Book Chapter - Bargaining in the Field

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1 Introduction

An important determinant of bargaining outcomes is the outside options available to individuals. In markets, outside options are largely determined by equilibrium forces outside the control of individual bargainers. In this chapter, we discuss bargaining in markets, illustrate theoretical issues that arise in this environment, discuss identification issues and present empirical evidence from bargaining field experiments in a taxi market.

2 Background

A crucial characteristic of the market we focus on is the presence of frictions. Demand and supply have to find each other and this takes time. When transaction frictions exists, it is possible that, in equilibrium, trade does not occur even if buyers and sellers have common knowledge that gains from trade are positive. Moreover, in the presence of frictions, multiple equilibria are possible. Bargaining outcomes are part of a market-level equilibrium – individual behavior affects and is affected by it.

As we will discuss throughout the chapter, some features of the market in which our experiments take place can be found in the bargaining literature using laboratory experiments. Bargaining experiments with random outside options are a stylized version of what bargainers face in the taxi market. However, the crucial aspect of this market is that these outside options are determined endogeneously and multiple equilibria are possible. The unit of observation is not the individual bargaining pair, but the individual bargaining pair given the behavior of all other bargainers in the market. By construction, bargaining experiments with individual bargaining pairs cannot test consistency with market equilibrium. Our results suggest the need to develop new experimental paradigms to better understand aggregate equilibrium behavior.

To give some background on the experimental work in this area, we provide a brief review of the large theoretical and experimental research on bargaining (see Ausubel, Cramtom, and Deneckere. (2002); Camerer (2004); Kagel and Roth (1995); Kennan and Wilson (1993) for surveys), paying particular attention to that which is most relevant to our field experiment results from both lab and field experimental research.[1]

A large amount of attention in the experimental bargaining literature has been given to behavior in simple environments like the ultimatum game. This game has been analyzed in hundreds of laboratory experiments, in many countries, and for large, as well as, small stakes. The results from these studies suggest that fairness in the minds of responders has a significant effect on final allocations.[2] Ochs and Roth (1989) show that subjects sometimes reject agreements, only to propose agreements that make them worse off. While fairness considerations might be a possible explanation of these results, Johnson, Camerer, Sen, and Rymon (2002) demonstrate that subjects ignore information that is strategically relevant to making decisions consistent with sequential rationality. Further evidence of subjects not using backwards induction is provided by Binmore, Morgan, Shaked, and Sutton (1991) who show that replacing a decision tree by its expected value is not irrelevant behaviorally. Importantly, Harrison and McCabe (1996) demonstrate that if subjects acquire experience along the decision tree, deviations from sequential rationality are less prevalent.

Experimental evidence in alternating offers environments (Rubinstein, 1982), such as our taxi market, is relatively more scarce. Weg, Rapoport, and Felsenthal (1990) report a lab experiment with n stages and a shrinking pie and find qualitative similarities with theory. Zwick, Rapoport, and Howard (1992) use random termination of games to simulate discounting and find that results are similar to those using a shrinking pie. There has also been research to experimentally test theoretical predictions in the presence of asymmetric information. Rapoport, Erev, and Zwick (1995) test Sobel and Takahashi (1983)'s sellers-only asymmetric information where the uninformed player makes all the offers. While they find that price changes are close to theoretical predictions, the ordering of initial offers is contrary to what is expected. Forsythe, Kennan, and Sopher (1991) design a game to test the hypothesis that asymmetric information is the reason behind delay in bargaining. In their game, incentive compatibility required immediate agreement some of the time and delay other times. The results support the idea that asymmetric information is an important factor in disagreement. We will see that this is a salient feature of the field market we study.

Evidence on alternating-offer bargaining in the field using experimental methods is more

[1]Subjects in experiments frequently do not behave as theory would predict. For example, Roth, Prasnikar, Okuno-Fujiwara, and Zamir. (1991) show that expectations and norms are important in bargaining outcomes. Early lab experiments demonstrate that cooperative and non-cooperative bargaining theories are not able to predict the way subjects behave. The experiments by Roth and Malouf (1979) illustrate that bargainers use irrelevant information during negotiations, and Roth and Murnighan (1977) show that concepts like the core and stable sets are not good predictors of multilateral negotiations. More recently Frechette, Kagel, and Morelli (2005), in analyzing party formation and coalitional bargaining, demonstrate that differences in bargaining protocols that are theoretically important do not manifest as strongly in the empirical data.

[2]For important recent contributions, see Slonim and Roth (1998) on large stakes, Eckel and Grossman (2001) on gender differences, and Harbaugh, Krause, and Berry. (2001) on the bargaining behavior of children. Andreoni, Castillo, and Petrie (2003a) look at the convex preferences of bargainers and Andreoni, Harbaugh, and Vesterlund (2003b) look at the effect of punishment.

recent. Andersen, Ertac, Gneezy, List, and Maximiano (2013) examine the effects of culture and social structure on bargaining outcomes in the lab and field, and Castillo, Petrie, Torero, and Vesterlund (2013) study gender discrimination in bargaining for taxi fares. Additional studies have looked at differential treatment in markets with bargaining in terms of in-group and out-group bias (Kim and Lopez de Leon, 2018), tribe and gender (Fitzpatrick, 2017) and copartisanship (Michelitch, 2015). Signals of how informed buyers are have been shown to influence outcomes for credence goods (Balafoutas, Beck, Kerschbamer, and Sutter, 2013) and automotive repairs (Busse, Israeli, and Zettelmeyer, 2017). Informal bargaining outside of formal channels can prove efficient (Bengtsson, 2015). In markets with foreign buyers, language can serve as a proy for reservation value (Lee and Park, 2018)

The literature on bargaining with asymmetric information (Chatterjee and Samuelson, 1987; Cramton, 1984; Fudenberg and Tirole, 1983) shows that very few comparative static results are obtained when there is uncertainty about the reservation valuation of sellers and buyers or when the informed players are able to make offers.[3] It is not clear, a priori, what equilibrium buyers and seller might reach.[4] Empirically, it is possible that inefficiencies arise due to coordination problems. While equilibrium selection may be unclear, our field setting does allow us to test for different equilibria as market conditions change, even in the presence of uncertain reservation values of buyers and sellers.

3 Bargaining in the field

3.1 Bargaining and Matching

To get a sense of the essential differences that may arise in the field, we present a simple theoretical example, which captures the main characteristics of the market we examine. The salient feature of the market under study is sequential bargaining and repeated matching. Buyers and sellers meet, negotiate sequentially until they reach an agreement, or return to the market in search of a suitable alternative. Samuelson (1992) shows that in a market where bargainers are matched randomly it is possible that disagreement occurs even when gains from trade are common knowledge. The reason is that the negotiating parties may reach a point where the return from a new match exceeds that of the existing match. Fudenberg, Levine, and Tirole (1987) demonstrate that haggling, when it is possible to bargain with a sequence of agents, occurs only when transaction costs are sufficiently high. Intuitively, when the seller's cost of finding a new buyer is low, the seller prefers negotiating with a new buyer over continued negotiation with a buyer that has revealed a low willingness

[3]Chatterjee and Samuelson (1983) use the revelation principle to find bounds on trade. Experimental research (Forsythe et al., 1991) shows that bargaining outcomes share qualitative features predicted by theory.

[4]For instance, Cramton (1984) constructs an equilibrium in the two-sided asymmetric bargaining game where only sellers make offers. As their reservation valuations rise, sellers start screening prices at higher levels. It is possible that this equilibrium remains valid if buyers are given the opportunity to make counteroffers but choose to remain silent.

to pay. While sellers with low switching cost will charge either a low price or a high take-it-or-leave-it price, sellers with high switching cost may engage in haggling.

