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Designing Price Contracts for Boundedly Rational Customers: Does the Number of Blocks Matter?

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When designing price contracts, one of the major questions confronting managers is how many blocks there should be in the contract. We investigate this question in the setting of a manufacturer-retailer dyad facing a linear deterministic consumer demand. Theoretical marketing models predict that the manufacturer's profits rise dramatically when the number of blocks in the contract is increased from one to two because both channel efficiency and its share of channel profits increase. However, increasing the number of blocks to three yields no incremental profits.

We test these predictions experimentally and find that increasing the number of blocks from one to two raises channel efficiency but not the manufacturer's share of profits. Surprisingly, having three blocks in the contract increases channel efficiency even further and also gives the manufacturer a slightly higher share of profits. We show that these results can be explained by a quantal response equilibrium model in which the manufacturer accounts for noisy best response due to nonpecuniary payoff components in the retailer's utility. We also show that the retailer is sensitive to the counterfactual profits it could have earned if it were charged a lower marginal price for earlier blocks in the multiple-block contract.

Key words: quantity discounts; price contracts; quantal response equilibrium; experimental economics; behavioral economics
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1. Introduction

One of the most challenging issues marketing managers face today is how to design price contracts: When should a firm adopt a simple linear price contract, and when should it use a more complex nonlinear contract? Furthermore, because there are many types of nonlinear price contracts available, which of these contracts should the firm choose? Specifically, what is the optimal number of *blocks*, or marginal prices, in a price contract? The "number of blocks" question is important because it is one of the key variables managers must consider when designing a price contract. A one-block price contract is simply the linear price contract. Contracts with multiple blocks and declining marginal prices are quantity discounts called multiblock tariffs.[1] Multiblock tariffs are also further differentiated by the number of blocks in the contract: If there are two blocks, the contract is known as a two-block tariff; if there are three blocks, it is called a three-block tariff; and so on. How does the number of blocks in a price contract affect the profits of a firm?

The answer to the above question depends on the environment under which the price contracts are used. In the environment of a manufacturer-retailer dyad facing a deterministic final demand, the number of blocks in a price contract affects the firm's profits in a specific way. Marketing models predict that the total profits appropriated by the channel increase when the number of blocks in a price contract increases from one to two (Jeuland and Shugan 1983, Weng

[1] The number of blocks in a price contract is also known as *schedule complexity* in Dolan's (1987) review on the use of quantity discounts in marketing. By the definition of a quantity discount, the number of blocks has to be equal to or greater than two. The other dimensions along which price contracts are defined are (1) whether the marginal price in each block is equal to the average price paid and (2) whether there is a lump-sum fixed fee independent of the unit sales. For example, if multiblock tariffs have the additional property that the marginal price in each block is equal to the average price, they are known as *all-units discounts*. With a fixed fee, the contract that has only one block is called a two-part tariff; if there are two blocks, then it is called a three-part tariff. Ho and Zhang (2006) study whether imposing a fixed fee in one-block pricing (i.e., linear pricing contract versus the two-part tariff) affects economic outcomes.

1995, Kolay et al. 2004), but would remain unchanged when the number of blocks increases from two to a higher number. Moreover, the manufacturer's share of the total profits is predicted to rise to 100% when the number of blocks increases from one to two, and remains unchanged as the number of blocks increases further. The above predictions carry over to an environment when the firm faces a homogeneous consumer segment: Both the total surplus (firm's profits and consumer surplus) and the firm's share of the total surplus increase as the number of blocks in the price contract changes from one to two, but remain constant thereafter even as the number of blocks increases. However, if there are many segments of consumers with different demand schedules, then theoretical models predict that the firm's profits increase with the number of blocks in a multiblock tariff, albeit in a declining fashion (Murphy 1977, Dolan 1987, Wilson 1993).

The above theoretical results are extremely valuable to managers because they dramatically simplify the decision complexity involved in designing a price contract. For instance, these results imply that managers need not "think beyond two blocks" when designing quantity discounts to coordinate a channel. Nevertheless, the value of these theoretical predictions has not been empirically validated. The reasons for this are apparent: To construct a causal test of these predictions in the field, researchers would have to ensure that all of the structural assumptions underlying the theoretical models (be it the channel structure or the price-setting process in the channel) are satisfied, and field data that are relatively "clean" are difficult to come by. This suggests that controlled laboratory experiments where decision makers are induced to have values over outcomes and are motivated by monetary incentives, might be an appropriate tool for conducting such an empirical test. (See Amaldoss et al. 2000, Amaldoss and Jain 2002, Amaldoss and Rapoport 2005, Srivastava et al. 2000 for examples of such success in marketing.)

Another reason it is important to test these theoretical predictions is because they rest on certain assumptions that have been increasingly challenged in behavioral economics, a field that incorporates boundedly rational behavior into formal models in economics (Ho et al. 2006a, b). Specifically, a sharp feature of the optimal price contracts that drive the above predictions is that they are designed so that the firm's customers will always purchase an optimal quantity in the "correct" block. This type of customer behavior is guaranteed as long as the firm offers the customer a payoff level such that the optimal purchase quantity in the "correct" block is just higher than the payoffs earned by purchasing in other blocks. The two underlying behavioral assumptions in this case are that customers (1) care only about their pecuniary payoffs and (2) are best-responding to differences in pecuniary payoffs across different blocks in the contract. However, these assumptions might be unnecessarily restrictive because customers might have latent components of utility that are not reflected in their pecuniary payoffs (McKelvey and Palfrey 1995). One example of these nonpecuniary components might be counterfactual payoffs that they could have received (Camerer and Ho 1999, Camerer et al. 2002, Ho et al. 2007). For example, customers might dislike paying different marginal prices for the same product and compare their payoffs to a case in which they pay a lower marginal price for all units of the product. The main implication is that if any of these behavioral assumptions is relaxed, then the resultant optimal number of blocks in a price contract might differ from that which is prescribed by standard theoretical models.

This paper contributes to the marketing literature by using experimental economics methodology to examine empirically whether the number of blocks in a price contract matters to firms. As a first step, we test the theoretical predictions in the simplest possible setting—a manufacturer-retailer dyad facing a linear deterministic demand function. In our experimental treatments, we vary the number of blocks in the price contracts from one to three. The contracts we chose for the multiple-block treatments are the two-block and three-block tariffs because they belong to the format of nonlinear price contracts that have been studied most extensively (Wilson 1993). The theoretical predictions we test are (1) the total profits appropriated by the dyad increase when the number of blocks in a price contract increases from one to two; (2) channel profits remain unchanged when the number of blocks increases from two to three; (3) the manufacturer's share of the total profits increases when the number of blocks changes from one to two; and (4) the manufacturer's share of channel profits remains unchanged with a three-block contract.

The experimental results indicate that while increasing the number of blocks in a price contract from one to two does increase channel efficiency, increasing the number of blocks from two to three raises channel efficiency even further, contrary to theoretical predictions. Moreover, the manufacturer's share of profits does not rise significantly with the addition of more blocks in the contract. We show that this pattern of results can be better explained using a quantal response equilibrium (QRE) model (McKelvey and Palfrey 1995, Baye and Morgan 2004). The QRE model allows for noisy best response by the retailer so that it need not choose to buy in the block that yields the highest pecuniary payoffs all the time (i.e., the retailer "better," instead of "best," responds to its pecuniary payoffs). We also hypothesize that a component of these nonpecuniary payoffs in the retailer's utility is the retailer's sensitivity to the counterfactual payoffs it forgoes due to the difference in marginal prices across blocks. In such a setting, the retailer will prefer the three-block tariff because an additional block with an intermediate marginal price reduces this disutility. The manufacturer incorporates the retailer's behavior into its profit maximization problem and revises its equilibrium contract offer accordingly. The structural model that incorporates quantal response and the role of counterfactual payoffs yields two additional parameters and nests the standard model as a special case. We estimated these two behavioral parameters from the experimental data using maximum likelihood methods. The results strongly support the presence of latent payoffs in the retailer's utility and indicate that every counterfactual dollar is worth about one-fifth of an actual dollar.

This paper proceeds as follows: In §2, we present the predictions of theoretical marketing models regarding how the number of blocks in a price contract can affect profit outcomes in a channel. The specific contracts we examine are the one-block linear price contract, the two-block tariff, and the three-block tariff. We then state the hypotheses to be tested. The experimental design and the results are discussed in §3. In §4, we present the QRE model and discuss the role of counterfactual profits in the multi-block tariff. We then present the results of the estimated model. Section 5 concludes the paper with a discussion of the research and managerial implications and some limitations of this paper.

