the more likely it is to receive an offer and to sell through bargaining (as opposed to selling through the Buy-It-Now option or not selling at all). We also see that the normalized price is higher by 19 percentage points for used goods and 22.5 percentage points for new goods when the number of photos increases by 1 log point.[27]

V. Unexplained Behavioral Patterns

We now turn to players' choices of counteroffers to further explore the gradual concessions we discussed in Section III.E and, in the process, uncover another interesting behavioral pattern that conventional bargaining theories cannot explain. In general, we are interested in exploring further patterns about how the offer in period t relates to the offers in periods $s < t$.

Let $\gamma_1 = \frac{p_1}{p_0}$, and, for $t = 2, 3, ..., 6$, let $\gamma_t \in [0, 1]$ be the weight such that $p_t = \gamma_t p_{t-1} + (1 - \gamma_t) p_{t-2}$. Therefore, γ_t represents the

27. Another benefit of disclosing information with photos is to better match buyers with different quality levels of goods based on their preference for quality levels, as in Tadelis and Zettelmeyer (2015).

weight that player t places on the opponent's previous offer, and $1 - \gamma_t$ represents the weight the player places on their own previous offer. Note that by definition, $p_1 = \gamma_1 p_0 + (1 - \gamma_1)0$, so we can think of the buyer's "previous" offer when he makes his first offer as his bliss point of paying nothing for the good. It is useful to think of γ_t as how much a player concedes to her opponent when she is making a counteroffer, or her concession weight. This notion will prove useful for exploring concession behavior in more detail as we show below. In the remainder of this section, we limit the sample to threads with back-and-forth sequences corresponding to the left side of the game tree displayed in Figure III, as in Section III.E. We also restrict to threads where $\gamma_t \in [0, 1]$ for all offers.

V.A. Reciprocal Gradualism

As we explained in Section III.E, existing theories have trouble explaining the appearance of gradual changes in counteroffers, and as Figure IV showed, the path of average counteroffers exhibits very strong gradual concessions. In fact, gradual changes in offers are vastly more common in the data than are the sudden changes predicted by most theoretical analyses. In the data, among observations in which the seller makes at least two offers (beyond the Buy-it-Now price), we observe that only 0.77% of observations involve a seller standing firm at the Buy-It-Now price for several periods and then conceding. In contrast, in 98.8% of the observed sequences the seller's first counteroffer already concedes a bit relative to the Buy-It-Now price. Examining analogous numbers for buyers, we find that only 0.42% involve concession only suddenly after holding firm at the previous offer for at least one period, whereas 95.9% involve a buyer conceding gradually.

To explore concession behavior within individual bargaining threads (rather than average behavior across bargaining threads), Table VII presents results from regressing a player's concession weight, γ_t, on the opponent's previous concession weight, γ_{t-1}, where the unit of observation is one movement along each bargaining thread starting from the buyer's first counteroffer in period $t = 3$.[28] A larger γ_{t-1} means that the player's opponent conceded

28. For these regressions, to guarantee that the offers constitute all relevant information that passes between parties, we eliminate threads in which prices were auto-accepted or auto-declined and threads in which the buyer or seller communicated via a message.

TABLE VII

CONCESSIONS REGRESSED ON PREVIOUS CONCESSIONS BY ONE'S OPPONENT

	γ_3 (1)	γ_3 (2)	γ_4 (3)	γ_4 (4)	γ_5 (5)	γ_5 (6)	γ_6 (7)	γ_6 (8)
γ_{t-1}	0.125***	0.120***	0.226***	0.223***	0.156***	0.149***	0.124***	0.166***
	(0.00185)	(0.00145)	(0.00362)	(0.00281)	(0.00712)	(0.00536)	(0.0113)	(0.00793)
Constant	0.347***	0.345***	0.166***	0.161***	0.281***	0.289***	0.174***	0.160***
	(0.000820)	(0.000654)	(0.00127)	(0.000990)	(0.00197)	(0.00148)	(0.00323)	(0.00228)
Condition	Used	New	Used	New	Used	New	Used	New
R^2	0.0605	0.0550	0.110	0.116	0.140	0.133	0.198	0.197
No. leaf FE	8,833	12,320	6,524	9,386	3,794	5,822	2,442	4,016
N	345,961	529,193	128,597	210,445	35,447	60,786	15,953	29,098