We draw on both of these models to build an example that shows how bargaining and screening may play out in a market environment. Using a model of sequential bargaining and random matching, we start with an example of only one population. We then extend the example to two identifiable populations to demonstrate that in these markets behavior consistent with statistical discrimination is possible. Another extension of the model shows that compromise and haggling can be sustained in equilibrium. These extensions inform our test of the theory in the field.

Consider a market with an infinite number of buyers (denoted B) and sellers (denoted S). At each time, $t = 1, 2, \ldots$, buyers and sellers are matched randomly. Sellers are matched with a buyer with probability θ_S ($\theta_S < 1$) and buyers are matched to a seller with probability θ_B ($\theta_B < 1$). Parameters θ_S and θ_B represent the level of friction in this market and capture the transaction cost of reaching a bargaining agreement. Sellers are assumed to produce the good at a cost of zero. A buyer's valuation of the good is either $\bar{v}$ with probability π or $\underline{v}$ with probability $1 - \pi$. A buyer's valuation of the good is private information. For the example, we assume that $1 < \underline{v} < 2 < \bar{v} < 3$ and that prices can only take integer values. The distribution of a buyer's value and the production cost of the seller are common knowledge. Buyers and sellers discount each period according to discount factors δ_S and δ_B with $0 < \delta_i < 1$ for $i = B, S$. If a seller is matched with a buyer, the seller quotes a price p that the buyer can accept or reject. If the buyer accepts, the buyer earns $v - p$ and the seller earns p. Both agents leave the market and are replaced by identical replicas. If the buyer rejects, the seller and then the buyer sequentially decide whether to continue negotiating or return to the pool of unmatched agents. Matches are broken if a matched agent decides to leave the match. If agents remain matched, the seller lists a second price that the buyer can either accept or reject. This process is repeated until they either reach an agreement or the match is broken. If they remain matched, but never reach an agreement, both agents receive a payoff of zero.

In this model, agents cannot learn about other agents with whom they have not interacted, and the environment remains stable. Samuelson (1992) characterizes two types of equilibria which may arise depending on the value of π.[5] There is an equilibrium in which sellers list a price of 1. In this equilibrium all buyers accept the price of 1, but reject a price of 2. There is another equilibrium in which sellers make a take-it-or-leave-it offer of 2 that only buyers with value $\bar{v}$ accept. Sellers enforce screening by abandoning a negotiation after being rejected by a buyer. Relying on the insights of Fudenberg et al. (1987), it is also possible to construct an equilibrium where haggling occurs. For instance, there is a haggling equilibrium in which sellers state a price of 2 as soon they are matched with a

[5]We assume that high-valuation buyers prefer to wait for a lower price (i.e., $\bar{v} - 2 < \delta_B(\bar{v} - 1)$). This allows us to construct the haggling equilibrium.

new buyer. Sellers then randomize between switching to a price of 1 and abandoning the negotiation. This equilibrium requires that sellers are indifferent between listing a price of 1 and leaving the negotiation. This is possible if the price of 2 is accepted by buyers with value $\bar{v}$ with probability $p = \frac{1-\delta_S}{(2-\delta_S)\pi}$ (see Appendix for derivation). For a buyer with value $\bar{v}$ to be indifferent between accepting a price of 2 and waiting for prices to drop to 1, the seller and buyer must remain matched and the seller must drop prices to 1 with probability $q = \frac{\bar{v}-2-\delta_B V_B(\bar{v})}{(\bar{v}-1-V_B(\bar{v}))\delta_B}$, where $V_B(\bar{v})$ is the equilibrium payoff of a buyer with value $\bar{v}$.[6]

The equilibrium with haggling requires that the portion of high-valuation buyers is sufficiently large $\pi > \frac{1-\delta_S}{2-\delta_S}$, and the high-price, take-it-or-leave-it equilibrium requires an even larger portion of high-valuation buyers in the market, $\pi > \frac{1-\delta_S}{(2-\delta_S)\theta_S}$. The intuition of the result is that sellers may engage in haggling as a way to screen buyers when the likelihood of finding a high-value buyer is sufficiently high. But, they may find it profitable to completely screen out low-valuation buyers if the fraction of high-valuation buyers is even higher.

Figure 1 illustrates the relationship between the frequency of re-matching (θ_S) and the prevalence of high valuation buyers (π) on the structure of the equilibrium of the model. Multiple equilibria are possible only when there is a sufficiently large number of high valuation buyers. In the absence of this, a low price is offered, even if re-matching happens at a high rate. The figure illustrates that an equilibrium in which low valuation buyers are excluded from the market occurs only when there are a sufficient number of high valuation buyers and the probability of re-matching is high for sellers.

The implications of the model yield our first prediction for the taxi market field data we present in the Results section.

Prediction 1: More rejections by sellers will occur during peak hours of demand, and buyers will be willing to pay higher prices.

This prediction is driven by the fact that during peak hours there are a large number of high-valuation buyers present in the market. We present evidence consistent with this prediction using the taxi price data from the field experiments.

3.2 Compromise

The model above considers haggling to be the result of asymmetric information. In other words, it represents bargaining as a zero-sum game. Compromise is a technique often used in bargaining. Sellers set prices high knowing they will negotiate down, and buyers often open with prices lower than they are willing to pay. This strategy is commonly used when negotiating for items such as a car, a house or goods at a flea market. While there are plenty of instances in everyday life of compromise in bargaining, it is not clear whether it

[6] Of course it is also possible to obtain a haggling equilibrium if some buyers strictly prefer to obtain the good sooner at a price of 2 rather than waiting for a price of 1. In this case, neither buyers nor sellers needs to randomize (see e.g., Fudenberg et al. (1987)

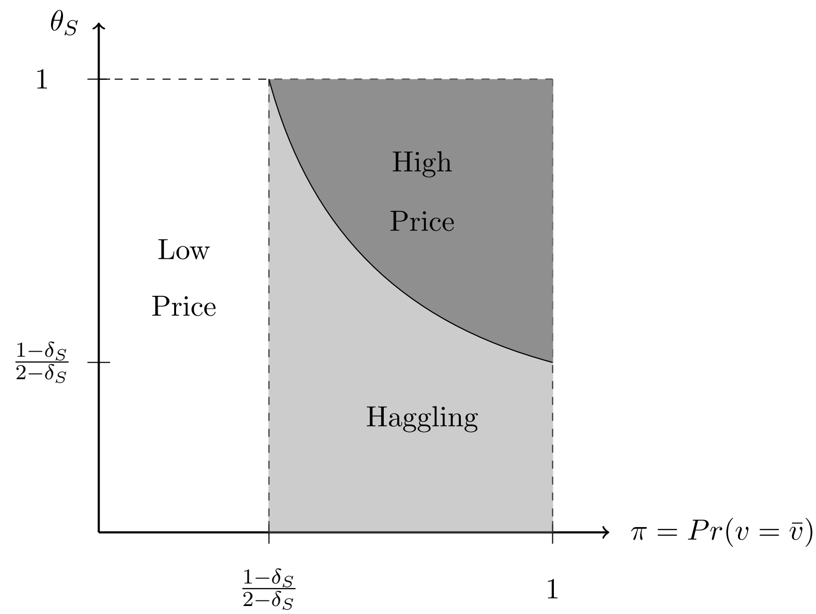


Figure 1: Relationship between frequency of re-matching (θ_S) and prevalence of high valuation buyers (π) on predicted equilibria

might work for reasons other than information transmission. In this context, if the final agreed upon price is the same with or without compromise, it should not matter how buyers and sellers got to that price. Incentive compatibility would suggest that this would be the case. Yet, reference dependent preferences would suggest that starting points in bargaining might matter even absent asymmetric information. Evidence from laboratory experiments shows that compromise in bargaining yields a higher likelihood of acceptance (Bazerman and Neale, 1993; Liebert, Smith, and Hill, 1968; Yukl, 1974).

