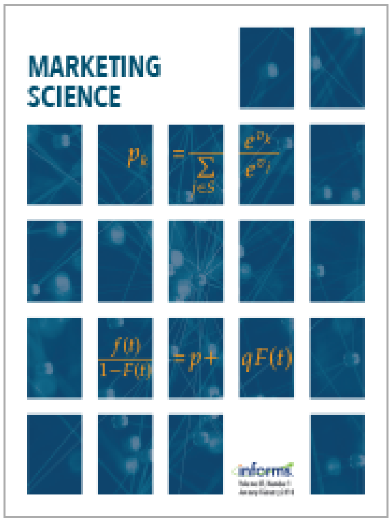

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Abstract

Manufacturers and distributors in marketing channels commonly establish prices, margins, and other trade terms through negotiations. These negotiations have significant impact on channel members' profit streams over the duration of the business relationship. We consider a situation where a manufacturer and an exclusive, independent distributor are negotiating the transfer (wholesale) price of a new product. The transfer price should lie between the manufacturer's production cost and the maximum resale price that the distributor can charge end consumers (consumers' reservation price). We assume that the negotiations occur in an incomplete and asymmetric information environment such that the manufacturer is uncertain about the consumers' reservation price, whereas the distributor knows it precisely because of proximity to the consumer. The negotiation is time-sensitive because of the threat of potential competitive entry. Both parties have identical opportunity costs of delay in reaching agreement.

In this incomplete and asymmetric information environment, the negotiators must learn before they can reach agreement. However, each negotiator has an incentive to convince the other that the available surplus is smaller than it really is. Hence, a high (low) offer (counteroffer) has little credibility without opportunity costs of delay. For any given manufacturer offer, a distributor facing a low consumer reservation price has a small available surplus and therefore more incentive to delay agreement than if the price is high. Willingness to delay agreement and incur delay costs lends credibility to the price signal in an offer (counteroffer), providing a means for communicating credibly and facilitating agreement. Thus, with incomplete, asymmetric information and opportunity costs of delay, a signaling formulation with alternating offers and counteroffers captures key strategic characteristics of marketing channel negotiations.

We adapt a game-theoretic model (Grossman and Perry 1986a, 1986b) to predict bargaining behavior and outcomes in this channel negotiation scenario. We derive both point predictions and directional implications from this sequential equilibrium (SE) bargaining model regarding how manufacturer uncertainty about distributor value (consumers' reservation price), opportunity cost of delay, and the actual reservation price (total surplus) should influence bargaining outcomes. The predictions are tested in two experiments. The point predictions serve as benchmarks against which we evaluate the observed bargaining outcomes, as we focus on testing the model's directional implications. We also explore the underlying bargaining process to assess the extent to which subjects conform to the SE signaling rationale in optimizing channel profits.

Both experiments show that the point predictions of the SE model fall considerably short in describing bargaining behavior and outcomes. The players bargained suboptimally, took longer to agree, and could not extract the total available surplus. Nevertheless, the data are consistent with several directional predictions of the SE model. There is consistent support for the predicted directional effects of manufacturer uncertainty and consumer reservation prices. As expected, high uncertainty impeded efficient negotiation, eliciting high first offers from manufacturers and increasing bargaining duration. Also, higher reservation prices (higher surplus) lowered bargaining duration, increased bargaining efficiency, and raised profits for both parties. However, support for the predicted directional effects of opportunity cost of delay is mixed. Higher delay costs produced quicker agreements, but distributors did not benefit from their informational advantage.

Although the directional results suggest that the SE model is a good representation of bargaining behavior, a closer analysis shows that the bargaining process data did not correspond to the specific signaling rationale of the SE model. Rather, these data suggest that the bargainers created simplified representations of the price negotiation and used heuristics to develop their offers and counteroffers. We observe two systematic patterns of deviations from the SE model. Some manufacturers may have used the counteroffer levels to infer the distributors' competitive stance and factored this into their responses. Thus, even though the distributor counteroffers carried signals of the consumer reservation price, the manufacturers delayed agreement because they either did not recognize the signal or thought it was unreliable. In other cases, the data are consistent with a simple, nonstrategic model (EMP) in which the manufacturer and the distributor divide the monetary payoff (surplus) equally. The results show that the effectiveness of signaling mechanisms depends not only on the economic characteristics of the bargaining situation, but also on shared individual and social contexts that influence how signals are transmitted and interpreted.

(*Distribution Channels*; *Margin Negotiation*; *Sequential Bargaining*; *Behavioral Game Theory*; *Experimental Economics*)

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1. Introduction

Consider a situation where a manufacturer has developed a new product and needs to employ an exclusive, independent distributor. The two parties (both profit maximizers) must negotiate an agreement on the product's transfer (wholesale) price, which is expected to lie between the manufacturer's production cost and the maximum resale price that the distributor can charge end consumers (consumers' reservation price). Because such negotiations are common and play an important role in facilitating coordination and resolving conflict in distribution channels (Jeuland and Shugan 1983), there is considerable interest in the underlying behavioral processes and normative principles governing them (Corfman and Gupta 1993).

Although there is an extensive theoretical and experimental literature in economics and psychology (Roth 1995a, 1995b) the marketing literature on negotiations is relatively sparse. The published work includes a few behavioral process studies (e.g., Dwyer and Walker 1981, McAlister et al. 1986) and a handful of normatively oriented papers (e.g., Balakrishnan and Eliashberg 1995). Very few studies have reported tests of normative bargaining outcomes in marketing contexts. Exceptions include Neslin and Greenhalgh (1983, 1986), who tested the predictive power of the Nash (1953) cooperative solution in a media-purchasing scenario; and Eliashberg et al. (1986), who examined Nash's theory along with two group-utility theories in a channel (price-setting) context. Consistent with the experimental economics and psychology literatures, these marketing studies also found weak correspondence between the Nash predictions and empirical outcomes.

Even though Nash's cooperative formulation is a key normative benchmark for testing models of two-person negotiations, it is limited as a representation of bargaining behavior. Time plays no role in this static formulation which ignores details of the bargaining *process* (Svejnar 1986) and cannot predict bargaining duration. Some of its axioms, e.g., independence of irrelevant alternatives and pareto-efficiency, are controversial (Luce and Raiffa 1957, Osborne and Rubinstein 1990). Also, the model assumes complete information, whereas the information environment in channel negotiations is often incomplete and/or asymmetric (Eliashberg et al. 1986). Sometimes, both parties in manufacturer-distributor negotiations are uncertain about the consumers' reservation price, p. Alternatively, as is common in consumer markets, the manufacturer may know p from market research and hold an informational advantage over the distributor. In other cases, perhaps more likely in industrial buying, the distributor is closer to the end consumer and has more information about p than the manufacturer (see Corey et al. 1989).

Recent developments in noncooperative models of two-person bargaining create new opportunities for examining bargaining behavior in marketing situations. Many of the models are based on Rubinstein's (1982) formulation of a sequential bargaining process in discrete time with alternating offers and counteroffers. Time and information are critical elements in these formulations. Delayed agreements (i.e., an extended sequence of offers and counteroffers) have opportunity costs that are represented by a discount factor or fixed delay cost that reduces payoffs to both parties. Although Rubinstein's (1982) analysis assumed complete information, several newer models relax this assumption, allowing both one-sided (e.g., Grossman and Perry 1986a, 1986b; Rubinstein 1985) and two-sided (e.g., Chatterjee and Samuelson 1988) uncertainty.

Incomplete information creates the need for negotiator learning before agreement can be reached. However, the process is complicated by each negotiator's incentive to convince the other that the available surplus is smaller than it really is. In a marketing channel context, the manufacturer and the distributor know each other's incentive to deceive. Hence, a high (low) offer (counteroffer) has little credibility were it not for the opportunity cost of delay. Marketing negotiations are often about time-sensitive opportunities (e.g., because of declining consumer interest as novelty erodes, or the threat of margin losses because of a potential competitive entry). For any given manufacturer offer, a distributor who faces a low consumer reservation price p has a small available surplus and therefore more incentive to delay agreement than if p were high. Hence, willingness to delay agreement and incur delay costs lends credibility to the price signal in a counteroffer. Delay thus provides a means for communicating credibly and facilitating agreement. With incomplete information and delay costs, a signaling formulation with alternating offers/counteroffers captures important strategic characteristics of marketing channel negotiations (Corfman and Gupta 1993, Eliashberg et al. 1993).

The present study examines price/margin setting in marketing channels within a sequential bargaining framework. A game-theoretic model due to Grossman and Perry (GP 1986a, 1986b; see also Gul and Sonnenschein 1988) is adapted to predict bargaining behavior and outcomes in marketing channels. We study a manufacturer and an independent distributor negotiating sequentially to establish the transfer (wholesale) price of an indivisible good in a one-sided incomplete information game. Both parties are assumed to maximize their expected utilities consistent with their beliefs. Following GP (1986a, 1986b), we derive point predictions and directional implications from the sequential equilibrium SE model about how market factors (e.g., informational disparities between the manufacturer and distributor and the opportunity cost of delay) influence bargaining. The predictions are tested in two laboratory experiments using a channel negotiation scenario adapted from a popular marketing case. The point predictions serve as benchmarks against which we assess the observed bargaining outcomes, although our focus is on testing the model's directional implications. Moreover, we examine the bargaining process underlying the outcomes to examine the degree to which subjects conform to the SE signaling rationale in order to optimize channel profits. The experiments assess the descriptive power of the game theoretic model and explore observed behavioral regularities that depart from the model's normative predictions.

The remainder of the paper is organized as follows. Section 2 motivates our choice of the bargaining model for this study. We then describe the bargaining mechanism, the SE solution, and present the point predictions and the directional implications of the model. In Section 3, we review prior empirical work on sequential bargaining models, and develop our framework for testing the SE solution. We outline the expected offer/counteroffer patterns under the SE signaling rationale, and possible behavioral departures in two situations. In one case, negotiators infer their opponents' bargaining stance from the offers and respond accordingly. In the second case, they settle on equal monetary payoffs (EMP) versus seeking to maximize income. Section 4 overviews the empirical work. Sections 5 and 6 describe the two experimental studies and their findings, respectively. Section 7 highlights the key results and interprets the observed behavioral processes with respect to the SE and other signaling assumptions and the EMP model. Section 8 presents the implications of the findings.