2. Predictions of Standard Theoretical Models

There has been extensive work in marketing on how different types of price contracts can affect firms' profits in a channel. Jeuland and Shugan (1983) were the first to show that if firms in a manufacturer-retailer dyad facing a deterministic final demand adopt a one-block linear price contract, then the total profits of the firms are less than that achieved by a firm that is vertically integrated. However, they showed that if the channel members can adopt more complex price contracts such as a quantity discount, they can coordinate the channel and achieve the same level of total profits that can be appropriated by the merged firm.[2] The quantity discount schedule they derived was format free, that is, the number of blocks in the contract was not explicitly specified. Weng (1995) was the first paper that addressed the issue of the number of blocks in a price contract in a channel setting. His model is slightly different in that final demand is stochastic instead of deterministic. He demonstrated that the number of blocks in the two major formats of quantity discounts—the multiblock tariff and the all-units discount—does not affect profit outcomes in a channel. Kolay et al. (2004) show that when final demand is deterministic, both the two-block tariff and the two-block all-units discount can coordinate the channel. Because price contracts with only two blocks are good enough, they did not study contracts with a higher number of blocks.

We now present the theoretical predictions of the profit effects of using the one-block, two-block, and three-block price contracts derived from the above literature. Consider a channel that consists of one manufacturer and one retailer. The manufacturer produces a product at a constant marginal cost c and sells the product to the retailer, who sells it to consumers by charging a retail price p. The consumers' demand is given by the linear function $q = a - p$, where a is the choke-off price. There are no other costs incurred by the firms. The manufacturer is a Stackelberg leader who offers a price contract to the retailer on a take-it-or-leave-it basis. If the retailer rejects the contract, both firms receive zero earnings. For notational purposes, the type of contract associated with the variables is indicated in parentheses in the subscript. When the type of contract is not specified, the variable applies to all the contracts discussed.

2.1. Theory: Two Blocks Are Better than One

With a one-block linear price contract, it is well known that the manufacturer will charge an equilibrium wholesale price of $w^*_{(1B)} = (a + c)/2$, and the manufacturer's profits and total profits will be $\pi^*_{M(1B)} = (a - c)^2/8$ and $\pi^*_{T(1B)} = 3(a - c)^2/16$, respectively. Marketing scholars have noted that $\pi^*_{T(1B)}$ is less than the benchmark profits that the vertically integrated firm earns, which is $(a - c)^2/4$. In fact, channel efficiency with a one-block contract is only 75%. What if the manufacturer offers a price contract with two blocks instead? We focus on the simplest two-block price contract, a quantity discount called the two-block tariff. In the two-block tariff (2B), the manufacturer charges a marginal price of $w_{1(2B)}$ for the first block of $x_{1(2B)}$ units, followed by a lower marginal price of $w_{2(2B)}$ on subsequent units. Mathematically, the contract is represented by

$$T(q_{(2B)}) = \begin{cases} w_{1(2B)} \cdot q_{(2B)} & \text{if } 0 < q_{(2B)} \le x_{1(2B)} \\ w_{1(2B)} \cdot x_{1(2B)} + w_{2(2B)} \cdot (q_{(2B)} - x_{1(2B)}) & \\ \qquad \text{if } q_{(2B)} > x_{1(2B)}, & \end{cases} \tag{2.1}$$

[2] Later papers that have studied channel coordination, channel efficiency, and quantity discounts in various settings include Shugan (1985), Moorthy (1987), Coughlan and Wernerfelt (1989), Choi (1991), Gerstner and Hess (1995), Ingene and Parry (1995), Iyer (1998), Iyer and Villas-Boas (2003), Raju and Zhang (2005), Shugan (2005), Liu and Zhang (2006), Arya and Mittendorf (2006).

where $w_{1(2B)} > w_{2(2B)}$. With this contract, the profits for the manufacturer and retailer are $\pi_{M(2B)} = T(q_{(2B)}) - c \cdot q_{(2B)}$ and $\pi_{R(2B)} = p_{(2B)} \cdot q_{(2B)} - T(q_{(2B)})$, respectively. It can be shown that this contract can restore channel efficiency to 100%. To achieve this, the manufacturer sets $w^*_{2(2B)} = c$, which induces the retailer to charge $(a+c)/2$, the same retail price charged by the merged firm, producing channel profits of $(a-c)^2/4$. Moreover, the manufacturer can appropriate all the channel profits of $(a-c)^2/4$. It does this by setting $w^*_{1(2B)} = a$ and $x^*_{1(2B)} = (a-c)/4$. Contrast this with the manufacturer's share of profits in the one-block price contract, which is $m^*_{(1B)} = \pi^*_{M(1B)}/\pi^*_{T(1B)} = 66.7\%$. Hence, it is clear that a price contract with two blocks is superior to a one-block contract: the manufacturer doubles its profits as channel efficiency rises from 75% to 100% and its share of profits increases from 66.7% to 100%.

2.2. Theory: Three Blocks Are Not Better than Two

Because both channel efficiency and the manufacturer's share of profits are already at 100% with a two-block contract, it is obvious that increasing the number of blocks to three cannot yield any additional benefits. But does it do any worse? Consider a three-block tariff (3B) which has the form

$$T(q_{(3B)}) = \begin{cases} w_{0(3B)} \cdot q_{(3B)} & \text{if } 0 < q_{(3B)} \le x_{0(3B)} \\ w_{0(3B)} \cdot x_{0(3B)} + w_{1(3B)} \cdot (q_{(3B)} - x_{0(3B)}) & \\ \qquad \text{if } x_{0(3B)} < q_{(3B)} \le x_{1(3B)} & \\ w_{0(3B)} \cdot x_{0(3B)} + w_{1(3B)} \cdot (x_{1(3B)} - x_{0(3B)}) & \\ \quad + w_{2(3B)} \cdot (q_{(3B)} - x_{1(3B)}) & \\ \qquad \text{if } q_{(3B)} > x_{1(3B)}, & \end{cases} \tag{2.2}$$

where $w_{0(3B)} > w_{1(3B)} > w_{2(3B)}$. In this contract, the retailer pays three marginal prices if it buys a quantity in the last block. It can be shown that the profit-maximizing contract for the manufacturer is to charge $w^*_{2(3B)} = c$, which induces the retailer to charge the same retail price as with a two-block tariff. Moreover, for a fixed $x_{0(3B)}$, the manufacturer should choose $w^*_{0(3B)} = a$, $w^*_{1(3B)}$ just slightly below a, and $x^*_{1(3B)} = (a-c)/4$ to extract all the channel profits of $(a-c)^2/4$. Hence, having three blocks over two blocks in a price contract does no better (or worse) for both the manufacturer and the channel.

Together, the above theoretical discussion yields the following four testable hypotheses.

Hypothesis 1 (H1). *Total channel profits increase when the number of blocks in a price contract increases from one to two. Specifically, channel efficiency increases from* 75% *in the one-block price contract to* 100% *with the two-block tariff.*

Hypothesis 2 (H2). *Total channel profits remain unchanged when the number of blocks in a price contract increases from two to three. That is, the two-block and three-block tariffs are revenue equivalent, and both contracts will achieve* 100% *channel efficiency.*

Hypothesis 3 (H3). *The manufacturer's share of the total profits increases from* 66.7% *in the one-block contract to* 100% *in the two-block tariff.*

Hypothesis 4 (H4). *The manufacturer's share of channel profits remains unchanged when the number of blocks in the price contract increases from two to three. Both the two-block and three-block tariffs are division equivalent and will give the manufacturer a* 100% *share of the profits.*

There are two important issues that must be mentioned about the above hypotheses. First, although they are described in terms of profit outcomes, they are actually underpinned by the equilibrium contract offers and purchase decisions of the manufacturer and retailer. For example, H2 is a result of the prediction that the manufacturer chooses $w^*_{2(2B)} = w^*_{2(3B)} = c$ in the optimal two-block and three-block contracts. H4 is an outcome of the predictions that the manufacturer will choose $w^*_{1(2B)} = w^*_{0(3B)} = a$, $w^*_{1(3B)} = a^-$ and $x^*_{1(2B)} = x^*_{1(3B)} = (a-c)/4$. Moreover, the retailer is predicted to choose $p^*_{(2B)} = p^*_{(3B)} = (a+c)/2$, in effect purchasing only in the last block of both the multiple-block contracts and paying all marginal prices in the two-block and three-block contracts. Second, there is an alternative hypothesis on the manufacturer's share of channel profits in the theoretical literature. Jeuland and Shugan (1983) postulated that the manufacturer's share of channel profits will be between 50% and 75% with the use of quantity discounts such as the two-block and three-block tariffs. They derived this range based on the logic that the channel members cannot make less profits if they were to agree on replacing the one-block contract with a multiblock tariff: For the manufacturer to prefer the new contract, it must make at least $\pi^*_{M(1B)} = (a-c)^2/8$, which is 50% of the total profits of $(a-c)^2/4$. The retailer must make at least $\pi^*_{R(1B)} = (a-c)^2/16$ as well, giving the manufacturer a maximum of 75% of $(a-c)^2/4$. However, H3 and H4 have the manufacturer's share of channel profits at 100% because in our theoretical model the outside option is set to zero profits instead of the profits of the one-block contract. We now proceed to describe the experimental design and analyze the results.