To illustrate the consequences of allowing buyers to make offers to sellers, consider a modification of the model in which a buyer can make a unique first offer to the seller. As before, the agent receiving the offer can either accept or reject it. In the case of accepting, the game ends. In the case of rejecting, the seller and the buyer decide whether to go separate ways or to continue to a new round of negotiations. All offers after the first can only be made by the seller. This game simply appends one round of negotiations to our previous game in which the buyer starts by making the first offer. This model, while differing from the actual way negotiations occur in our field market, is complex enough to illustrate the issues caused by allowing buyers, the informed party, to make initial offers. More important to us, this model will allow us to derive testable hypotheses for the market under study.

Notice that the mixed-strategy equilibrium constructed for the case in which a buyer's valuation of the good can take only two values cannot be an equilibrium of a game in which buyers can make initial offers. For this to be an equilibrium, the high-valuation buyer is made indifferent between accepting a high price right away and waiting an extra period for prices to drop at the risk of the negotiation being terminated. If negotiation is costly, buyers with high valuations will strictly prefer to declare their valuation when given the chance, destroying the possibility of this equilibrium. For screening of buyers by sellers to survive in equilibrium, buyers must be sufficiently afraid that revealing information about themselves will lead to even higher prices than those in equilibrium. That is, the seller must not be able to charge the highest price that some buyer might be willing to pay. Some pooling of types is necessary.

We now describe an equilibrium in which communication is used to coordinate on what equilibrium to play. We present an example in which communication by the informed party is meaningful.[7] Suppose that buyers' valuations can take one of three possible values: v_3, v_2, and v_1 with probability π_3, π_2, and π_1. Buyers' values are such that $v_3 > 3 > v_2 > 2 > v_1 > 1$.[8] Buyers with valuation v_3 would prefer to wait one period to pay 2 rather than paying 3 immediately, but they would not prefer to wait one more period to pay 1 rather than paying 2 immediately. Buyers with valuation v_2 prefer to wait one period to pay 1 rather than paying 2 immediately. Sellers have zero costs of production. The distribution of buyers' valuations and the seller's production cost are common knowledge.

There is an equilibrium in which buyers with value v_1 who are indifferent between offering a price of 0 and a price of 1 offer to pay 1 with probability q_1 and 0 with probability $1 - q_1$. Buyers with values v_2 and v_3 always offer sellers a price of 1. That is, there is pooling at price 1. A seller that observes an offer of 0 is indifferent between offering a price of 1, which he does with probability y_0, and stopping negotiations altogether, which he does with probability $1 - y_0$. A seller that observes a offer of 1 counter-offers a price of 2 with probability 1. If rejected, the seller randomizes between lowering the price to 1, with probability y_1, and ending negotiations altogether, which he does with probability $1 - y_1$. Finally, if a seller observes an offer of 2 he counter-offers with a price of 3 until this price is accepted.[9] Buyers with value v_1 always accept a price of 1 and reject any price higher than 1. Buyers with value v_2 always accept a price of 1 and randomize between accepting a price of 2, with probability q_2, and rejecting it. They always reject prices above 2. Finally, buyers with valuation v_3 accept any price below 3. The probabilities q_1 and q_2 are chosen in a manner that insures that the seller's outside option is equal to 1. Similarly, probabilities y_0 and y_1 are chosen to secure that buyers with valuations v_1 and v_2 randomize.

The basic feature of this equilibrium is that buyers can credibly coordinate. Low valuation buyers trade-off between receiving a price of 1 early but less frequently and receiving it later more frequently. High valuation buyers prefer to reduce the risk of not trading by revealing a higher willingness to pay. Finally, buyers with valuations v_2 and v_3 prefer to

[7] Ausubel and Deneckere (1992b) show that under certain circumstances there are no equilibrium in which the informed party reveals meaningful information.

[8] Samuelson (1992) shows that it is possible for buyers to engage in haggling if the asymmetry of information is both-sided. With only two types, the possible equilibria entail only one side of the market haggling. The model presented here allows both sides of the market to engage in communication.

[9] This situation is off the equilibrium path.

avoid being tagged as one that can pay 3.

An important feature of this equilibrium is that sellers must be more likely to abandon negotiations when buyers' offers are low (offer $p = 0$) than when buyers offers are high (offer $p = 1$). In particular, this equilibrium is consistent with buyers being offered lower prices immediately, conditional on a seller having not abandoned a negotiation altogether after observing a low price. In other words, if information is truthfully revealed, there is no reason for sellers to further screen low-valuation buyers. The model also predicts that negotiations should be more likely to end immediately after a low offer is received. That low offers lead to more frequent termination of negotiations is necessary to prevent higher valuation buyers to pool with low-valuation buyers. The important empirical implication of this observation is that signals must be costly to carry information.

Offers made by buyers can also be used to build a reputation. Consider the alternative extreme situation where only the informed agent, the buyer, makes offers and the uninformed agent, the seller, does not make offers and instead only decides whether to accept, renegotiate or abandon negotiations. In this case, the seller can delay acceptance of an offer as a way to screen buyers. Buyers therefore build reputations on how much they are willing to pay. Intuitively, incentive compatibility (that must hold in any equilibrium of the game) will require that lower prices are accepted less frequently or with delay. If the only cost associated with haggling is delay, it must be the case that the only way a buyer can signal his type is by making a sufficient number of unacceptable offers. The content of the unacceptable offer is irrelevant. This is important because it implies that only the length, and not the content, of past offers is informative.

Figure 2 illustrate the structure of equilibria when buyers can make an initial offer. As in the first model where only sellers make offers, haggling requires the presence of a sufficiently large proportion of high-valuation buyers. That is, whenever a high-price, take-it-or-leave-it equilibrium exists, it is possible to construct an equilibrium in which the seller haggles. Contrary to the first model, an equilibrium in which buyers partially reveal their types and sellers screen high types cannot occur if there are too many buyers with the highest valuation possible (v_3). Buyers with valuation v_3 can pool with lower valuation buyers only if there are not too many of high-valuation types.[10] The "Talk & Haggling" area in Figure 2 represents the set of parameters in which it is possible to construct an equilibrium in which both buyers signal their types and sellers screen buyers. The area called "Haggling" represents the set of parameters in which screening by sellers is possible, but signalling by buyers is not.

The models presented in this section illustrate that whether talk by buyers is meaningful or not, incentive compatibility must be respected. Initial offers by buyers affect

[10] The equilibrium of a reputation model in our context is similar to those presented by Camerer and Weigelt (1988) and Neral and Ochs (1992) for the case of lending and by Cho (1990) for bargaining. Equilibrium of the model predicts that negotiations stop in finite time. Equilibrium strategies might also require a period where all players use pure strategies followed by a period in which players use mixed strategies.