2. The Sequential Bargaining Model

The GP bargaining model is chosen in this study for two main reasons. First, our goal is to study the effects of information asymmetry and opportunity costs of delay in the substantive context of price and margin negotiations in marketing channels. Hence, we choose a sequential bargaining model with one-sided incomplete information and delay costs. This corresponds to a case where the distributor is close to end consumers and knows the reservation price p, thus holding an informational advantage over the manufacturer. Our model allows the bargainers to alternate offers and counteroffers (the manufacturer moves first), has no exogenous restrictions on bargaining duration (infinite horizon), but delay has opportunity cost that is attributed in our study to the threat of a potential competitive entry. These model features are fairly general and correspond to the time-sensitive, incomplete information and sequential character of marketing channel negotiations (see Corey et al. 1989, Stern and El-Ansary 1988).

Second, experimental economists and psychologists have reported many empirical tests of sequential bargaining models, examining the predictive power of the equilibrium solutions and the role of various strategic factors. Together, these studies explore the status of game theory as a descriptive model of observed bargaining behavior (Roth 1995a, 1995b). The initial empirical work focused on complete information models. Some studies tested finite horizon models with exogenous restrictions on bargaining duration (e.g., Guth et al. 1982, Ochs and Roth 1989), whereas others examined infinite horizon models (e.g., Rapoport et al.

1990, Weg et al. 1990). The patterns of rejections and disadvantageous counteroffers in these studies depart systematically from predictions based on income maximization, suggesting that considerations such as fairness and equity may have influenced bargaining behavior.

Few experimental tests have been reported for incomplete information models (either one-sided or two-sided), where one or both parties have private information (Roth 1995b). Also, the studies have usually focused on finite horizon games. Rapoport et al. (1995) test an infinite horizon model, but their "Tunisian Bazaar" mechanism allows only the uninformed player to make offers that the informed player can merely accept or reject. In contrast, the model we test allows negotiators to make alternate offers and counteroffers and to delay agreement without a restricted bargaining duration. These features enhance the model's correspondence to price/margin negotiations in marketing channels and extend the two-person bargaining institutions tested in experimental economics and psychology. Moreover, we show that the offer/counteroffer relationships in this mechanism provide diagnostics regarding the extent to which fairness and equity considerations may override income-maximizing behavior.

2.1. Bargaining Mechanism

In our scenario, a manufacturer negotiates with a prospective distributor on the transfer (wholesale) price of a new product. The manufacturer's cost (reservation price) for the product is c, and we assume (for tractability) a product technology such that c is common knowledge (i.e., known to both the distributor and the manufacturer). Without market information, the manufacturer may consider a price based on cost rather than end-consumer or distributor perceived value (Monroe 1990). The information environment is incomplete, however. The available public information on market demand leaves the manufacturer uncertain about the maximum (reservation) price p that consumers will pay for the product. This uncertainty is denoted by a probability distribution, $F(p)$, with support $[p_l, p_h]$, where $p_l \geq c$. $F(p)$ is common knowledge, i.e., the distributor knows the manufacturer's $F(p)$. However, being close to the market, the distributor has additional private information and knows p with certainty. In this one-sided information structure, the two parties must negotiate a transfer price, w where ($c \leq w \leq p$).

Bargaining is modeled as a stylized sequential process with the parties making alternate offers. Time is divided into discrete periods ($t = 1, 2, 3\ldots$). At $t = 1$, the manufacturer makes a price offer that the distributor can either accept or reject. If the distributor accepts, bargaining ends (at $t = 1$). Rejection is followed by a counteroffer at $t = 2$. Offers and counteroffers continue until agreement is reached, or one or both parties terminate the negotiation. Bargaining is driven by the opportunity cost of delayed agreements, which could be the same or different for the two parties. In our study, delay cost is attributed to the threat of potential competitive entry. It is denoted by a discount factor δ ($0 < \delta < 1$) that is assumed to be known and equal for both parties. If agreement is reached on an offer (counteroffer) w at t, the game outcome is the pair (w, t). The associated utility (payoff) functions for the manufacturer and distributor are $U_m(w, t) = \delta^{t-1}(w - c)$ and $U_d(w, t) = \delta^{t-1}(p - w)$, respectively.

The above two-person sequential bargaining process with one-sided uncertainty has been analyzed by Grossman and Perry (1986a, 1986b) and also by Gul and Sonnenschein (1988). These authors have derived and studied the properties of an SE solution (a refinement of the Nash equilibrium) in which both parties maximize their expected utilities consistent with their beliefs (see appendix). The information structure and bargaining rules for this model correspond well to marketing channel negotiations. However, other informational structures (e.g., two-sided incomplete information) and bargaining processes (e.g., seller offers only, instead of an offer/counteroffer sequence) are also possible and require different analyses.

The SE can be informally characterized as follows. Bargaining starts with the manufacturer making the first offer, w. In each period, given a manufacturer offer, w, the distributor partitions the probability distribution $F(p)$ into three segments (high, moderate, and low). If p is in the high segment relative to w, the distributor accepts the offer. If p is low relative to w, the distributor rejects the offer and makes an unacceptable counteroffer (an offer less than what the manufacturer would accept knowing with certainty that $p = p_l$). Finally, if p is in the moderate segment, the distributor rejects w as before, but makes an acceptable counteroffer (the lowest offer that the manufacturer should accept with certainty). An unacceptable counteroffer from the distributor implicitly signals the manufacturer that p is much lower than what s/he might have presumed.

The main theoretical result is that distributors who derive only a small surplus from the transaction reveal their lower willingness to pay WTP and signal their low p with a counteroffer that delays settlement. Without explicit communication, this allows the distributor to convey private information credibly to the manufacturer. Indeed, because of the implicit incentive to deceive in this situation, even explicit communication may only produce cheap talk. Hence, delay is a key ingredient in this intuition. The distributor can assert that p is low, but the manufacturer can verify this by delaying long enough. Depending on the level of δ, delaying agreement allows the manufacturer to assess the distributors' true WTP. If p is indeed high, the distributor benefits by agreeing early. Thus, the bargaining process establishes a common informational basis for p among the negotiators and facilitates agreement.

This signaling mechanism has conceptual appeal because the negotiators can potentially infer reservation prices and converge to agreement. However, the underlying behavioral process assumptions remain unexplored. For instance, one party may not recognize the price signal embedded in the counteroffer or may use the counteroffer to infer the opponent's bargaining stance. Other evidence shows that fairness and equity considerations may influence the bargainers. We explore the extent to which players follow the SE model's signaling assumptions, use other heuristics, or use fairness considerations in making offers and counteroffers.

2.2. Model Predictions and Testable Hypotheses

The SE solution provides a set of empirically testable predictions. We examine three factors: manufacturer uncertainty $[p_l, p_h]$, opportunity cost of delay δ, and reservation price p; and we assess their effects on dependent measures such as first prices, bargaining duration, final prices, and individual profits. These measures allow examination of both bargaining outcomes and underlying processes. We focus first on the SE predictions and then examine the deviations to determine if these are directionally consistent with the implications of the SE model. This explores the possibility that deviations from the predicted solution simply reflect inaccurate assessment of utility functions and perhaps imprecise Bayesian updates of beliefs (Ochs and Roth 1989). We then explore whether behavioral regularities in the data suggest significant departures from the utility maximization and signaling intuition of the SE model. Finally, we examine the correspondence of the data to a model (EMP) in which the negotiators simply seek equal monetary payoffs.

2.2.1. Manufacturer Uncertainty. We represent the manufacturer's uncertainty by the probability distribution $F(p)$ with support $[p_l, p_h]$. Table 1 shows the point predictions of the SE for the two sets of uncertainty parameters (low $[p_l = \$130, p_h = \$150]$, and high $[p_l = \$110, p_h = \$170]$) selected for Study 1 (see Srivastava et al. 1996 for solution procedures).[1] Given a mean-preserving spread, a directional implication of the SE is that the manufacturer's first offer should increase as manufacturer uncertainty increases. The wider range implies a higher p_h and suggests to the manufacturer the possibility of a higher surplus. By making a higher first offer, the manufacturer increases the likelihood of capturing the same or a larger proportion of the surplus (if it is indeed higher). As Table

[1]The predictions are expected values over the range of consumer reservation prices denoted by $F(p)$.

Table 1 Experiment 1: Expected and Observed Means of Dependent Measures

	High Uncertainty		Low Uncertainty	
Dependent Measures	Expected	Observed	Expected	Observed
First Price ($)	119.62	133.89 (11.27)***	118.49	127.03 (6.98)***
Number of Periods	3.23	5.67 (3.42)**	1.00	3.00 (2.65)***
Final Price ($)	109.52	114.87 (7.54)***	118.49	118.46 (3.23)
Bargaining Efficiency	0.79	0.70 (0.26)**	1.00	0.84 (0.16)***
Manufacturer Profit ($)	7.85	11.21 (8.14)***	18.49	15.49 (4.64)***
Distributor Profit ($)	25.25	15.75 (12.43)***	21.51	16.94 (5.39)***

Note: Standard deviations appear in parentheses.

Difference between the observed mean and the point prediction significant at *** ($p < 0.0001$); ** $p < 0.005$.

1 shows, the expected SE results for the given parameters are consistent with this intuition.[2]

The SE also determines a function $t(p, F)$ that specifies the number of bargaining periods before agreement is reached. This bargaining duration is a function of the consumers' reservation price p and the manufacturer's beliefs $F(p)$. Rubinstein (1982) shows that under complete information (i.e., when p is common knowledge) there is a unique subgame perfect equilibrium where bargaining ends immediately (at $t = 1$). However, the SE solution concept changes with incomplete information since the offers and counteroffers carry information about p. Thus, as the mean preserving spread of the manufacturer's beliefs $[p_l, p_h]$ increases, $t(p, F)$ also increases. The intuition is that more uncertainty must be resolved through information transmission. The longer sequence of offers and counteroffers delays agreement. In turn, the longer bargaining duration decreases the final SE price, lowering the manufacturer's profit and increasing that of the distributor. The SE results for our study parameters are consistent with this reasoning (Table 1). Also, for any given final price, the discount factor for delay ($\delta < 1$) further lowers the manufacturer's profit. The distributor's higher profit reflects the net impact of the gain from a lower final price and the lost surplus due to delayed agreement.

2.2.2. Opportunity Cost of Delay. A discount factor δ represents the opportunity cost of delay (e.g., because of the threat of potential competitive entry). Table 2 shows the point predictions for the two levels of δ (high = 0.9 and low = 0.6) used in Study 2. The SE implies that the first price should increase as δ decreases (i.e., more surplus is lost each period). Because delayed agreements are more costly when δ is lower, the distributor may feel more pressure to accept the first offer. Hence, the manufacturer should ask for a higher initial price to press home the advantage of moving first.[3] The SE also implies that bargaining duration increases with δ. In other words, the lower the surplus lost from delaying agreement, the more patient the bargainers should be.

