

# An Empirical Analysis of Insistent Bargaining\*

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## Abstract

In alternating-offer bargaining, a seller is “insistent” if she demands the same asking price more than once. We provide empirical evidence on insistence and inform the theoretical literature by analyzing millions of eBay bargaining threads taken from Backus et al. (2020). Focusing on the best predictors of first-period insistence, we find that insistence is sticky—a seller who was insistent in the past is more likely to be insistent in the future—and a seller is more likely insistent if the buyer has been particularly lenient or tough in her counteroffer.

*JEL classification codes: C78, D51.*

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# 1 Introduction

Bilateral bargaining is a staple in economics. Although the theoretical literature on bilateral bargaining has a long and prolific tradition, little empirical evidence has documented how bilateral bargaining develops in the field—what key variables affect the outcome, and how—, until the blossoming of online marketplaces in the last two decades. Online marketplaces provided a rich source of data to bridge the gap and systematically study real-world bilateral bargaining.

A uniquely rich dataset is analyzed and publicly released by Backus, Blake, Larsen, and Tadelis (2020)—henceforth, BBLT.<sup>1</sup> They make use of millions of observations of bilateral bargaining taking place on eBay to study patterns of bargaining behavior between sellers and buyers. They document the following key robust empirical findings, among others, which are not rationalized by existing theories: i) bargaining offers tend to change gradually over the course of the bargaining interaction, ii) concessions are reciprocated with more concessions, and iii) offers that split the difference between the two most recent offers are often made and accepted. In brief, they document gradual, reciprocal, and split-the-difference concessions. We use their dataset to study “no concession at all”, or insistence. For instance, a seller posts an item at an asking price of \$90, a buyer counteroffers \$70, and then the seller counters the buyer’s counteroffer by asking *again* for \$90.

As previously documented by others—including Bagwell et al., 2020—the number of back-and-forth offers and counteroffers in any bilateral bargain is relatively small (1.66 offers on average in the BBLT dataset). This poses a challenge to the empirical analysis of insistence, as a seller can only be insistent when countering a counteroffer. Hence, we need at least two alternating offers following the asking price to possibly observe insistence. Conditional on having at least two alternating offers, the dataset of BBLT still yields 88,150 bargaining interactions where the seller is insistent in the first period.<sup>2</sup> This

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<sup>1</sup>The data can be accessed at <http://www.nber.org/data/bargaining.html>.

<sup>2</sup>1.31% of the times sellers are insistent in the first period in the BBLT dataset. This figure goes up to 5.31% when considering sellers who are insistent in *any* period of the thread.

provides a sufficient mass to draw meaningful conclusions on insistence, thus making the uniquely rich dataset of BBLT an unprecedented opportunity to empirically analyze insistence.<sup>3</sup> The present paper makes the first empirical cut, to the best of our knowledge, into documenting when and how insistence arises in real-life bilateral bargaining.

**Findings.** Call  $S0$  the seller’s asking price,  $B1$  the buyer’s counteroffer, and  $S1$  the seller’s counteroffer to  $B1$ . We refer to a sequence of back-and-forth offers as a thread. We analyze the occurrence of first-period insistence, defined as the occurrence of  $S1 = S0$ , henceforth simply called insistence.<sup>4</sup> In Section 3, we document that several actions of the buyer (Section 3.1), actions and features of the seller (Section 3.2), and features of the item (Section 3.3) are positively associated with insistence. In Section 3.4, we investigate the best predictors of insistence among all the variables we considered Section 3. We do so by adopting the Shapley Value regression approach to compare the power of predicting insistence of all the variables we considered Section 3. We find that the two best predictors of insistence are the insistence of the same seller when she bargained with other buyers in the past and the price concession  $B1/S0$  by the buyer. In particular, we find that insistence is sticky—a seller (not) insistent in some threads is more likely (not) insistent in future threads—and a seller is more likely insistent if the buyer has been particularly lenient or tough in her counteroffer ( $B1/S0$  particularly high or low).

More exhaustively, we find that insistence is positively (and significantly) associated with; (1)  $B1$  being close to  $S0$ , (2) the time-span between  $S0$  and  $B1$  being short, (3) the seller’s lack of experience, (4) insistence by the same seller in other (preceding) threads with other buyers, (5)  $S0$  being low as opposed to a reference price for that item, (6) the item belonging to a category of “objective value”, such as tickets & experiences and gift cards &

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These figures are computed in the sample after applying a number of natural restrictions we discuss in Section 2; importantly, we only focus on threads with alternation of offers between buyer and seller.

<sup>3</sup>Their dataset is “the largest offer-level negotiations dataset to be analyzed in the literature” (BBLT, p. 1321).

<sup>4</sup>Our two main findings hold even when insistence is defined as the occurrence of  $S0 = S1 = S2$  instead.

coupons, (7) the item being used rather than new, (8) the number of parallel bargaining threads the seller is having with different buyers for the same item, and (9) the number of photos posted for the item by the seller.

In Section 4, we document the relation between insistence and the outcome of the thread; that is, variables that, on the contrary to the variables discussed in Section 3, realize *after* the potential occurrence of insistence (after  $S1$ ). We document that insistence is negatively associated with the probability of agreement and the number of alternating offers of the thread. We find that insistence is not significantly associated with the final price agreed on.

**Related literature.** After Rubinstein’s (1982) seminal theoretical work on bargaining, a burgeoning strand of the literature focused on the role of insistent postures in bargaining. The theoretical work on insistence (often also called stubbornness) in bargaining dates back to the seminal contributions by Kreps (1990), Myerson (1991) and Abreu and Gul (2000), and several extensions have been analyzed.<sup>5</sup> These include imperfect commitment to announced postures (Kambe, 1999; Wolitzky, 2012), outside options (Compte and Jehiel, 2002), complex insistent types (Abreu and Pearce, 2007), markets with search frictions (Atakan and Ekmekci, 2014), and deadlines (Fanning, 2016). A widely-adopted model is an alternating-offer bargaining game à la Rubinstein, except for an exogenous probability that a player is of a behavioral stubborn type, who irrationally insists on a particular price. A typical equilibrium feature is that rational types may imitate irrational stubborn types to convince their opponent of their irrationality (build a reputation), and hence to acquiesce to their demand right away. A parallel strand of the literature endogenized the existence and strategy of such stubborn types: e.g., Abreu and Sethi (2003), Atakan and Ekmekci (2014), Weinstein and Yildiz (2016), Sanktjohanser (2020), and Basak (2019).

The abundance of theoretical works on insistent bargaining is not matched by comparably abundant empirical evidence. Embrey et al. (2015) run a series of laboratory experiments to test the theory of Abreu and Gul (2000).<sup>6</sup> Their

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<sup>5</sup>See Fanning and Wolitzky (2022) for a nice exposition of the Abreu-Gul setup and its numerous extensions.

<sup>6</sup>Malik et al. (2021) build on the design in Embrey et al. (2015) to experimentally

subjects may be randomly matched with computer players who are coded to be insistent and never concede in the second stage. Subjects are not informed on whether they are matched with a computer or another subject, despite knowing the likelihood of a match with a computer and the computer’s strategy. Embrey et al. (2015)’s findings corroborate Abreu and Gul’s theory: subjects mimic insistent types in the first stage, and thus the bargaining typically entails costly delays. The exogenous introduction of insistent types in the laboratory has the advantage of drawing a clear picture on mimickers of insistent types (in line with Abreu and Gul’s theory), but also the potential of changing players’ behavior; for instance, Embrey et al. (2015) find that “following the introduction of an experimentally induced 20-type, there is a substantial increase in demands of 20.” Hence, a natural complementary exercise to that of exogenously introducing insistent types in the laboratory is that of documenting in the real world when, if, and how insistence arises. This is the focus of the present paper.

**Structure of the paper.** In Section 2, we briefly describe the dataset of BBLT, spell out the imposed restrictions, and define the variables that will play a role in our analysis. In Section 3, we investigate how the emergence of insistence is associated with observables that realized *before* insistence may emerge (before counteroffer  $S1$ ): the size and timing of the asking price  $S0$  and the counteroffer  $B1$ , seller’s experience, past insistence, reference price, outside options, and features of the item for sale (category, condition, and number of posted photos). We conclude with a discussion of the best predictors of insistence. In Section 4, we investigate how the emergence of insistence is associated with observables that realize *after* insistence may emerge (after counteroffer  $S1$ )—namely, the probability of reaching an agreement, the final price agreed on, and the number of alternating offers of the bargaining. Section 5 discusses and concludes. The Appendix contains details on the dataset restrictions.

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investigate the role of gender and gender revelation. Heggedal et al. (2021) experimentally investigate the role of outside options in an environment similar to that of Embrey et al. (2015).

