

Appendix A. Bargaining Sequence and Model Selection

The figure consists of six identical game trees arranged horizontally, each representing a step in a sequential bargaining process. Each tree starts with a node for the Buyer (B). An arrow labeled 'Initial offer made to Seller' points from the Buyer to a node for the Seller (S). From the Seller's node, there are two branches: an upward branch labeled 'Accept (A)' leading to a 'Sale' node, and a downward branch labeled 'Reject (R)' leading to a 'No Sale' node. If the offer is rejected, an arrow labeled 'Counter (C)' points from the Seller to a new Buyer node. This process repeats for the next three trees, showing the progression of offers and counteroffers. In the final tree, the counteroffer leads to a Buyer node that has no outgoing arrows, indicating the process ends with a 'No Sale' outcome.

Appendix B. Simulation Designs and Results

Design	Model	Note
1	$Y_i = \sum_{j=1}^5 X_{ij} + T_{i1} + T_{i2} + \zeta_i + \epsilon_i$	homogeneous effects
2	$Y_i = \sum_{j=1}^5 X_{ij} + T_{i1} + T_{i2} + \zeta_i + \epsilon_i$	$\epsilon_i \sim \text{Exp}(10)$
3	$Y_i = \sum_{j=1}^5 X_{ij} + T_{i1} + T_{i2} + \zeta_i + \epsilon_i$	$\epsilon_i \sim \text{Unif}(0, 1)$
4	$Y_i = \sum_{j=1}^5 X_{ij} + T_{i1} + T_{i2} + \zeta_i + \epsilon_i$	$X_{ij}, \zeta_i \sim \text{Norm}(0, 1)$
5	$Y_i = \sum_{j=1}^5 X_{ij} + 2 \times (X_{i4}) T_{i1} + 2 \times (X_{i4}) T_{i2} + \zeta_i + \epsilon_i$	heterogeneous effects
6	$Y_i = \sum_{j=1}^5 X_{ij} + (4 \times \mathbb{I}\{X_{i4} \leq 0\} - 2 \times \mathbb{I}\{X_{i4} > 0\}) T_{i1} + T_{i2} + \zeta_i + \epsilon_i$	X_{i4} interacts with T_{i1}
7	$Y_i = \sum_{j=1}^5 X_{ij} + (4 \times \mathbb{I}\{X_{i4} \leq 0\} - 2 \times \mathbb{I}\{X_{i4} > 0\}) T_{i1} + (4 \times \mathbb{I}\{X_{i4} \leq 0\} - 2 \times \mathbb{I}\{X_{i4} > 0\}) T_{i2} + \zeta_i + \epsilon_i$	X_{i4} interacts with T_{i1} and T_{i2}
8	$Y_i = \sum_{j=1}^5 X_{ij} + 2 \times (\mathbb{I}\{X_{i4} + X_{i5} \leq 1\} - \mathbb{I}\{X_{i4} + X_{i5} > 1\}) T_{i1} + T_{i2} + \zeta_i + \epsilon_i$	X_{i4} and X_{i5} interact with T_{i1}
9	$Y_i = \sum_{j=1}^5 X_{ij} + 2 \times (\mathbb{I}\{X_{i4} + X_{i5} \leq 1\} - \mathbb{I}\{X_{i4} + X_{i5} > 1\}) T_{i1} + 2 \times (\mathbb{I}\{X_{i4} + X_{i5} \leq 1\} - \mathbb{I}\{X_{i4} + X_{i5} > 1\}) T_{i2} + \zeta_i + \epsilon_i$	X_{i4} and X_{i5} interact with T_{i1} and T_{i2}

Note: This table summarizes the designs of the simulation study. Each design has a total of seven features. Irrelevant feature X_{10} does not appear in the models, because it does not affect the outcome or treatments. Unless specified otherwise in the Note column, we let $X_{i,j} \sim \text{Bern}(0.5)$, $\zeta_i \sim \text{Bern}(0.5)$, $\epsilon_i \sim \text{Norm}(0, 1)$, $\text{Corr}(Z_i, T_{i1}) = 0.6$, and $\text{Corr}(\zeta_i, T_{i1}) = 0.3$. More specifically, if $\text{Corr}(Z_i, T_{i1}) = \text{Corr}(Z_i, T_{i2})$ and $\rho_2 = \text{Corr}(\zeta_i, T_{i1})$, we construct the IV as $Z_i \sim \text{Norm}(0, 1)$, $T_{i1} \sim \rho_1 Z_i + 2 \times \rho_2 \zeta_i + \sqrt{1 - \rho_1^2 - \rho_2^2} \epsilon_i$ if $\zeta_i \sim \text{Bern}(0.5)$, $T_{i1} \sim \rho_1 Z_i + \rho_2 \zeta_i + \sqrt{1 - \rho_1^2 - \rho_2^2} \epsilon_i$ if $\zeta_i \sim \text{Norm}(0, 1)$, and $T_{i2} = T_{i1}^2$.

Appendix C. Comparison with Other Approaches

To further evaluate the performance of the MT-IVF approach, we compare the MT-IVF approach with three other emerging approaches: the causal forest (CF), the instrumental variable forest (IVF), and the k-nearest neighbors (KNN). We adopt the same designs in the simulation study of the MT-IVF approach.