Table 2 **Experiment 2: Expected and Observed Means of Dependent Measures**

	High Discount Factor		Low Discount Factor	
Dependent Measures	Expected	Observed	Expected	Observed
First Price ($)	119.62	141.22 (10.80)***	120.82	129.47 (5.80)***
Number of Periods	3.23	6.15 (8.33)*	1.57	2.40 (1.22)***
Final Price ($)	109.52	118.05 (9.24)***	112.06	117.54 (9.73)**
Bargaining Efficiency	0.79	0.72 (0.28)*	0.77	0.57 (0.31)***
Manufacturer Profit ($)	7.85	13.74 (9.16)***	11.76	11.76 (11.14)
Distributor Profit ($)	25.25	15.11 (11.41)**	23.46	12.49 (10.86)***

Note: Standard deviations appear in parentheses; Difference between the observed mean and the point prediction significant at *** ($p < 0.0001$); ** $p < 0.005$; *$p < 0.05$.

Third, when δ is high the distributor has more incentive to indicate falsely that p is low. As $\delta \rightarrow 1$, delaying agreement has little effect on the surplus and the manufacturer is not in a strong position to use delay strategically. This should result in a lower final price. Consequently, in equilibrium, the manufacturer's profit should decrease as δ increases. The distributor's share of the surplus should increase correspondingly. As shown in Table 2, the SE solutions correspond to this intuition for the Study 2 parameters. Note that the net impact on the distributor's profit will reflect the surplus lost from the increase in bargaining duration.

2.2.3. Consumers' Reservation Price. The manufacturer does not know the consumers' reservation price p when bargaining begins. Therefore, the first offer should be unaffected by the value of p. However, the model assumes that as negotiation proceeds, information about p is transmitted via the offers and counteroffers. Distributors who derive a relatively small surplus from the transaction (lower p) reveal a lower WTP by delaying settlement. Hence, the SE implies that the higher the p, the higher the final price and the

[2]Although these directional implications cannot be analytically confirmed, the SE solution procedure (see appendix) was replicated with several parameter sets to confirm that the model predictions were directionally consistent with intuition.

[3]In contrast, the bargaining literature in psychology suggests that increased cost of delay (a lower discount factor) will lead to lower first offers in efforts to hasten agreement and avoid the cost of prolonged negotiation.

shorter the bargaining duration. The total gain from trade (surplus) increases with p, and less surplus is lost since agreement is reached more quickly. The shorter bargaining duration (because of the higher surplus) should increase profits for both parties.

3. Process Underpinnings of the Bargaining Model

The above point predictions and directional implications of the sequential bargaining model with one-sided incomplete information are based on the SE analysis. Comparing the predictions to the observed bargaining outcomes directly tests the model. However, the equilibrium is driven by an underlying signaling rationale in which the income-maximizing players use Bayesian updating to interpret and respond to the offers/counteroffers that carry information about p. We assess the degree to which the bargaining process conforms to this signaling rationale by examining the relation between the offers and counteroffers along several dimensions.

First, the signaling rationale implies a specific pattern of relationships between offers and counteroffers. Thus, for the Study 1 parameters, the SE prediction in the high uncertainty condition (HU) is that the manufacturer should make an initial offer of \$119.62, which the distributor should accept if the reservation price, $p \geq \$161$. But, for p between \$110 and \$161, the distributor should reject the offer and make an unacceptable counteroffer (<\$104.74) regardless of the value of p.[4] In other words, the SE model implies that the counteroffer and the reservation price (p) should be correlated zero for all values of $p < \$161$. In the low uncertainty (LU) condition, the SE predicts that the manufacturer's first offer should be \$118.49 and the distributor should accept immediately.

Second, the SE model also predicts that distributors in a specific range of p values should reach agreement in the same period. Thus, in condition HU (Study 1) the SE prediction is that bargaining should end in three periods for all p values between \$143 and \$161. The prediction stems from the belief that the distributor will take strategic advantage of being the fully informed party. The correspondence between predicted and observed behavior indicates the extent to which the subjects followed the SE signaling rationale.

Third, departures from the SE signaling rationale may be explored using the observed correlations between the manufacturer's first price and the distributor's counteroffer, and between the distributor's counteroffer and the manufacturer's second offer, respectively. If the price signals embedded in the offers go unrecognized, or if players infer their opponents' bargaining stance from the offers and factor this into their responses, the correlations should differ systematically from the SE predictions. For example, a low distributor counteroffer may lead the manufacturer to infer an excessively competitive stance and respond similarly. Such behavior, if systematic, should generate a correlation between offers and counteroffers in domains where the SE rationale would predict no correlation. Therefore, these correlations, along with the players' self reported perceptions of opponent behavior, may suggest qualitative departures from the SE signaling rationale.

Similar SE predictions exist for the discount factor manipulation in Study 2. The high discount (HD) condition in Study 2 has the same parameters as the HU condition in Study 1. In the low discount LD condition, the SE model predicts that, given the manufacturer's first offer of \$120.82, the distributor should accept if $p \geq \$144$. If $p < \$144$, the distributor should reject the offer and make an acceptable counteroffer of \$105.37. Thus, the distributor should make the same counteroffer for p values between \$110 and \$144, (i.e., the counteroffer should be uncorrelated with p in this range). The match between these normative predictions regarding bargaining duration and the relation between offers and counteroffers and observed behavior suggests whether subjects follow the SE model's signaling rationale.

Finally, a basic implication of the SE model is that rational distributors will not make disadvantageous

[4]An unacceptable counteroffer is one that is lower than what the manufacturer would accept if (s)he knows with certainty that $p = p_l$ (i.e., \$110 here). It is calculated as $\delta(p_l - c)/(1 + \delta)$. For the remaining sequence, the manufacturer offers \$109.92 assuming that $p = p_h = \$161$ (updated from its first period value of \$170). The distributor accepts the offer if $p \geq \$143$. However, if $p < \$143$, the distributor rejects the manufacturer's offer and makes an acceptable counteroffer of \$106.24.

counteroffers. In other words, a distributor who rejects an allocation at period t will always demand a share at period $t + 1$ that equals or exceeds the share that s/he has rejected. However, in tests of complete information bargaining models, both experimental economists and psychologists report frequent and systematic violations of this seemingly innocuous requirement (Roth 1995b). Some authors (e.g., Camerer 1990, Prasnikar and Roth 1992, Straub and Murnighan 1995) interpret these results as evidence that fairness and equity considerations interact with the strategic aspects of the sequential bargaining game. Others (e.g., Ochs and Roth 1989) argue that while fairness considerations may influence bargaining outcomes, it is not the case that players aspire to be fair. They suggest that experiments testing complete information sequential bargaining games may have failed to control for the bargainers' preferences such that these were not common knowledge.

Incomplete information games (where uncertainty is explicitly modeled) may provide a better forum for testing the role of fairness and equity considerations (Kennan and Wilson 1993). Here, the uninformed player does not know what is a "fair" offer. Hence, it is easier to distinguish between the strategic and fairness concerns of the informed player. We therefore compare the SE model to a model called equal monetary payoffs (EMP) that is an obvious "focal point" because it incorporates notions of both fairness and equality (Roth 1995b). The EMP model is not game-theoretic but simply postulates that the players tend to reach agreements in which their net payoffs are about equal (Rapoport et al. 1990). This is a prominent empirical result in both experimental economics (Prasnikar and Roth 1992) and psychology (Rapoport et al. 1990).

To illustrate and compare the predictions of the SE and EMP models, consider the Experiment 2 parameters: [p_l = \$110, p_h = \$170, $\delta = 0.6$, c = \$100], and let p = \$130. The SE model predicts that the manufacturer's initial offer should be \$120.82, which the distributor should reject. At $t = 2$, the distributor should make a counteroffer of \$105.37 which the manufacturer should accept. Bargaining should last for two periods and yield net payoffs of \$3.22 and \$14.78 for the manufacturer and distributor, respectively. The EMP model predicts an equal split. Although the EMP model cannot predict the first offer or the bargaining duration (the manufacturer does not know p), it predicts a distributor counteroffer of $(c + p)/2$ such that the profits are shared equally. If the uncertainty is reduced to [p_l = \$130, p_h = \$150], the SE model predicts that the manufacturer's profit will increase relative to the earlier case. In contrast, the EMP model continues to predict an equal split of the surplus. Thus, the predictions of the two models differ significantly.

4. Overview of Empirical Work

The SE and EMP models were tested in two experiments that simulated marketing channel negotiations. The scenarios were realistic adaptations of a popular case on distributor price and margin setting ("Cumberland Metal Industries—Engineered Product Division 1980," Quelch et al. 1993). Subjects played a manufacturer or a distributor negotiating the transfer price for a new industrial product that had significant impact on end-consumer economics. In our adaptation, the manufacturer had little market information and significant uncertainty about the consumers' reservation price p. In contrast, the distributor was close to the consumer and knew p precisely. For any price, subjects playing the manufacturer role knew only their own profits, whereas those playing the distributor role knew both players' profits. The study scenario conformed closely to the SE model assumptions. No communication was allowed other than offers and counteroffers.

Experiment 1 tested how varying manufacturer uncertainty influenced the bargaining process and outcomes. Experiment 2 tested the effects of different levels of opportunity cost of delay. The two variables were manipulated (within-subject) in Experiments 1 and 2, respectively, and changes were examined in a set of dependent measures of bargaining outcomes and processes. Uncertainty, $F(p)$, was manipulated by varying the range of p to be high or low with constant mean. Opportunity cost of delay δ was varied at two levels and attributed to the potential threat of competitive entry. Each subject played the bargaining game at least eight times and was matched with different opponents. Consumer reservation price was varied randomly from game to game to preserve the one-shot nature of the games, consistent with theory. The design also permitted us to study how consumers' reservation price affects bargaining behavior and outcomes.

Subjects in both studies had full-time work experience and were recruited from graduate business programs (including the regular and executive MBA) at a large public university. A total of 46 subjects (35% female) participated in the two studies. Subjects' mean age was 29, and they had 4 years of full-time work experience on average. About 60% had prior experience with business negotiations. Subjects were paid a token $5 for participation as well as a monetary reward contingent on performance. The studies were computer-administered using custom software written for this research (Srivastava 1996, Srivastava et al. 1996).

5. Experiment 1: Effects of Manufacturer Uncertainty

5.1. Procedure

In Experiment 1, manufacturer uncertainty, $F(p)$, was manipulated at two levels (the range of p was varied to be high and low with constant mean) holding opportunity cost of delay constant ($\delta = 0.9$). Thirty subjects participated in three groups of ten. Five subjects in each group were randomly assigned the manufacturer role, and five others were assigned the distributor role. Each read a scenario that included a common background for the negotiation, as well as instructions for the assigned (manufacturer or distributor) role. Subjects had 20 minutes to read the instructions and played two practice games (to become familiar with the computer-based bargaining process) before starting negotiations. Each subject sat in a separate booth through the experiment.