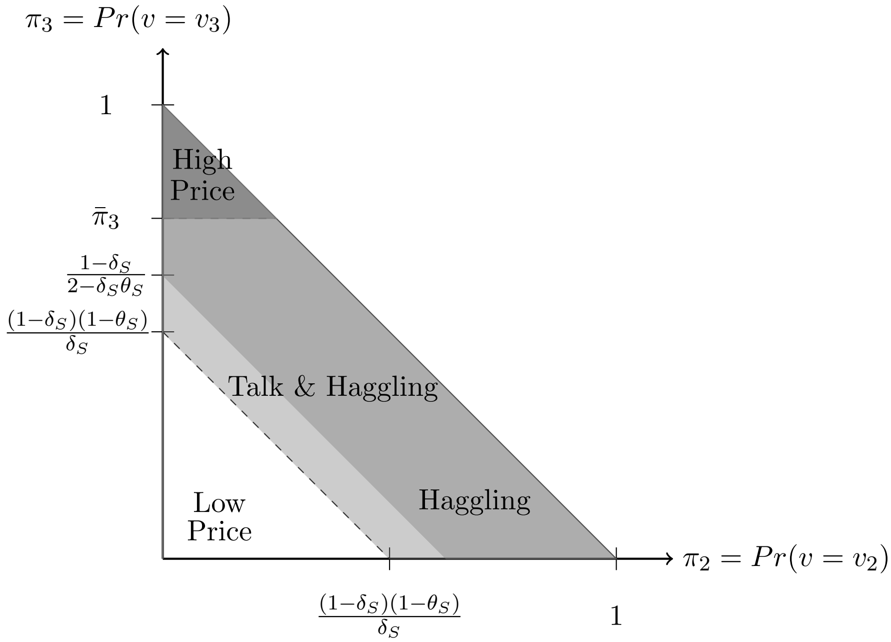


Figure 2: Structure of equilibria when buyers can make an initial offer

how bargaining proceeds, but it requires that one type of buyer trades-off between shorter negotiations with a higher likelihood of rejection and longer negotiations with fewer disagreements. Also, buyers can pool on a series of equally unacceptable offers as a way to signal their willingness to pay. What a buyer says before the first acceptable offer is irrelevant. In all cases, buyers cannot obtain lower prices sooner without violating incentive compatibility. This yield another prediction of the model.

Prediction 2: Opening offers from buyers will affect how bargaining proceeds but will not affect final prices.

Evidence consistent with this prediction is presented in the Results section using the taxi price data from the field experiment.

4 Field Experiment Designs

4.1 Experiment 1 - Sellers

The first experiment is designed to examine the behavior of sellers in the taxi market (i.e. taxi drivers). The protocol and data of this first experiment are from Castillo et al. (2013).[11] Six men and six women are trained to be taxi passengers. They negotiate for a predetermined taxi fare to travel from one destination to another. Passengers are instructed to negotiate for and travel along a number of different routes. Each route consists of three

[11] The description of the experimental protocol is largely borrowed from Castillo et al. (2013).

locations, that is, they travel from destination A to B, then from B to C and then return from C to A. Passengers travel in the reverse direction as well.

At each location they hail a taxi at random, approach the passenger window and ask: "How much would it cost to go to [destination X]?" After the taxi driver quotes a price, the passenger follows a fixed-offer bargaining script by stating an experimenter determined price p_{max}. We will refer to p_{max} as the maximum-acceptable offer. The specific response to the taxi driver's price is nothing other than "p_{max}." There is no other dialogue. The passenger repeats this response after each price from the taxi driver and continues until either the taxi driver accepts the price or leaves in disagreement. Thus only the driver can change the price and terminate the negotiation. If the first price quoted by the taxi driver is p_{max}, then there is no further negotiation. If the driver accepts the passenger's offer, the passenger takes the taxi to the predetermined destination. If the offer is rejected and the taxi leaves in disagreement, the passenger is instructed to step away from the street, take out a cell phone as if they just received a call, and wait for the street to clear of any taxis that might have seen that the passenger's last negotiation ended unsuccessfully. From the passenger's perspective, any subsequent negations can therefore be perceived as fresh. Passengers who, after a period of time, failed to reach the predetermined price for travel to a location were instructed to take a taxi (at a possibly higher price) to the next location. This protocol permits us to obtain observations for all passengers on all routes across the morning.

There are several reasons why we selected this very simple bargaining structure. First, the bargaining approach is similar to that used in the market. It is common practice for customers to approach the passenger-side window and ask for a price with the expectation that the taxi driver makes an initial offer and some negotiation will ensue. Second, as noted earlier, while there is substantial variation in how passengers respond to the drivers stated price in the market, the strategy of simply responding with a maximum-acceptable offer is commonly used by both men and women. Third, the limited language of the script makes it easier for our passengers to follow the instructions of staying as neutral as possible, avoiding facial expression and intonation. Finally and most importantly, the script along with passengers completing the transaction allows us to observe the entire path of negotiation.

To get informative reservation prices and to secure demanding bargaining we wanted to use maximum-acceptable offers which were low enough to trigger bargaining and rejections, yet high enough to be taken seriously by the driver. Consultation with several taxi drivers and taxi companies helped us select maximum-acceptable offers which were meant to capture the lowest price a taxi driver would accept for a particular route.

To secure a competitive environment, we conduct the experiment at central and busy business locations between 8 am to 1 pm, Monday through Friday. Focusing on these hours helps secure that the objective of travel is comparable for men and women and that drivers have similar outside options. We examine negotiations on 30 different routes over a total of 9 days. The distance between the three points on each route varied greatly. The two shortest routes were 1.2 miles and 1.6 miles long and the two longest routes were 3.8 miles and 3.9 miles long. We chose several routes and distances to ensure that the results are robust and not simply a reflection of a particular population of taxi drivers favoring certain routes.

The six men and six women passengers were chosen so that we have "couples" for whom the primary difference is gender. The two members of a couple are chosen to have similar age, appearance and height. All passengers are trained in the same way and by the same experimenters. All passengers dress alike to avoid attire that might signal personal characteristics. In particular, all participants wear dark pants and a plain, long-sleeve, dark shirt for the entire period of the study. Women do not wear make-up, and men are clean shaven. Neither of these characteristics differs from common attire or appearance in the market. Our trained passengers are paid 15 soles for transportation to the study and another 45 soles per day to conduct the study.[12] Each passenger carries a small notebook to keep a record of the prices of the negotiation, the time of the negotiation, car characteristics, market conditions etc. In addition they also carry an MP3 player that is used to record negotiations. The recordings of the negotiations allow us to verify the passengers recorded data and to reconstruct data in case of faulty note taking. The recordings also serve as a monitor that the passenger follows the experimental protocol. We verified the recordings, and all passengers followed the protocol.

In total, there were 1090 negotiations between a male driver and one of our twelve trained passengers.

4.2 Experiment 2 - Buyers

The second experiment is designed to examine the behavior of buyers in the taxi market (i.e. taxi passengers). In this experiment, a confederate taxi driver operated in commuter areas of the city during peak and non-peak commuting hours. The driver stopped when any individual standing alone hailed the taxi, yielding 286 observations - 245 (85%) with a single passenger and 35 (12%) with two passengers and 6 with three passengers.[13] Prices were quoted only to those taking short (5-10 minutes) and medium (10-25 minutes) routes. Long routes were avoided to speed up data collection.[14] The protocol established that a

[12]At the time of the study, the Peruvian currency, the sol, was worth about US$0.27 (or US$1 = 3.65 soles).

[13]There were 390 "contacts" with potential passengers across the morning and afternoon sessions (155 observations between 7am and noon and the remainder from 2-5pm), however, only 286 resulted in a negotiation between the taxi driver and at most two passengers and followed the experimental protocol. The majority of the remaining contacts were with a single buyer but involved a long route. A few contacts were with a large group of passengers or did not follow the protocol (e.g. involved an opening price initiated by the passenger).

[14]Because the taxi driver actually took the passenger on the negotiated ride, long rides would have reduced the number of observations collected. If the passenger requested a long trip, the driver asked what price the passenger would be willing to pay and then, following a common practice to end a negotiation in this

passenger willing to pay the quoted price would be driven to their destination. There were 183 passengers who were given a ride.