## 2 Preliminaries

We borrow the dataset of BBLT containing all single-unit listings created between the 31<sup>st</sup> of May 2012 and the 1<sup>st</sup> of June 2013 on the US eBay Best Offer platform: in total, over 90 million listings. For each listing, a sequence of back-and-forth offers by the seller and the potential buyer may emerge; we call such sequence a thread.<sup>7</sup> Threads start with a seller posting an asking price  $S_0$ . The buyer may counteroffer a price  $B_1$ . Then, the seller may further counter the offer of the buyer with a counteroffer  $S_1$ . And so on. Each party is limited to three offers (except  $S_0$ );  $S_3$  is the last possible counteroffer. For a more detailed description of the dataset and the functioning of the US eBay Best Offer platform, we refer the reader to Section 2 of BBLT.

We define an indicator function that takes value 1 in case of insistent behavior by the seller; that is,

$$\alpha_t \equiv \begin{cases} 1 & \text{if } S_t = S(t-1) \\ 0 & \text{otherwise} \end{cases} \quad \text{with } t = 1, 2, 3.$$

If the seller's initial counteroffer to  $B_1$  is identical to the seller's asking price (if  $S_1 = S_0$ ), then  $\alpha_1 = 1$  and we refer to this behavior as insistence.

We apply a number of restrictions to the dataset. Below, we only list the four main restrictions, which are violated by at least 0.025% of observations in the original sample. The complete set of restrictions (including those that are violated by fewer than 0.025% of the observations in the sample) are listed and discussed in the Appendix.

First, we focus on alternating bargaining only. Formally, the bargaining continues until either party accepts, or until the buyer declines. If the seller declines, the buyer may still respond with a counteroffer. We neglect this contingency, which for instance would allow the thread to move from  $B_1$ , to a decline (without counteroffer  $S_1$ ) by the seller, to a  $B_2$ . This restriction is also adopted by BBLT when they analyze the choices of counteroffers and how they relate to previous offers (see Section 5 of BBLT). This restriction rules

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<sup>7</sup>Clearly, not every listing evolves into a thread.

out around 15% of the bargaining threads of the original sample.

Second, we focus on threads reaching at least stage  $S1$ . In fact, if the thread stops earlier (at  $S0$  or  $B1$ ), then insistence simply cannot possibly emerge. This restriction rules out around 58% of the bargaining threads of the original sample.

Third, we focus on monotonic bargaining; that is,  $S_t \in [B_t, S(t-1)]$  for  $t \in \{1, 2, 3\}$ ,  $B1 \leq S0$ , and  $B_t \in [B(t-1), S_t]$  for  $t \in \{2, 3\}$ . In words, any offer is always between the two previous offers; e.g., if  $S0 = \$90$  and  $B1 = \$70$ , then  $S1 \in [\$70, \$90]$ . As documented by BBLT, if a thread displays, for instance,  $S0 = 100$ ,  $B1 = 80$ , and then  $S1 = 120$ , it could be that the parties agreed through message-exchange to trade two copies of the object for sale for 120.<sup>8</sup> Also, as documented by BBLT, “prices tend to converge in a pattern consistent with Coasian dynamics, with seller offers declining and buyer offers increasing over the duration of the bargaining interaction.” For more details about price convergence see Section 4.3 of BBLT. The monotonic bargaining restriction rules out around 1.17% of the bargaining threads of the original sample.

Fourth, we focus on  $S0 \leq \$1,000$ , as in BBLT, as “an arbitrary restriction to simplify the analysis and the graphics” (BBLT, online Appendix, p. 2). This restriction rules out around 10% of the bargaining threads of the original sample.<sup>9</sup>

Table 1 shows the descriptive statistics for the variables we use throughout the analysis after all restrictions are applied.<sup>10</sup> After all restrictions are applied, we have roughly 6.7 million threads.

In the analysis of Section 3 and Section 4, we visualize how the variables in Table 1, which are described in detail in Sections 3 and 4, are associated with the probability of insistence ( $\alpha_1 = 1$ ) and test our results statistically. A crucial advantage of running regressions for each variable in order to confirm

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<sup>8</sup>“It is possible that it happens because the sellers have agreed to bundle other products or services with the sale, however this is abnormal and inconsistent with eBay guidelines for communication in Best Offer bargaining.” See BBLT, page 2 of the Online Appendix.

<sup>9</sup>Our two main findings carry over when considering  $S0 > \$1000$  instead.

<sup>10</sup>For the descriptive statistics before the restrictions are applied, see BBLT.

	Mean	St. Dev.	Min	Median	Max
Insistence ( $\alpha_1$ )	0.013	0.114	0	0	1
$B1/S0$	0.575	0.173	0	0.588	1.000
Days between $S0$ and $B1$	30.962	61.601	0.002	7.656	577.8
$B1$ within first 31 days	0.807	0.395	0	1	1
Seller experience	5,280	47,057	1	214	1,350,480
Insist. in other threads	0.013	0.060	0	0	1
Reference price index	0.139	0.304	-0.997	0.131	1.000
Reference price index $> 0$	0.716	0.451	0	1	1
No. parallel threads	0.384	0.976	0	0	35
No. photos	3.414	3.095	0	2	12
Agreement reached	0.320	0.467	0	0	1
Final price/reference ( $\beta$ )	1.370	11.506	0.002	0.984	3,400
No. alternating offers	2.463	0.885	2	2	6

Table 1: This table presents summary statistics for our dataset, which has 6,704,668 observations after applying the restrictions we describe in the main body, and in more detail in the Appendix. Note that Insist. in other threads is missing for 514,389 observations, Reference price index and Reference price index  $> 0$  are missing for 6,117,121 observations, and Final price/reference ( $\beta$ ) is missing for 6,547,823 observations.

the visual findings of the tables is that we can control for the other variables that may be playing a simultaneous key role; in fact, for each set of variables in Section 3 and Section 4 we run both regressions considering each variable separately as well as putting them all together in one regression. Note that the probability of insistence is defined, conditional on the restrictions, as the number of threads with  $S1 = S0$  over the number of threads that reach  $S1$  (regardless of the value of the counteroffer  $S1$ ).

### 3 Before $S1$

In this section, we analyze how the emergence of insistence is associated with observables that realize *before* insistence may emerge (before the counteroffer

$S1$ ). In particular; we analyze the buyer’s actions (size and timing of  $B1$ ) in Section 3.1, the seller’s observable features and actions (experience, stickiness of insistence across threads, and size of  $S0$  relatively to a reference price) in Section 3.2, and the item’s features (its category and condition, with how many other buyers the item is simultaneously being bargained over, and the number of photos) in Section 3.3. In Section 3.4, we run Shapley Value regressions for all variables considered in Section 3 in order to find the best predictors of insistence.

### 3.1 Buyer’s action

**The initial counteroffer of the buyer,  $B1$ .** Here, we analyze how insistence is associated with the initial counteroffer of the buyer,  $B1$ . Figure 1 shows the probability of insistence (the probability of  $\alpha_1 = 1$  as opposed to  $\alpha_1 = 0$ ) as a function of  $B1/S0$ . We bin observations of  $B1/S0$  by intervals of length .01.<sup>11</sup>

The plot is U-shaped; the seller is more likely to behave insistently in her choice of  $S1$  when the buyer’s counteroffer  $B1$  is either close to \$0 or to the seller’s initial asking price  $S0$ . Instead, when the buyer’s counteroffer is close to the split-the-difference one, the seller typically concedes on her choice of  $S1$  rather than behaving insistently. BBLT find, in Section V.A, that the more a bargaining party concedes in period  $t - 1$ , the more her opponent will concede in period  $t$ .<sup>12</sup> Figure 1 shows that, when focusing only on full insistence (no concession at all), a monotonicity similar to that found in BBLT holds for sufficiently tough counteroffers (low  $B1/S0$ ), but it reverses for sufficiently lenient counteroffers (high  $B1/S0$ ).

The first column of Table 2 shows the results of regressing the probability of insistence on the initial offer  $B1/S0$ , with a squared term. All regressions

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<sup>11</sup>There are three threads where  $B1/S0 = 0$  and we bin them together with the 2,472 other threads in the  $[0, .01]$  bin. There is no observation with  $B1/S0 = 1$ .

<sup>12</sup>BBLT formally define the concession  $\gamma_t$  in period  $t$  as the  $\gamma_t$  such that  $p_t = \gamma_t p_{t-1} + (1 - \gamma_t) p_{t-2}$ , where  $p_t$  is the offer at period  $t$ . The only time BBLT talk about “stubbornness” is to mention lower values of  $\gamma_t$  in the interval  $[0, 1]$ : “the opponent responds to stubbornness by not conceding and to concession by reciprocating with more concession.”