In two of the three groups, each subject played a total of 10 games. In the third group, technical problems limited each subject (five manufacturers and five distributors) to only eight games. To minimize confusion, subjects in each group first completed five (four) games in the first uncertainty condition and then five (four) more games in the second condition. For example, in two groups, five manufacturers first played one game with each of the five distributors in the HU condition and then played another game with each of the distributors in the LU condition. For the third group the order was reversed.

Each dyad communicated via computers using interactive software. The manufacturer made the first offer. The distributor either accepted the offer or rejected it and made a counteroffer. If the offer/counteroffer was accepted at period t, the game ended with profits $\delta^{t-1}(w - c)$ and $\delta^{t-1}(p - w)$ for the manufacturer and distributor, respectively. The δ^{t-1} values were shown on the computer screen. Subjects completed a short questionnaire after each game and a longer questionnaire after completing all games. To motivate careful decisions, subjects were told that their mean earnings in three randomly chosen games would be paid to them in cash at the end of the study. Subjects earned about $16.00 on average.

5.2. Experimental Variables

Manufacturer Uncertainty. Different mean preserving spreads of the beliefs $[p_l, p_h]$ were used to manipulate manufacturer uncertainty at two levels (high and low) by varying the endpoints of a uniform distribution. In each game, subjects in the manufacturer role were asked to negotiate the selling price of one unit of the new product with marginal cost $c = \$100$. In both uncertainty conditions, the cover story was that industry sources estimated that the consumers' reservation price, p, could be any integer between two numbers with equal likelihood. In the LU condition, p_l and p_h were set at $130 and $150, respectively, whereas in HU condition, p_l and p_h were $110 and $170, respectively.

Consumers' Reservation Price. The instructions stressed that although p was always in the range $[p_l, p_h]$, it would vary across games. This reduced carryover effects and preserved the one-shot nature of the games.

5.3. Dependent Measures and Analyses

Subjects' task perceptions (realism, comprehension, involvement, etc.) were collected on several seven-point Likert scales. Subjects reported that the study scenario was realistic, that they understood the bargaining environment, and that they performed the tasks carefully. Two measures (seven-point Likert scales) of the perceived range of prices distributors could get from end consumers served as checks for the manipulation of manufacturer uncertainty about p. Comparing these scores for the HU and LU conditions confirmed a successful manipulation ($p < 0.0001$). Note that the focal unit of analysis in this study is the unique manufacturer-distributor dyad (not the individual subject). There were a total of 70 dyads across the three groups (data for five dyads were lost because of technical problems). Each dyad played two games (in the HU and LU conditions, respectively), for a total of 140 games. A separate analysis of variance (ANOVA) showed that the order in which the subjects played the two uncertainty conditions had no effect on any of the dependent measures. Hence, data from the two order conditions were pooled for subsequent analyses.

The bargaining outcome dependent measures included the first price (the manufacturer's opening offer), the counteroffer (the distributor's offer, if the manufacturer's first offer was rejected), bargaining duration (the number of periods required to reach agreement), and the final price (the price at which the manufacturer and distributor reached agreement). We also computed measures of individual profits (the net present value of the manufacturer/distributor earnings at the end of each game) and bargaining efficiency (the ratio of the combined individual profits to the undiscounted total surplus that could be obtained if agreement were reached in the first period). Other supplemental measures included the price schedule (the sequence of offers and counteroffers from the manufacturer's first offer to the final agreed-upon price) and the post-bargaining attitudes of the players (several seven-point Likert scale measures of perceived fairness, whether opponent's bargaining strategies were competitive versus cooperative, etc.).

All relevant dependent measures were analyzed at the dyad level using repeated measures ANOVAs, unless otherwise noted. Because subjects played multiple games in which the consumer reservation price p varied randomly, we explored both iteration effects for evidence of learning over games, as well as the impact of varying p.[5] We then present the results for the manufacturer uncertainty manipulation with respect to the point predictions and the directional implications of the SE model. Finally, we describe the bargaining process results.

5.4. Bargaining Outcome Results

5.4.1. First Prices. The SE model predicts the exact value of first price as a function of uncertainty. Table 1 shows the expected and observed means and standard deviations of the dependent measures in the two uncertainty conditions.[6] The mean first prices were significantly higher than the SE predictions (HU \$133.89 vs. \$119.62, $t = 10.59$, $p < 0.0001$; LU \$127.03 vs. \$118.49, $t = 10.25$, $p < 0.0001$). Indeed, first prices were higher than predicted 90% and 100% of the time in HU and LU, respectively. Thus, uncertainty about p may have led manufacturers to use an "open high" heuristic in the hope of reaching more advantageous agreements (Siegel and Fouraker 1960).

Directionally, the SE predicts that the manufacturer's first offer should be higher in condition HU than in LU. A nonparametric Kolmogorov-Smirnov (K-S) test shows a significant difference in the distributions of first prices between the two conditions (KS $= 2.11$, $p < 0.0003$). Moreover, first prices were higher in the HU versus the LU condition (Means = \$133.89 vs. \$127.03; $F(1, 68) = 20.31$, $p < 0.0001$). Thus, although the results do not match the SE point predictions in either condition, they are consistent with the directional prediction.

5.4.2. Bargaining Duration. As Table 1 shows, the observed bargaining duration was higher than the

[5]There were no iteration effects because none of the dependent measures varied over time. Next, each dependent measure was regressed separately as a function of p. The first prices were unaffected by p (parameter value, $\beta = 0.04$, $t = 0.54$, ns). This was as expected because the manufacturers did not know p at the outset. Bargaining duration decreased ($\beta = 0.17$, $t = 5.36$), bargaining efficiency improved ($\beta = 0.008$, $t = 6.41$), and final prices were higher ($\beta = 0.35$, $t = 13.6$) as p increased. These significant effects (p's < 0.0001) are consistent with the notion that distributors were willing to pay more and settle sooner when p was higher. Consistent with these results and the directional SE predictions, higher values of p led to higher profits for both manufacturers ($\beta = 0.39$, $t = 13.3$, $p < 0.0001$) and distributors ($\beta = 0.64$, $t = 22.6$, $p < 0.0001$).

[6]These normative predictions reflect expectations taken over the range of possible consumers' reservation prices. We also compared the game outcomes to point predictions computed for the specific reservation prices (p values) that were drawn in each game. The results, available from the authors, are essentially similar.

SE model prediction (5.67 vs. 3.23, $t = 2.74$, $p < 0.008$ for HU and 3.00 vs. 1.00, $t = 6.31$, $p < 0.0001$ for LU respectively). In HU, only 18.6% ($n = 13$) of the games ended as predicted. Of the remainder, 44.3% ($n = 31$) ended earlier and 37.1% ($n = 26$) ended later than predicted. In LU, only 22.9% (n = 16) of the games ended as predicted. The remaining 77.1% ($n = 54$) ended later than predicted. Bargaining efficiency (the ratio of combined profit gain to total surplus) was lower than the SE prediction. Thus, relative to the SE solution, the players bargained suboptimally and could not extract the available surplus. However, the proportion of games ending in one period increased from 12.9% in HU to 22.9% in LU. This is directionally consistent with the SE prediction.

The directional SE prediction is that bargaining duration should be higher in HU than in LU. As predicted, there was a significant difference between the distributions of bargaining duration in the two uncertainty conditions (K-S = 1.61, $p < 0.01$). On average, the number of periods taken to reach agreement was higher in HU than in LU (Means = 5.67 vs. 3.00; $F(1, 68) = 10.66$, $p < 0.001$). Bargaining efficiency also improved as uncertainty decreased (Means = 0.70 vs. 0.84 in HU and LU, respectively; $F(1, 68) = 13.18$, $p < 0.0005$).

5.4.3. Final Prices. Interestingly, the observed final price is virtually identical to the SE prediction in the LU condition (Table 1), whereas it is significantly higher than predicted in the HU condition ($t = 5.94$, $p < 0.0001$). Thus, although the normative outcome was achieved in LU, the process was less efficient than that predicted by the SE solution. Counter to intuition, the manufacturer realized a higher price than what was normatively predicted in HU. Directionally, the SE solution implies a higher final price when manufacturer uncertainty is low versus high. The observed final prices support this prediction (Means = \$118.46 vs. \$114.87; $F(1, 69) = 11.53$, $p < 0.001$). The final price distributions in the two conditions were also significantly different (K-S = 2.87, $p < 0.0001$).

5.4.4. Individual Profits. Table 1 shows that, relative to the SE prediction, the observed manufacturer profit was higher in HU (\$11.75 vs. \$7.85, $t = 6.46$, $p < 0.0001$) but lower in LU (\$15.49 vs. \$18.49, $t = 5.40$, $p < 0.0001$). In contrast, the distributor's profit was significantly lower than the normative predictions in both conditions (\$15.75 vs. \$25.25, $t = 13.78$, $p < 0.0001$ for HU; and \$16.94 vs. \$21.51, $t = 6.07$, $p < 0.0001$ for LU, respectively). As the bargaining efficiency results show, the negotiators could not extract the normatively available (SE) surplus.

The directional prediction of the SE model is that the manufacturers' profit would be higher in the LU (vs. the HU) condition, whereas the distributors' profit would be lower. The manufacturers did make higher profits in LU relative to HU (\$15.49 vs. \$11.21; $F(1, 68) = 11.53$, $p < 0.001$). The distributors' profit, though, was not different for the two conditions (\$16.94 and \$15.75, respectively; $F(1, 68) = 0.42$, ns). The manufacturer made less profit than the distributor in condition HU, whereas the surplus was about equally divided in LU. Thus, the manufacturers did better relative to the SE criterion in HU. However, in absolute terms, they were clearly better off in condition LU. It is worth noting that profits decreased with first price for both manufacturers and distributors ($t = 2.67$, $p < 0.008$ and $t = -3.68$, $p < 0.0003$, respectively). Thus, if manufacturers indeed used an "open high" heuristic, the delayed agreement adversely affected the profits of both parties.

5.5. Bargaining Process Results

The bargaining outcome results show that the point predictions of the SE model do not match the observed bargaining outcomes. However, the directional effects predicted by the SE model for manufacturer uncertainty and consumer reservation price receive general support. It is tempting to conclude from these results that the SE model is a good representation of the observed bargaining behavior. Nevertheless, we use the tests described earlier to examine if the subjects' bargaining *process* followed the SE rationale. Did subjects indeed interpret the offers and counteroffers as signals of the reservation price, or were their responses influenced by inferences about their opponents' bargaining stance? In this context, we also examine the role played by other behavioral norms such as the EMP.