3. Experimental Design and Results

3.1. Design

The treatment variable in our experiment is the number of blocks in the price contract. There are three levels in the treatment variable, corresponding to the one-block linear price contract, the two-block tariff and the three-block tariff. We conducted two experimental sessions for each of the three contracts, with each session lasting about 90 minutes. Subjects were recruited from an undergraduate marketing course at a major research university. Each subject was allowed to participate in only one session and received course credit for arriving on time. During the experiment, subjects earned experimental points as their payoffs, which were converted into cash at the end of each session. The conversion rate was set at \$0.20 per 100 points. Average earnings were \$12.00, with minimum and maximum earnings of \$4.00 and \$20.00, respectively.

Each experimental session consisted of 11 subjects and 11 decision rounds. In each round, there were five manufacturer-retailer pairs. Each subject participated in a total of 10 rounds and sat out one round. In every round in which she participated, each subject was assigned either the role of a manufacturer or a retailer. In order to ensure that subjects better understood the incentives facing each channel member, we designed the experiment so that every subject assumed each of the two roles five times, with the sequence randomly determined. To control for reputation-building behavior, each subject was matched with another subject only once in the session. This translated effectively into 10 independent one-shot games played by each subject.

Once the subjects entered the room, they were seated apart and the instructions were read aloud by the experimenter. Subjects were also provided a computer spreadsheet to help calculate their payoffs. This spreadsheet also functioned as a decision aid: it allowed subjects to simulate different decisions for both the manufacturer and the retailer and obtain the payoffs for both channel members. To ensure that subjects were familiar with the use of the spreadsheet, they were led through some exercises before the experimenter started the first decision round. Because subjects were able to link decisions to payoff consequences accurately using the spreadsheet, our design yields a conservative test of any deviations from the theoretical predictions.[3]

The experiment involved complex pricing contracts, so we kept the instructions and the decision tasks as simple as possible. In each treatment, subjects were told that the manufacturer produces a product at a unit cost of 20 points and sells the product to the retailer, who in turn sells it to a group of customers. The customers' demand is given by $QUANTITY = 100 - PRICE$. Each decision round began with the manufacturer offering a pricing contract to the retailer. In the one-block contract, the manufacturer determined only a single wholesale price, X, corresponding to $w_{(1B)}$. In the two-block tariff treatment, the manufacturer offered a contract that consisted of prices X and Y and a breakpoint $BREAK$ (corresponding to $w_{1(2B)}$, $w_{2(2B)}$, and $x_{1(2B)}$, respectively). In the three-block tariff treatment, the values of $w_{0(3B)}$ and $x_{0(3B)}$ were exogenously set to $a = 100$ and $(a - c)/10 = 8$, respectively. We eliminated the two decision variables to equalize the number of decisions vis-à-vis the two-block tariff treatment. The value of $w_{0(3B)}$ has to be fixed at 100 because it is the only value that can allow the manufacturer to capture all the channel profits. The value of $x_{0(3B)} = 8$ was chosen to pin the minimum share of profits earned by the manufacturer down to 40% of the maximum possible pie. Hence, the manufacturer also determined an offer that involved prices X (which must be less than 100) and Y, and a breakpoint $BREAK$ ($w_{1(3B)}$, $w_{2(3B)}$, and $x_{1(3B)}$, respectively). In both treatments, the manufacturer was told to choose integer values of 0 to 100 for X, Y, and $BREAK$, with the condition that X must be greater than Y.

After the subjects acting as manufacturers made their decisions, the experimenter collected the decisions and revealed them privately to their retailer counterparts. The retailer then chose the $PRICE$ that determined the final $QUANTITY$ sold by the manufacturer (p and q, respectively) if she accepted the contract offer. This $QUANTITY$ sold in turn determined the payoffs π_M and π_R. Alternatively, the retailer could reject the offer, which resulted in zero point earnings for both players. The payoff functions are as given in §2: for example, if the retailer purchases a $QUANTITY$ that is greater than $BREAK$ in the two-block tariff, the manufacturer earned $\pi_{M(2B)} = X * BREAK + Y * (QUANTITY - BREAK) - 20 * QUANTITY$ points, while the retailer earned $\pi_{R(2B)} = PRICE * QUANTITY - X * BREAK - Y * (QUANTITY - BREAK)$ points.

We also conducted two sessions of another experiment that may conform more closely to decision making by firms in the real world. In this experiment, we raised the level of subjects' managerial experience, doubled the stake size, gave subjects more time to understand the instructions, and allowed subjects to make decisions in groups. First, in order to better simulate decision making by experienced managers, we recruited subjects who are MBA students at the same university. These MBA students are 10 years older on average and have more decision-making experience in the actual business world, compared to our undergraduate subjects. Moreover, more than half of these subjects are experienced managers enrolled in

[3] Ho and Zhang (2006) conducted experiments of the one-block contract without providing subjects with spreadsheets or other computational aids. Their results are qualitatively similar to ours, suggesting that subjects have no problems in calculating profits.

the part-time MBA program. We also doubled the stake size by increasing the conversion rate from \$0.20 to \$0.40 per 100 experimental points. To ensure that subjects were given sufficient time to understand the complexities of the contract, the instructions were given out one week before the sessions. Furthermore, the subjects were randomly assigned into groups of about four members each. There were a total of 12 groups in each session. Each group participated in a total of three decision rounds, making decisions for the two-block tariff treatment. The main objectives of this additional experiment are to check if the results of our main experiment involving undergraduate subjects are robust and to collect data that are perhaps more representative of actual managerial decision making.

The theoretical predictions for each of the contracts given our design parameters are shown in Table 1. In the one-block linear price treatment, the manufacturer is predicted to choose a wholesale price of $w_{(1B)} = 60$, while the retailer will respond with a retail price of $p_{(1B)} = 80$, and total profits will be 1,200, resulting in a channel efficiency of 75%. In the two-block tariff and three-block tariff treatments, the manufacturer is predicted to choose $w_{(2B)} = w_{(3B)} = 20$ to induce the retailer to choose a retail price of 60 in both contracts. Total channel profits in both contracts are predicted to be 1,600 at 100% channel efficiency. Furthermore, the manufacturers' share of total profits m is predicted to be 66.7%, 98.75%, and 99.25% in the one-, two-, and three-block treatments respectively. The reason $m_{(2B)}$ and $m_{(3B)}$ are not 100% is as follows: In the two-block tariff treatment, to guarantee that the retailer accepts the contract, the maximum $w_{1(2B)}$ that the manufacturer can charge is 99. In the three-block treatment, we required $w_{1(3B)}$ to be less than 100 so subjects can see that the contract is a quantity discount. Because they can use only integers, the predicted $w_{1(3B)}$ is 99, so that the manufacturer's profits are slightly higher compared to the two-block treatment. We imposed this constraint because we do not want to increase the difficulty of the decision tasks by making subjects use decimals.

Table 1 Theoretical Predictions for the Experiment

	Contract		
	One-block (1B)	Two-block tariff (2B)	Three-block tariff (3B)
Manufacturer's decisions	$w_{(1B)} = 60$	$w_{2(2B)} = w_{2(3B)} = 20$ $w_{1(2B)} = w_{1(3B)} = 99$ $x_{1(2B)} = x_{1(3B)} = 20$	
Retailer's decisions	$p_{(1B)} = 80$	$p_{(2B)} = p_{(3B)} = 60$	
Channel profits and efficiency	$\pi_{T(1B)} = 1{,}200$ Efficiency = 75%	$\pi_{T(2B)} = \pi_{T(3B)} = 1{,}600$ Efficiency = 100%	
Manufacturer's share of total profits	$m_{(1B)} = 66.7$	$m_{(2B)} = 98.75$, $m_{(3B)} = 99.25$	

Notes. $a = 100$, $c = 20$, $q = 100 - p$.
[#]In our experiments, because $w_{1(3B)}$ has to be lower than $w_{0(3B)}$, the manufacturer's share of channel in the three-block tariff treatment is predicted to be 99.25%.