After the passenger stated the desired destination for the ride, the passenger was quoted a fixed, pre-established price based on distance that was high enough to prompt negotiations. The procedure to choose the initial offer varied throughout the data collection. During the first two days, prices were chosen at random within a range of set prices by distance (short, medium). The procedure was changed to a fixed price by distance to ease implementation for the driver. Data were always collected on the passenger's response to the opening offer and market conditions. Some negotiations moved to a second round. Different protocols were used to respond to second round counter offers. Of the 286 negotiations, 160 reached a second round. In this case, the driver insisted on the same price in 71 observations, and he dropped the price by 1 unit in 50 obs. For the remaining 39 obs, the passenger made the offer and offered at least one currency unit less.

Negotiations were audio and video recorded discretely, and the taxi had a GPS device in the vehicle so trip routes were recorded. All data have been verified, and the driver followed the experimental protocol.[15] The average length of a taxi ride, calculated using shortest path available, is 9.1 minutes (s.d. 6.4). Fifty-one percent of the passengers were male. The average guessed age of passengers is 35.3 (s.d. 11.1).

4.3 Experiment 3 - Compromise

The third experiment is designed to examine if actions by buyers affect negotiation outcomes. In this experiment, we use a simple variation of Experiment 1. First, data are collected for a no-compromise experiment that replicates the design of Experiment 1. Second, data are collected for a compromise treatment that modifies Experiment 1 by simply having the confederate taxi passenger start one currency unit below the minimum-acceptable price for the first offer. If the negotiation moves to a second round, the passenger then increases the offer to the minimum-acceptable price. Once a passenger reaches the minimum-acceptable price, he or she insists on this price as in experiment 1. Thus, in this experiment, confederate passengers show a willingness to negotiate.

There are 376 negotiations in the no compromise treatment and 316 in the compromise treatment.

market, simply said he did not go there and drove away. 70 negotiations ended for this reason.

[15] There is no evidence that prices (treatments) quoted by the driver varied with the characteristic of the passenger. The coefficient for male in the regression of initial price quoted by the confederate taxi driver is 0.275 (s.e. = 0.212, p-value = 0.195). The regression controls for the length of the ride, hour of the day and day of the week.

5 Results

Using the results from the three experiments, we discuss bargaining outcomes in this field market and the empirical relevance of the predictions derived in the theory section.

The data from Experiment 1 show that, as expected, there is a large amount of competition in the market. Our passengers reported that for 70 percent of the negotiations a second taxi pulled up behind the first taxi to wait for the first negotiation to fail. Despite the additional taxi waiting behind, prices quoted by the driver of the first taxi were not affected. This absence of a response is perhaps an indication of both the passenger's transaction cost in moving from one taxi to the next and of the large number of taxis in the market. Whether or not there was a taxi waiting behind for a failed negotiation, alternate taxis were always readily available in the vicinity.

We begin by determining whether we succeeded in selecting maximum-acceptable offers which were low enough to trigger negotiations and potentially rejections, yet high enough to be taken seriously. Conditional on the route's maximum-acceptable offer, Table 1 reports the distribution of initial prices quoted by drivers. Consistent with our example in the theory section, in 99.9 percent of the cases, drivers only stated prices in integers. Also, as an indication that prices were aggressively determined, the driver's initial prices were never below the maximum-acceptable offer we used on the route, and only rarely (2.8 percent) did the two prices coincide. Evidence that agreement was within reach is seen from 22.5 percent of the initial prices being within one sol of being acceptable. Conditional on the maximum-acceptable offer, we see substantial variation in the initial prices passengers received. This heterogeneity is to be expected given that we are considering different routes at each offer, and that the market conditions and the driver's outside option are changing over the course of the day. The mode of the initial price is in bold for each maximum-acceptable offer, and shows that the gap between the driver's initial price and the passenger's maximum-acceptable offer was most commonly 2 soles (38 percent). While a gap of 2 soles is the mode for routes with maximum-acceptable offers of 3, 4, and 6 soles, the 5 soles routes appear to have been priced more aggressively with a modal gap of 3 soles. Overall 40 percent of our negotiations start off with a 3 soles or greater gap between the driver's initial price and the maximum-acceptable offer.

The maximum-acceptable offers were low enough to trigger rejections. The last row in Table 1 reports the rate at which the passenger and driver failed to reach an agreement during the negotiation. Sixty-two percent of the negotiations ended with the drivers final price being higher than the maximum-acceptable offer and the driver rejecting the passenger. The rate of rejection was largest on the 5-soles routes where the initial-price gap was largest.

While the rate of rejection is high in our study, it is important to note that rejections are common in this market. For comparison, we discretely observed naturally-occurring taxi negotiations at a distance at four of the locations and during the hours we examined in our study. The objective was to determine the rejection rates naturally seen in the market

Table 1: Distribution of Initial Prices by Maximum-Acceptable Offer

	Maximum-acceptable offer				
Initial price	3	4	5	6	Total
3	7	0	0	0	7
4	18	9	0	0	27
5	**51**	100	9	0	160
6	20	**212**	31	5	268
7	19	128	51	66	264
8	3	57	**107**	**98**	265
9	1	5	21	20	47
10	0	4	24	20	48
12	0	0	1	1	2
13	0	0	0	1	1
15	0	0	0	1	1
Total	119	515	244	212	1090
Average Initial Price (s.d.)	5.3 (1.2)	6.3 (1.0)	7.7 (1.2)	8.0 (1.1)	6.8 (1.4)
Rejection Rate	0.555	0.639	0.734	0.505	0.625

Note: The highlighted bold entries indicate the modal price for each maximum-acceptable offer.

without experimental intervention. Although we do not have information on prices or the pattern of negotiations, because we were too far away to hear, we can observe whether a negotiation ends with the passenger getting in the taxi or moving on to negotiate with a different taxi. Of the 211 negotiations we observed, 196 were ones when the passenger first entered the market (i.e., negotiating with the first taxi). We found that 28 percent of these new negotiations and 29 percent of all negotiations failed. While this rate of failure is smaller than that observed in our study, it nonetheless makes clear that rejections are common in the market.

Our data from experiment 1 reveal substantial differences in the length of the negotiation. Table 2 presents the outcome of the negotiations at each round. Here we define a negotiation round to consist of the driver asking for a price, the passenger responding with the maximum-acceptable offer and the driver deciding whether to accept or reject the passenger. In the first negotiation round (row 1) 20 percent of the passengers were accepted at the maximum-acceptable offer, 28 percent of passengers were rejected, and 52 percent negotiated for an additional round. As the duration of the negotiation increases the rate of rejection increases and it becomes less and less likely that the driver enters another round of negotiations.

While our trained passengers experienced substantial variation in the initial price and in the length of the negotiation, changes in driver prices were quite similar over the course of the negotiation. The driver's second price was most likely to be one sol smaller than the first, and discounts of two soles or more were only seen in 15 percent of the negotiations. Figure 3 shows the price path for negotiations that lasted exactly one round (immediate rejection), two rounds (offer and counter-offer), and three and four rounds. We observe that

Table 2: Distribution of Negotiation Outcomes

	Acceptances	Rejections	Renegotiations	Total
Round 1	221 (20)	303 (28)	566 (52)	1090
Round 2	136 (24)	271 (48)	159 (28)	566
Round 3	44 (28)	90 (57)	25 (16)	159
Round 4	7 (28)	16 (64)	2 (8)	25

Note: Row percentages in parentheses.