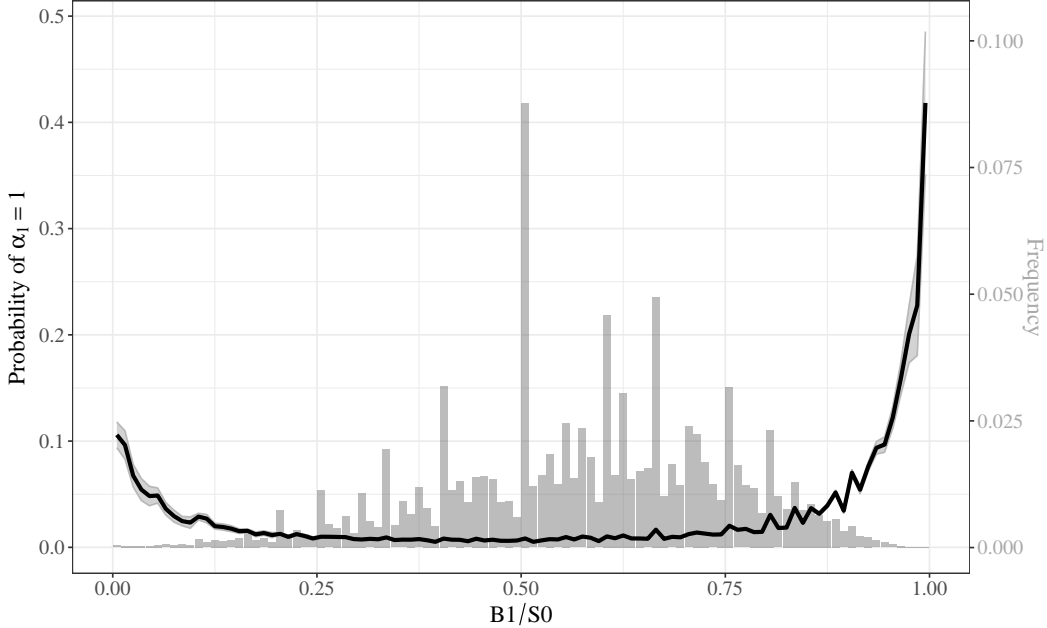


Figure 1: Probability of  $\alpha_1 = 1$  (as opposed to  $\alpha_1 = 0$ ) as a function of  $B1/S0$ , with bin-wise 95% confidence intervals. The scale for the histogram is on the right.

throughout the paper include condition and leaf category fixed effects.<sup>13</sup> The regression confirms that insistence and  $B1/S0$  are related in a U-shaped manner.

The U-shaped pattern of Figure 1 is robust to removing the top and bottom 5%, to considering the more demanding definition of insistence  $S0 = S1 = S2$ , to focusing on items with  $S0 > 1000\$$  (rather than  $S0 \leq \$1000$ ), and to dividing the sample into observations where  $B1$  was offered along with a message and without a message.<sup>14</sup>

The importance of the first counteroffer of the buyer is stressed and experimentally investigated by Engler and Page (2021). Despite the setup being

<sup>13</sup>“Leaf category” is defined, as in BBLT, at the finest category level available in the eBay data.

<sup>14</sup>This provides suggestive evidence that buyers do not send “fake offers”—e.g., with particularly low  $B1/S0$ —just to ask a question to the seller. For a thorough analysis of the role of messages and their contents, see Backus et al. (2021). The BBLT dataset does not contain the content of the messages.

structurally different than ours,<sup>15</sup> they also observe that “the first offer has a substantial effect on the bargaining outcome”. They also find that, in “a substantial number of cases, the Responder chooses a “punishing” counter-offer which is lower than what he believes is the Proposer’s minimum acceptable amount”. This is in line with insistence as a response to tough counteroffers (low  $B1/S0$ ), which we observe in the BBLT dataset.<sup>16</sup> An alternative explanation is that tough counteroffers are perceived as disrespectful and “pride-wounding”, and hence trigger a seller’s insistence (see Straub and Murnighan, 1995; Yamagishi et al., 2012). On the other hand, one way to interpret our results for sufficiently lenient counteroffers (high  $B1/S0$ ) is that they are a seller’s attempt to extract as much rent as possible from an apparently soft bargainer.

In a related paper, Green and Plunkett (2021) also use the dataset from BBLT. They train and characterize the optimal behavior of a reinforcement learning agent to optimally bargain on the BBLT eBay dataset. Their reinforcement learning sellers sell more items for higher prices than human sellers. The importance of the level of  $B1$  emerges from their analysis and from ours. For instance, they find that reinforcement learning sellers react particularly harshly when receiving generous counteroffers  $B1$ . This happens because such generous offers signal high willingness to pay by the buyer. Relatedly, we find that particularly generous counteroffers  $B1$  are the contingencies where insistence emerges more often. From the viewpoint of reinforcement learning buyers, Green and Plunkett find that a particularly simple strategy is nearly-optimal: offer  $B1 = (2/3)S0$  and accept any subsequent  $S1$ . Such strategy keeps the buyer far away from the region of  $B1$  for which the seller is likely to react with insistence. In words, the reinforcement-learning buyer seems to understand the convenience of avoiding to trigger insistence by the seller.<sup>17</sup>

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<sup>15</sup>Rather than a seller and a buyer bargaining over an item, their setup has two stages where two players may agree on how to share a fixed pie; a Proposer makes a sharing proposal to a Responder, who either accepts or makes a counteroffer. If the counteroffer is rejected, players earn nothing.

<sup>16</sup>About the empirical importance of first offers, see also Goldreich and Pomorski (2011).

<sup>17</sup>For evidence about changes in human strategic behavior when interacting with computer players see March (2021).

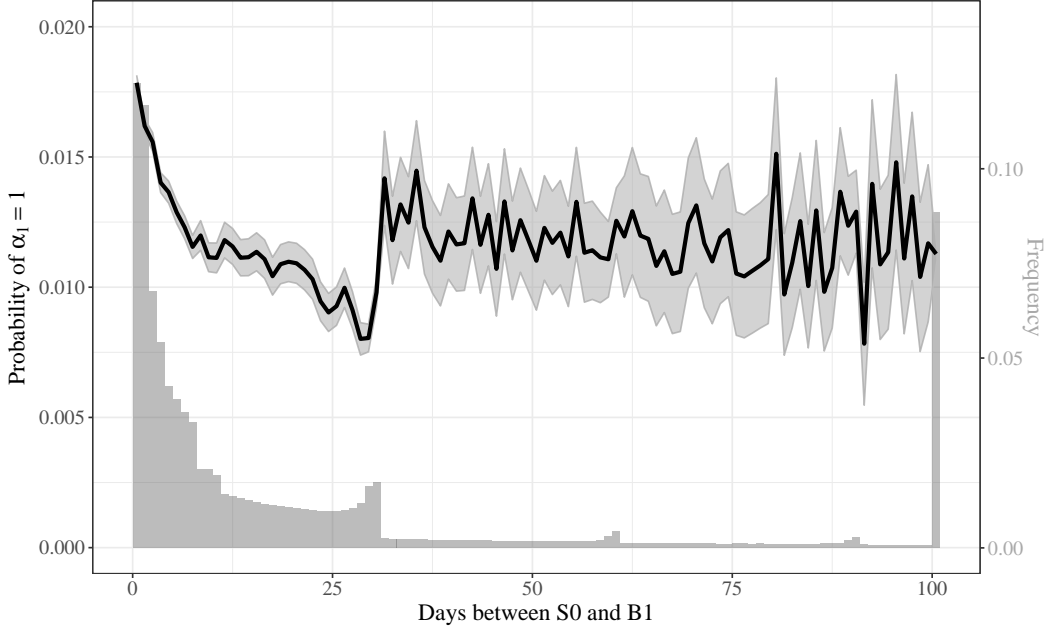


Figure 2: Probability of  $\alpha_1 = 1$  (as opposed to  $\alpha_1 = 0$ ) as a function of the time between  $S_0$  and  $B_1$ , with bin-wise 95% confidence intervals. The scale for the histogram is on the right.

**Days between  $S_0$  and  $B_1$ .** Figure 2 shows the probability of insistence as a function of the time that passes between  $S_0$  and  $B_1$ . We bin observations on the horizontal axis by days.

Figure 2 displays a decreasing trend if we focus on buyers responding to the seller’s asking price within a month (which accounts for roughly 80% of the observations), as intuition would suggest. If a seller posts an item and immediately receives a counteroffer, the item is likely to be high in demand and thus the seller may try an insistent strategy in an attempt to obtain a more favorable final price. If instead the buyer’s counteroffer comes later in time, the seller is less likely to behave insistently.<sup>18</sup> This finding and interpretation is in line with: (1) the behavior of Green and Plunkett (2021)’s reinforcement learning sellers, who understand that if the first offer  $B_1$  arrives particularly

<sup>18</sup>In a similar way, we also analyzed the time between  $B_1$  and  $S_1$  and found a positive trend.

early, then chances are that other buyers will arrive soon and, in turn, that the item can sell at a price more favorable for the seller, and (2) the idea that bargainers adopt strategic time delays in order to signal their relative strength (e.g., Admati and Perry, 1987; or Cramton, 1992).