Notes. This table presents results from regressions of γ_t on γ_{t-1} for $t = 3$, 4, 5, and 6. All regressions include leaf category fixed effects. Robust standard errors are presented in parentheses. *: $\alpha = 0.10$, **: $\alpha = 0.05$, and ***: $\alpha = 0.01$.

more in his previous round, and a positive coefficient means that the player in period t is herself conceding more in response to a larger concession. This is the pattern we see for all periods $t = 3$, 4, 5, and 6, for new and used goods: the more a player concedes in period $t - 1$, the more will his opponent concede in period t. Hence, gradual behavior is reciprocal, in that deeper concessions from one player are "rewarded" by deeper concessions from the following player.[29]

Together with the discussion in Section III.E, the data strongly suggest that a major gap in the bargaining literature is a theory that can generate—from both parties in equilibrium—agreement and disagreement, delay and immediate termination, and the very robust pattern of reciprocal gradualism.

V.B. "Split-the-Difference" Offers

In defining the concession weight γ_t, it is insightful to observe the distributions of γ_t in different rounds of the game. Figure VIII displays histograms of these concession weights for the bargaining threads observed in the data. Panel A plots a histogram of γ_1, Panel B plots a histogram of γ_2, limiting to those threads in the data in which a period-2 offer was made, and so on.

Several interesting patterns are evident in this analysis. We note first that offers typically make nonzero concessions that are closer to the sender's own prior offer than the other party's (concession weights below 0.5), with the exception of the first offer, which is often close to the Buy-It-Now price. Second, some common mass points emerge, and of particular notice are counteroffers that are halfway between the previous two offers, or "split-the-difference" counteroffers. The pattern even holds for buyers' first offers (γ_1), where the modal initial offer is half of the Buy-It-Now. The midpoint offer is also the modal offer for the first seller counter (γ_2), the first buyer counter (γ_3) and the second buyer counter (γ_5). For other counters, the modal offer gives zero or nearly zero weight to the buyer's most recent offer, and second only to this choice is again the split-the-difference point.

This pattern is consistent with previously documented laboratory evidence and behavioral economic theory (Roth and Malouf

29. We find the same pattern of reciprocal gradualism if instead of regressing γ_t on γ_{t-1} we regress the percent change in a player's offer on the percent change in the opponent's offer (regressing, for example, $\frac{P_3-P_1}{P_1}$ on $\frac{P_0-P_2}{P_0}$). See Online Appendix Table A-5.