Table 2 Undergraduates vs. Experienced Managers

	Two-block tariff (2B)			
	Undergrad $N = 110$	MBA $N = 36^{+}$	t-stat	p-value
Efficiency[#]	80.0% (26.1)	83.2% (12.7)	−0.95	0.343
$m^{\#}$	64.6% (13.9)	67.5% (10.3)	−1.27	0.207

Notes. Standard deviations are in parentheses.
[+]Each observation represents a decision made by a group of about 4 members.
[#]Conditional on the retailer accepting the contract.

3.2. Results

3.2.1. Are the Results Sensitive to "Real-World" Factors? Before we determine if the experimental results support the hypotheses, we examine if they are robust to factors such as experience, stake size, and group decision making by comparing the outcomes of the experiment involving undergraduates with those involving the MBA students. The results of two-sample t-tests shown in Table 2 reveal no differences in channel efficiency ($\pi_T/1{,}600$) and the manufacturer's share of profits m (π_M/π_T) across the two experiments (p-value $= 0.343$ and 0.207, respectively). Moreover, there are no significant differences in the decision variables except that $w_{2(2B)}$ is slightly higher (and farther away from the theoretical prediction) in the group involving experienced managers. These results suggest that real-world factors such as experience, stake size, and group decision making do not affect the results. In our subsequent analysis of the two-block tariff, we pool the data of these two experiments.

3.2.2. Summary Statistics. The mean values of the subjects' decisions and outcomes are reported in Table 3.[4] In the one-block linear price treatment, the

[4] There is no evidence of learning in the data, even for the more complex multiblock treatments. To test for possible learning effects, we specified a model of $w(t) = \alpha + \beta \cdot (1/t) \cdot w(t-1) + \epsilon$, where $w(t)$ is the manufacturer's decision variable, for $w_{(1B)}$, $w_{2(2B)}$, and $w_{2(3B)}$. In this model, α represents the steady-state value of the decision variable and β captures the learning effects. Two versions of this model were specified. First, each subject's decision was matched with her actual or observed decisions in the previous round. In the second version, the average value of the decisions across subjects in a round was matched to the average in the previous round. For all three contracts and in both versions of the model, β was not

Table 3 Mean Values of Decisions and Outcomes

Decisions	One-block linear price $N = 110$	Two-block tariff $N = 146$	Three-block tariff $N = 110$
w	60.3		
	(7.4)		
w_1		63.7	57.3
		(12.0)	(15.0)
w_2		33.9	29.9
		(10.8)	(11.3)
x_1		25.9	20.6
		(12.9)	(6.9)
p	82.3	74.0	66.2
	(6.0)	(10.6)	(6.4)
Rejection rate (%)	2.0	11.0	15.0
Conditional on acceptance			
Efficiency	66.6%	80.8%	95.1%
	(18.5)	(23.4)	(7.1)
m	64.2%	65.3%	72.7%
	(9.0)	(13.1)	(13.8)
Entire sample			
Efficiency#	65.4%	71.9%	80.4%
	(20.4)	(33.6)	(35.1)
m#	63.9%	63.6%	69.2%
	(9.1)	(13.2)	(15.1)

Notes. Figures in parentheses are the standard deviations.
#For rejected contracts, efficiency is coded as 0% and m is coded as 50%.

Table 4 Are Two Blocks Better than One?

Tests	t-statistic	p-value
Conditional on acceptance		
Efficiency (1B) = 75%	−4.69*	0.000
Efficiency (2B) = 75%	2.82*	0.006
Efficiency (2B) = 100%	−9.37*	0.000
Efficiency (2B) = Efficiency (1B)	5.24*	0.000
m(2B) = m(1B)	0.80	0.423
	Z#	p-value
Entire sample		
Efficiency (1B) = 75%	−4.20*	0.000
Efficiency (2B) = 75%	1.23	0.218
Efficiency (2B) = 100%	−10.10*	0.000
Efficiency (2B) = Efficiency (1B)	4.77*	0.000
m(2B) = m(1B)	−0.53	0.595

*Denotes significance at the 5% level.
#Based on the Wilcoxon Rank Sum Test.

value of $w_{(1B)}$ is 60.3, extremely close to the theoretical prediction of 60 (p-value = 0.894). The retail price $p_{(1B)}$ is 82.3, slightly higher than predicted. This results in a channel efficiency of 66.6%. The manufacturer's share of channel profits is 64.2%, lower but very close to the predicted value of 66.7%. In the two-block tariff and three-block tariff treatments, both $w_{2(2B)}$ and $w_{2(3B)}$ are at 33.9 and 29.9, respectively, higher than the predicted value of 20. The same pattern of results is true for the retail prices: both $p_{(2B)}$ and $p_{(3B)}$, at 74.0 and 66.2, respectively, are higher than the theoretical optimum of 60. Conditional on contract acceptance, channel efficiency in the two-block tariff is 80.8%. However, channel efficiency is 95.1% in the three-block contract, relatively close to full efficiency. The values of $w_{1(2B)}$ and $w_{1(3B)}$ are 63.7 and 57.3, very far from the predicted value of 99. The mean values of $x_{1(2B)}$ and $x_{1(3B)}$ are higher than predicted; however, the modal values in both contracts are 20, as predicted by theory. Overall, the manufacturer receives 65.3% and 72.7% of the channel profits in the two-block and three-block tariffs, respectively, conditional on contract acceptance.

3.2.3. Result: Two Blocks Are Better than One. We begin by examining H1 and H3, which predict that a two-block contract is better than a one-block contract because both channel efficiency and the manufacturer's share of channel profits increases. Table 4 shows the results of the statistical tests. First, the two-sample t-tests show that having an additional block in the price contract does indeed raise channel efficiency from 66.6% to 80.8% (p-value = 0.000). In fact, efficiency in the two-block tariff is also higher than the theoretical prediction of 75% efficiency in the one-block contract (p-value = 0.006). However, the specific point predictions of the theoretical models are not supported: the level of channel efficiency in the one-block contract is significantly lower than the predicted 75%, and the 80.8% level of efficiency in the two-block tariff is far lower than the predicted 100% (both p-values 0.000). Moreover, the marginal increase in efficiency is only 14.2% instead of 25% as predicted. Overall, H1 is only partially supported in that channel efficiency does rise with an additional block in the price contract, but not by as much as what theory predicts. Second, we note that the manufacturer's share of channel profits does not increase from 66.7% to 100% as predicted. In the one-block contract, conditional on contract acceptance, the manufacturer's share of channel profits is 64.2%; in the two-block tariff, it is not significantly different at 65.3% (p-value = 0.423). Hence, H3 clearly is not supported.

3.2.4. Result: "Two Blocks Good, Three Blocks Better." H2 and H4 together state that having three blocks instead of two blocks in the contract will not yield additional benefits both in terms of raising the channel efficiency and in terms of the manufacturer's share of channel profits. We begin by examining H2, which predicts that both the two-block and

significantly different from zero. For example, for $w_{2(2B)}$ the estimates for α and β in the first version were 33.29 (t-stat = 17.09) and −0.189 (t-stat = −0.69), respectively. We thank one of the reviewers for suggesting this specification. Another interesting observation is that there is no evidence of a segment of fully rational or efficiency-maximizing subjects. In the two-block and three-block contracts, no manufacturer chose $w_2 = 20$ in all five rounds.

Table 5 Channel Efficiency: Are Three Blocks Better than Two?