5.5.1. Counteroffers. The SE model implies that a rational distributor should not make a disadvantageous counteroffer. In other words, if the distributor rejects a given allocation of the surplus at period t, (s)he should demand an equal or a larger share (of the discounted surplus) at period $t + 1$. Interestingly, previous authors (e.g., Ochs and Roth 1989) have reported that this condition was violated in as much as 81% of their complete information games. Others (e.g., Weg et al. 1990) have reported similar findings, fueling speculation that fairness and equity issues may interact with strategic considerations in bargaining. In our study, we examined all games lasting at least two periods and found no disadvantageous counteroffers. The remarkable absence of disadvantageous counteroffers may imply that our subjects were more strategic than previous research findings would indicate.

Disadvantageous counteroffers suggest that the players consider more than just their own payoffs in bargaining. However, in contrast to prior complete information games, we examined a one-sided incomplete information scenario in which the manufacturer had to interpret and act upon the price signal embedded in the distributor's counteroffer. Here, the absence of disadvantageous counteroffers may imply that the distributors recognized that the manufacturers (who did not know p) could not interpret the gesture implied in a disadvantageous counteroffer. Hence, they did not confound the price signal with fairness or equity considerations that violated self-interest. However, there is still the issue of whether the distributors were signaling price based on the SE rationale, or were using a different signaling approach wherein their counteroffers were simply correlated with the known p.

Recall that the SE model prediction is that in HU, the distributor should accept the manufacturer's initial offer of \$119.62 if $p \geq \$161$. For $p < \$161$, the distributor should reject and make an unacceptable counteroffer (<\$104.74). In LU, the distributor should immediately accept the manufacturer's first offer (\$118.49). In contrast, if the subjects follow EMP, the counteroffers will show an equal split of the surplus in both conditions. The frequency of counteroffers consistent with the SE and EMP models is shown in Table 3. In HU, distributors made counteroffers in only 61 cases (vs. the SE prediction that all 70 games would produce counteroffers). Of the 61 counteroffers, only 4.9% ($n = 3$) were unacceptable by the SE criterion. Yet, of the 58 counteroffers deemed acceptable, the manufacturer accepted only 25.9% ($n = 15$)! In LU, the SE implies that the distributors should accept all first offers from manufacturers (bargaining ends in one period without a counteroffer). In reality, 77.1% ($n = 54$) of the initial offers were rejected and met with a counteroffer. Of the 54 counteroffers, 50% ($n = 27$) were accepted by the manufacturers. Thus, the SE model provides a poor account of the counteroffers.

Table 3 **Counteroffers and Individual Profits Corresponding to the SE and EMP Models**

	Experiment 1 Uncertainty		Experiment 2 Discount factor	
Counteroffers	High	Low	High	Low
SE	3/61 (4.9)*	No counteroffers	2/35 (5.7)	21/30 (70)
EMP	23/61 (37.7)	21/54 (38.9)	15/35 (42.9)	16/30 (53.3)
Individual Profits				
SE				
Manufacturer	10/70 (14.3)	6/70 (8.6)	2/40 (5.0)	3/40 (7.5)
Distributor	4/70 (5.7)	0/70 (0.0)	2/40 (5.0)	1/40 (2.5)
EMP	24/70 (34.3)	19/70 (27.1)	17/40 (42.5)	17/40 (42.5)
	[52.9]**	[47.1]	[35.0]	[30.0]

Note: *Percentage; **Percentage of dyads where distributor had higher profits.

Relative to the SE model, the EMP model provides a better account of the counteroffers. The counteroffers conformed to equal payoffs in 37.7% ($n = 23$) and 38.9% ($n = 21$) of the cases in the HU and LU conditions, respectively. Over 50% of these equal-split offers came from the same subjects. Not surprisingly, in both conditions, all the counteroffers that were not equal splits favored the distributor. About 55% (39/71) of these came from four subjects (out of 30).

It is tempting to conclude that the SE model failed because of inappropriate counteroffers made in response to inappropriate first offers. However, there was no significant correlation between the first offers and the counteroffers in either HU ($r = 0.12$, ns) or LU ($r = 0.21$, ns). Rather, the offer sequences show that distributors in HU made inappropriate acceptable counteroffers, whereas those in LU rejected offers that were acceptable by the SE criterion.[7] The effects of a

[7] The SE optimal play is conditional on all prior plays being optimal.

player's normative errors seem to propagate through the game. For example, in the LU condition, the manufacturers' "open high" strategy was suboptimal and elicited distributor counteroffers that extended bargaining. Thus, regardless of the contingent optimality of the distributors' actions, a manufacturer's initial error influenced the game sequence and lowered bargaining efficiency.

The SE also predicts that distributors within a specific range of consumers' reservation price should make the same counteroffer. In condition HU for p between 110 and 161, the SE model predicts that the counteroffer and reservation price should be uncorrelated. However, the observed correlation between the counteroffers and the reservation price was significant in this price range ($r = 0.77$, $p < 0.0001$). Overall, the counteroffers tracked the consumer reservation price, p ($t = 12.09$, $p < 0.0001$). Thus, distributors were sensitive to the size of the surplus and increased their counteroffers as the surplus increased in both the HU ($r = 0.77$, $p < 0.0001$) and LU ($r = 0.49$, $p < 0.0002$) conditions. In other words, the counteroffers actually did embed signals of the consumer reservation price and the distributors did not take full strategic advantage of being the fully informed party.

5.5.2. Bargaining Duration. The SE model also specifies that distributors within a particular range of consumers' reservation price (p) should reach agreement in the same period. For instance, in HU, for p between 143 and 161, the SE model predicts that bargaining should end in three periods. However, in violation of this prediction, bargaining duration was significantly correlated with consumers' reservation price ($r = -0.32$, $p < 0.04$). This is not surprising given that first prices and counteroffers also violated the SE predictions.

To assess if signaling did occur in some form, we examined the relationship between the distributors' counteroffer (at $t = 2$) and the manufacturers' second offer (at $t = 3$) in games that lasted at least three periods in HU. The correlation was not significant ($r = 0.19$, ns). Moreover, the manufacturer's second offer was also higher than the SE prediction ($t = 5.17$, $p < 0.0001$). Thus, even if the distributor counteroffers signaled the level of p, the manufacturers reacted inappropriately either because they did not recognize the signal or did not consider it reliable.

Bargaining duration increased systematically with first price ($t = 3.46$, $p < 0.0007$). Because most of the first offers were significantly higher than predicted, it is not surprising that bargaining lasted longer. Also, while bargaining duration decreased with higher counteroffers ($t = 3.70$, $p < 0.0003$), it increased as the difference between the first offer and counteroffer increased ($t = 4.10$, $p < 0.0001$). Thus, the counteroffer may have influenced the manufacturer's perception of the distributor's competitiveness. A low counteroffer, or a large gap between the first offer and the counteroffer may have been interpreted as the distributor adopting a tough bargaining stance. The manufacturer then may have also reciprocated with a tough stance, prolonging bargaining.

Because the above evidence is against the SE signaling rationale, we explored the viability of our account further. First, manufacturer concession (first price–final price) affected bargaining duration ($t = 4.96$, $p < 0.0001$) showing that agreement took longer the more the manufacturer had to concede his/her initial position. Moreover, the post-bargaining measures show that manufacturer perceptions of the distributors' competitiveness increased both as the counteroffer decreased ($r = -0.50$, $p < 0.0001$), and as the gap between the first offer and counteroffer increased ($r = 0.39$, $p < 0.002$). Distributor perceptions of manufacturers' competitiveness increased with bargaining duration ($r = 0.65$, $p < 0.0001$). Perhaps the distributors did try to signal the level of p but the manufacturers were unable or unwilling to respond appropriately. This delayed agreement and eroded the profits of both parties.

5.5.3. Division of Profits. Table 3 shows the frequency of games supporting the SE and EMP models by condition. In the HU condition, only 14.3% ($n = 10$)

The distributors' counteroffers are compared to the SE solutions assuming optimal first offers from manufacturers. Because 90% and 100% of manufacturers' first offers (in HU and LU, respectively) were too high, the distributors' decisions to reject and counteroffer may have been justified. We do not evaluate such contingent optimality. The SE data (Table 3) serve to benchmark the EMP model in which distributor counteroffers do not depend on prior plays.

of the manufacturers and 5.7% ($n = 4$) of the distributors attained bargaining profits consistent with the SE predictions. Interestingly, while 68.6% ($n = 48$) of the manufacturers attained profits higher than the SE predictions, 81.4% ($n = 57$) of the distributors' profits were lower than the SE prediction. In the LU condition, only 8.6% ($n = 6$) of the manufacturers' profits and none of the distributors' profits matched the SE prediction. Moreover, the majority of manufacturers (65.7%, $n = 46$) and distributors (77.1%, $n = 54$) earned lower profits than predicted. These data, along with the bargaining efficiency indices, confirm that the negotiators could not extract the available surplus. The distributors could not take as much advantage of being fully informed as the SE solution implied. In contrast, the profitability data provide better support for the EMP model in both HU and LU, with the surplus split equally in 34.3% ($n = 24$) and 27.1% ($n = 19$) of the dyads, respectively. Although unequal splits generally favored the distributors, the proportion of games in which the manufacturer earned more than the distributor increased from 12.9% ($n = 9$) in HU to 25.7% ($n = 18$) in LU.

5.5.4. Price Schedule. The SE predicts a monotone descending price path for the manufacturer. To obtain stable measures, we examined the price path for dyads that took at least six periods (three offers and counteroffers) to reach agreement.[8] The manufacturers' prices in both the HU and LU conditions show a descending linear trend ($t = 3.73$, $p < 0.001$ and $t = -3.55$, $p < 0.005$, respectively). The distributors' prices shows no linear trend in HU ($t = 0.66$, ns) but an ascending linear trend in LU ($t = 2.57$, $p < 0.03$). The manufacturers had steeper price paths than the distributors, showing that the former conceded more. With uncertainty about the consumer reservation price p, manufacturers seem to start conservatively, making high first offers and then adjusting subsequent offers. The fact that manufacturers made more concessions may reflect the informational asymmetry in favor of the distributors (who knew p precisely).

[8]Dyads that took at least four periods to reach agreement also showed similar price paths.