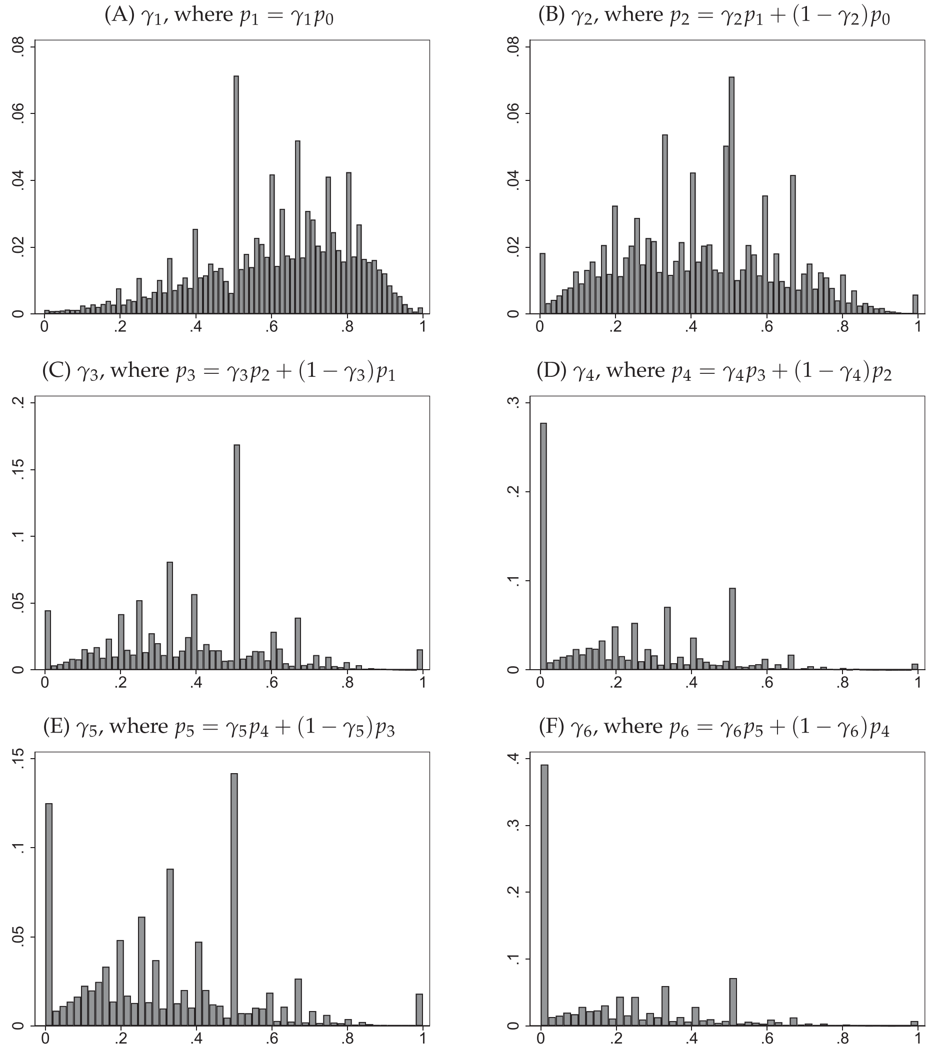

FIGURE VIII

Where Current Offer Lies Relative to Previous Offers

Each panel displays a histogram of offer weights defining how the current offer relates to the previous offers, where $\gamma_1 = \frac{p_1}{p_0}$, and, for $t = 2, 3, \ldots, 6$, γ_t is such that $p_t = \gamma_t p_{t-1} + (1 - \gamma_t) p_{t-2}$.

1979; Roth 1985; Binmore, Shaked, and Sutton 1985; Bolton 1991; Bolton and Ockenfels 2000; Charness and Rabin 2002; Andreoni and Bernheim 2009), in which market participants may care about notions of fairness and may favor a split-the-difference strategy in negotiations. Interestingly, however, the split-the-difference pattern we observe is not necessarily a pattern of splitting surplus between the two parties, as the surplus is not necessarily

TABLE VIII
PROBABILITY OF SPLIT OFFER ACCEPTED

	$t = 1$ (1)	$t = 2$ (2)	$t = 3$ (3)	$t = 4$ (4)	$t = 5$ (5)	$t = 6$ (6)
Split	0.0381***	0.0628***	0.0848***	0.0978***	0.0951***	0.0998***
	(0.000343)	(0.000556)	(0.00110)	(0.00219)	(0.00344)	(0.00691)
γ_t	0.932***	0.617***	1.191***	0.811***	1.019***	0.771***
	(0.00167)	(0.00266)	(0.00473)	(0.00635)	(0.0106)	(0.0125)
Constant	0.188***	0.182***	0.411***	0.342***	0.458***	0.488***
	(0.000131)	(0.000247)	(0.000581)	(0.00117)	(0.00178)	(0.00347)
R^2	0.114	0.0479	0.108	0.118	0.167	0.204
No. leaf FE	17,051	16,190	14,486	11,777	8,748	6,154
N	9,638,253	3,185,044	1,010,604	362,583	138,571	62,953

Notes. This table displays the results from a linear regression where the dependent variable is an indicator for whether the offer in period t of the game is accepted and this is regressed on the offer weight, γ_t, and on an indicator for whether γ_t is approximately equal to 0.5. Columns (1)–(6) display results for γ_t for $t = 1$, ..., 6. All regressions include leaf category fixed effects. Robust standard errors are presented in parentheses. *: $\alpha = 0.10$, **: $\alpha = 0.05$, and ***: $\alpha = 0.01$.

known to the players given the potential presence of incomplete information about opponent valuations. Rather, the split-the-difference phenomenon we observe in our data refers to splitting the two most recent offers, regardless of how those offers relate to surplus.