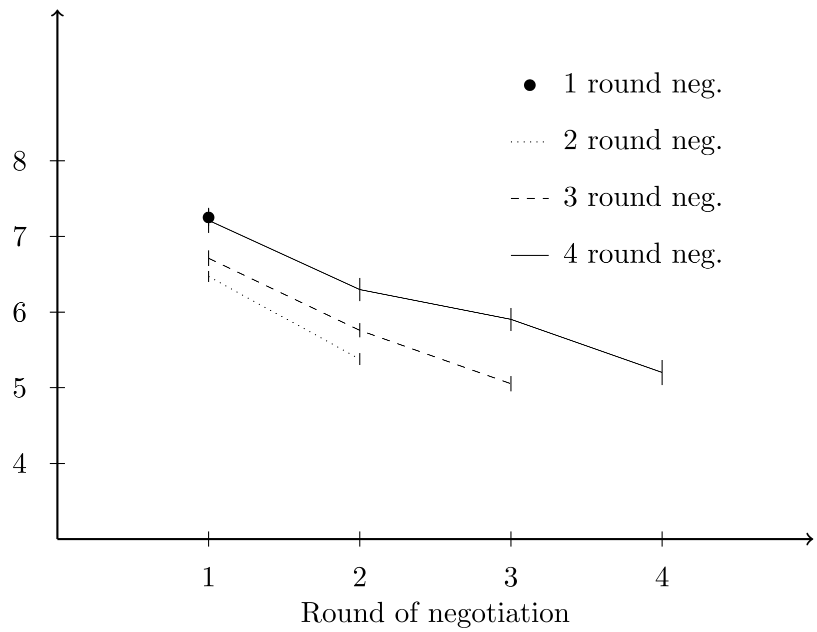


Figure 3: Price paths of negotiations

prices tend to drop about 1 sol per round and that negotiations that lasted longer tended to start at higher prices.

As indicated by the greater rejection rate on the more aggressively priced 5-soles routes, the outcome of the negotiation is sensitive to the gap between the drivers initial price and the passengers maximum-acceptable offer. Figure 4 shows the outcome of the negotiation conditional on the initial price differential. As noted earlier the modal price differential between the initial price and the maximum-acceptable offer was 2 soles. The probability of reaching an agreement decreases substantially with the gap in initial prices. When the initial gap in prices is 2 soles or less, 56.5 percent of negotiations end with the driver accepting the maximum-acceptable offer, however this percentage drops to a mere 8.9 percent when the initial price gap is 3 soles or more.

The aggregate data show that the selected maximum-acceptable offers were low enough to trigger negotiations and rejections, yet high enough to result in transactions. As expected the driver initially asks for a high initial price, then lowers the price and ultimately rejects

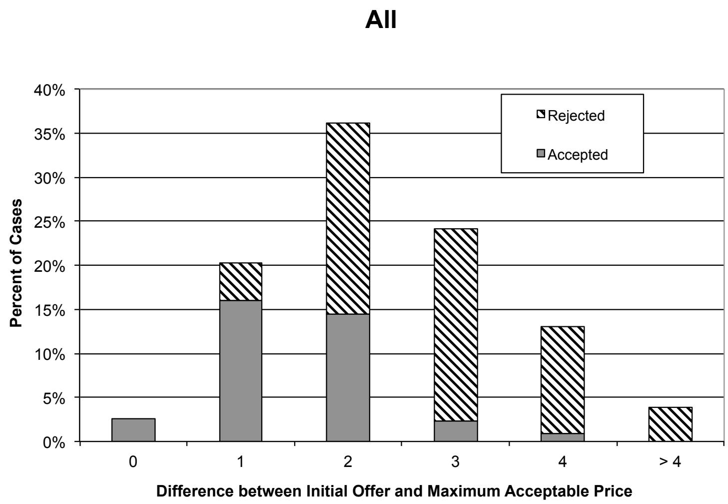


Figure 4: Bargaining Outcome Conditional on Difference Between Initial Price and Maximum-Acceptable Offer

the passenger when there are no gains from trade.

In summary, behavior of sellers in this market is consistent with a model of screening. While prices drop by round, there is no certainty that negotiations will continue to another round. Importantly, the fact that the probability of agreement depends on the gap between first offers and the maximum acceptable price suggests that the costs of sellers are heterogeneous as well.

5.1 Haggling

The analysis thus far has examined behavior at the negotiation level. That is, it abstracts from variations in market conditions and the reactions of agents to these changes. The discussion in the theory section, however, shows that environmental conditions determine which equilibrium is likely to be observed. The ability to look at general equilibrium effects as market conditions change is one distinct advantage of collecting bargaining data in the field.

Figure 5 present observational data on disagreements from our "on the street" observations. These data were collected in four different market locations during the morning hours. As discussed in the theory section, disagreements are more likely to occur whenever sellers face a larger proportion of high-valuation buyers and when the probability of re-matching is high. To observe changes in equilibrium effects, it is necessary that supply cannot meet demand. This occurs naturally in congested markets such as the market for a taxi. The figure shows that disagreements are more likely to occur early in the morning and around noon when individuals are traveling to work at the start of the business day and are taking a lunch break.

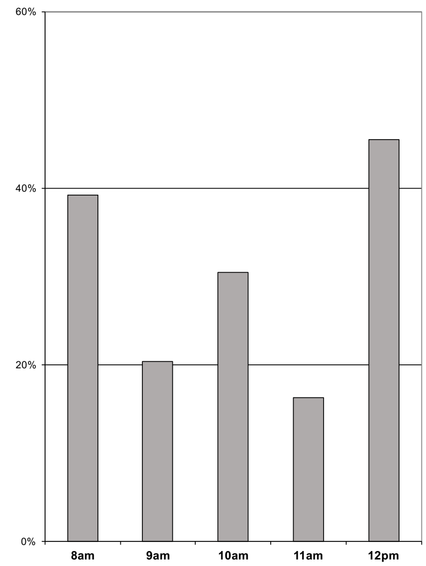


Figure 5: "On the Street" Observed Disagreements (N = 211, 4 sites)

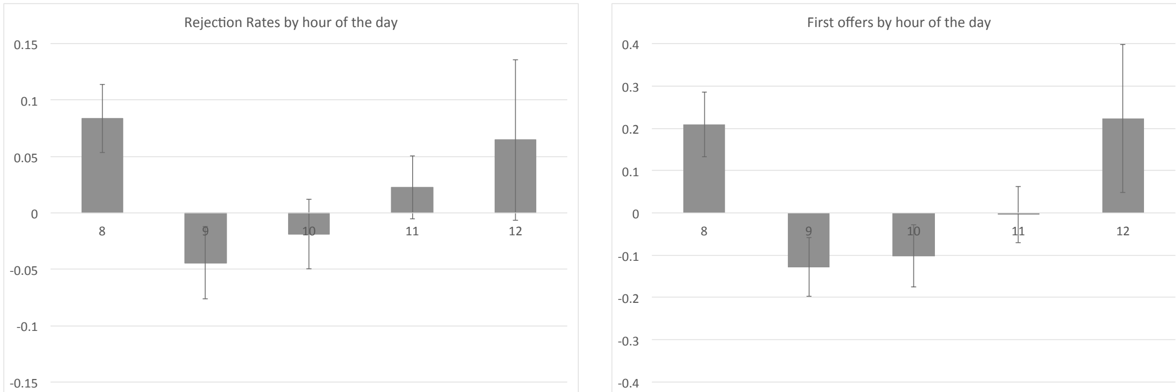
While suggestive, the results are not conclusive because those in the market during those hours select to be there and the strategies they play. In order to identify both supply and demand, we need to fix either the strategies of buyers or sellers.

Using the data from Experiment 1, we can test Prediction 1 of the model and examine if market conditions affect rejection rates and opening offers. These data eliminate selection and strategy as an explanation of outcomes because all of our confederate passengers participated in the market from 8am to noon and all used the same bargaining strategy. Figure 6 presents deviations from average rejection rates and opening offers by hour of the day using data from experiment 1.[16] Consistent with Prediction 1, we see that rejection rates and offers are higher early in the morning and around noon. These results show that market conditions do affect the selection of equilibrium in the field.