6. Experiment 2: Effects of Delay Cost

6.1. Procedure

In Experiment 2, the opportunity cost of delay δ was manipulated at two levels (high/low) holding manufacturer uncertainty constant [$p_1 = \$110$, $p_h = \$170$]. The cover story stated that the threat of potential competitive entry increased with delay. Sixteen subjects were run in two groups of eight, and each subject played ten bilateral monopoly games. The order in which the subjects saw the two levels of δ was counterbalanced across groups. The dyads in one group first played five games in the high δ (HD) condition and then five more games in the low δ (LD) condition. The dyads in the second group played in the reverse order.

6.2. Experimental Variables

Opportunity Cost of Delay. The discount factor had two levels: high ($\delta = 0.90$) and low ($\delta = 0.60$). Both parties were told that after each period without agreement, the payoffs would shrink based on δ for the reason above. For high δ, little surplus was lost from delay. A low δ was an incentive to agree with minimal delay.

Consumers' Reservation Price. As in Experiment 1, p was varied across games to avoid carryover.

6.3. Bargaining Outcome Results

The dependent measures in Experiments 2 were identical to those in Experiment 1. Because each subject played 10 games, a total of 80 games were played at the dyad level. The effects of consumer reservation price were similar in Experiment 2 and Experiment 1.[9] Responses to the two seven-point Likert scales showed

[9]As in Experiment 1, none of the dependent measures varied with time in either HD or LD. Regressions of each measure as a function of p showed that the first prices were unaffected by p ($\beta = -0.05$, $t = -0.17$, ns). Bargaining duration decreased ($\beta = -0.12$, $t = -3.55$), bargaining efficiency improved ($\beta = 0.01$, $t = 5.95$), and final prices were higher ($\beta = 0.45$, $t = 13.2$) as p increased. Higher values of p also led to higher profits for both manufacturers ($\beta = 0.46$, $t = 11.7$) and distributors ($\beta = 0.56$, $t = 13.4$). These significant effects ($ps < 0.0001$) are consistent with the directional SE predictions for the effects of consumer reservation price.

a successful manipulation of opportunity cost of delay ($p < 0.0001$).

6.3.1. First Prices. Table 2 displays the point predictions as well as the means and standard deviations of the dependent measures in the two discount factor conditions. Observed first prices were higher than the point predictions in both conditions ($t = 13.00$, $p < 0.0001$ and $t = 9.64$, $p < 0.0001$, for HD and LD, respectively). In both HD and LD, 92.5% of the first offers were higher than the SE prediction. This pattern of high first offers was also found in Experiment 1. The directional SE prediction reasons that the manufacturer is more likely to make a high first offer (to press home a first mover advantage) when δ is low versus high. Contrary to this expectation, the observed first prices were higher in HD than in LD (Means = 141.22 vs. 129.47; $F(1, 38) = 51.28$, $p < 0.0001$). There was a significant difference between the first price distributions in HD and LD ($KS = 3.0$, $p < 0.0001$). Thus in LD, manufacturers made lower first offers in order to avoid prolonged bargaining.

6.3.2. Bargaining Duration. The data in Table 2 show that the observed bargaining duration was significantly higher on average than the SE predictions ($t = 1.97$, $p < 0.05$ and $t = 5.82$, $p < 0.0001$ for HD and LD, respectively). Relative to the SE predictions for HD, 42.5% ($n = 17$) of the games ended earlier, 25% ($n = 10$) of the games ended as predicted, and 32.5% ($n = 13$) of the games ended later. In LD, 40% ($n = 16$) of the games ended as predicted and 60% ($n = 24$) ended later than predicted. Overall, bargaining efficiency was lower than the SE predictions.

The directional SE prediction is that the bargaining duration will increase with δ. As expected, the number of periods to reach agreement was higher in HD than in LD (Means = 6.15 vs. 2.40; $F(1, 38) = 7.24$, $p < 0.01$). However, bargaining efficiency was marginally higher in HD relative to LD (Means = 0.71 vs. 0.59; $F(1, 38) = 3.11$, $p < 0.07$). Because bargaining efficiency depends on both δ and the bargaining duration, this result shows that the surplus loss resulting from increased duration was more than offset by the gains resulting from the higher discount factor. As in Experiment 1, the bargaining duration decreased as a function of the level of the counteroffer ($t = -2.66$, $p < 0.009$), increased with the gap between the first offer and counteroffer ($t = 1.67$, $p < 0.08$), and also increased as a function of manufacturer concession ($t = 2.56$, $p < 0.01$).

6.3.3. Final Prices. Table 2 shows that the final prices were significantly higher than the associated point predictions in both HD and LD ($t = 5.84$, $p < 0.0001$ and $t = 3.45$, $p < 0.0005$, respectively). Directionally, we expected final prices to decrease as δ increased since the manufacturer is less able to use delay strategically. However, the final prices in HD and LD were not significantly different (Means = \$118.05 vs. \$117.54, $F(1, 38) = 0.36$, ns).

6.3.4. Individual Profits. Table 2 also shows that the manufacturers' profit was higher than predicted in HD ($t = 4.06$, $p < 0.0001$) but not significantly different from the prediction in LD ($t = 0.27$, ns). The distributors' profit was significantly lower than the model predictions in both conditions ($t = -7.33$, $p < 0.0001$ and $t = -3.28$, $p < 0.002$ for HD and LD, respectively). Clearly, significant surplus was lost in both conditions because of suboptimal bargaining.

Table 3 shows the frequency of games that supported the SE model in each condition. In condition HD, only two manufacturers (5%) and two distributors (5%) attained the profits predicted by the SE solution. Interestingly, whereas 80% ($n = 32$) of the manufacturers made higher profits than the SE prediction, 87.5% ($n = 35$) of the distributors attained lower profits than predicted. In LD only three manufacturers (7.5%) and one distributor (2.5%) attained the predicted profits. Indeed, most manufacturers (57.5%, $n = 23$) and distributors (80%, $n = 32$) earned lower profits than the SE prediction. These data, along with the first offers, suggest that subjects who played the manufacturer role did not recognize the advantage of moving first, or that the advantage increases as δ decreases. Moreover, the subjects playing the distributor role could not take complete advantage of being the fully informed party.

6.4. Bargaining Process Results

As in Experiment 1, we examined the sequence of offers and counteroffers for evidence of conformity with the signaling rationale of the SE model as well as systematic evidence of other behavioral mechanisms. We also examined the extent to which the EMP model accounts for the data.

6.4.1. Counteroffers. The game parameters (and hence the normative predictions) for condition HD in Experiment 2 were identical to those for condition HU in Experiment 1. As Table 3 shows, distributors made counteroffers in 35 games (vs. all 40 as predicted). Of the 35 counteroffers, only two (5.7%) were unacceptable by the SE criterion, whereas 33 were acceptable. Yet, only 12 (36.4%) were accepted by the manufacturers. In LD, given the manufacturer's initial offer of \$120.82, the SE model predicts that the distributor should accept the offer if $p \geq \$144$. For $p < \$144$, the distributor should reject the offer, and make a counteroffer of \$105.37, which the manufacturer should accept. Of the 24 distributors who should have accepted the manufacturer's first offer, only 41.7% ($n = 10$) accepted. Further, when all 30 counteroffers should have been acceptable, as many as nine (30%) were unacceptable. Of the 21 acceptable offers, the manufacturers accepted 71.4% ($n = 15$).

With distributors making inappropriate acceptable counteroffers in HD and rejecting offers that should have been accepted in LD, the SE signaling rationale is called into question. Further analysis showed that, as in Experiment 1, there was no significant relation between first offers and counteroffers in either HD or LD. Also, in LD, for p between \$110 and \$144, the SE solution predicts that the counteroffer and reservation price would be correlated zero. Contrary to this prediction, the observed correlation ($r = 0.77$, $p < 0.0001$) was significant. In both HD and LD, the counteroffers varied significantly with p ($t = 13.89$, $p < 0.0001$; $r = 0.91$, $p < 0.0001$ and $r = 0.82$, $p < 0.0001$, respectively). As in Experiment 1, distributors increased their counteroffers as p increased. Thus, although the counteroffers may have signaled the level of p, the distributors did not shade their price offers or take advantage of being fully informed. Analysis of games that lasted for at least two periods showed that in this incomplete information scenario, distributors did not make the disadvantageous counteroffers that are common in complete information games (Roth 1995b).

Table 3 also shows the frequency of games in each condition wherein data supported the EMP model. Relative to the spotty correspondence with the SE model, the data were more consistent with the EMP model. The surplus was split equally in 43% ($n = 15$) of the counteroffers in HD, and in 53.3% ($n = 16$) of those in LD. Moreover, the post-bargaining attitude measures showed that the players' perceptions of their rival's competitiveness were linked to how the offers and counteroffers were related. Consistent with the Experiment 1 findings, manufacturers' perceptions of the distributors' competitiveness decreased with the counteroffer ($r = 0.39$, $p < 0.001$) and increased with the difference between the first offer and the counteroffer ($r = 0.25$, $p < 0.005$). Also, distributors' perceptions of manufacturer competitiveness increased with the bargaining duration ($r = 0.39$, $p < 0.0005$). These data suggest that the offers and counteroffers were not interpreted as signals about the level of p. Rather, the players may have used them to infer their opponents' level of competitiveness, and then responded according to their perceptions.

6.4.2. Division of Profits. As shown in Table 3, the EMP model is superior to the SE model in accounting for individual profits. In both HD and LD 42.5% ($n = 17$) of the dyads split the surplus equally. The SE solution implies that the distributor has a greater incentive in HD (vs. LD) to signal a low p. Hence, the manufacturer's profits should be lower when δ is high versus low. However, the manufacturer profits in HD and LD were not significantly different (Means = \$13.74 and \$11.76, respectively; $F(1, 38) = 0.96$, ns). This result may be attributed to the higher surplus loss in LD resulting from the low δ. The distributor profits in HD and LD were also not different (Means = \$15.11 vs. \$12.49, respectively; $F(1, 38) = 1.23$, ns).

6.4.3. Price Schedule. As in Experiment 1, a regression analysis showed a linear descending price path for the manufacturer and a relatively flat path for the distributor in both discount factor conditions.

7. Discussion

This paper reports two experiments testing a sequential bargaining model in the context of price/margin setting in a marketing channel. The infinite horizon model incorporates one-sided incomplete information and opportunity cost of delay. Negotiators make alternating offers/counteroffers. The SE model assumes that the offers carry signals about the available surplus. Beliefs are updated in a Bayesian framework, and delay is used strategically to communicate with credibility and facilitate agreement. In both experiments, observed bargaining behavior and outcomes were significantly different from the SE model's point predictions. In particular, the players bargained suboptimally and could not realize the total available surplus. As a consequence, the total channel profits were lower than optimal.