Table C.1 Comparing the Performance of CF, IVF, KNN, and MT-IVF

Design	Approach	MSE of the First Treatment			MSE of the Second Treatment		
		4,000	5,000	6,000	4,000	5,000	6,000
1	CF	8.843e-02	8.705e-02	8.809e-02	0.575	0.564	0.565
	IVF	4.115e-03	3.604e-03	3.209e-03	0.373	0.371	0.368
	KNN	1.093	0.828	0.823	0.287	0.345	0.199
	MT-IVF	2.536e-03	2.592e-03	2.145e-03	2.719e-03	2.547e-03	1.766e-03
2	CF	8.906e-02	8.369e-02	8.809e-02	0.572	0.529	0.582
	IVF	2.412e-03	2.874e-03	2.279e-03	0.371	0.328	0.385
	KNN	0.760	0.724	0.683	0.237	0.235	0.187
	MT-IVF	5.707e-04	4.823e-04	3.100e-04	5.433e-04	4.355e-04	3.953e-04
3	CF	8.827e-02	8.876e-02	8.555e-02	0.571	0.569	0.566
	IVF	3.423e-03	2.797e-03	2.945e-03	0.373	0.367	0.361
	KNN	0.824	0.798	0.643	0.263	0.255	0.178
	MT-IVF	7.596e-04	4.000e-04	4.426e-04	8.844e-04	5.229e-04	4.186e-04
4	CF	1.697e-03	1.561e-03	1.257e-03	8.849e-02	9.060e-02	9.727e-02
	IVF	4.865e-03	3.277e-03	4.067e-03	5.916e-03	5.498e-03	4.354e-03
	KNN	1.978	1.709	12.548	0.316	0.308	0.340
	MT-IVF	2.207e-03	3.047e-03	2.145e-03	4.548e-03	3.748e-03	3.559e-03
5	CF	1.089	0.676	9.028e-02	0.695	0.670	0.700
	IVF	1.024	0.734	3.173e-02	0.510	0.460	0.508
	KNN	2.465	1.652	1.372	0.696	0.729	0.623
	MT-IVF	4.414e-03	3.556e-03	2.316e-03	3.928e-03	3.258e-03	2.348e-03
6	CF	8.843e-02	0.114	0.500	0.794	0.812	0.806
	IVF	3.380e-02	0.018	1.779e-02	0.588	0.613	0.597
	KNN	4.773	2.103	0.842	3.125	2.819	2.883
	MT-IVF	3.292e-03	3.160e-03	2.496e-03	4.391e-03	3.331e-03	2.200e-03
7	CF	9.183	5.624	0.119	1.834	1.520	1.633
	IVF	9.169	6.825	0.284	1.660	1.334	1.432
	KNN	9.133	6.422	6.004	2.889	2.956	3.512
	MT-IVF	3.611e-03	2.715e-03	2.306e-03	3.502e-03	2.905e-03	2.614e-03
8	CF	9.108e-02	9.242e-02	0.121	2.188	2.160	2.173
	IVF	1.424e-02	1.484e-02	7.857e-03	1.981	1.948	1.977
	KNN	1.261	1.001	0.651	1.924	1.348	1.304
	MT-IVF	4.827e-03	4.074e-03	2.932e-03	4.123e-03	3.926e-03	3.022e-03
9	CF	3.110	2.493	1.534	1.868	1.899	1.880
	IVF	3.042	2.611	1.693	1.621	1.696	1.658
	KNN	3.798	2.716	2.563	1.451	1.685	1.449
	MT-IVF	3.964e-03	3.243e-03	3.368e-03	3.939e-03	3.310e-03	2.718e-03

Note: This table compares the simulation results of different approaches across different designs. The size of the training sample increases from 4,000 to 6,000. The size of the testing sample is 8,000 for all designs. The scientific notation of e means “10 to the power of.”

We implement the CF and IVF approaches using the R package GRF (Athey et al. 2019). For both approaches, we first use a regression forest to perform the local centering. We then follow the examples provided on the package website²² to specify the outcome, features, treatments, and

²² <https://grf-labs.github.io/grf/index.html>.

IV (for IVF only). For an apples-to-apples comparison, we select the same number of trees and minimum node size as used in the MT-IVF approach. We implement the KNN approach using the R package FNN (Beygelzimer et al. 2013). Following the approach in Athey et al. (2019), we evaluate 10, 30, 100, and 300 neighbors and report the best result.

As Table C.1 shows, the MT-IVF approach has a superior performance across all designs. This result is expected because the MT-IVF approach is effective in addressing potential endogeneity issues faced by multiple treatments. The IVF approach also performs well because it is effective in addressing potential endogeneity issues faced by a treatment. The CF and KNN approaches perform the worst because they cannot address potential endogeneity issues.

Appendix D. Summary Statistics and Correlation Matrix

Table D.1 Definitions and Summary Statistics of the Dependent and Independent Variables