We now explore how a player's choice of offer, as measured by the weight, γ_t, relates to later outcomes in the bargaining game. We create a measure for whether the offer is a "split" offer by creating an indicator that is equal to 1 if γ_t is equal to 0.5 (after being rounded to the nearest hundredth) for each $t \in 1, 2, 3, 4, 5, 6$. We find that about 8% of offers are split offers by this definition.[30] We estimate a local linear regression of an indicator for whether each offer is accepted on both this split indicator and the underlying γ_t.[31] Results are shown in Table VIII.

Table VIII demonstrates that, as would be expected, the coefficient on the concession rate (γ) is positive: the more a player concedes relative to previous offers, the more likely it is that the opposing player accepts the offer. The key result of Table VIII, however, is that an offer in bargaining is more likely to be accepted if it is a split offer than if it is not, and this effect is both

30. Broader definitions of split, by rounding γ_t to the nearest five hundredths or nearest tenth yield 11% and 16% split rates, respectively.

31. We follow Fan and Gijbels (1992) in the construction of the optimal variable bandwidth for estimation of the effect at 0.5 using a rectangular kernel.

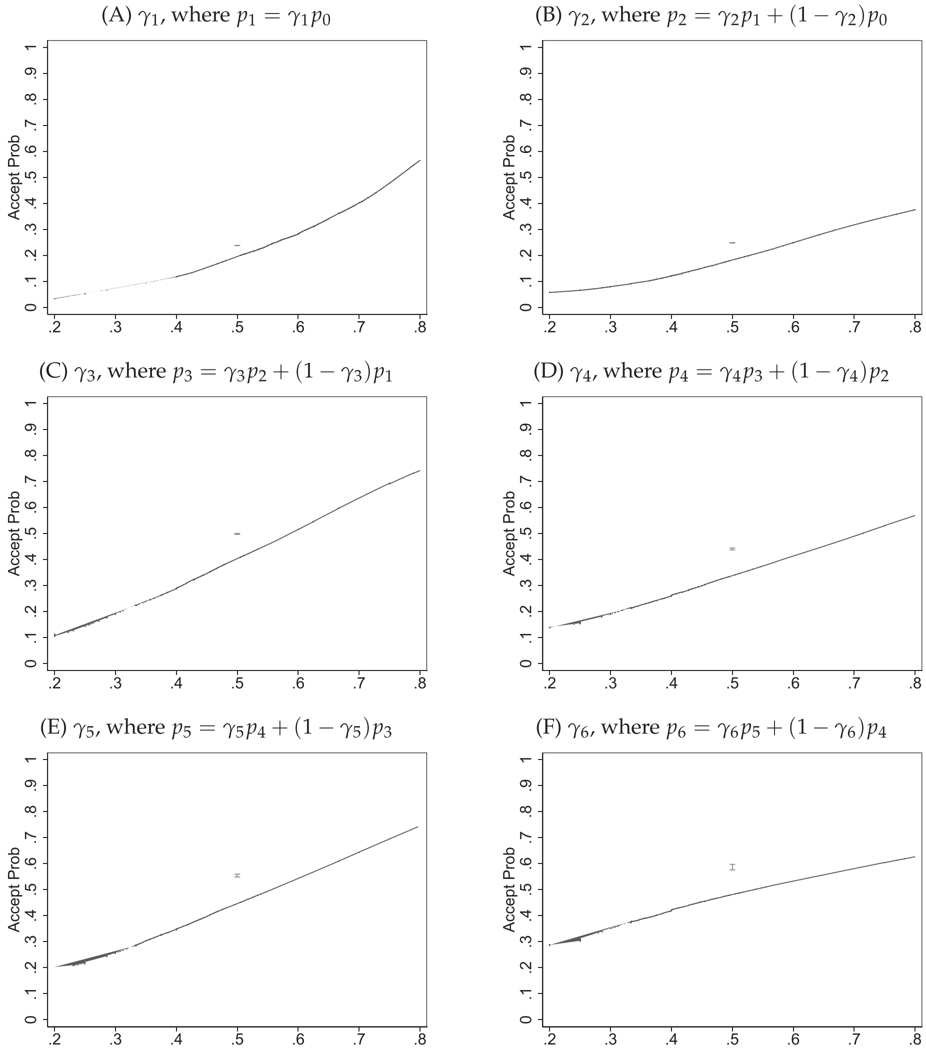

FIGURE IX

Probability of Split Offer Accepted

This figure displays a LOWESS fit of the probability of an offer being accepted regressed on the offer weight, γ_t, and on an indicator for whether γ_t is approximately equal to 0.5. From left to right, top to bottom, the panels display results for γ_t, where t ranges from 1 to 6.