Traditional game theory postulates equilibrium play on the informal assumptions that the players are inherently rational and that this rationality is common knowledge. Models with multiple equilibria (such as the SE model) also require some specification of notion of how players arrive at expectations of a common equilibrium (Fudenberg and Levine 1998, Samuelson 1997). With these processes unspecified, there are nontrivial problems with using point predictions as normative benchmarks against which to assess systematic deviations from the SE rationale. Tests of game-theoretic models usually address several assumptions simultaneously. These include expected utility maximization, linear utility functions, moves on a set equilibrium path, and Bayesian updating of beliefs. One or more of these assumptions may be untenable in a given bargaining environment and/or experimental context and may contribute to deviations from the point predictions. As such, the point predictions may simply serve as benchmarks that provide a measure of the deviation (Ochs and Roth 1989) and the experiments could focus mainly on testing the directional predictions of the SE model.

Shifting focus from the point predictions to the directional predictions, we find that the SE model provides a reasonable account of the results. The predicted effects of manufacturer uncertainty were supported in Experiment 1 and consumers' reservation price effects were as predicted in both experiments. More specifically, the bargaining outcomes in Experiment 1 showed that high uncertainty (even if restricted to the manufacturer) is detrimental to efficient negotiation. Manufacturers made higher first offers and bargaining duration increased as uncertainty increases. Contrary to prior studies (Benton et al. 1972, Chertkoff and Conley 1967), we find that higher (extreme) first offers may not translate into higher profits and could lead to inefficient bargaining. The results also showed that manufacturers achieved better profits as uncertainty decreases. Thus, ignorance appears to be of little advantage (c.f. Beisecker et al. 1989, Siegel and Fouraker 1960), underscoring the value of market research to reduce uncertainty.

Consistent with the directional SE predictions, consumers' reservation price systematically affected bargaining behavior and outcomes in both experiments. Because the reservation price determines the available surplus, its effects indicate how the size of the pie impacts bargaining behavior and outcomes. Although in our (one-sided uncertainty) scenario, only the distributor knew the available surplus with certainty, a higher surplus lowered bargaining duration, improved bargaining efficiency, and increased the profits of both parties. Thus, even in cases where the manufacturer is uncertain of the total gains from trade, a larger total surplus leaves both parties better off. These directional results seem consistent with the idea that as manufacturers learn the relation between the realized p and distributor offers (with corresponding distributor learning of manufacturer behavior), bargaining behavior and outcomes should approach the normative SE analysis (see Fudenberg and Levine 1998).

The directional SE predictions about the effects of opportunity cost of delay were not consistently supported in Experiment 2. Even though a higher delay cost (low δ) produced quicker agreements, contrary to the SE predictions, the manufacturer's first offer decreased, and their profits showed no increases. This result is consistent with previous findings in both psychology (e.g., Chertkoff and Esser 1976) and experimental economics (e.g., Rapoport et al. 1995). It shows that even when delay cost is high, manufacturers did not press home a first mover advantage and made lower first offers to hasten agreement. On the other hand, the manufacturers lacked exact information about p and one might have expected distributors to do better when delay cost is low (δ is high). Yet, manufacturers' profit remained relatively high even when

δ was high. Thus, although the distributors had an information advantage, they did not realize its potential benefits.

Notwithstanding some inconsistencies, the results (particularly Experiment 1) suggest that the SE model is a good representation of observed bargaining behavior and outcomes. However, a closer analysis of the bargaining process shows weak correspondence between the bargaining process data and the normative assumptions of the SE model. The evidence suggests that instead of using the strategic signaling rationale of the SE model, subjects may have created simplified representations of the price/margin negotiation task and used simple heuristics to develop their offers. The negotiators may have used the offer and counteroffer levels to infer their opponents' competitive stance and factored this into their responses. Also, a simple nonstrategic model (EMP) that predicts an equal split of the surplus accounted for significant portions of the data. We discuss these findings next.

The data show that manufacturers opened with inappropriately high offers, and the distributors often responded with inappropriate counteroffers and rejected offers that should have been accepted. The distributors' counteroffers were positively correlated with the consumer reservation price, showing that the counteroffers did indeed carry information about p (intentionally or otherwise). Yet, the bargaining outcomes were inefficient because the manufacturers did not respond appropriately, either because they did not recognize the signals or because they thought the signals were unreliable. Indeed, the data show that manufacturers' perceptions of the extent to which distributors' competitiveness increased as the counteroffer decreased and as the gap between the first offer and counteroffer increased. Manufacturers may have then reciprocated this competitive stance, prolonging negotiation. The distributors used the bargaining duration as an indicant of the manufacturers' competitiveness. Thus, even if distributors had tried to signal p to the manufacturers, the communication was unsuccessful.

The results suggest that in a noncooperative framework, even credible signals (incurring costs by delaying agreement) may fail to produce efficient solutions unless the players share an understanding of the signaling mechanism. Even a rational distributor whose counteroffers embed appropriate price signals may be perceived as unduly competitive (or excessively conciliatory), depending on the interpretive frame used by the manufacturer. The normative model suggests that manufacturers should use the counteroffers only to assess and refine a probabilistic assessment of the distributors' value. However, it seems that the counteroffers also influence interpersonal judgments that then mediate bargaining behavior. This invariably makes bargaining inefficient relative to normative (SE) criteria and produces suboptimal bargaining outcomes.

In our experimental setting, bargaining was anonymous (versus face-to-face), and no explicit communication was permitted. It may appear that explicit communication may enhance bargaining effectiveness in a marketing channel. However, explicit communication is not necessarily credible because of the inherent incentive to deceive, the possibility of "cheap talk," and other communication gaps. In the real world, the effectiveness of a signaling mechanisms rests not only on the economic characteristics of the bargaining problem but also on shared individual, social, and cultural contexts that influence how market signals are transmitted and interpreted. Individual factors such as power and personality, sociological factors like trust and relationships, and cultural norms of equity and fairness will play important roles (see also Eliashberg et al. 1993).

It is significant that for some players and contexts a simple, nonstrategic model provides a satisfactory account of bargaining behavior. Although the EMP model cannot predict first offers and bargaining duration (because of asymmetric information), it accounted for a significant proportion of the counteroffers and individual profits in both studies. This is consistent with suggestions that fairness and equity notions may interact with strategic considerations to influence bargaining in zero-sum games (e.g., Roth 1995b). However, even though disadvantageous counteroffers are very common in complete information games (Ochs and Roth 1989), it is difficult to assess if players are being fair or strategic without their preferences being common knowledge (see Roth 1995b).

In the present asymmetric information study, manufacturers were unaware of the total available surplus. Hence, knowledgeable distributors who offered equal splits to manufacturers were perhaps being "truly fair" (see Straub and Murnighan 1995). The absence of disadvantageous counteroffers in our study provides support for this assertion. At the same time, the number of unequal splits that favored the distributors suggests that at least some of the distributors were also bargaining strategically. Thus, within reason, fairness and strategic behavior can coexist in bargaining contexts. Nevertheless, it is significant that the distributors could not take the normative level of advantage predicted by the SE model. Their strategy also did not follow the SE signaling rationale. Rather, as the correlated offers and counteroffers suggest, the subjects may have inferred their opponents' competitiveness based on their counteroffers and then factored this into their responses.

Like any laboratory abstraction of actual negotiations, this research has some limitations that bear comment. The adapted channel negotiation scenario stresses experimental control and correspondence with model assumptions. Although our new product scenario did not require such ties, the model and the bargaining environment do not capture the interdependency and the long-term aspects of channel relationships. Some other aspects of the situation (e.g., computer-based bargaining, anonymity, and lack of explicit and direct communication) may have lowered motivation despite the cash incentive. Finally, although subjects were graduate students and were prequalified for work and business negotiation experience, their bargaining skills may have been lower than that of experienced channel members.

8. Conclusion

This is the first experimental paper to evaluate sequential strategic bargaining models in the marketing literature. The GP (1986a, 1986b) model was picked because its process features correspond to many channel negotiation contexts. The one-sided, incomplete information scenario used allows us to explore how price signals may be transmitted and (mis)interpreted and also how fairness and equity issues interact with strategic considerations to influence bargaining behavior and outcomes. This extends the bargaining literature in experimental economics and psychology. Our research also contributes to the behavioral game theory literature (Camerer 1990) by assessing the descriptive power of a well-known but previously untested game-theoretic model of two-person bargaining.

Empirical data that systematically violate a normative bargaining model call for alternative accounts of the behavior (Weg et al. 1990). Our theories must allow considerations beyond income maximization to improve description of bargaining behavior. The strategic approach to two-person bargaining is sensitive to specific institutional rules (Corfman and Gupta 1992), and small variations can change outcomes dramatically (Osborne and Rubinstein 1990). Hence, institutional rules that drive boundary conditions for equity and fairness norms to prevail over income maximization are worth study. However, the literature must move beyond comparing models like the SE (which provides a precise and complete account of the negotiation) to formulations like EMP (which is simply a behavioral tendency offering only a partial account). In other words, the equity and fairness models that serve as contrasts to the game-theoretic formulations should be specified more formally and completely. The ERC (equity, reciprocation, and competition) model (Bolton and Ockenfels 1998), which argues that people are motivated by both their monetary payoffs and relative payoff standing, has promise in this regard.

Sequential bargaining models provide a conceptual framework for examining bargaining behavior and outcomes in real world marketing contexts. As shown here, the models may be tested at three levels. The accuracy of the point predictions is a first-level indicant. At a second level, one may examine the effects of key factors (e.g., uncertainty and discount rates) to see if they are directionally consistent with the posited equilibrium solutions. However, directional correspondence between behavioral outcomes and model predictions does not necessarily validate the postulated process. As we show, direct tests of the information processing rationale of the SE models can suggest new and different perspectives. Such multilayered studies should enhance both descriptive and managerial understanding of marketing negotiations.[10]

[10]This paper is based on the first author's Ph.D. dissertation. The

Appendix: The Sequential Equilibrium Model

The Solution Concept

The bargaining situation and the mechanism described has been analyzed by Grossman and Perry (1986a, 1986b). The model generalizes Rubinstein's (1982) model to incorporate incomplete information aspects. Grossman and Perry (1986a) show that their equilibrium is the unique candidate for a "perfect sequential equilibrium," i.e., one supported by credible beliefs. Just as some Nash equilibria are supported by threats that are not credible (i.e., if the point is reached the threat will not be carried out), some sequential equilibria are supported by the threat that a player will adopt a noncredible belief if s/he observes an out-of-equilibrium action.