Variable	Definition	Mean	Std. Dev.
Key Variables			
BuyerConcession (%)	The buyer's price increase relative to her prior offer	19	35
SellerRespTime (min)	The seller's response time in minutes	249	436
SellerRespTime ²	The square of the seller's response time	252,121	841,497
Bargaining Features			
SellerOfferPrice (\$)	The seller's offer price	86	123
SellerConcession (%)	The seller's price decrease relative to his prior offer	17	11
Buyer Features			
BuyerPurchase	The buyer's average eBay purchases per month	1.224	5.725
BuyerPastExperience	The buyer's past experience in best-offer bargaining	121	422
Item Category (Top 10)			
ClothingShoesAndAccessories	The item category is clothing shoes & accessories	0.240	0.427
SportsMemCardsAndFanShop	The item category is sports mem cards & fan shop	0.152	0.359
Collectibles	The item category is collectibles	0.087	0.282
ToysAndHobbies	The item category is toys & hobbies	0.064	0.244
JewelryAndWatches	The item category is jewelry & watches	0.053	0.223
SportingGoods	The item category is sporting goods	0.045	0.208
TabletsAndNetworking	The item category is tablets & networking	0.045	0.207
VideoGamesAndConsoles	The item category is video games & consoles	0.033	0.177
ComputerElectronics	The item category is computers & electronics	0.032	0.177
HomeGarden	The item category is home & garden	0.032	0.174
Item Condition			
New	The item condition is new	0.230	0.421
NewOther	The item condition is new (other)	0.071	0.257
NewWithDefects	The item condition is new (with defects)	0.004	0.067
ManufacturerRefurbished	The item condition is manufacturer refurbished	0.002	0.043
SellerRefurbished	The item condition is seller refurbished	0.005	0.066
LikeNew	The item condition is like new	0.034	0.182
Used	The item condition is used	0.380	0.485
VeryGood	The item condition is very good	0.020	0.141
Good	The item condition is good	0.010	0.101
Acceptable	The item condition is acceptable	0.003	0.058
For parts / not working	The item condition is not working	0.013	0.113
Unknown	The item condition is unknown	0.228	0.419
Item Photo Number	The number of photos in listing	3.219	2.962
Competition and Popularity			
BuyerCompetition	The number of competing buyers	0.081	0.590
SellerCompetition	The number of competing sellers	0.009	0.182
ItemCompetition	The number of the same items listed on eBay	0.268	3.051
Views	The number of buyers who viewed an item	51	106
WatchLists	The number of buyers who added an item to their watch lists	2.560	3.647
Round Features			
BargainRoundThree	The bargaining round is the third round	0.905	0.293
BargainRoundFive	The bargaining round is the fifth round	0.095	0.293
Number of Observations		537,852	

Note. This table provides the definitions and summary statistics of the dependent and independent variables. These 23 item categories are included in the analysis but not shown in the table: antiques, art, baby, books, business & industrial, cameras & photo, cell phones & accessories, coins & paper money, crafts, dolls & bears, DVDs & movies, entertainment memorabilia, everything else, gift cards & coupons, health & beauty, music, musical instruments & gear, pet supplies, pottery & glass, specialty services, stamps, tickets & experiences, and travel.

Table D.2 Correlation between Dependent and Independent Variables

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) BuyerConcession	1.00												
(2) SellerRespTime	0.02	1.00											
(3) SellerRespTime ²	0.01	0.91	1.00										
(4) lnSellerOfferPrice	-0.11	0.02	0.02	1.00									
(5) SellerConcession	0.10	0.06	0.05	-0.24	1.00								
(6) ItemPhotoNumber	-0.01	-0.03	-0.01	0.25	-0.01	1.00							
(7) BuyerPurchase	-0.00	0.01	0.01	-0.04	0.07	-0.06	1.00						
(8) lnBuyerPastExperience	-0.02	0.04	0.03	-0.04	0.13	-0.11	0.31	1.00					
(9) BuyerCompetition	-0.04	-0.01	0.00	0.14	-0.12	0.02	-0.02	-0.01	1.00				
(10) SellerCompetition	-0.01	0.00	0.00	0.04	-0.03	0.00	0.00	0.02	0.15	1.00			
(11) ItemCompetition	-0.02	-0.02	-0.01	0.06	-0.05	0.01	-0.01	-0.01	0.14	0.30	1.00		
(12) Views	-0.03	0.03	0.02	0.22	-0.09	0.11	-0.05	-0.07	0.12	0.02	0.02	1.00	
(13) WatchLists	-0.04	0.05	0.04	0.30	-0.15	0.18	-0.07	-0.09	0.08	0.01	-0.01	0.35	1.00

Note: This table summarizes the correlation between the dependent and independent variables. The dummies of item categories and conditions are included in the analysis but not shown in the table.

Appendix E. Testing for Instrument Validity

Table E.1 Results from the First-Stage Regression Model

Variable	SellerRespTime		SellerRespTime ²	
	Coefficient	Standard Error	Coefficient	Standard Error
Instrumental Variables				
SellerPastRespTime	0.147 ***	0.016	144.095***	15.974
SellerPastRespTime ²	-1.720e-5***	6.580e-6	0.027***	0.010
Bargaining Features		Included		Included
Buyer Features		Included		Included
Item Features		Included		Included
Competition and Popularity		Included		Included
Round Fixed Effects		Included		Included
Seller Fixed Effects		Included		Included
Time Fixed Effects		Included		Included
Number of Observations		495,588		495,588

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. This table summarizes the results from the first-stage regression model, in which the dependent variables are the linear and quadratic terms of the seller's current response time. The independent variables are the linear and quadratic terms of the seller's past response time, bargaining features, buyer features, item features, competition and popularity features, round fixed effects, and seller and time fixed effects. The scientific notation of e means "10 to the power of."

Table E.2 Testing for Instrument Validity

Statistics	SellerPastRespTime	SellerPastRespTime ²
F-Test	186.990***	212.750***
Cragg-Donald Wald F statistic		751.370-
Stock-Yogo Weak ID F Test Critical Value (10%)		19.930-
Anderson-Rubin Wald Test		8.880**

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. This table summarizes all tests for IV validation. Numbers with – on the right do not have a p-value. We report the chi-square value of the AR Wald test.

Table E.3 Correlations between IVs and Features

Variable	$\text{SellerPastRespTime}$	$\text{SellerPastRespTime}^2$
Buyers Features		
BuyerPurchase	0.002	0.002
lnBuyerPastExperience	0.023	0.019
SellerFeatures		
SellerBayStore	-0.018	-0.014
SellerReview	-0.004	-0.004
SellerSaleVolume	0.007	-0.010
SellerAvgPastSellingPrice	0.026	0.023
Item or Bargaining Features		
ItemPhotoNumber	-0.026	-0.015
lnSellerOfferPrice	0.026	0.022
Competition and Popularity		
BuyerCompetition	-0.005	-0.001
SellerCompetition	0.002	0.003
ItemCompetition	-0.012	-0.008
Views	0.023	0.019
WatchLists	0.037	0.031

Note: This table summarizes the correlations between IVs and features. We exclude *SellerFeedbackCount*, *SellerPastExperience*, and *SellerTotalListing*, because they are highly correlated with *SellerSaleVolume* (each pair's correlation exceeds 0.83). The correlations between these features and *SellerPastRespTime* or *SellerPastRespTime*² are below 0.04.