Tests		Results	
t-tests		t-statistic	p-value
$w_{2(2B)} = 20$		14.88*	0.000
$w_{2(3B)} = 20$		7.74*	0.000
$w_{2(2B)} = w_{2(3B)}$		2.81*	0.005
$p_{(2B)} = 60$		15.07*	0.000
$p_{(3B)} = 60$		9.40*	0.000
$p_{(2B)} = p_{(3B)}$		6.85*	0.000
Conditional on acceptance			
Efficiency (2B) = Efficiency (3B)		−6.55*	0.000
		$Z^{\#}$	p-value
Entire sample			
Efficiency (2B) = Efficiency (3B)		−3.69*	0.000
Mixture model	Full model	Nested model	
Parameters		Constraints:	
y_{2B}	0.077	$y_{2B} = y_{3B}$	
	(3.29)*+	$\lambda_{2B} = \lambda_{3B}$	
y_{3B}	0.172		
	(4.40)*		
λ_{2B}	0.0030		
	(12.39)*		
λ_{3B}	0.0105		
	(10.94)*		
−LL	1,322.60	1,357.04	
		Chi-square statistic = 68.88*	
		p-value = 0.000	

*Significant at the 5% level.
#Based on the Wilcoxon Rank Sum Test.
+Figures in parentheses represent the t-statistics.

three-block tariffs will be revenue equivalent and will achieve 100% channel efficiency with total profits of 1,600, given our experimental design.

First, we look at the subjects' decisions. The hypotheses tests reported in Table 5 show that the values of $w_{2(2B)}$ and $w_{2(3B)}$ are significantly higher than the predicted value of 20 (both p-values = 0.000). More important, $w_{2(3B)}$ is lower than $w_{2(2B)}$ (p-value = 0.005). Next, the retail prices in both treatments are significantly higher than the theoretical optimum of 60 (both p-values 0.000). Furthermore, $p_{(2B)}$ is higher than $p_{(3B)}$ (p-value = 0.000). Conditional on retailers accepting the contract, channel efficiency levels are at 80.8% and 95.1% for the two-block and three-block tariffs, respectively. The two-sample t-tests suggest that having three blocks in the price contract is better than two blocks, as channel efficiency in the three-block tariff is higher (p-value = 0.000).

To test H2 more conclusively, we need to account for the fact that the errors are non-Gaussian and assume only nonpositive values under the null hypothesis. This is so because errors are bounded above by 1,600 theoretically. Moreover, it would be useful to construct a test that clearly separates the joint predictions of (1) $\pi_T = (a-c)^2/4 = 1{,}600$ and (2) $\pi_{T(2B)} = \pi_{T(3B)}$. To begin, we define $Z = 1{,}600 - \pi_T$, where Z is the deviation from the predicted total profits of 1,600. We assume that Z is a random variable and its p.d.f. is $f(Z)$. We also allow for a mass point at $Z = 0$ with probability y and assume $f(0) = 0$. Note that y is the proportion of cases achieving full channel efficiency. We assume that $f(Z)$ is captured by the exponential density, which has the following p.d.f.:

$$f(Z) = \lambda \cdot \exp(-\lambda \cdot Z), \tag{3.1}$$

where $\lambda > 0$. The mean of this distribution is $1/\lambda$. Given a total of n observations in a contract, the general form of the likelihood function for Z in this mixture model is

$$L(y, \lambda) = \prod_{i=1}^{n} \{y \cdot I(Z) + (1-y) \cdot f(Z)\}, \tag{3.2}$$

where $f(0) = 0$, $f(Z)$ is exponential and

$$I(Z) = \begin{cases} 1 & \text{if } Z = 0, \\ 0 & \text{otherwise.} \end{cases} \tag{3.3}$$

The parameters are estimated by maximizing the logarithm of the joint likelihood function (for both contracts) and the results are presented in the bottom half of Table 5. First, note that the estimates of the proportions of full channel efficiency for the two-block and three-block, y_{2B} and y_{3B}, are 0.077 and 0.172, respectively, clearly far below the theoretical prediction that $y_{2B} = y_{3B} = 1$. To test the prediction of H2, we perform a likelihood-ratio test by comparing the full model with the nested model where all parameters are constrained to be the same across the two-block and three-block tariffs. The chi-square statistics in the last row of Table 5 show that the prediction that the contracts yield the same channel profits is strongly rejected with a p-value at 0.000. These results also hold when we specified $f(Z)$ to be gamma or half normal. As a final test of H2, we obtained a bootstrapped 95% confidence interval (CI) for the mean of the channel profits for each of the two contracts. The CI for the two-block tariff is (1,223, 1,350), while that of the three-block tariff is (1,494, 1,543). Because the CIs do not overlap, we can reject the hypothesis that channel profits in both contracts are equal. Overall, all our tests conclude that H2 is not supported. That is, contrary to theoretical predictions, having three blocks in the contract is clearly better for channel efficiency than having just two blocks.

What happens to the manufacturer's share of channel profits when the number of blocks in the contract is increased from two to three? H4 states that it remains unchanged and that both the two-block and three-block tariffs will give the manufacturer 100%

Table 6 Manufacturer's Share: Are Three Blocks Better than Two?

Tests 2-sample t-tests	t-statistic	p-value
Conditional on acceptance		
$m(2B) = m(3B)$	-4.03^*	0.000
	$Z^\#$	p-value
Entire sample		
$m(2B) = m(3B)$	-3.04^*	0.002
Regression estimates	**Full model**	**Nested model**
κ_{2B}	1.497 (20.30)$^{*+}$	
κ_{3B}	1.875 (11.56)*	
$\kappa_{2B} = \kappa_{3B}$		1.573 (23.53)*
$-$LL	1,707.7	1,710.4
Chi-square statistic		5.40* p-value = 0.02

*Significant at the 5% level.
$^\#$Based on the Wilcoxon Rank Sum Test. m is coded as 50% for rejected offers.
$^+$Figures in parentheses represent t-statistics.

of the profits. We already know that for all accepted contract offers the manufacturer's share of channel profits m is 65.3% in the two-block tariff. This figure is slightly higher at 72.7% in the three-block tariff. Hence, the prediction of 100% share of profits can clearly be rejected. Furthermore, the two-sample t-test reported in Table 6 shows that m is higher in the three-block tariff (p-value = 0.000).

Another way of testing H4 is to consider the following zero-intercept regressions:

$$\pi_{M(2B)} = \kappa_{(2B)} \cdot \pi_{R(2B)}$$
$$\pi_{M(3B)} = \kappa_{(3B)} \cdot \pi_{R(3B)}, \tag{3.4}$$

where $\kappa_{(2B)}$ and $\kappa_{(3B)}$ represent the ratios of the manufacturer profits to retailer profits in the respective contracts. H4 implies that $\kappa_{(2B)} = \kappa_{(3B)} \to \infty$. The estimates for $\kappa_{(2B)}$ and $\kappa_{(3B)}$ reported in the bottom half of Table 6 are 1.497 and 1.875, respectively, far lower than predicted by theory. Moreover, the hypothesis that $\kappa_{(2B)} = \kappa_{(3B)}$ is rejected (p-value = 0.02). Hence, the data show having three blocks in the price contract yields a slightly higher share of profits for the manufacturer.

It is interesting to note that the above results support Jeuland and Shugan's (1983) hypothesis that the manufacturer's share of channel profits will range from 50% to 75% (or $\kappa_{(2B)}$ and $\kappa_{(3B)}$ between one and three) with the use of a quantity discount, despite the fact that in both of the multiple-block treatments both firms earn zero profits instead of the profits of the one-block contract if the retailer rejects the contract.

Overall, the experimental data suggest that while having two blocks is good relative to the one-block price contract, having three blocks in a contract is even better in raising both channel efficiency and the manufacturer's share of profits. So the empirical answer to our question in the title of the paper is, "The number of blocks matters, both when it is predicted to do so and when it is not."

4. Explaining the Behavioral Regularities

The experimental test raises two major questions that cannot be explained by the theoretical models based on standard economic theory. First, why is channel efficiency higher in the three-block tariff relative to the two-block contract? In other words, what accounts for the retailer's decision of $p_{(2B)} > p_{(3B)}$ in the data? Second, why did manufacturers set $w_{1(2B)}$ and $w_{1(3B)}$ well below the predicted value of 99, taking a share of profits that is less than predicted? Further analyses of the data reveal the following. First, whenever the retailer purchases in the last block of the multiple-block contracts, it purchases a relatively smaller quantity in the two-block tariff compared to the three-block tariff because the manufacturer sets $w_{2(2B)} > w_{2(3B)}$. This explains the lower channel efficiency in the two-block tariff to some extent. Second, whenever the retailer accepts the contract, it purchases in the last block of the contract only 60% of the time in the two-block tariff compared to 83% in the three-block tariff. Hence, channel efficiency is also lower in the two-block tariff because the retailer purchases a smaller quantity on average because it purchases in the last block of the contract less frequently. However, as noted in §2, the standard model predicts that the retailer will purchase in the last block of the two contracts 100% of the time. Why do the retailers sometimes make purchases in the other blocks? Is there a model that can explain these behavioral regularities?