The theoretical model shows that the behavior of sellers and buyers can adjust to market conditions. A priori, we would expect to see the change in behavior by buyers to mirror that of sellers. The data from experiment 2 allow us to examine this possibility. Figure 7 presents the probability that a buyer rejected the offer made by the confederate taxi driver and, if a rejection did not occur, the requested price discount. As in Figure 6, the graphs present deviations from average rejection rates and requested price discounts.[17] For this experiment, we have observations for a wider time frame (i.e. from 7am to noon and from 4pm to 7pm). Again, consistent with Prediction 1, we observe that, with the exception of 7am, buyers, as sellers, are also less likely to reject offers and ask for discounts in the

[16] These are deviations from linear regressions that control for day of the week and route.

[17] Deviations are calculated from a linear regression that controls for day of the week and route characteristics.



Rejections   First offers

Figure 6: Sellers behavior by hour of the day - Deviations from the mean (data from Experiment 1)

morning, and buyers are tougher bargainers in the evening.

The experimental data on the behavior of buyers and sellers in this market are consistent with the intuition from the theoretical model.

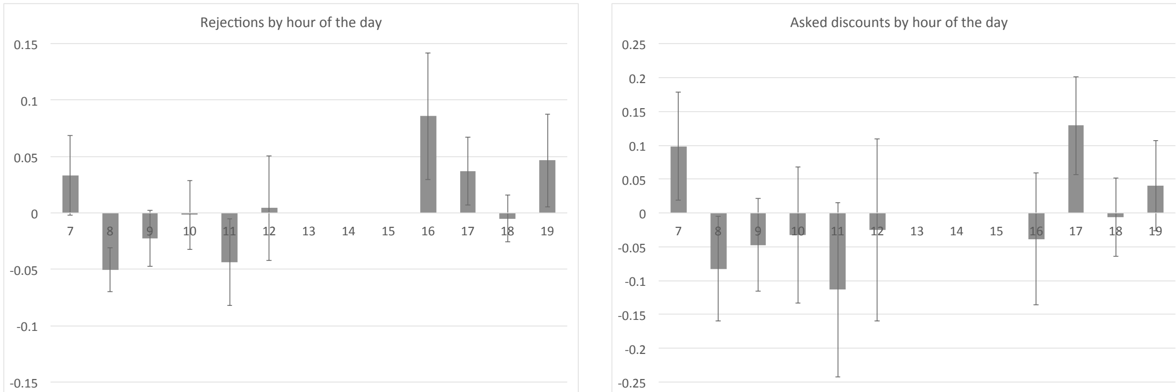
5.2 Compromise

The theory section provides an example in which buyers find it profitable to signal their valuation of the good. Buyers with relatively high valuations pool into a message that reveals that they are willing to pay a higher price. To avoid paying the maximum possible price, however, the highest valuation buyer pools with lower valuation buyers. The lowest valuation buyers are indifferent between revealing their valuation by making a non-serious offer and offering the minimum price charged by the seller.

The take away from that example is that communication is incentive-compatible. Buyers with different valuations must weakly prefer the messages they send. As discussed by Ausubel and Deneckere (1992a,b), bargaining outcomes can be implemented in alternative ways provided these strategies are part of an equilibrium. In the particular example provided in the theory section, another possible equilibrium is one in which buyers never volunteer information, but sellers still screen them through delay.

Experiment 3 tests Prediction 2 that bargaining outcomes are impervious to attempts by buyers to manipulate outcomes through negotiation. In particular, we examine whether bargaining outcomes are affected by the first offer tendered by buyers. Recall that in Experiment 3 confederate passengers altered only the first offer and then followed the strategy used in Experiment 1.

Table 3 shows the distribution of initial offers by taxi drivers by treatment and time of



Rejections

Amount of requested price discount

Figure 7: Buyers behavior by hour of the day - Deviations from the mean (data from Experiment 2)

Table 3: Distribution of prices by treatment and time of the day

	7am till 1pm		7am till 10am		10am till 1pm	
Price	Compromise	No Compr.	Compromise	No Compr.	Compromise	No Compr.
5	6 (2)	9 (3)	4 (5)	4 (2)	2 (1)	5 (3)
6	17 (7)	17 (5)	3 (4)	8 (5)	14 (8)	9 (6)
7	39 (15)	50 (15)	10 (13)	26 (15)	29 (16)	24 (16)
8	114 (44)	136 (41)	32 (41)	61 (35)	82 (46)	75 (49)
9	28 (11)	36 (11)	8 (10)	25 (14)	20 (11)	11 (7)
10	49 (19)	74 (23)	18 (23)	47 (27)	31 (17)	27 (18)
12	4 (2)	5 (2)	2 (3)	4 (2)	2 (1)	1 (1)
13	1 (0)	1 (0)	1 (1)	0 (0)	0 (0)	1 (1)

Note: Column percentages in parentheses.

the day. We observe price dispersion and higher prices in the early hours of the day. However, there are no large differences in initial offers by taxi drivers between the compromise treatment and the no compromise treatment. Our experimental data are balanced.

Tables 4 and 5 present the outcomes of negotiations by round and treatment. These tables suggest that, consistent with Prediction 2, the final outcome of the negotiation (acceptance or rejection) is independent of the bargaining procedure (difference in distributions test p-value = 0.7548). In the first round, those in the no compromise treatment are more likely to be accepted and not be rejected, whereas those in the compromise treatment are less likely to be accepted and more likely to renegotiate. In the second round, those in the compromise treatment are more likely to be accepted than those in the no compromise (diff in means test p-value = 0.000). Despite these initial differences in rejection rates across

Table 4: No compromise treatment

	Accept	Reject	Renegotiate	Total
Round 1	93 (25)	68 (18)	215 (57)	376 (43)
Round 2	60 (28)	87 (40)	68 (32)	215 (39)
Round 3	17 (25)	36 (53)	15 (22)	68 (14)
Round 4	3 (20)	9 (60)	3 (20)	15 (3)
Round 5	1 (33)	1 (33)	1 (33)	3 (1)
Round 6	0 (0)	1 (100)	0 (0)	1 (0)
Accept/Reject	46	54		

Table 5: Compromise treatment

	Accept	Reject	Renegotiate	Total
Round 1	19 (6)	74 (23)	223 (71)	316 (29)
Round 2	116 (52)	59 (26)	48 (22)	223 (55)
Round 3	7 (15)	31 (65)	10 (21)	48 (12)
Round 4	4 (40)	2 (20)	4 (40)	10 (2)
Round 5	1 (25)	3 (75)	0 (0)	4 (1)
Accept/Reject	47	53		

treatments, they disappear in later rounds and look the same in the aggregate.

These results imply that either starting negotiations with higher prices and compromising allows buyers and sellers to coordinate on an equilibrium that reaches an agreement sooner or initial prices are not informative at all. While higher rejection rates after starting negotiations with higher prices in the no compromise treatment is consistent with the coordination equilibrium, incentive compatibility would require that more outright rejections in the compromise treatment condition be observed.

Figure 8 presents the price paths by round in the compromise and no compromise treatments. We observe that these price paths are similar and reproduce the finding in Figure 2. Overall, bargaining outcomes are the same across treatments, but the path to that same outcome is different depending on whether the buyer shows compromise or not. This further illustrates the overall consistency of behavior in markets with theoretical predictions.