The downward trend of Figure 2 is only clear in the first month and the plot becomes highly noisy after the first month.<sup>19</sup> This should be interpreted in the light of the histogram in Figure 2; most offers  $B1$  arrive within the first 10 days, there is a mild spike before the end of the first (and every) month, and a sudden drop right at the end of the first (and every) month. To interpret these drops, note that some eBay accounts for sellers include a fixed number of free listings per month;<sup>20</sup> if an item does not receive an offer within the first month, the seller may consider not renewing the free listing slot for that item for another month and rather take the item down and allocate the free listing slot to another item. This suggests a possible explanation for the decrease in the number of observations and the increase in the noise after a month, as clear in Figure 2.<sup>21</sup>

The second column of Table 2 shows the results of regressing the probability of insistence on the time of the first offer, a dummy that takes value 1 if the offer comes within the first 31 days, and their interaction. The regression confirms the main lesson of Figure 2; the time of the first offer  $B1$  is negatively associated with insistence in the first month.

### 3.2 Seller’s features and actions

**Experience.** Following BBLT, we measure a seller’s experience by the number of her prior best-offer listings. Figure 3 shows probability of insistence

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<sup>19</sup>Beyond 100 days the data is also highly noisy. The last bin at day 100 contains all observations after 100 days.

<sup>20</sup>See eBay (2021).

<sup>21</sup>Right before the sharp decrease, the histogram has a mild spike at the end of the month; one possible explanation is that buyers anticipate that sellers are “running out of time” for their items and hence attempt to exploit this bargaining power by making an offer  $B1$ . An alternative explanation is that buyers make an offer  $B1$  close to the end of the month as they are afraid of missing the item if the seller reallocates the free listing slot to another item.

	Insistence ( $\alpha_1$ )		
	(1)	(2)	(3)
$B1/S0$	-9.683** (0.0952)		-9.647** (0.0955)
$(B1/S0)^2$	10.39** (0.0867)		10.33** (0.0868)
Days between $S0$ and $B1$		0.0002* (0.0001)	0.0003** (0.0001)
$B1$ within first 31 days		0.1631** (0.0169)	0.0302 (0.0170)
(Days between $S0$ and $B1$ ) $\times$ ( $B1$ within first 31 days)		-0.0175** (0.0006)	-0.0110** (0.0006)
Category fixed effects	Yes	Yes	Yes
Condition fixed effects	Yes	Yes	Yes
Pseudo $R^2$	0.05554	0.02785	0.05618
Observations	4,839,398	4,839,398	4,839,398

Table 2: Outcome of regressions of insistence ( $\alpha_1$ ) on buyer’s actions. All regressions include leaf category and condition fixed effects. Heteroskedasticity-robust standard errors are in parentheses. \*= $p < .05$ , \*\*= $p < .01$ .

as a function of experience.<sup>22</sup> We find that insistent sellers are typically inexperienced; 1.88% of sellers with below-median-experience are insistent, and only 0.75% of sellers with above-median-experience are insistent.<sup>23</sup> This is in line with the downward trend of Figure 3. The first column of Table 3 shows the results of regressing insistence on experience. Insistence is negatively and significantly associated with experience.

Note that BBLT document that more experienced sellers concede less on the price in nearly every round of the game. Hence, they result, together with

<sup>22</sup>We plot experience in logarithmic scale as the distribution of the number of prior best-offer listings by the seller is particularly skewed: for instance, the maximum is 1.35 million and many sellers have thousands of listings.

<sup>23</sup>We compute the median experience out of all the bargaining threads, not out of all the sellers. The median experience is 214.

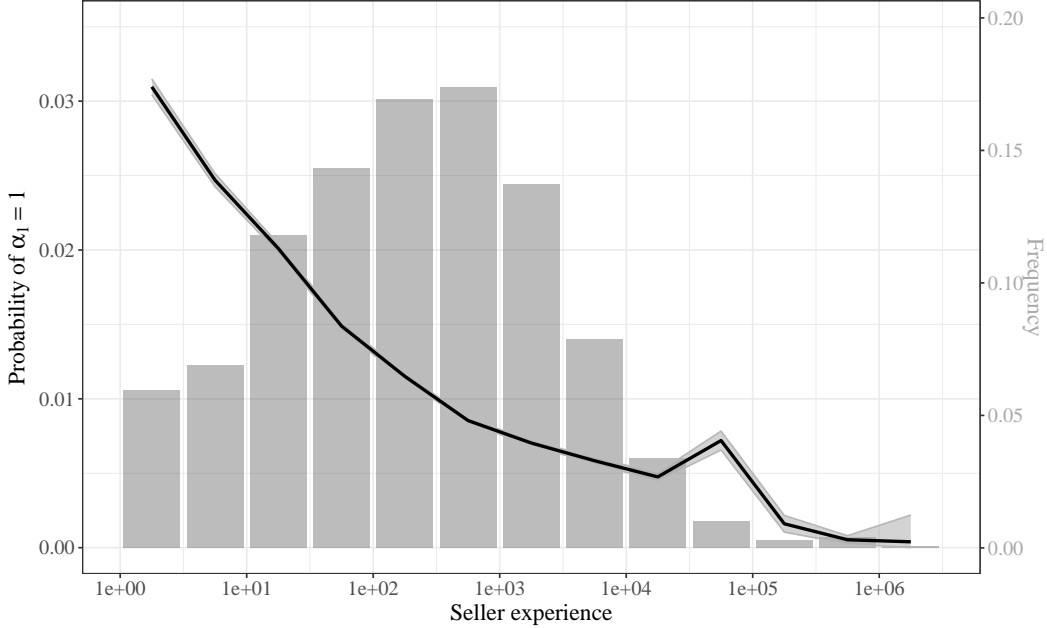


Figure 3: Probability of  $\alpha_1 = 1$  (as opposed to  $\alpha_1 = 0$ ) as a function of experience, measured by the logarithm of the number of prior best-offer listings by the seller, with bin-wise 95% confidence intervals. The scale for the histogram is on the right.

our finding on insistence (or “no concession at all”) being negatively associated with experience, shows that the experienced sellers tend to choose intermediate levels of concessions, rather than generous concessions or no concessions. This is in line with the reinforcement learning agents trained in Green and Plunkett (2021) on the BBLT dataset.

**Sellers’ stickiness of insistence.** We investigate whether the same sellers are repeatedly insistent across threads. Figure 4 shows the probability of insistence of a given seller as a function of the probability of insistence of the same seller in other threads that occurred before the thread under scrutiny.<sup>24</sup> The horizontal axis has 100 bins. The vast majority of threads has a very low probability of insistence of the same seller in other threads, hence the left part

<sup>24</sup>If we consider the seller’s insistence in all other threads, before and after the thread under scrutiny, the results are qualitatively similar.

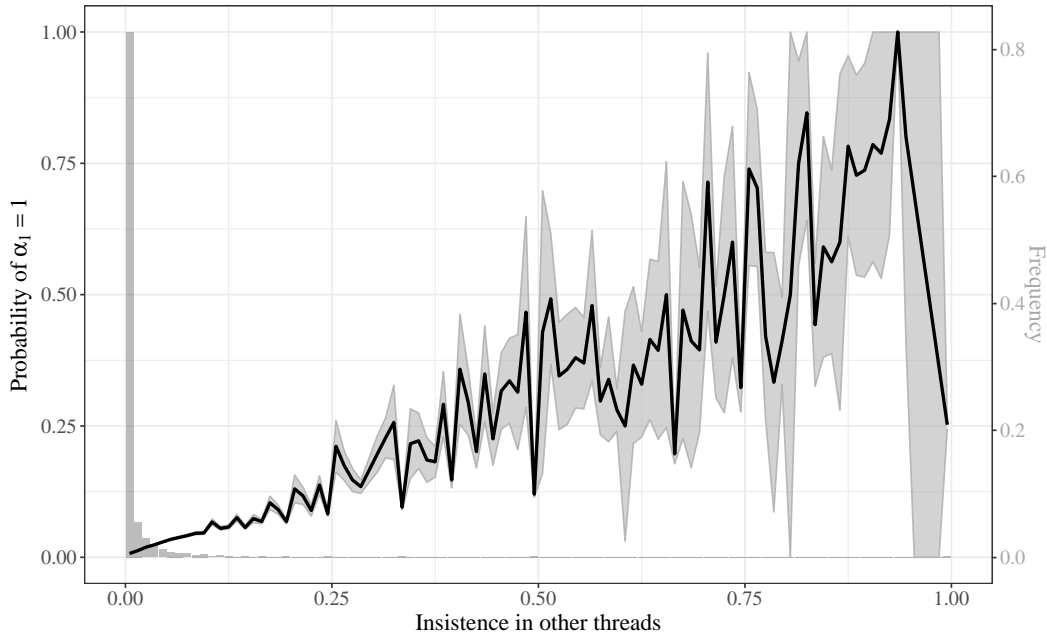


Figure 4: Probability of  $\alpha_1 = 1$  (as opposed to  $\alpha_1 = 0$ ) as a function of the probability of  $\alpha_1 = 1$  (as opposed to  $\alpha_1 = 0$ ) by the same seller in other threads that occurred before the thread under scrutiny, with bin-wise 95% confidence intervals. The scale for the histogram is on the right.