4.1. A Quantal Response Equilibrium Model

The theoretical model in §2 predicts a subgame perfect Nash equilibrium such that the manufacturer will always make contract offers to ensure that the retailer will always purchase in the last block of the multiblock contract. The manufacturer can ensure that the retailer will never purchase from the "wrong" block by offering a contract such that the profits from buying in the last block is just higher than the profits earned by purchasing in other blocks. In our experiments, it can easily be seen that if the manufacturer charges $w_{1(2B)} = w_{1(3B)} = 99$, the highest profits the retailer can earn if it buys in a block other than the last is zero.[5] The assumption of such an equilibrium is that the retailer cares about only its pecuniary payoffs (that is, its own profits) and is perfectly sensitive to differences in profits across the different blocks in the contract (that is, it will always choose the best-response action based solely on its profits). The empirical finding that the retailers do not buy in the last block all the time and that the manufacturer sets $w_{1(2B)}$ and $w_{1(3B)}$ "too low" suggests that this assumption might be too restrictive. McKelvey and Palfrey's (1995) game-theoretic solution concept of QRE provides a way to relax this assumption by allowing for stochastic best response by the retailer. In a QRE, all actions are chosen with strictly positive probability, but actions with higher expected payoffs are chosen more often. The common interpretation of why players in a game are not perfectly sensitive to the observable payoffs, or appear to make decision errors, is because of latent payoffs in the player's utility functions. The players choose their strategies by taking into account these latent components in other players' utility functions.

To specify a QRE model in our setting, we note that given the manufacturer's contract offer, the retailer effectively chooses among three options in the multiple-block contract. First, it can reject the offer, earning zero profits. If it accepts the offer, in the two-block tariff it can purchase a quantity either in the first block ($q_{(2B)} \le x_{1(2B)}$) or second block ($q_{(2B)} > x_{1(2B)}$). In the three-block tariff, because $w_{0(3B)}$ is fixed at a, the retailer will never choose $q_{(3B)} < x_{0(3B)}$ (this is also confirmed in the experimental data). Hence, the retailer effectively faces two options if it accepts the contract: purchase in the second block, that is, choose a quantity between $x_{0(3B)}$ and $x_{1(3B)}$, or purchase in the third block ($q_{(3B)} > x_{1(3B)}$). To summarize, in both contracts the retailer chooses among the three actions of (1) "reject" and getting zero earnings, (2) "left" by purchasing in the first and second blocks of the two-block and three-block tariffs, respectively, earning U_R^l, and (3) "right" by purchasing in the last blocks of both contracts, earning U_R^r. We assume that the retailer follows a multinomial logit choice rule so that the probability of the retailer choosing "right" is

$$\frac{e^{\gamma U_R^r}}{1+e^{\gamma U_R^l}+e^{\gamma U_R^r}}. \tag{4.1}$$

The manufacturer incorporates the above retailer behavior when formulating its optimal contract offer of w_1 and w_2 in the two contracts (for fixed values of $x_{1(2B)}$, $w_{0(3B)}$, $x_{0(3B)}$, and $x_{1(3B)}$). Its profit function is represented by

$$E(\pi_M) = \frac{e^{\gamma U_R^l}}{1+e^{\gamma U_R^l}+e^{\gamma U_R^r}} \cdot \pi_M^l + \frac{e^{\gamma U_R^r}}{1+e^{\gamma U_R^l}+e^{\gamma U_R^r}} \cdot \pi_M^r + \frac{1}{1+e^{\gamma U_R^l}+e^{\gamma U_R^r}} \cdot 0, \tag{4.2}$$

where π_M^l and π_M^r are the manufacturer's profits when the retailer chooses "left" and "right," respectively.

The QRE model generalizes the standard economic model by introducing an additional behavioral parameter γ, which captures the retailer's degree of sensitivity to the observable payoffs and can be estimated from the experimental data. It nests the standard economic model as a special case when $\gamma = \infty$. The QRE predicts $\gamma > 0$ and finite, which means that the retailer will choose the action with a higher observable payoff more frequently, but not all the time. The QRE contract offer is the solution to the manufacturer's profit maximization problem in (4.2) when it endogenizes the retailer's behavior.

4.2. Counterfactual Profits in a Multiple-Block Contract

Besides its own profits, what are the nonpecuniary components that might be present in the retailer's utility? In a multiblock tariff, the retailer is asked to pay multiple marginal prices across different blocks of the same product. The retailer might be sensitive to the differences between marginal prices and might wish that the lower marginal prices could be applied to those blocks with higher marginal prices. Here, the retailer experiences disutility because it is averse toward losing the counterfactual (or forgone) profits it would have earned if the lower marginal prices were actually applied.[6]

In specifying the role of counterfactual profits in the retailer's utility function, we make three assumptions. First, we assume that the retailer focuses on the upward counterfactual of earning additional profits if

[5] In the two-block tariff, the best response of the retailer if it chooses to buy in the first block is to buy either 0 or 1 units, both of which yield zero profits. In the three-block tariff, the best response if it chooses to buy in the second block is to buy 0 units. Because $w_{0(3B)} = 100$, it will never buy any positive units in the first block. As the retailer earns 20 and 12 experimental points by buying in the last blocks of the two-block and three-block tariffs, respectively, it is predicted to do so all the time.

[6] Thinking about "what if" is known in psychology as counterfactual thinking (Kahneman and Miller 1986, Roese 1994, Medvec et al. 1995, Roese 1997, Medvec and Savitsky 1997). The Experience-Weighted-Attraction model of Camerer and Ho (1999) and Camerer et al. (2002) also shows that people care about counterfactual payoffs in a game-theoretic setting. Our definition of counterfactual profits also draws on the concept of reference-dependence in that the counterfactual price can be thought of as the reference point (Kahneman and Tversky 1979). Note that the counterfactual payoff is a kind of context effects (e.g., Tversky and Simonson 1993) in that it is generated by comparing to a reference point.

the lower marginal price paid in a subsequent block were applied to the current block. This is because research has shown that upward counterfactuals are generated more frequently (Roese and Olsen 1997) and that economic agents are likely to be self-serving in bargaining situations (Babcock et al. 1995). Second, we assume that the counterfactual marginal price(s) must actually be paid by the retailer. Third, we use the lower marginal price in the adjacent block as the counterfactual because it is the most proximate price. The latter two assumptions are consistent with findings that counterfactuals are more likely to be generated when the desired outcome is closer or more salient (Kahneman and Miller 1986). In the two-block tariff, the retailer's utility is given by

$$U_{R(2B)} = \begin{cases} \pi^l_{R(2B)} \quad \text{if } 0 < q_{(2B)} \le x_{1(2B)} \\ \pi^r_{R(2B)} - \beta(w_{1(2B)} - w_{2(2B)}) \cdot x_{1(2B)} \\ \qquad \text{if } q_{(2B)} > x_{1(2B)}, \end{cases} \tag{4.3}$$

where $\pi^l_{R(2B)}$ and $\pi^r_{R(2B)}$ are the retailer's profits from buying in the first and second block, respectively. The parameter β is the value of every counterfactual dollar and $(w_{1(2B)} - w_{2(2B)}) \cdot x_{1(2B)}$ represents the counterfactual profits. We expect $0 < \beta \le 1$ because it is unlikely that the value of a counterfactual dollar exceeds that of an actual dollar. In the three-block tariff, the retailer's utility (for $q_{3B} > x_{0(3B)}$) is

$$U_{R(3B)} = \begin{cases} \pi^l_{R(3B)} - \beta(w_{0(3B)} - w_{1(3B)}) \cdot x_{0(3B)} \\ \quad \text{if } x_{0(3B)} < q_{(3B)} \le x_{1(3B)} \\ \pi^r_{R(3B)} - \beta(w_{0(3B)} - w_{1(3B)}) \cdot x_{0(3B)} \\ \qquad - \beta(w_{1(3B)} - w_{2(3B)}) \cdot (x_{1(3B)} - x_{0(3B)}) \\ \quad \text{if } q_{(3B)} > x_{1(3B)}, \end{cases} \tag{4.4}$$

where $\pi^l_{R(3B)}$ and $\pi^r_{R(3B)}$ are the retailer's profits from buying in the second and third blocks, respectively. Again, β is the value of every counterfactual dollar. For example, if the retailer purchases in the last block of the contract, the counterfactual profits are equal to $(w_{0(3B)} - w_{1(3B)}) \cdot x_{0(3B)} + (w_{1(3B)} - w_{2(3B)}) \cdot (x_{1(3B)} - x_{0(3B)})$. The first term represents the additional profits the retailer would have earned if it had paid $w_{1(3B)}$ instead of $w_{0(3B)}$ for the first block of units, while the second term is the profits it would have obtained if it had paid $w_{2(3B)}$ instead of $w_{1(3B)}$ for the second block.