6 Studying bargaining in the field

Much of the experimental work on bargaining behavior has been done in tightly-controlled lab experiments. These have proven to be extremely insightful and provide a direct test of theory under various sets of parameters. Tests of bargaining theory can also be taken to

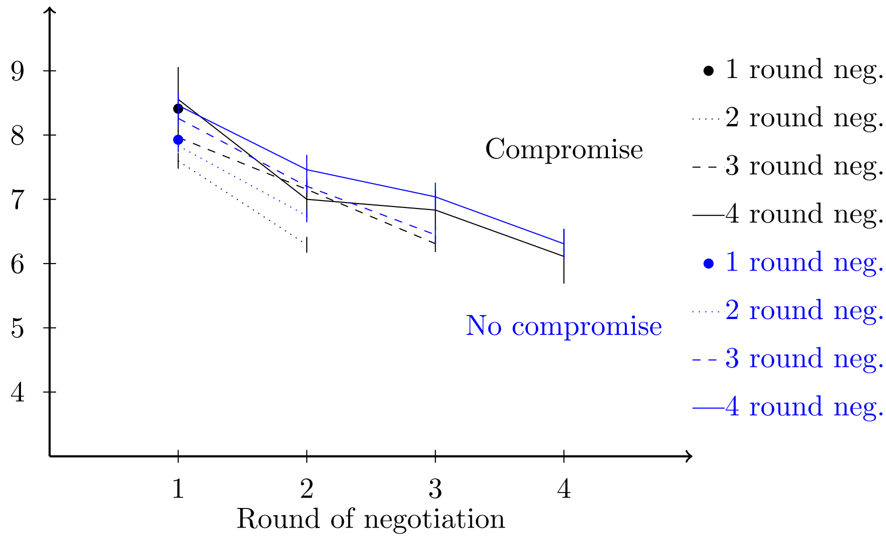


Figure 8: Price paths by round of negotiation

the field and provide important discoveries of behavior and strategies of buyers and sellers.

Given that outcomes of a bargaining encounter are the result of a market equilibrium, it is of particular interest to test bargaining theory in the field. As we have illustrated, this can be done by fixing the bargaining strategy of one side of the market (buyer or seller) and examining the behavior of the other side of the market under various market conditions (e.g. when demand increases and decreases over the course of the day). This approach is fruitful and relevant to a deeper understanding of behavior in the field. While the field yields a bit of the tight control of a laboratory environment, experiments can be designed to deliver a direct test of the theory in the natural market under study with minimal compromise and an opportunity to exploit changing market conditions to test for the existence of various equilibria. Our results show that the theory seems to work well in the field.

7 Conclusions

We test bargaining theory using negotiations between a buyer and a seller in a field experiment in the taxi market in Peru. Taxi passengers and taxi drivers engage in alternating offer bargaining in this market, and the market environment and outcomes are consistent with a model of screening. Theoretical predictions suggest that market conditions will affect outcomes – when demand is high, there should be more rejections and higher prices. In addition, the theory also predicts that, due to incentive compatibility, an expression of compromise will alter the bargaining price path but will not alter final prices.

Our field experimental design focuses on testing these predictions directly. By fixing the bargaining strategy of either the buyer or the seller, we test the predictions in the field. Also, by entering in negotiations over the course of a week day, as demand fluctuates during rush hour, lunch hour and work time, we examine how market conditions affect outcomes.

Consistent with the predictions from the theoretical model, we show more rejections and higher prices during peak commuting times when high-value buyers are looking for transportation. We also show that showing a willingness to compromise in the negotiation does alter the sequence of offers, however, the final transaction price is no different from showing no willingness to compromise.

Studying the predictions of bargaining theory in the field is important to further understanding of how markets with screening work and how equilibrium selection interacts with market conditions. Conditions are not static and outcomes respond as predicted.

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8 Appendix

The appendix provides more detail on the construction of the equilibria included in the theory section.

8.1 Matching in markets

Unmatched buyers and sellers always search for a new match. The actions available to a seller if matched are to offer a price of 1 or 2 and remain in the match or to leave the match and search for a new partner in the event that the price is rejected. The actions available to a buyer if matched is to accept an offered price and remain matched or to reject an offer and leave the match to search conditional on the seller remaining in the match.

Table A1 reproduces the proposed equilibria in Samuelson (1992). Strategies depend only on whether the agents are matched or not. Samuelson (1992) shows that the no return equilibrium exists for all values of π. Denote by V_s the expected equilibrium payoff of a seller. A matched seller will offer a price of 1 if this is better than eventually returning to the pool of unmatched agents and obtaining $\delta_s V_s$. This will be the outcome if players follow the recommended equilibrium strategies since $V_s = \theta_s 1 + (1 - \theta_s)\delta_s V_s < 1$. Given the strategies, it is also the case that after a rejection, both seller and buyer prefer to remain matched and trade at 1 than going back to the pool of unmatched agents and be matched again with less than certainty. Finally, since we assume that $\bar{v} - 2 < \delta_B(\bar{v} - 1)$, it follows that high-value buyers are better off rejecting an offer of 2 than trading later at a price of 1.

In the return equilibrium, sellers offer a price of 2 and abandon negotiations if the buyer rejects the offer. The equilibrium requires that sellers find it profitable to return to the pool of unmatched agents after a rejection and obtain $\delta_s V_s$ rather than offering a price of 1 and obtaining $\delta_s 1$. It also requires that offering a price of 2 and obtaining an expected payoff of $\pi 2 + (1 - \pi)\delta_s V_s$ is better than offering a price of 1 that is accepted by everyone. Since the expected payoff of the seller in this equilibrium is $V_s = \theta_s(\pi 2 + (1 - \pi)\delta_s V_s) + (1 - \theta_s)\delta_s V_s$, it follows that $V_s > 1$ implies that $\pi 2 + (1 - \pi)\delta_s V_s > 1$. Given these conditions, this equilibrium is possible if $\pi > \frac{1-\delta_s}{2-\delta_s\theta_s}$.

In addition to these equilibria, we also can construct a haggling equilibrium as the one discussed in the theory section. Let p be the probability with which a high-value buyer accepts a price of 2 when offered and let q be the probability with which a seller drops the price to 1 if the price of 2 is rejected. A seller is indifferent between dropping the price to 1 and searching for a new partner if V_s equals 1. p is the probability with which a high-value buyer accepts a price of 2 such that V_s equals 1. However, high-value buyers will be indifferent between accepting and rejecting an offer of 2 if $\bar{v} - 2 = \delta_B(\bar{v} - 1)q + V_b(\bar{v})(1 - q)$, where $V_b(\bar{v})$ is the equilibrium payoffs of a buyer of value $\bar{v}$. Note that the above equalities imply that $p = \frac{1-\delta_s}{(2-\delta_s)\pi}$ and $q = \frac{(\bar{v}-2)-V_b(\bar{v})\delta_B}{(\bar{v}-1)\delta_B-V_b(\bar{v})\delta_B}$.[18] This implies that a haggling equilibrium can occur only if $\bar{v} < \frac{2-\delta_B}{1-\delta_B}$ and $\pi > \frac{1-\delta_s}{2-\delta_s}$. The haggling equilibrium can occur when a screening (return) equilibrium cannot.

Table A1

Strategies of matched agents in period t:							
	Seller	Buyer with value $\underline{v}$			Buyer of value $\bar{v}$		
	search if buyer rejects	response to $p = 1$	response to $p = 2$	search if seller stays	response to $p = 1$	response to $p = 2$	search if seller stays
No return	no	accept	reject	no	accept	reject	no
Return	yes	accept	reject	no	accept	accept	no

[18] In equilibrium, $V_B(\bar{v}) = \frac{\theta_B(\bar{v}-2)}{1-\delta_s+\theta_B\delta_s}$.