of Figure 4 is less noisy and more salient;<sup>25</sup> this is in line with the fact that most sellers are never insistent. What emerges is an increasing trend; a seller who has been more insistent in other threads is more likely to be insistent in the thread being analyzed too. This provides evidence of stickiness of insistence. Several theoretical works model insistence as a fully sticky behavioral type, such as the seminal contributions by Kreps (1990), Myerson (1991) and Abreu and Gul (2000). Other works model insistence as sticky with some probability,

<sup>25</sup>Clearly, the noise increases for higher values; for instance, in order to be in the bin  $[0.84, 0.85]$  there must be a relatively high number of observations for the same seller. In the right-most bin, where the seller displayed insistence in all her earlier threads, we observe a different stickiness. The reason is that it is sufficient to have only one previous observation for a seller to be in that bin. Thus, the average number of threads per seller drastically drops at 1. If, for instance, we were to focus only on sellers with at least five previous threads, the drop at the right-most bin would roughly half. Note that the drop seems to occur even before the right-most bin, but that is because there are no observations between 0.95 and 0.99, as the number of threads necessary to be in one of these bins is very high.

such as Kambe (1999) where players, after their initial demands are chosen, become committed to them with some exogenous probability, or Wolitzky (2012), where players have some exogenous probability of becoming committed to the (possibly non-stationary) bargaining strategy they announce.

The second column of Table 3 shows the results of regressing insistence on insistence in other threads. The regression confirms that insistence is positively associated with insistence by the same seller in other (preceding) threads.

**Reference price.** We do not observe the true value of the item. However, BBLT build a reference price for items, by pairing them to the average Buy-It-Now price for all listings of the item sold without the bargaining mechanism enabled on eBay. Such pairing is often not available and the number of observations reduces to 587,547 threads (see also Table 1). The reference price provides a useful proxy to distinguish between over- and underpriced items; a high  $S0$  with respect to the reference price is an indicator of a possibly overpriced item.

In Figure 5, we show the probability of insistence as a function of a reference price index, defined as

$$\frac{S0 - RefPrice}{\max\{S0, RefPrice\}}, \quad (1)$$

where  $RefPrice$  is the reference price provided by BBLT. This reference price index has the convenient property of symmetry around 0.

There seems to be a different pattern between over- and underpriced items (when  $S0$  is respectively greater or smaller than the reference price). In particular, if  $S0$  is below the reference price, the probability of insistence is on average 2.5%, while above it is 1.8%. In words, sellers who underpriced the item when choosing  $S0$  are more likely to be insistent in the subsequent period (their initial  $S0$  was already “lenient”) and to stick to  $S0$  insistently, rather than if her initial  $S0$  is “tough”.<sup>26</sup>

The third column of Table 3 shows the results of regressing insistence on the reference price index (1). The regression confirms that insistence is negatively

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<sup>26</sup>For values of  $S0$  lower than the reference price, the plot is significantly more noisy as there are fewer observations, as can be seen in the histogram in Figure 5.

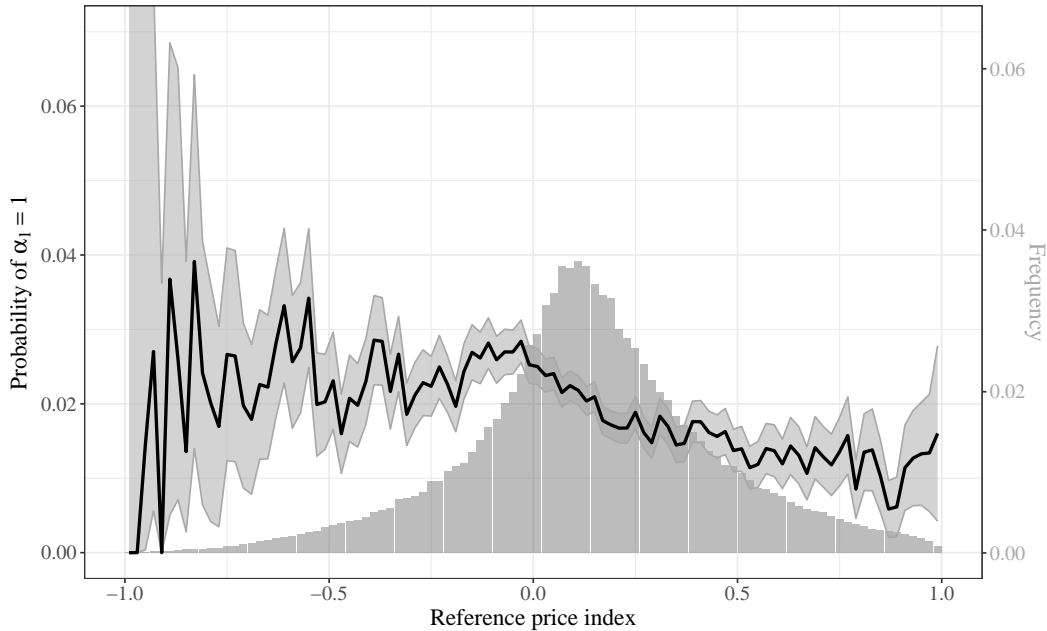


Figure 5: Probability of  $\alpha_1 = 1$  (as opposed to  $\alpha_1 = 0$ ) as a function of the reference price index (1), with bin-wise 95% confidence intervals. The scale for the histogram is on the right.

associated with the dummy for overpriced items and its interaction with the reference price. Insistence is greater when the item’s asking price is below the reference price, and it decreases with reference price when the item is overpriced.

### 3.3 Item’s features

**Category and condition of the item.** We analyze whether insistence is more likely for some categories of the item for sale than for others. Figure 6 shows the probability of insistence by category and suggests that sellers are more insistent when selling items which have more “objective values”; for instance, for tickets & experiences and gift card & coupons the value of the item is typically standardized, while for cell phones, computers and consoles the high commonness of the item makes prices more well-established and less

	Insistence ( $\alpha_1$ )			
	(1)	(2)	(3)	(4)
log(Seller experience)	-0.1972** (0.0017)			-0.0845** (0.0050)
Insist. in other threads		4.274** (0.0208)		3.868** (0.0465)
Ref. price index > 0			-0.2477** (0.0309)	-0.2453** (0.0359)
Ref. price index			-0.1169 (0.0917)	-0.1807 (0.1059)
(Ref. price index > 0) $\times$ (Ref. price index)			-0.4494** (0.1154)	-0.3037* (0.1330)
Category fixed effects	Yes	Yes	Yes	Yes
Condition fixed effects	Yes	Yes	Yes	Yes
Pseudo R <sup>2</sup>	0.04500	0.07707	0.01727	0.09085
Observations	4,839,398	4,402,725	577,904	509,313

Table 3: Outcome of regressions of insistence ( $\alpha_1$ ) on sellers’s features and actions (experience is measured in natural logarithm of the number of prior best-offer listings by the seller). All regressions include leaf category and condition fixed effects. Heteroskedasticity-robust standard errors are in parentheses. \*= $p < .05$ , \*\*= $p < .01$ .

negotiable.<sup>27</sup> Conversely, sellers are typically less insistent when selling items with more variable and “subjective” value, such as stamps, coins, sports memorabilia cards, crafts, jewelry, music, and antiques.

We analyze whether insistence is more likely for some conditions of the item for sale (whether it is new, used, et cetera) than for others. Figure 7 shows the probability of insistence per condition of the item. It suggests that, for new items, sellers are less insistent than for used.

**Parallel bargaining threads.** It is well-known that the bargaining outcome could be heavily affected by the seller’s outside option (see, e.g., Shaked

<sup>27</sup>The category real estate contains only 28 observations, while the average number of observations in all categories but real estate is 203,171.

Figure 6: Probability of  $\alpha_1 = 1$  (as opposed to  $\alpha_1 = 0$ ) per category of the item, with bin-wise 95% confidence intervals.