Note that our utility specifications nest the standard economic model as a special case: if $\beta = 0$, there is no effect of counterfactual profits and the observable component of the retailer's utility function is only its own profits. We use the revised retailer utility functions in the QRE model: that is, the retailer cares about the counterfactual profits that it loses in a multiple-block contract and the manufacturer takes into account this nonpecuniary component of the retailer's utility.

4.3. Estimation of QRE Model with Counterfactual Profits

We now estimate the two behavioral parameters γ and β using the decisions made by the manufacturer and retailer in the experiments. Let the subscripts i and t denote each manufacturer-retailer pair and the round number in the experiment, respectively. We assume the manufacturer's decisions w_{1it}, w_{2it} in each contract follow a bivariate normal density given by

$$\begin{pmatrix} w_{1it} \\ w_{2it} \end{pmatrix} \sim N\left\{ \begin{pmatrix} w_1^* \\ w_2^* \end{pmatrix}, \begin{pmatrix} \sigma^2_{w_1} & \rho_{12}\sigma_{w_1}\sigma_{w_2} \\ \rho_{12}\sigma_{w_2}\sigma_{w_1} & \sigma^2_{w_2} \end{pmatrix} \right\}. \tag{4.5}$$

The terms w_1^* and w_2^* are the equilibrium predictions of the QRE model and are solved numerically from the maximization of the expected profits function of the manufacturer. The errors for these decisions are distributed with zero means and variances $\sigma^2_{w_1}$, $\sigma^2_{w_2}$ and the correlation in the errors are captured by ρ_{12}.[7]

The QRE contract offers of w_1^* and w_2^* for each contract must be solved numerically because of the complex nature of the manufacturer's profit function. In the numerical optimization, the manufacturer's expected profits function is specified in terms of w_1 and w_2 in the following way. We used the retailer's revised utility functions in Equations (4.3) and (4.4) (that is, taking into account counterfactual profits) and the retailer's best-response price and purchase decisions for π^l_M, π^r_M, U^l_R, and U^r_R in Equation (4.2). Thus, in the two-block tariff, we have

$$\begin{aligned} \pi^l_M &= \frac{1}{2}(a - w_{1(2B)}) \cdot (w_{1(2B)} - c) \\ \pi^r_M &= w_1 \cdot x_{1(2B)} + w_2 \cdot \left(\frac{100 - w_2}{2} - x_{1(2B)}\right) \\ &\quad - c \cdot \left(\frac{100 - w_{2(2B)}}{2}\right) \\ U^l_R &= \frac{(a - w_{1(2B)})^2}{4} \\ U^r_R &= \frac{(a - w_{2(2B)})^2}{4} - (1+\beta) \cdot (w_{1(2B)} - w_{2(2B)}) \cdot x_{1(2B)}, \end{aligned} \tag{4.6}$$

[7] A descriptively more accurate but much more complex model would be to constrain w_{1it} to be greater than w_{2it} for any pair of draws. Post-estimation checks of our model reveal that the probabilities of w_1 and w_2 overlapping are very small at 0.027 and 0.079 for the two-block and three-block tariffs, respectively.

and

$$\pi_M^l = w_{0(3B)} \cdot x_{0(3B)} + w_{1(3B)} \cdot \left(\frac{a - w_{1(3B)}}{2} - x_{0(3B)}\right) - c \cdot \left(\frac{a - w_{1(3B)}}{2}\right),$$

$$\pi_M^r = w_{0(3B)} \cdot x_{0(3B)} + w_{1(3B)} \cdot (x_{1(3B)} - x_{0(3B)}) + w_{2(3B)} \cdot \left(\frac{a - w_{2(3B)}}{2} - x_{1(3B)}\right) - c \cdot \left(\frac{a - w_{2(3B)}}{2}\right) \tag{4.7}$$

$$U_R^l = \frac{(a - w_{1(3B)})^2}{4} - (1+\beta) \cdot (w_{0(3B)} - w_{1(3B)}) x_{0(3B)}$$

$$U_R^r = \frac{(a - w_{2(3B)})^2}{4} - (1+\beta) \cdot (w_{0(3B)} - w_{1(3B)}) x_{0(3B)} - (1+\beta) \cdot (w_{1(3B)} - w_{2(3B)}) \cdot x_{1(3B)} + \beta (w_{1(3B)} - w_{2(3B)}) \cdot x_{0(3B)}$$

in the three-block tariff with $w_{0(3B)} = a = 100$, $x_{0(3B)} = 8$, $x_{1(2B)} = x_{1(3B)} = 20$, and $c = 20$.

For each contract offer of w_{1it}, w_{2it}, and x_{1it}, the retailer's utilities U_{Rit}^l and U_{Rit}^r for the two-block and three-block tariffs are specified by Equations (4.3) and (4.4), respectively. The values of π_R^l and π_R^r for each observation are the retailer's actual profits for a block that was chosen, and the best-response profits if it was not.

Assuming that the decision errors of the manufacturer and retailer are independent, the joint log-likelihood function of our model for each of the multiblock tariffs is

$$\begin{aligned} LL(\beta, \gamma, \sigma_{w_1}, \sigma_{w_2}, \rho_{12}) &= \sum_{i=1}^{N} \sum_{t=1}^{T} \Bigg\{ -\ln(2\pi) - \frac{1}{2} \ln|\Sigma| - \frac{1}{2}(\Omega' \Sigma^{-1} \Omega) \\ &\quad + \text{Reject}_{it} \cdot \ln\left(\frac{1}{1 + e^{\gamma U_{Rit}^l} + e^{\gamma U_{Rit}^r}}\right) \\ &\quad + \text{Left}_{it} \cdot \ln\left(\frac{e^{\gamma U_{Rit}^l}}{1 + e^{\gamma U_{Rit}^l} + e^{\gamma U_{Rit}^r}}\right) \\ &\quad + \text{Right}_{it} \cdot \ln\left(\frac{e^{\gamma U_{Rit}^r}}{1 + e^{\gamma U_{Rit}^l} + e^{\gamma U_{Rit}^r}}\right) \Bigg\}, \end{aligned} \tag{4.8}$$

where

$$\Sigma = \begin{pmatrix} \sigma_{w_1}^2 & \rho_{12} \sigma_{w_1} \sigma_{w_2} \\ \rho_{12} \sigma_{w_2} \sigma_{w_1} & \sigma_{w_2}^2 \end{pmatrix} \quad \text{and} \quad \Omega = \begin{pmatrix} w_{1it} - w_1^* \\ w_{2it} - w_2^* \end{pmatrix}.$$

The above model and a series of nested models in which γ and β are constrained are then estimated using maximum likelihood methods. In our estimation, we specified γ to be contract specific because the latent payoffs in the retailer's utility can vary across contracts; however, β is common across the two multiblock tariffs because the value of a counterfactual dollar should be a stable preference.

4.4. Estimation Results

The results of the estimated models are presented in Table 7. The t-statistics of the parameter estimates are in parentheses. Column (1) displays the parameter estimates and model fit of the QRE model with counterfactual profits. First, we note that the estimates of γ_{2B} and γ_{3B} are highly significant. The values of 1.96 and 5.36 reported in Table 7 are estimates with the retailer's utilities scaled to dollar terms instead of experimental units. Second, β is significant and every counterfactual dollar is worth about one-fifth of an actual dollar, consistent with our prediction that β is between 0 and 1. Overall, the data support our hypothesis that both the manufacturer and retailer make decisions taking into account the latent components of utility and the role of counterfactual profits in the retailer's utility.

Next, the results of the nested models that constrained either one or both of the behavioral parameters are shown in Columns (2) to (4). Column (2) shows results of the model that only incorporates the role of counterfactual profits without QRE, while Column (3) is for the QRE model without counterfactual profits. The likelihood ratio tests show that each of these nested models can be rejected; that is, each of the QRE and the counterfactual profits is a significant factor in explaining actual firm behavior (p-value = 0.000 in each of the two cases). As expected, when β is constrained to be zero, the estimates of γ in both contracts drop. Finally, the chi-square statistic in Column (4) shows that the model based on standard economic theory (no QRE and no counterfactual profits) can be strongly rejected (p-value = 0.000). Table 8 compares the in-sample predictions of the QRE model with counterfactual profits versus the predictions of the standard theoretical model against the experimental data. Clearly, the introduction of just two additional behavioral parameters produces a far superior explanation of actual behavior. These results show that slight generalizations of the standard model can yield high payoffs in predictive performance.