Appendix F. Robustness Checks

We perform six robustness checks to analyze the sensitivity of our results. The first robustness check explores an item's listing price or reference price as an alternative feature. The second robustness check uses seller features instead of seller fixed effects to control for the differences across sellers. The third robustness check clusters standard errors by buyer, item, bargaining threads, item categories, and seller-category pairs, and performs subsample analyses focusing on the third round of bargaining sequences. The fourth robustness check considers an alternative model that includes the cubic term of the seller's response time. The fifth robustness check investigates the effect of response time under different bargaining outcomes (e.g., accept or reject). The final robustness check examines how bargaining round dynamics influence our main findings.

F.1. Alternative Item Prices

In the main analysis, we did not include an item's listing price or reference price, because they are highly correlated with the seller's offer price. A potential concern is that the seller's offer price is endogenously determined and may change over time. To address this concern, we use an item's listing price or reference price as an alternative feature and re-estimate the effect of the seller's response time. From Table F.1, we see the coefficients of *SellerRespTime* and *SellerRespTime*² are not significantly different from those in the main analysis, which suggests that our results in the main analysis are not driven by using the seller's offer price instead of an item's listing price or reference price.

Table F.1 Results from the IV Regression Model (Alternative Item Prices)

Variable	Reference Price		Listing Price	
	Coefficient	Standard Error	Coefficient	Standard Error
Key Variables				
SellerRespTime	14.103***	5.231	12.070**	5.025
SellerRespTime ²	−0.008**	0.003	−0.006**	0.003
Bargaining Features	Included		Included	
Buyer Features	Included		Included	
Item Features	Included		Included	
Competition and Popularity	Included		Included	
Round Fixed Effects	Included		Included	
Seller Fixed Effects	Included		Included	
Time Fixed Effects	Included		Included	
Number of Observations	475,282		495,588	
Adjusted R-Squared	0.015		0.013	

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. This robustness check uses an item's reference price or listing price as an alternative item feature. For ease of interpretation, we have multiplied all coefficients and standard errors by 1,000.

F.2. Additional Seller and Buyer Features

In this robustness check, we include additional seller and buyer features to verify the robustness of our main results.

In the main analysis, we use seller fixed effects to control for the differences across sellers. A potential concern is that some of the seller features may be time-variant. To address this concern, we include seller features in our main model. The seller features we consider in this robustness check include whether the seller has an eBay store (denoted by *SellereBayStore*), the seller's feedback score at the time of listing (denoted by *SellerReview*), the seller's sales volume in the last two years (denoted by *SellerSaleVolume*), and the seller's average past item selling price (denoted by *SellerAvgPastSellingPrice*).²³

Table F.2 summarizes the results when we include seller features instead of seller fixed effects in our main model. From the upper part of the table, we see the coefficients of *SellerRespTime* and *SellerRespTime*² are significantly different from zero at the 5% significance level. These coefficients are not significantly different from those in the main analysis, which suggests that our results in the main analysis are not driven by including seller fixed effects in the econometric model. From the lower part of the table, we see the coefficients of the seller features are not significantly different from zero at the 10% significance level. However, the coefficient of the seller's feedback score at the time of listing (i.e., *SellerReview*) is negative with a p-value of 0.108, suggesting that a higher seller feedback score is associated with a lower buyer concession.

²³ We do not include the amount of feedback received by the sellers at the time of listing (denoted by *SellerFeedbackCount*), the seller's past bargaining experience (denoted by *SellerPastExperience*), or the number of listings created by the seller (denoted by *SellerTotalListing*), because they are highly correlated with *SellerSaleVolume*. Using any of these three features instead of *SellerSaleVolume* does not change the conclusion of this robustness check.

This finding is different from the common conclusion in the e-economics literature (e.g., Li et al. 2020) that a seller’s quality or reputation, reflected by the feedback score, positively impacts sales. A potential explanation for this discrepancy is that high feedback scores may weaken sellers’ bargaining positions. Buyers might perceive that sellers with higher feedback scores are more motivated to maintain their reputation and, therefore, are more willing to accept lower prices. Perceiving the seller as having a weak bargaining position, buyers may hold firm on low offer prices (Amanatullah et al. 2008). The coefficients of other seller features, such as whether the seller has an eBay store, the seller’s sales volume in the last two years, and the seller’s average past item selling price, are not significantly different from zero at the 10% significance level. These findings suggest that buyers may prioritize the item features (e.g., the number of photos, the item category, and the item condition) and the seller’s feedback score over these seller features when deciding their offers.

Table F.2 Results from the IV Regression Model (Including Seller Features)

Variable	Coefficient	StandardError
Key Variables		
SellerRespTime	12.032**	5.012
SellerRespTime ²	−0.006**	0.003
Seller Features		
SellereBayStore	240	155
SellerReview	−58.459	36.552
SellerSaleVolume	−0.003	0.010
SellerAvgPastSellingPrice	−3.955	4.410
Bargaining Features	Included	
Buyer Features	Included	
Item Features	Included	
Competition and Popularity	Included	
Round Fixed Effects	Included	
Time Fixed Effects	Included	
Number of Observations	495,588	
Adjusted R-Squared	0.013	

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. This robustness check includes seller features as additional control variables. We exclude *SellerFeedbackCount*, *SellerPastExperience*, and *SellerTotalListing*, because they are highly correlated with *SellerSaleVolume* (each pair’s correlation exceeds 0.83). Using any of these three features instead of *SellerSaleVolume* does not change the conclusion of this robustness check. For ease of interpretation, we have multiplied all coefficients and standard errors by 1,000.