statistically significant and surprisingly large in magnitude, as well as being curiously stable across periods of the bargaining, lying in a range of 5–10% independent of what point in the bargaining game the split offer occurs. We supplement this approach with a more flexible fit of γ_t by plotting LOWESS fits of acceptance and γ_t in Figure IX using observations where γ_t is not a split offer. We then also plot in Figure IX the average acceptance probability for observations that are split offers, along with 95% confidence bound about this mean. As can be seen, the underlying relationship between γ_t and acceptance is positive and split offers are substantially more likely to be accepted.

This pattern of behavior is particularly surprising because, taken seriously, it implies a nonmonotonicity in the likelihood of acceptance—that is, a player is more likely to accept a split-the-difference offer than an even slightly more favorable offer. This kind of discrete and nonmonotonic behavior is not easy to rationalize with existing theories, even those that incorporate other-regarding preferences, such as altruism or inequity aversion. Other-regarding preferences can explain why the well-being of the player making the offer would be accounted for by the responder, but this cannot rationalize the observed behavior. Namely, a discontinuous drop in the probability of accepting an offer that is slightly more generous for the respondent hurts both players, and as such, it seems suggestive of some norm that players are expected to follow. For that matter, any standard preferences for which bargaining can be modeled as a Bayesian game would be unable to explain the observed behavior. Namely, if one considers the probability of trade as an equilibrium outcome, then a general mechanism design approach as in Myerson and Satterthwaite (1983) implies that the probability of trade should be monotonic along some notion of private types if standard notions of interim incentive compatibility hold. Hence, the observed behavior presents a challenge to standard equilibrium theory and suggests that there is some kind of "numerosity" effect at the split-the-difference points that seems to go beyond preferences, possibly some kind of norm, or some notion of salience.

VI. Conclusion

In this article we analyzed a novel data set of bilateral bargaining used by millions of users in a live ecosystem. We documented a number of facts consistent with rational theories of bargaining behavior. In particular, we found that existing theories can explain a nontrivial fraction of the data in terms of how the bargaining ends (immediately versus with delay, and in agreement vs. disagreement). We also found evidence favoring fixed over proportional costs of bargaining. This is important for understanding mechanism selection but also for thinking about the external validity of experimental studies of low-stakes bargaining: if our conclusion is correct, behavioral patterns in high- and low-stakes bargaining will be very different. We also found that more patient or more experienced players obtain better deals, as do players facing less competition (or having a better outside option). We find that listings with more photos—a potential measure of reduced adverse selection—tend to receive offers more quickly and sell for higher negotiated prices.

We then documented several features of the data that are clearly not consistent with any existing models of bargaining. First, we showed that bargaining often ends in disagreement after several back-and-forth offers. Second, we showed that buyer and seller offers tend to change gradually, not suddenly, over the course of the bargaining sequence, and this gradualism is not one-sided but is instead bilateral and gradual: more concession by one player is associated with more concession by her opponent as well. These two data patterns stand in stark contrast with existing bargaining theory models.

Finally, we offered stark evidence of "splitting-the-difference" behavior, a result that supports the incorporation of behavioral elements to understanding bargaining dynamics. We documented the surprising fact that counteroffers lying halfway between the two preceding offers are significantly more likely to be accepted by the opposing party than are offers that are even slightly more favorable to the opposing party.

We believe that the rich data we used herein, which we have made publicly available, offers opportunities to explore how people bargain and can help shed light on what determines bargaining outcomes in the real world.

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Supplementary Material

An Online Appendix for this article can be found at *The Quarterly Journal of Economics* online. Data and code replicating tables and figures in this article can be found in Backus et al. (2020), in the Harvard Dataverse, doi: 10.7910/DVN/ZOWWO7.

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