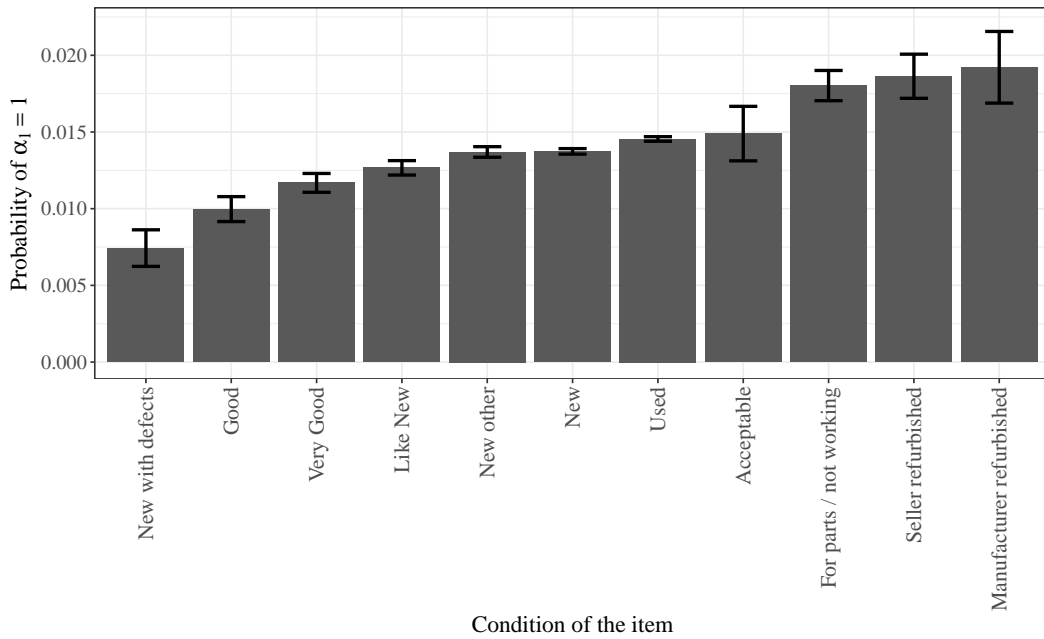
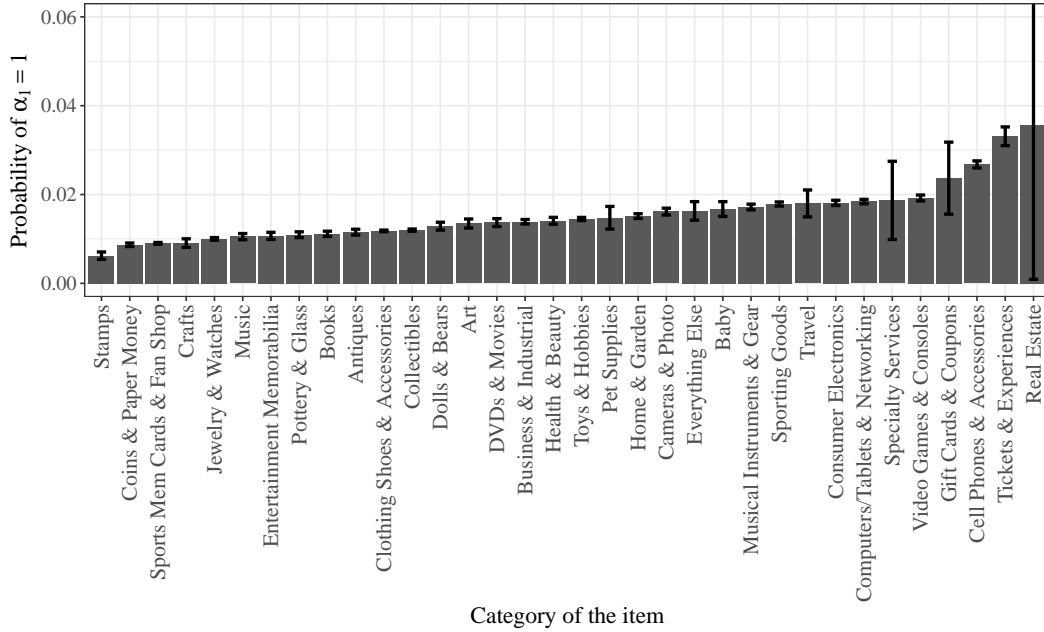


Figure 7: Probability of  $\alpha_1 = 1$  (as opposed to  $\alpha_1 = 0$ ) per condition of the item, with bin-wise 95% confidence intervals.

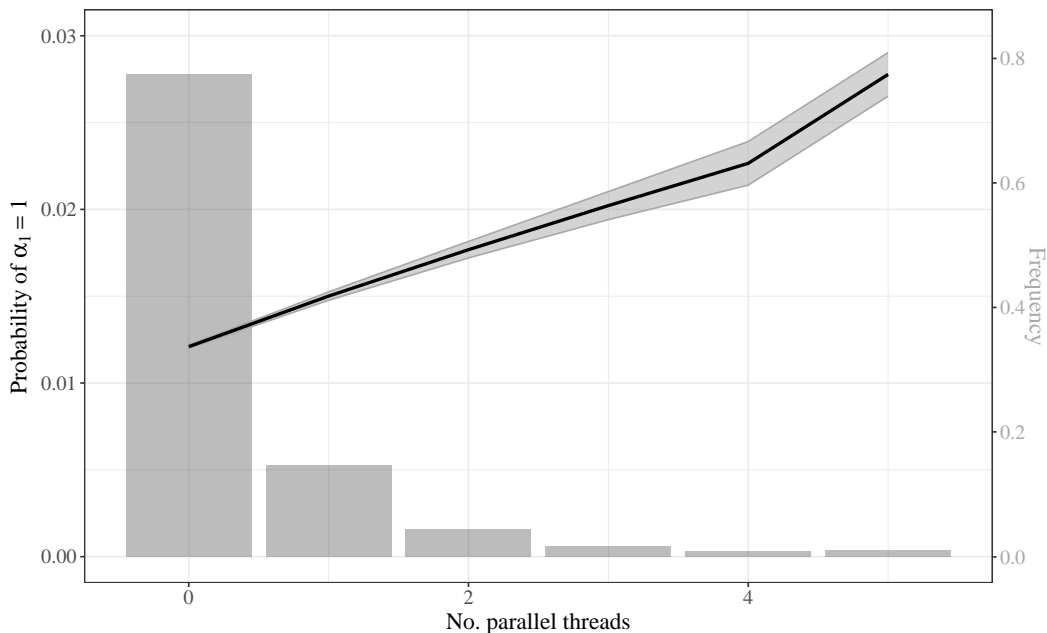


Figure 8: Probability of  $\alpha_1 = 1$  (as opposed to  $\alpha_1 = 0$ ) as a function of the number of parallel bargaining threads the seller is having with different buyers for the same item, with bin-wise 95% confidence intervals. The scale for the histogram is on the right.

and Sutton, 1984; Binmore, Shaked, and Sutton, 1989). The seller's outside option improves in case of multiple buyers negotiating with the same seller for the same item. Figure 8 shows the probability of insistence as a function of the number of parallel bargaining threads the seller is having with different buyers for the same item. Hence, a value of 0 can be interpreted as the worst outside option for the seller, who is bargaining with only one buyer. The value of 5 includes all the values greater than 5. Each bin has at least 3,176 observations.

The key emerging feature is an upward trend; a better outside option for the seller in terms of number of buyers she is simultaneously bargaining with increases the seller's possibility to extract more rent from the sale of the item, and insistence arises.<sup>28</sup> The first column of Table 4 shows the results of regressing insistence on the number of parallel bargaining threads. The

<sup>28</sup>For a model with endogenous behavioral types in a two-sided search market where the matching market serves as an endogenous outside option, see Atakan and Ekmekci (2014).

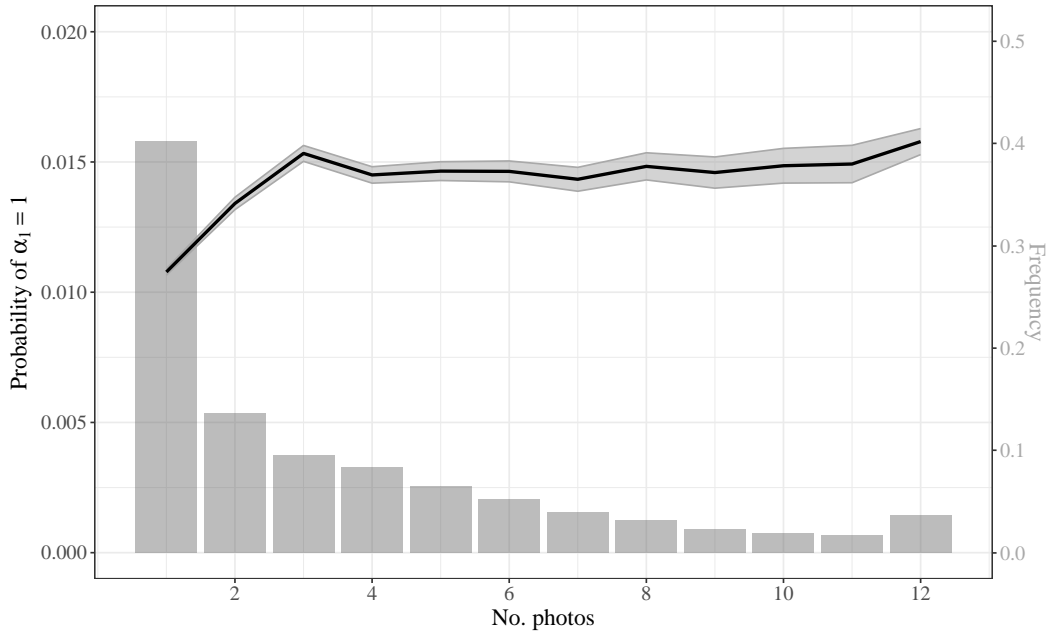


Figure 9: Probability of  $\alpha_1 = 1$  (as opposed to  $\alpha_1 = 0$ ) as a function of the number of posted photos, with bin-wise 95% confidence intervals. The scale for the histogram is on the right.

regression confirms that insistence is positively associated with the number of parallel bargaining threads.