5. Discussion and Conclusion

This paper experimentally investigates the theoretical predictions on whether the number of blocks in a price contract matters to profit outcomes in a simple channel. Theoretical models predict that the manufacturer in the channel should prefer a two-block contract to a one-block linear price contract because of both efficiency gains and an increase in the manufacturer's share of channel profits. Moreover, while two blocks in the price contract are better than one, three blocks are not better than two: adding a third block does not lead to any further increase in profits. These predictions are tested using experimental economics methods. The results show that while

Table 7 Estimation Results

Estimated parameters	(1) Full model	(2) No QRE $\gamma_{2B} = \gamma_{3B} = 150$	(3) No counterfactual profits $\beta = 0$	(4) No QRE and counterfactual profits $\beta = 0$, $\gamma_{2B} = \gamma_{3B} = 150$
β	0.1964	0.1258		—
	(8.10)	(35.00)		
γ_{2B}	1.96	—	0.81	—
	(7.08)		(9.30)	
γ_{3B}	5.36	—	2.40	—
	(7.12)		(26.06)	
$\sigma_{w_{1(2B)}}$	11.97	28.10	13.59	37.13
	(16.17)	(12.12)	(15.90)	(15.23)
$\sigma_{w_{2(2B)}}$	10.92	18.07	11.30	17.97
	(15.91)	(12.27)	(15.19)	(15.23)
ρ_{2B}	$-0.0003^{\text{n.s.}}$	$-0.0111^{\text{n.s.}}$	$0.0019^{\text{n.s.}}$	−0.7742
	(−0.0041)	(−0.0834)	(0.02)	(−19.45)
$\sigma_{w_{1(3B)}}$	14.94	28.84	15.04	42.49
	(13.98)	(13.88)	(13.86)	(13.97)
$\sigma_{w_{2(3B)}}$	11.92	13.04	12.04	15.21
	(13.99)	(14.07)	(13.79)	(13.97)
ρ_{3B}	0.2381	−0.2736	0.2658	−0.527
	(2.65)	(−3.09)	(3.00)	(7.31)
−LL	2,186.70	4,431.20	2,225.80	4,772.80
Chi-square		4,489	78.20	5,172.20

Note. Figures in parentheses represent the t-statistics. All parameter estimates are significant except where n.s. is indicated.

increasing the number of blocks from one to two does indeed increase channel efficiency, that increase is lower than predicted. Surprisingly, when the number of blocks increases from two to three, channel efficiency rises further. Moreover, the manufacturer's share of total profits remains unchanged from one to two blocks and increases slightly from two to three blocks. Hence, the key takeaway is that having more blocks in the price contract is better for the manufacturer. We show that the results can be better explained by a QRE model that allows for noisy best response by retailers and also accounts for the retailer's sensitivity to counterfactual payoffs in the multiblock tariffs. We estimated the QRE model with counterfactual profits and show that the generalized model predicts the data much better than does the standard theoretical model.

Table 8 Predictions of QRE Model with Counterfactual Profits

	Actual data	Model predictions	Standard economic theory
2-block tariff			
$w^*_{1(2B)}$	63.70	63.51	99
$w^*_{2(2B)}$	34.0	32.20	20
Left	0.36	0.38	0.00
Right	0.53	0.50	1.00
Reject	0.11	0.12	0.00
Efficiency# (%)	80.80	85.70	100
$m^{\#}$ (%)	65.30	67.90	98.75
3-block tariff			
$w^*_{1(3B)}$	57.30	56.10	99
$w^*_{2(3B)}$	29.90	28.40	20
Left	0.11	0.11	0.00
Right	0.74	0.82	1.00
Reject	0.15	0.07	0.00
Efficiency# (%)	95.10	96.00	100
$m^{\#}$ (%)	72.70	77.40	99.25

#Conditional on retailer accepting the contract.

In using the QRE model and considering effects such as counterfactual profits in the retailer's utility, we are providing an example of how marketing researchers can model boundedly rational behavior in economic settings (Ho et al. 2006a, b). The incorporation of nonpecuniary payoff components into the retailer's utility function in the multiblock tariff is also in line with recent psychological research on behavioral biases in two-part tariffs (Redden and Hoch 2005) and the study of optimal two-part tariff design in the presence of behavioral biases (Della Vigna and Malmendier 2004, Ho and Zhang 2006). We do not advocate abandoning standard theoretical models, but only suggest that existing models can be generalized. Hence, it is critical that the alternative model that is proposed nests the standard theoretical model as a special case. Moreover, estimating the behavioral parameters is important so that the economic consequences of bounded rationality can be quantified to be managerially useful.

There are some caveats and limitations to this paper that should encourage further lines of research. First, there is an issue regarding the external validity of the results. For example, it is possible that retailers will be more rational than our undergraduate subjects because the former have professional experience, and the decisions in real life involve much higher stakes. Our experiment shows that mimicking a real-world decision-making environment more closely (by using working managers with mid-level managerial experience as subjects, increasing the monetary incentives, and allowing group decision making) does not change the pattern of results. These results are consistent with evidence from multiple laboratory experiments showing that, in the majority of cases, increasing monetary stakes have little effect on aggregate results (Camerer and Hogarth 1999), and using subject pools with more professional experience or even better academic pedigree does not result in behavior that is more rational (Ball and Cech 1996). While this suggests that our findings are likely to be robust in the real world, they must be qualified until extensive field studies are conducted. Perhaps our results will generalize more readily to the case of a firm facing a homogeneous segment of boundedly rational end consumers whose usage of a product increases when price drops.

Second, the stylized setting of our experiments means that some other important factors that govern channel behavior in practice have not received full consideration. These include factors such as the power relationships in the channel, the length of the relationship between channel partners, and the process by which contracts are negotiated. For example, the retailer could be the party that makes contract offers. In such a case, we believe that it is the retailer that will have to incorporate possible nonpecuniary components in the manufacturer's payoffs, with corresponding changes to the specification of counterfactual profits—for instance, the manufacturer might have an aversion to charging too much of a discount across blocks. Also, a manufacturer may face multiple retailers in practice and it is interesting to study the effect of retail competition. Through careful experimentation, one can determine whether it leads to a higher channel efficiency and allows the manufacturer to gain a greater portion of the total surplus. Furthermore, contract negotiations might not be a one-shot game, but might rather be repeated over time. Multiple interactions should help channel partners learn each other's preferences (e.g., through reputation-building behavior); the implication for our model is that the firms should appear more sensitive to utilities that can be specified more explicitly over time (i.e, γ in the QRE model should increase).

Third, the sources of nonpecuniary payoffs in the retailer's utility have not been fully explored and represent an important area of future research. Because the model we test in this paper is a more intricate version of the ultimatum game (i.e., in addition to rejecting the contract, the retailer can engage in efficiency-damaging behavior through changing the retail price), one of the possible sources of nonpecuniary payoffs in the retailer's utility could be equity concerns about the distribution of channel profits. This might explain why the manufacturer sets the contract such that it keeps only about 60% to 70% of the channel profits to avoid contract rejection, consistent with Proposers' behavior in ultimatum games (Camerer 2003). However, we do not think that equity concerns can fully explain other key features of the data, because they do not account for why the manufacturer would set $w_{2(2B)}$ and $w_{2(3B)}$ away from marginal cost.

We also have not fully explored the types of counterfactual profits that are triggered by a multiple-block price contract. While our specification for the counterfactual marginal price(s) is grounded in psychological theory and explains the data well, in reality the counterfactuals could be more complicated in the brain (e.g., some weighted combination of lower marginal prices, including those that are not paid). Future research should aim at dissecting how the process of counterfactual thinking works in multiblock tariffs.

Finally, there are many other types of price contracts that deserve more research. First, the theory on the optimal number of blocks in the other major format of quantity discounts, the all-units discount, has not been studied. Second, we have only studied contracts up to three blocks. Would customers behave differently when offered contracts with even more blocks—for example, would they be prone to choose blocks in the middle (compromise effects)? Last, marketing researchers should explore the benefits of applying models such as the QRE that account for nonpecuniary components in customers' utility functions, especially in cases where the assumptions of incentive compatibility and perfect payoff sensitivity are strongly relied on.

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