We now examine additional buyer features. In the main analysis, we include a broad range of features (e.g., bargaining, buyer, and item), seller and time fixed effects (e.g., year, month, day, and hour) in our model. In this robustness check, we consider two new buyer features in our analysis. The first is the number of previous bargaining threads the buyer has participated in and succeeded in (denoted by *BuyerPastSuccessExperience*), which captures the buyer’s bargaining success experience. The second is the average historical concession made by a buyer (denoted by

BuyerPastConcession), which captures the buyer’s sacrifice in past negotiations. Table F.3 summarizes the results when we include these two new variables. The coefficients of *SellerRespTime* and *SellerRespTime*² are not significantly different from our results, which suggests that our main results are not driven by omitting these variables. We also find that the coefficient of *BuyerPastConcession* is positive and different from zero at the 1% significance level. This result suggests that buyers who have historically been more willing to concede are also more likely to make larger concessions in the current negotiation, reflecting a consistent pattern in individual bargaining behavior.

Table F.3 Results from the IV Regression Model (Including Additional Buyer Experiences)

Variable	Coefficient	Standard Error
Key Variables		
SellerRespTime	11.915**	5.006
SellerRespTime ²	-0.006**	0.003
BuyerPastSuccessExperience	-1.109	1.813
BuyerPastConcession	134.085***	34.271
Bargaining Features		Included
Buyer Features		Included
Item Features		Included
Competition and Popularity		Included
Round Fixed Effects		Included
Seller Fixed Effects		Included
Time Fixed Effects		Included
Number of Observations		495,588
Adjusted R-Squared		0.014

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. In this robustness check, we include the number of previous bargaining threads the buyer has participated in and succeeded (denoted by *BuyerPastSuccessExperience*) and the average historical concession made by a buyer (denoted by *BuyerPastConcession*) as two additional control variables in our main model. For ease of interpretation, we have multiplied all coefficients and standard errors by 1,000.

F.3. Alternative Clusters and Subsamples

In the main analysis, we cluster standard errors by seller. A potential concern is that the observations are not independent, because some bargaining threads have five or more rounds. To check whether our results are driven by the data structure, we follow the existing literature (e.g., Altman et al. 2021, Pierce et al. 2021, Wang et al. 2023) to cluster standard errors at the individual levels of buyers, items, bargaining threads, item categories, and seller-category pairs (i.e., seller-category combinations that reflect whether a seller consistently lists items in specific categories). From Table F.4, we see that the coefficients of *SellerRespTime* and *SellerRespTime*² are significant at the 5% significance level. The results from all alternative clusterings are similar to those in the main analysis.

To further address concerns regarding the independence of observations, we conduct a subsample analysis with observations confined to the third round of bargaining sequences. We see from

Table F.5 that the coefficients of *SellerRespTime* and *SellerRespTime*² are significant at the 5% significance level and are not significantly different from those in the main results. These results collectively conclude that our findings are not driven by the data structure.

Table F.4 Results from the IV Regression Model (Alternative Clusters)

Variable	(1) Cluster by Buyer		(2) Cluster by Item		(3) Cluster by Bargaining		(4) Cluster by Category		(5) Cluster by Seller-Category	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Key Variables										
SellerRespTime	12.156 **	5.084	12.156 **	5.076	12.156 **	5.082	12.156 **	4.870	12.156 **	5.388
SellerRespTime ²	-0.006 **	0.003	-0.006 **	0.003	-0.006 **	0.003	-0.006 **	0.003	-0.006 **	0.003
Bargaining Features	Included		Included		Included		Included		Included	
Buyer Features	Included		Included		Included		Included		Included	
Item Features	Included		Included		Included		Included		Included	
Competition and Popularity	Included		Included		Included		Included		Included	
Round Fixed Effects	Included		Included		Included		Included		Included	
Seller Fixed Effects	Included		Included		Included		Included		Included	
Time Fixed Effects	Included		Included		Included		Included		Included	
Number of Observations	495,588		495,588		495,588		495,588		495,588	
Adjusted R-Squared	0.013		0.005		0.013		0.013		0.013	

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. This robustness check clusters standard errors by buyer, item, bargaining threads, item categories, or seller-category pairs. The standard errors for *SellerRespTime*² are identical across all clusterings due to rounding. For ease of interpretation, we have multiplied all coefficients and standard errors by 1,000.

Table F.5 Results from the IV Regression Model (Alternative Subsample)

Variable	Coefficient	Standard Error
Key Variables		
SellerRespTime	12.121**	4.953
SellerRespTime ²	-0.006**	0.003
Bargaining Features	Included	
Buyer Features	Included	
Item Features	Included	
Competition and Popularity	Included	
Round Fixed Effects	Included	
Seller Fixed Effects	Included	
Time Fixed Effects	Included	
Number of Observations	440,877	
Adjusted R-Squared	0.004	

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. This robustness check uses a subsample that only includes observations of the third round. For ease of interpretation, we have multiplied all coefficients and standard errors by 1,000.