In a related work, Backus et al. (2019) find that round values of  $S_0$  (multiples of \$50 or \$100) are looked at more by potential buyers and receive more offers. This, together with Figure 8 and the first column of Table 4, implies a better outside option for the seller who thus reacts with more insistence. In fact, we also find that insistence is more likely for round values of  $S_0$ .

**Photos and adverse selection.** The number of photos included in a listing is a measure of the amount of information about the item’s quality disclosed by the seller—a proxy for the reduced severity of adverse selection (see Lewis, 2011; BBLT). Figure 9 shows the probability of insistence as a function of the number of posted photos, for items with at least one photo. We find that an increase in the number of photos, especially when this number is low, is associated with an increase in the seller’s insistence; this suggests that

	Insistence ( $\alpha_1$ )		
	(1)	(2)	(3)
No. parallel threads	0.0570** (0.0030)		0.0559** (0.0031)
log(No. photos)		0.1114** (0.0050)	0.1091** (0.0050)
Category fixed effects	Yes	Yes	Yes
Condition fixed effects	Yes	Yes	Yes
Pseudo $R^2$	0.02687	0.02731	0.02772
Observations	4,839,398	4,720,679	4,720,679

Table 4: Outcome of regressions of insistence ( $\alpha_1$ ) on the item’s features. We restrict our dataset to listings with at least one photo. All regressions include leaf category and condition fixed effects. Heteroskedasticity-robust standard errors are in parentheses. \*= $p < .05$ , \*\*= $p < .01$ .

sellers are less willing to make any concession on the price when there is less asymmetric information between buyer and seller.<sup>29</sup> In words, disclosing more information (photos) about the item “entitles” the seller to insist on  $S_0$ .

The second column of Table 4 shows the results of regressing insistence on the logarithm of the number of photos. The regression confirms that insistence is positively associated with the number of photos.

### 3.4 Comparison of predictive power of variables

Which of the variables we have considered above best predicts insistence? To answer this question, we run a Shapley Value regression (see, e.g. Lipovetsky, 2006). More precisely, we compute linear regressions using all possible combinations of the variables considered above in Section 3, with the pseudo  $R^2$  being computed for each such regression. Then, for each variable, we compute the improvement that is created when adding that variable to the model

<sup>29</sup>As BBLT, we focus on items with at least one photo.

and finally we average for each variable such average improvements, where we equally weight the regressions based on the number of possible models. Table 5 reports our results.<sup>30</sup>

The best predictor of insistence (corresponding to the highest Shapley Value in Table 5) is insistence in other threads.<sup>31</sup> This strengthens the evidence that insistence is sticky; a seller insistent in the past is more likely insistent in the future. This evidence is in line with the vast majority of the theoretical literature, which models insistence as a sticky behavioral feature of players (e.g., Kreps, 1990; Myerson, 1991; Abreu and Gul, 2000). The second best predictor of insistence (the second-highest Shapley Value in Table 5) is  $B1/S0$ . This, together with Figure 1 and Table 2, strengthens the evidence that a seller is more likely insistent if the buyer has been particularly lenient or tough in her counteroffer. The importance of  $B1/S0$  as determinant of insistence that we document (see Section 3.1 for details) is reminiscent of first-period concession as a determinant of second-period concession documented by BBLT (see their Section V.A).

## 4 After S1

In this section, we analyze how insistence is associated with observables that realize *after* the potential occurrence of insistence (after counteroffer  $S1$ ). For each of the three outcome variables we consider—probability of reaching an agreement, final price agreed on, and number of alternating offers—, we first report its average value with and without insistence. Then, we restrict our dataset to tough counteroffers (values of  $(S1 - B1)/(S0 - B1)$  sufficiently close to 1) and run regressions to check whether insistence ( $\alpha_1 = 1$ , or equivalently,  $(S1 - B1)/(S0 - B1) = 1$ ) predicts the outcome variable beyond what tough counteroffers in general do. Formally, we narrow our attention to the

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<sup>30</sup>Our results are confirmed by the alternative method of running a regression with all variables that realize before  $S1$  and then check which one reduces the pseudo  $R^2$  the most when omitted from the regression.

<sup>31</sup>The Shapley Value approach reduces the number of threads to 417,608 because not all variables are defined for all observations.

	Shapley
$B1/S0$	0.01525
$B1$ within first 31 days:	0.00050
$\log(\text{Experience})$ :	0.00800
Reference price index:	0.00305
Insistence in other threads:	0.06839
Category of the item:	0.00789
Condition of the item:	0.00127
No. parallel threads:	0.00067
$\log(\text{No. photos})$ :	0.00003

Table 5: Shapley Value regression.

window  $(S1 - B1)/(S0 - B1) \in [.8, 1]$  and regress the outcome variable on insistence ( $\alpha_1$ ) within this restricted dataset.<sup>32</sup> In addition to using category and condition fixed effects, we control for all the variables we considered in the previous sections (“Before  $S1$  Controls” in Table 6): buyer’s actions, seller’s features and actions, and the item’s features.

**Probability of reaching an agreement.** We analyze whether insistence is associated with a higher or lower probability of reaching an agreement. We find that 9.6% of threads displaying insistence end up in agreement, while this value becomes 32.3% when considering threads *not* displaying insistence (see panel (a) of Figure 10).<sup>33</sup> Hence, insistence is negatively associated with the agreement probability.

The first column of Table 6 shows the linear regressions on the window  $(S1 - B1)/(S0 - B1) \in [.8, 1]$  of the probability of reaching an agreement on insistence. Insistence is negatively and significantly associated with the probability of agreement; that is, being insistent, rather than being “tough” more generally in the counteroffer  $S1$ , is associated with a lower probability

<sup>32</sup>All the results are robust to considering any alternative window  $[x, 1]$ , with  $x \in [.7, .9]$ .

<sup>33</sup>These numbers are based on 88,150 observations and 6,616,518 observations, respectively.

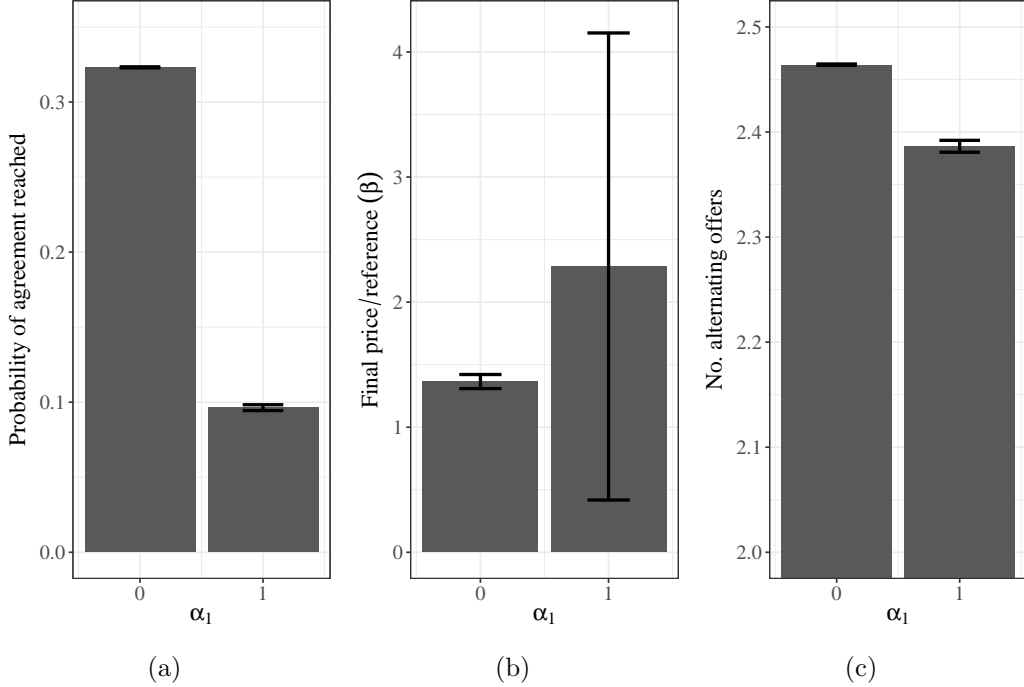


Figure 10: (a) Probability of agreement reached (b) Average value of the normalized final price ( $\beta$ ) (c) Average number of alternating offers of the thread; when  $\alpha_1 = 0$  or 1, and including corresponding 95%-confidence intervals.

of agreement. This evidence is in line with the above-documented (see panel (a) of Figure 10) lower probability of agreement under insistence than under  $\alpha_1 = 0$ .