Grossman and Perry (1986a) argue that a credible belief must satisfy three conditions. First, observing an out-of-equilibrium event should not change the manufacturer's probabilities for things s/he was certain about. Second, if the observed distributor action is part of the equilibrium strategy set, the manufacturer updates as a Bayesian. For the third condition, note that the distributor has three alternatives: (1) Stick to the equilibrium strategy with certainty; (2) randomize between deviating and sticking to the equilibrium strategy; and (3) deviate from the equilibrium strategy to an out-of-equilibrium strategy. The manufacturer uses Bayes' rule to assign posterior probabilities to the type of strategy a distributor will use.

If the manufacturer observes an out-of-equilibrium strategy, s/he can ask, "Which type of distributor is actually better off after deviating than staying at equilibrium, given my induced action?" The beliefs adopted are credible if the distributor postulated (not) to deviate is indeed (worse) better off than at the equilibrium, and the distributor assumed to randomize is indifferent between deviating and staying with the equilibrium strategy. The manufacturer must adopt a credible belief if such exists. If none exists, the out-of-equilibrium beliefs are restricted only by the first condition.

Thus, the third condition restricts the belief set that the manufacturer can adopt if s/he observes an out-of-equilibrium event. Thus, on observing the deviation, the manufacturer reasons as to which distributor has an incentive to make this deviation. Given a consistent answer that, if believed correct, induces actions on the manufacturer's part that justify the deviation for only one distributor type, then this answer must be adopted as the manufacturer's belief. The stationary equilibrium (Grossman and Perry 1986a) is described next.

The Stationary Equilibrium

The following constructs and notations are employed in the model (Grossman and Perry 1986).

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p = Consumers' reservation price or the maximum price that the consumers are willing to pay for the product such that $p \in [p_l, p_h]$, or the distributor is of any possible type between p_l and p_h;

δ = common discount factor;

$w\ (p_l, p_h)$ = The price the manufacturer asks when it is his/her turn to make an offer and s/he knows that $p \in [p_l, p_h]$;

$w_a(p_l, p_a)$ = The acceptable counteroffer made by the distributor along the equilibrium when it is the distributor's turn to make an offer and the manufacturer knows that $p \in [p_l, p_a]$;

$p_a(w;\ p_l, p_h) \equiv$ The marginal distributor's type that accepts the manufacturer's offer w when the manufacturer knows that $p \in [p_l, p_h]$;

$p_c(p_l, p_a) \equiv$ The marginal distributor's type that makes an acceptable counteroffer;

$V(p, p) \equiv$ The perfect equilibrium offer by the manufacturer in a game of complete information (Rubinstein 1982) or the manufacturer's maximum expected payoff when the consumers' reservation price p is known with certainty. If manufacturer's cost, $c = 0$, then $V\ (p, p) = p/(1 + \delta)$, and it follows that $\delta V(p, p)$ is the distributor's payoff in a game of complete information (see Rubinstein 1982).

The stationary equilibrium involves the manufacturer making an offer based on the belief that p lies between p_l and p_h. Grossman and Perry (1986a) show that along the equilibrium there lie numbers p_a, p_c, and w such that the manufacturer's offer w is accepted if $p \geq p_a$, and rejected otherwise. If the distributor rejects the manufacturer's offer w, then s/he makes an acceptable counteroffer if p lies between p_a and p_c, or an unacceptable counteroffer if $p < p_c$. An unacceptable counteroffer by the distributor signals to the manufacturer that the consumers' reservation price lies between p_l and p_c. The manufacturer then makes another offer based on this updated belief, and the game continues.

Following Grossman and Perry (1986b), the manufacturer's problem can be represented analytically as choosing the maximum w to ask based on the knowledge that the consumers' reservation price, p, lies between p_l and p_h. Given stationary strategies, the manufacturer's optimization problem is represented by the following functional equation, which is subject to certain constraints (distributor's decision rule):

$$\begin{aligned} V(p_1, p_h) = \text{Max}[&w\{F(p_h) - F(p_a)\}/\{F(p_h) - F(p_l)\} \\ &+ \delta w_a\ \{F(p_a) - F(p_c)\}/\{F(p_h) - F(p_1)\} \\ &+ \delta^2 V(p_1, p_c)\ \{F(p_c) - F(p_1)\}/\{F(p_h) - F(p_1)\}], \end{aligned} \tag{1}$$

where the Max is subject to (2), (3), and (4), and where $w(p_l, p_h)$ is a w that achieves the Max in Equation (1),

$$w_a \equiv \delta V[p_c(p_1, p_a), p_a], \tag{2}$$

$$p_c = p_c(p_1, p_a) = \text{Min } p \in [p_1, p_a] \quad \text{if } p - \delta V(p, p_a) \geq \delta(p - w(p_1, p)), \tag{3a}$$

$$p_c = p_c(p_1, p_a) = p_a \text{ if } p - \delta V(p, p_a) < \delta(p - w(p_1, p)) \text{ for all } p \in [p_1, p_a]. \tag{3b}$$

Let f denote the distributor's net benefit,

$$f(p_1, p) = p - w - \delta[p - w_a(p_1, p)] \text{ if } p_c(p_1, p) < p, \quad (4a)$$

$$f(p_1, p) = p - w - \delta^2[p - w(p_1, p)] \text{ if } p_c(p_1, p) = p, \quad (4b)$$

$$\text{then } p_a = p_a(w; p_1, p_h) = p_h \text{ if } f(p_1, p) < 0 \text{ for all } p \in [p_1, p_h], \quad (4c)$$

$$p_a = p_a(w; p_1, p_h) = \text{Min } p \text{ such that } f(p_1, p) \geq 0. \quad (4d)$$

Equation (1) is a complex functional equation that represents the manufacturer's problem of determining the optimal first offer w, based on uncertain knowledge of p. The first term on the RHS of Equation (1) represents the manufacturer's payoff if the first offer w is accepted immediately. It is thus the product of the first offer w and its probability of immediate acceptance. The second term is the manufacturer's payoff if the distributor rejects the first offer and makes an acceptable counteroffer, w_a. It is the product of the counteroffer (discounted one period) and the probability that the distributor will make such an acceptable counteroffer. The third term represents the manufacturer's payoff if the distributor makes an unacceptable counteroffer. This signals to the manufacturer that p lies between p_l and p_c. The third term thus is the manufacturer's payoff if the game continues beyond two periods. Here, the manufacturer makes an offer based on the knowledge that $p \in [p_l, p_c]$. In other words, Equation (1), which is the sum of these three terms, represents the manufacturer's expected payoff.

Equation (2) develops the acceptable counteroffer of the distributor. Equation (3) may be interpreted as the distributor's decision rule such that if $p = p_c$, the s/he prefers to make an acceptable counteroffer and settle in the second period rather than make an unacceptable counteroffer that extends the bargaining beyond two periods. Similarly, Equation (4) simply states that if $p = p_a$, the distributor prefers to accept the manufacturer's first offer w, rather than to reject it and make an acceptable counteroffer. Through Equation (4), one can represent the Max in Equation (1) with just p_a. Then p_a is the only choice variable, where w is determined by Equation (4) as the largest price that induces p_a to be the number such that if $p = p_a$, the distributor accepts the manufacturer's offer w.

GP (1986b) solve Equations (1)–(4) and show that the solution constitutes a stationary equilibrium. The solution approach distinguishes between "informationally small" versus "informationally large" games. The smallest bargaining game is obviously one of certainty, and it ends immediately (Rubinstein 1982). A slightly larger game is one where the bargaining lasts for at most two periods. In such "small games," the manufacturer's first offer is either accepted immediately or the distributor rejects it and makes a counteroffer that the manufacturer accepts. Thus, in a "small game," one of the parties (e.g., the manufacturer) is not perfectly certain about the other party's reservation value (e.g., distributor's resale value).

The two-period game is represented in the following equations:

$$V(p_1, p_h) = \text{Max}[w\{F(p_h) - F(p_a)\}/\{F(p_h) - F(p_1)\} + \delta\, w_a\, \{F(p_a) - F(p_1)\}/\{F(p_h) - F(p_1)\}, \quad (5)$$

where the Max is subject to (6), (7), and $p_1 \leq p_a \leq p_h$.

$$p_a - w = \delta(p_a - w_a), \quad (6)$$

$$\text{where } w_a = \delta V(p_1, p_a). \quad (7)$$

Note that if it is optimal for a distributor to accept w when $p = p_a$, then it is also optimal to accept w for all values of $p \in [p_a, p_h]$. Equation (5) can then be rewritten using (6) and (7) as:

$$V(p_1, p_h) = \text{Max}[(1 - \delta)p_a\{F(p_h) - F(p_a)\}/\{F(p_h) - F(p_1)\} + \delta^2 V(p_1, p_a)]. \quad (8)$$

The game becomes "larger" as uncertainty increases and bargaining lasts beyond two periods. However, even if the starting point is a large game, the bargaining process evolves to the point when the game is essentially identical to the small game. The rationale is that the bargaining process, i.e., the sequence of offers and counteroffers, reduces uncertainty. Following this logic, Grossman and Perry (1986b) first solve for a "small game" where the bargaining lasts at most two periods. They then find the equilibrium for the "large game" in which bargaining lasts longer than two periods. In the large game, the manufacturer's uncertainty increases relative to the small game. Grossman and Perry argue that once the equilibrium for the small game is determined, the equilibrium for the larger game can also be solved because the bargaining process essentially reduces the manufacturer's uncertainty, forcing the game to reach a node of the type solved for in the small game.

Numerical Example

The solution for a small game is first obtained from Equations (6)–(8), and it is then used to specify Equations (2)–(4). This makes it possible to solve Equation (1) with p_a being the only choice variable. The value p_a that maximizes Equation (1) is then used to calculate w from (4). This process is repeated until the values of V, w, p_a, and p_c converge. We present a brief numerical example below.

Consider the parameters p_l = \$20, $p_{h.}$ = \$90, $\delta = 0.8$, and c = \$0. The SE model predicts that the manufacturer's initial offer should be \$18.16, and the distributor should accept if p is between \$45 and \$90. However, if $p <$ \$45, the distributor should reject the offer at $t = 2$ and make an acceptable counteroffer of \$11.45. Bargaining lasts for two periods. In this game, p_a = \$45 and $p_c = p_l$ = \$20. For $\delta = 0.95$ (holding other parameters constant) the SE model predicts that the manufacturer's first offer should be \$14.09, which the distributor should accept if p lies between \$68 and \$90. However, if p is between \$21 and \$68, the distributor should make an acceptable counteroffer of \$11.26. For p = \$20, then the distributor makes an unacceptable counteroffer and the manufacturer makes a new offer of \$11.21. Here, p_a = \$68, p_c = \$21 and bargaining lasts for a maximum of three periods.

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