F.4. Alternative Model

In the main analysis, we incorporate both linear and quadratic terms, namely, *SellerRespTime* and *SellerRespTime*², to capture the nonlinear effect of the seller's response time. The significance of both terms at the 5% significance level indicates an inverted-U-shaped relationship between the seller's response time and the buyer's concession. A potential concern is that including the cubic term of the seller's response time may better capture the empirical relationship. To address this concern, we include the cubic term along with the linear and quadratic terms to construct the cubic model and construct an IV for the cubic term following the same process in Section

4.2. From Table F.6, we see that the coefficients of *SellerRespTime* and *SellerRespTime*² are significantly different from zero at the 5% significance levels, respectively. However, the coefficient of *SellerRespTime*³ is not significantly different from zero at the 5% significance level. This result suggests that our main model fits the empirical setting better. Moreover, we follow Kesavan et al. (2014) to compare the Akaike information criterion and the Bayes information criterion for the cubic model and our main model. Our results show that in each case, the value for our main model is lower, indicating that our main model is more preferred, as suggested by Greene (2003).

Table F.6 Results from the IV Regression Model (Alternative Model)

Variable	Coefficient	Standard Error
Key Variables		
SellerRespTime	32.824 **	13.274
SellerRespTime ²	-0.038 **	0.018
SellerRespTime ³	1.028e-5 *	5.798e-6
Bargaining Features		Included
Buyer Features		Included
Item Features		Included
Competition and Popularity		Included
Round Fixed Effects		Included
Seller Fixed Effects		Included
Time Fixed Effects		Included
Number of Observations		495,588
Adjusted R-Squared		0.011

Note: *** p < 0.01, ** p < 0.05, * p < 0.1. This robustness check includes the linear, quadratic, and cubic terms of the seller's response time. For ease of interpretation, we have multiplied all coefficients and standard errors by 1,000. The scientific notation of e means "10 to the power of."

F.5. Alternative Bargaining Results

In the main analysis, we do not include the eventual bargaining outcome (i.e., accept or reject). A potential concern relates to the buyer's or the seller's intention to accept or reject an offer. One might argue that the overarching intention could overshadow the estimated effect of the seller's response time on the buyer's concession. To address this concern, we conduct subsample analyses by comparing accepted offers with rejected offers. Table F.7 summarizes the results. We see the coefficients estimated using these two subsamples are significantly different from zero. We also see the coefficients have the same signs as those in our main results. This finding confirms that the nonlinear effect of the seller's response time holds for both accepted- and rejected-offer subsamples. We further find the seller's best response time is similar in these two subsamples (16.7 hours in the accepted offer subsample and 15.9 hours in the rejected offer subsample) and is similar to that calculated using our main results. To further explore how seller response time affects bargaining outcomes, we first use *Sale* to indicate whether the negotiation has resulted in a sale. That is, *Sale* equals one if the negotiation results in a sale, and zero otherwise. We then estimate an IV probit model using *Sale* as the dependent variable. As shown in Table F.8, the seller's response

time has a U-shaped effect on the probability of successfully selling an item. The tipping point is $61.61/(2 \times 0.014) = 2,200$ minutes (or 36.7 hours). Therefore, the likelihood of a sale first decreases and then increases as the seller's response time increases. Overall, we conclude our results in the main analysis are robust to different bargaining results.

Table F.7 Results from the IV Regression Model (Alternative Bargaining Results)

Variable	(1) Accepted Offers		(2) Rejected Offers	
	Coefficient	Standard Error	Coefficient	Standard Error
Key Variables				
SellerRespTime	8.018**	3.550	19.026***	6.689
SellerRespTime ²	-0.004*	0.002	-0.010**	0.004
Bargaining Features	Included		Included	
Buyer Features	Included		Included	
Item Features	Included		Included	
Competition and Popularity	Included		Included	
Round Fixed Effects	Included		Included	
Seller Fixed Effects	Included		Included	
Time Fixed Effects	Included		Included	
Number of Observations	220,124		41,347	
Adjusted R-Squared	0.045		0.005	

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. This robustness check explores two subsamples that include only accepted offers or rejected offers, respectively. For ease of interpretation, we have multiplied all coefficients and standard errors by 1,000.

Table F.8 Bargaining Outcome as the Dependent Variable

Variable	Coefficient	Standard Error
Key Variables		
SellerRespTime	-61.610***	7.660
SellerRespTime ²	0.014***	0.005
Bargaining Features	Included	
Buyer Features	Included	
Item Features	Included	
Seller Features	Included	
Competition and Popularity	Included	
Round Fixed Effects	Included	
Time Fixed Effects	Included	
Number of Observations	537,852	
Log likelihood	-11,910,616	

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. In this robustness check, we use *Sale* as the dependent variable. All independent variables are the same as those in the main model, except that seller features instead of seller fixed effects are used due to the limitations of the probit model. For ease of interpretation, we have multiplied all coefficients and standard errors by 100,000.

F.6. Bargaining Round Dynamics

Because our observations include both rounds three and five, a potential concern is that treatment effects may vary across bargaining rounds. For example, buyers may adjust their strategies due to the bottoming effect. To address this concern, we interact the treatment variables with the round five dummy to assess round-specific effects. Table F.9 summarizes the results. For round three, the

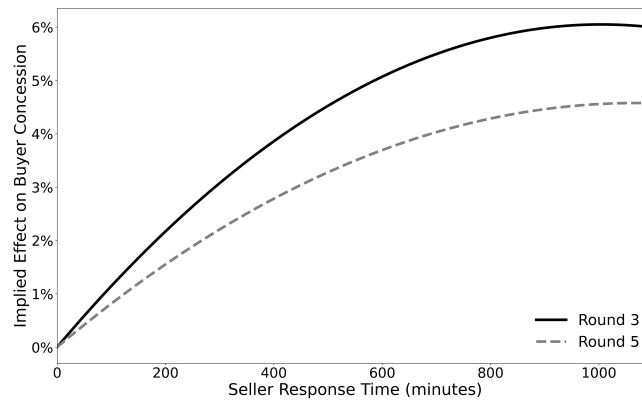
coefficient of the linear term has a mean of 12.049 and a standard error of 5.042, and the coefficient of the quadratic term has a mean of -0.006 and a standard error of 0.003. Because both coefficients are significantly different from zero at the 5% significance level, the effect of the seller's response time on the buyer's concession follows an inverted-U shape. For round five, a linear combination test finds the coefficient of the linear term has a mean of 8.557 and a standard error of 5.034, and the coefficient of the quadratic term has a mean of -0.005 and a standard error of 0.003. The coefficient of the linear term is significantly different from zero, and the coefficient of the quadratic term is not significantly different from zero at the 10% significance level. Therefore, the effect of the seller's response time on the buyer's concession is approximately linear. Figure F.1 provides a visual illustration of the implied effect of the seller's response time on the buyer's response for rounds three and five based on Table F.9.