**Final price.** We analyze how and whether the final price agreed on is associated with insistence. Here, as in BBLT, we define a normalized final price,

$$\beta = \frac{FinalPrice}{RefPrice} \in [0, 1].$$

Hence, high (low) values of  $\beta$  denote a good deal for the seller (buyer) in terms of final price agreed on. First, the average  $\beta$  is approximately 1.365 when  $\alpha_1 = 0$  and 2.284 when  $\alpha_1 = 1$  (see panel (b) of Figure 10). Nevertheless, the relation between final price and insistence is found to be not significant (see the confidence intervals in panel (b) of Figure 10 and the regression result in the second column of Table 6), the reason likely being the small sample size

	Agreement reached (1) Logit	Final price/ reference ( $\beta$ ) (2) OLS	No. alternating offers (3) OLS
Insistence ( $\alpha_1$ )	-1.008** (0.0553)	1.561 (1.152)	-0.0936** (0.0125)
Category fixed effects	Yes	Yes	Yes
Condition fixed effects	Yes	Yes	Yes
Before $S1$ fixed effects	Yes	Yes	Yes
$R^2$		0.22208	0.01103
Pseudo $R^2$	0.13563	0.03543	0.00375
Observations	99,595	8,387	100,388

Table 6: Outcome of regressions of the probability of agreement, the normalized price and the number of alternating offers on insistence ( $\alpha_1$ ). Regressions are on the window  $(S1 - B1)/(S0 - B1) \in [.8, 1]$ . All regressions include leaf category and condition fixed effects, as well as before  $S1$  controls. Heteroskedasticity-robust standard errors are in parentheses. \*= $p < .05$ , \*\*= $p < .01$ .

due to the limited availability of a reference price for items: in fact, for  $\alpha_1 = 1$  there are only 790 observations.

**Number of alternating offers.** We analyze the effects of insistence on the number of alternating offers, which is defined as follows. A value of 2 corresponds to the thread ending at  $S1$ . A value of 3 corresponds to the thread ending at  $B2$ , of 4 at  $S2$ , and so on. We find that, if  $\alpha_1 = 1$ , the average number of alternating offers is 2.39, while if  $\alpha_1 = 0$ , it is 2.46, as can be seen in panel (c) of Figure 10. The regression presented in the third column of Table 6 supports the result that insistence is associated with a lower number of alternating offers.

The typical complete information model of bilateral bargaining predicts immediate agreement or disagreement. Nevertheless, adding to such a standard model some degree of private information on insistence typically causes

inefficient delays in equilibrium—as found by, for instance, Abreu and Gul (2000), Abreu and Sethi (2003), and Sanktjohanser (2020).<sup>34</sup> As documented by BBLT, immediate agreement occurs in just a third of the cases. Additionally, the fact that an active display of insistence reduces the number of alternating offers (see panel (c) of Figure 10 and the third column of the regression in Table 6) is consistent with the typical belief updating dynamics which is common to models with insistent types. In particular, the more a party is certain that her rival is of a insistent type, the less profitable she will find it to participate in costly haggling, and the earlier she accepts or rejects the offer of her likely-insistent rival. For instance, Sanktjohanser (2020), in her model with endogenous stubborn types, finds the following: “A rational player is willing to wait to concede as long as he is uncertain about the opponent’s type. Yet, once the player is certain he is facing a stubborn opponent, he strictly prefers to concede.” This is a core feature of most reputational bargaining models, dating back to Myerson (1991) and Abreu and Gul (2000).

## 5 Discussion

We make use of the uniquely rich dataset of Backus, Blake, Larsen, and Tadelis (2020) from the US eBay Best Offer platform to study the emergence of insistence in bilateral bargaining between sellers and buyers. Calling  $S_0$  the seller’s asking price,  $B_1$  the buyer’s counteroffer, and  $S_1$  the seller’s counteroffer to  $B_1$ , we find that insistence (defined as  $S_1 = S_0$ ) is positively associated with: (1)  $B_1$  being close to \$0 or  $S_0$ , (2) the seller’s lack of experience, (3) the time-span between  $S_0$  and  $B_1$  being short, (4) insistence by the same seller in other (preceding) threads with other buyers, (5) the initial  $S_0$  being low as opposed to a reference price for that item, (6) the selling item having “objective” value,

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<sup>34</sup>Alternatively, one could rationalize delays by adding to the typical complete information model of bilateral bargaining some degree of private information about strength or valuation, rather than about insistence. In models with endogenous time between offers, if information is complete, then delays to agreement typically do not arise (e.g., McLennan, 1986), whereas if it is incomplete, delays often arise as bargainers strategically delay offers in order to signal their relative strength (e.g., Admati and Perry, 1987; or Cramton, 1992).

(7) the item being used rather than new, (8) the number of parallel bargaining threads with other buyers bargaining for the same item, and (9) the number of photos posted for the item. Focusing, in particular, on the two best predictors of insistence, we find evidence that insistence is sticky—as a seller insistent in the past is more likely insistent in the future—and a seller is more likely insistent if the buyer has been particularly lenient or tough in her counteroffer. Stickiness of insistence is a feature already present in many theoretical models of insistence. However, the second result on the nature of insistence (i.e., a seller is more likely insistent if the buyer has been particularly lenient or tough in her counteroffer) suggests a gap in the theoretical literature on insistence; we are not aware of any model that makes such predictions. The next natural step is hence to develop a theory that could offer guidance to interpret our result on seller’s insistence and particularly lenient or tough buyer’s counteroffer. Complementary empirical works may provide a solid starting point to develop such a theory. For instance, Engler and Page (2021) observe that, in “a substantial number of cases, the Responder chooses a “punishing” counter-offer which is lower than what he believes is the Proposer’s minimum acceptable amount”, and Straub and Murnighan (1995) and Yamagishi et al. (2012) observe that tough counteroffers trigger a seller’s insistence as they are often perceived as disrespectful and “pride-wounding”.

Our analysis is, to the best of our knowledge, the first empirical investigation of the emergence of insistence in the field. As a first cut, we adopted a number of simplifying assumptions which call for future research to further the empirical analysis of insistence. First, we potentially pooled together several different behaviors and label them all “insistence,” based solely on the observation of a seller insisting at least once on the asking price. However, what we defined as insistence could arise, for instance, from shamming stubbornness or “true” stubbornness. A seller shamming stubbornness in the first period may eventually find it optimal to later agree on a final price lower than  $S_0$ . A truly stubborn seller never agrees on anything lower than  $S_0$ . True stubbornness itself may be influenced by factors such as the timing since listing or presence of other buyers. Second, we focused for simplicity on the *first-period* insistence

( $S0 = S1$ ) in order to capture the main insights. Focusing on the first-period insistence allowed us to make the first cut into the empirical analysis of the emergence of insistence while abstracting away from higher order analysis—such as understanding the effect of the *entire* sequence of offers on insistence in *each* period.<sup>35</sup> Relaxing this restriction may open up interesting avenues for future research.

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<sup>35</sup>Our two main findings carry over to the more demanding definition of insistence  $S0 = S1 = S2$ .

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## 6 Appendix: dataset restrictions

The original sample of BBLT has 98,307,281 Best Offer listings. For 78,760,973 of those listings, there are no matching threads. We first apply the seven restrictions as in BBLT (see their online Appendix): restrictions L1-2 on listing attributes and T1-5 on thread attributes. These restrictions are applied on the listings level; as explained by BBLT, “even if the sample restriction pertains to characteristics of an offer, we removed all listing that are associated with any offer that violates the restriction.” For each restriction, we specify the non-exclusive number of listings that violate the restriction in the original dataset:

L1  $S_0 \leq 1000$ : 9,547,987

L2 The final price agreed on is smaller than  $S_0$ : 42,524

T1 All offers at or below  $S_0$ : 386,096

T2 Neither the buyer nor the seller makes more than three offers: 3,537

T3 For all offers with a status of “countered,” a counteroffer exists in the dataset: 1,453

T4 For all offers accepted, there are no subsequent offers in the thread: 1,112.

T5 Duplicated time stamps:<sup>36</sup> 5,656

After restrictions L1-2 and T1-5, we are left with 18,213,642 listings. Besides the above restrictions, we apply a number of additional restrictions on the listing level: N1-4.

N1 Status is agreed but there is no item price: 669

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<sup>36</sup>Under restriction T5 no more than one offer arrives at the exact same time by the same buyer for the same item.

N2 Response time is too short or too long:<sup>37</sup> 5,912

N3 Monotonicity (offers are between the two previous offers): 212,470

N4 Same offer by parties, but the thread continues: 22,392

So far, all restrictions have been applied at the listing level, and they leave a total of 24,856,765 threads. At this point, the last step is to apply, on the thread level, the restrictions which are idiosyncratic to our analysis of insistence:

A1 Bargaining thread reaches at least  $S1$ : 14,394,014,

A2 Alternating thread: 3,758,083.

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<sup>37</sup>Despite counteroffers beyond  $B1$  being only allowed within 48 hours, we observe in some bargaining threads offers made at a later point. We also observe counteroffers happening before the offer. We rule these two cases out in N2, as these observations are likely to be dataset errors.