Table F.9 Results from the IV Regression Model (Interacting Treatments with Round Five)

Variable	Coefficient	Standard Error
Key Variables		
SellerRespTime	12.049**	5.042
SellerRespTime ²	-0.006**	0.003
Interaction Terms		
SellerRespTime*BargainRound5	-3.492*	1.905
SellerRespTime ² *BargainRound5	0.002	0.001
Bargaining Features		Included
Buyer Features		Included
Item Features		Included
Competition and Popularity		Included
Round Fixed Effects		Included
Time Fixed Effects		Included
Number of Observations		495,588
Adjusted R-Squared		0.013

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. This robustness check includes two interaction terms: (1) *SellerRespTime* and the round five dummy, and (2) *SellerRespTime*² and the round 5 dummy. For ease of interpretation, we have multiplied all coefficients and standard errors by 1,000.

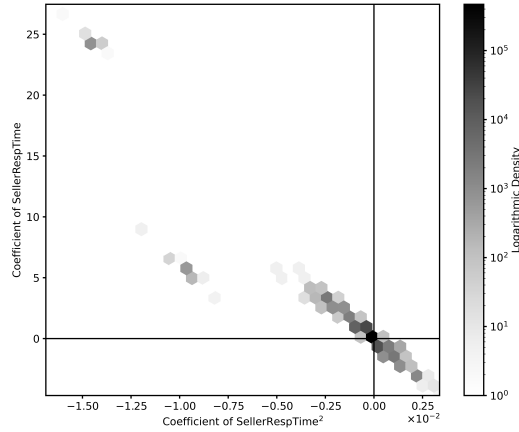
Figure F.1 Implied Effect of the Seller's Response Time for Different Rounds



Note: This figure provides a visual illustration of the implied effect of the seller's response time for different rounds based on Table F.9.

Appendix G. Estimated Treatment Effects Across Observations

Figure G.1 Estimated Treatment Effects Across Observations



Note: This figure depicts the coefficients of *SellerRespTime* and *SellerRespTime*² for different observations. The vertical and horizontal axes indicate the coefficients of *SellerRespTime* and *SellerRespTime*² (measured in units of 10^{-2}), respectively. Each hexagonal bin represents the logarithmic density of the number of observations, calculated as $\log_{10}(\text{number of observations})$, with darker colors indicating higher densities. For ease of interpretation, we include 35 bins along the x-axis and multiply all coefficients by 1,000.

Appendix H. Verifying the Capability of MT-IVF

We analyze whether the MT-IVF approach has succeeded in identifying the heterogeneous effects of the seller's response time on the buyer's concession. Following the existing literature (see, e.g., [Athey et al. 2019](#) and [Wang 2022](#)), we categorize observations into two equal-sized groups based on their estimated treatment effects. Comparing the average effects of two groups allows us to evaluate the strength of heterogeneity, because these effects are estimated based on out-of-bag predictions that do not directly depend on the features or outcomes.

Table [H.1](#) summarizes the results when we divide the observations into two equal-size groups based on the estimated effects of *SellerRespTime*.²⁴ From the left part of the table, we see that the coefficient of *SellerRespTime* is negative and the coefficient of *SellerRespTime*² is positive, which suggests that the buyer's concession first decreases and then increases with the seller's response time. From the right side of the table, we see that the coefficient of *SellerRespTime* is positive and that of *SellerRespTime*² is negative, which suggests that the buyer's concession first increases and then decreases with the seller's response time. Because the coefficients on the left and right sides of the table are significantly different, we conclude that the MT-IVF approach has succeeded in identifying the heterogeneous effects of the seller's response time.

²⁴ Dividing the observations into two groups based on the estimated effects of *SellerRespTime*² does not change the main conclusion of this analysis.

Table H.1 Comparing Groups with Small and Large Effects of the Seller’s Response Time

Variable	Group with Small Effects		Group with Large Effects	
	Coefficient	Standard Error	Coefficient	Standard Error
Key Variables				
SellerRespTime	−14.216***	3.752	47.205***	11.491
SellerRespTime ²	0.008***	0.002	−0.026***	0.007
Bargaining Features	Included		Included	
Buyer Features	Included		Included	
Item Features	Included		Included	
Competition and Popularity	Included		Included	
Round Fixed Effects	Included		Included	
Seller Fixed Effects	Included		Included	
Time Fixed Effects	Included		Included	
Number of Observations	233,634		234,949	
Adjusted R-Squared	0.011		0.011	

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. This table summarizes the average effects when we divide the observations into two equal-sized groups based on the estimated effects of *SellerRespTime*. For ease of interpretation, we have multiplied all coefficients and standard errors by 1,000.

Appendix I. Managerial Insights

In Table I.1, we demonstrate the improvement in the buyer offer price across various categories when the seller adopts the thread-average or thread-specific best response time. To further generalize the insights behind the variation in improvement across item categories, we examine whether certain features systematically differ between categories with large improvement and categories with small improvement. In particular, we group the five categories with the highest improvement²⁵ and the five with the lowest improvement²⁶ based on the thread-average best response time. To ensure that the focused features are observable and actionable for sellers, we compare popularity and seller features across these two groups.

Our results show that, compared to products in categories with lower improvement, products in categories with higher improvement tend to be more popular (i.e., higher numbers of views, *Views*, and times being added to a buyer’s watch list, *WatchLists*). In addition, sellers in high-improvement categories tend to have lower feedback scores (*SellerReview*) but higher sales volume (*SellerSaleVolume*) and higher average past item selling prices (*SellerAvgPastSellingPrice*). These differences are significant at the 1% significance level using t-tests. These results suggest that sellers selling popular products or with these seller features may have greater potential to benefit from optimizing response time. A similar comparison based on the thread-specific best response time yields consistent findings.

²⁵ These categories are Cameras & Photo, Crafts, Dolls & Bears, Entertainment Memorabilia, and Jewelry & Watches.

²⁶ These categories are Books, DVDs & Movies, Gift Cards & Coupons, Sports Cards & Fan Shop, and Stamps.

Table I.1 Improvement in Buyer's Offer Price Across Item Categories and Conditions

Item Category/Condition	Percentage of Observations	Observed	Thread-Average Analysis		Thread-Specific Analysis	
			Optimal	Improvement	Optimal	Improvement
Item Category						
Antiques	0.78%	110.03	117.37	6.67%	128.05	16.38%
Art	0.47%	121.88	128.24	5.22%	149.14	22.37%
Baby	0.46%	65.49	69.06	5.45%	88.26	34.77%
Books	1.57%	29.11	30.49	4.74%	36.81	26.45%
Business & Industrial	2.75%	126.57	135.16	6.79%	152.37	20.38%
Cameras & Photo	1.37%	201.83	219.25	8.63%	243.94	20.86%
Cell Phones & Accessories	2.34%	178.96	190.65	6.53%	235.18	31.41%
Clothing Shoes & Accessories	24.04%	57.89	62.82	8.52%	70.26	21.37%
Coins	2.60%	112.12	119.78	6.83%	137.01	22.20%
Collectibles	8.73%	53.39	56.08	5.04%	63.38	18.71%
Computers & Electronics	3.26%	88.49	96.03	8.52%	108.58	22.70%
Crafts	0.43%	31.36	36.62	16.77%	41.05	30.90%
Dolls & Bears	0.65%	42.93	46.86	9.15%	52.02	21.17%
DVDs & Movies	1.30%	17.49	17.93	2.52%	26.36	50.72%
Entertainment Memorabilia	0.91%	53.59	58.26	8.71%	66.98	24.98%
Everything Else	0.18%	50.24	53.86	7.20%	66.57	32.50%
Gift Cards & Coupons	0.02%	76.16	79.12	3.89%	84.36	10.77%
Health & Beauty	1.40%	38.59	40.93	6.06%	48.27	25.09%
Home	3.15%	77.28	83.32	7.82%	98.27	27.16%
Jewelry & Watches	5.27%	123.40	134.96	9.37%	150.79	22.20%
Music	0.91%	19.44	20.64	6.17%	23.92	23.05%
Musical Instruments & Gear	1.77%	200.28	213.18	6.44%	241.33	20.50%
Pet Supplies	0.12%	42.93	45.78	6.64%	52.54	22.38%
Pottery & Glass	1.00%	51.85	54.96	6.00%	60.58	16.84%
Specialty Services	0.00%	82.45	87.53	6.16%	88.68	7.56%
Sporting Goods	4.52%	100.31	108.30	7.97%	141.15	40.71%
Sports Cards & Fan Shop	15.16%	52.96	55.52	4.83%	65.79	24.22%
Stamps	0.25%	77.66	81.08	4.40%	92.70	19.37%
Tablets & Networking	4.48%	141.94	153.81	8.36%	180.35	27.06%
Tickets & Experiences	0.39%	239.94	257.23	7.21%	329.40	37.29%
Toys & Hobbies	6.36%	43.09	46.63	8.22%	52.59	22.05%
Travel	0.11%	131.59	142.92	8.61%	148.26	12.67%
Video Games & Consoles	3.25%	37.98	40.53	6.71%	46.83	23.30%
Item Condition						
New	22.97%	74.78	80.99	8.30%	96.82	29.47%
New Other	7.10%	89.55	94.66	5.71%	111.87	24.93%
New with Defects	0.44%	71.89	90.52	25.92%	100.92	40.38%
Manufacturer Refurbished	0.18%	211.82	235.68	11.26%	288.23	36.07%
Seller Refurbished	0.45%	165.69	177.24	6.97%	213.43	28.81%
Like New	3.44%	36.77	38.86	5.68%	45.87	24.75%
Used	37.97%	84.22	90.91	7.94%	102.41	21.60%
Very Good	2.03%	24.96	26.14	4.73%	31.13	24.72%
Good	1.02%	19.20	19.73	2.76%	23.98	24.90%
Acceptable	0.33%	15.95	16.59	4.01%	19.89	24.71%
For Parts/Not Working	1.29%	84.54	89.81	6.23%	101.85	20.48%
All Others	22.77%	70.65	74.81	5.89%	87.18	23.40%

Note. This table summarizes the improvement (relative to the observed) in the buyer's offer price across item categories and conditions. In the thread-average analysis, we calculate the buyer's offer price when the seller uses the thread-average best response time (obtained from the average effect analysis). In the thread-specific analysis, we calculate the buyer's offer price when the seller uses the thread-specific best response time (obtained from the heterogeneous effect analysis). The three most common categories and conditions are in bold text.

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