

MEASURING INDIVIDUAL FRICTIONAL COSTS AND WILLINGNESS-TO-PAY VIA NAME-YOUR-OWN-PRICE MECHANISMS

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Name-your-own-price is a pricing mechanism where the buyer instead of the seller determines the price, because the buyer makes a bid at a certain price, which the seller can either accept or reject. Based on consumers' bidding behavior at a name-your-own-price seller, we develop and empirically test a model to simultaneously estimate individual willingness-to-pay (WTP) and frictional costs. Further, we compare analytically and empirically bidding behavior and profit implications of the single bid model to those of the repeated bidding model. Thereby, we derive closed form solutions for the optimal bids which describe the influence of willingness-to-pay and frictional costs on consumer's bidding behavior. In addition, we develop a procedure for estimating empirically willingness-to-pay and frictional costs for individual consumers. Finally, we discuss the findings and limitations as well as their implications for providers of name-your-own-price mechanisms.

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JOURNAL OF INTERACTIVE MARKETING VOLUME 18 / NUMBER 4 / AUTUMN 2004

Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/dir.20022

INTRODUCTION

Name-your-own-price is a pricing mechanism where the buyer instead of the seller determines the price, because the buyer makes a bid at a certain price, which the seller can either accept or reject. The most prominent provider of such a pricing mechanism is the online seller Priceline (www.priceline.com), which has been active on the market since 1998 and has mainly specialized in selling flights. Besides flights, potential buyers can now bid at Priceline for rental cars, hotel accommodation, holidays, and interest payments on mortgages. At Priceline, a potential buyer of a flight states how much she is willing to pay for a flight between two locations. Hereby, the buyer can specify her personal flexibility regarding the departure times, the number of stopovers, and possible alternative airports (e.g., Newark, New Jersey instead of JFK, New York). Priceline decides within 15 minutes if it accepts or rejects the consumer's bid. In the case of rejection, the consumer is not permitted to bid again within 7 days for the same flight at Priceline.

This restriction to a single bid (within a certain period of time) is one major design possibility of such a name-your-own-price mechanism. Other sellers using a name-your-own-price mechanism allow the consumer to rebid immediately if her initial bid is rejected. The possibility of rebidding after a previous (e.g., first) bid has been rejected describes another major design possibility of a name-your-own-price mechanism. Both major design possibilities lead to different implications for consumers' bidding behavior. A single bid prevents the consumer from incrementally bidding up to the threshold price of the seller (i.e., the lowest acceptable price for the seller). Yet, this procedure may result in lost revenues since a sale does not take place, because a first bid is rejected, but the consumer would have been willing to increase the amount of further bids. Knowledge about the influence of both different major design possibilities on consumers' bidding behavior and profits is important for providers of such name-your-own-price mechanisms because they have to decide which design to choose. However, current knowledge is rather limited. Notable exceptions are Hann and Terwiesch (2003), Ding, Eliashberg, Huber, and Saini (2002), Chernev (2003), and Fay (2003).

Apart from the question of how to best design a name-your-price mechanism, the data generated by this mechanism are interesting from a marketing research perspective because they reveal information about consumers' willingness-to-pay (WTP). Information on consumers' WTP is required for pricing decisions, especially in situations where prices should differ across consumers, channels, or product alternatives as is the case, among others, for price bundling, price discrimination, versioning products, or offering a menu of tariffs (e.g., Bakos & Brynjolfsson, 1999; Stremersch & Tellis, 2002; Skiera & Spann, 1999; Philips, 1989). Comparing prices with consumers' WTP allows us to determine consumer surplus, and this information might serve to further optimize price structures in such a way that sellers can skim additional consumer surplus.

Thereby, a name-your-own-price mechanism collects individual bids in a way that shows similarities to incentive compatible methods such as Vickrey auctions (Vickrey, 1961) and the method proposed by Becker, DeGroot, and Marschak (1964) (BDM mechanism). Hoffman, Menkhaus, Chakravarti, Field, and Whipple (1993) and Wertenbroch and Skiera (2002) demonstrate that the incentive-compatibility characteristic of these methods allows them to obtain a higher validity for measurements of WTP than contingent valuation methods. At the same time, such individual bids could make a more exact statement about the individual WTP than genuinely revealed preferences, since prices normally do not vary significantly in the case of the latter (e.g., Ben-Akiva et al., 1994; Wertenbroch & Skiera, 2002).

However, in contrast to Vickrey auctions and the BDM mechanism, name-your-own-price mechanisms in their design typically implemented are not incentive compatible. Consumers' optimal strategy at incentive compatible mechanisms is to bid exactly the amount of their WTP. Contrary to this, it is optimal for consumers to bid below their WTP at a name-your-own-price mechanism. The reason for this is that bids at Vickrey auctions and the BDM mechanism do not set the price itself but only determine the acceptance of a bid (Wertenbroch & Skiera, 2002). Therefore, consumers influence their probability of acceptance with their bid, but not the price. In the form of the present designs of name-your-own-price mechanisms, a bid

sets the price directly. Thus, the surplus maximizing consumer has to solve the tradeoff between increasing (decreasing) her probability of acceptance and decreasing (increasing) her consumer surplus by bidding high (low).

Therefore, individual bids at a name-your-own-price mechanism cannot be interpreted as consumers' WTP. If WTP estimation based on such bids is the goal, then two possibilities exist. The first possibility is to modify the design of the name-your-own-price mechanism in an incentive compatible manner. An alternative possibility is to model the decision-making process of the potential buyer and to derive her WTP from her bids. This is the approach we take in this paper.

Hence, the aim of this paper is to develop and empirically test a model to simultaneously estimate individual WTP and frictional costs based on consumers' bidding behavior at a name-your-own-price seller. Further, we compare analytically and empirically bidding behavior and profit implications for the two major design possibilities, i.e., the single bid model and the repeated bidding model. Thereby, we derive closed form solutions for the optimal bids, which we use for analytical comparisons as well as for our estimation procedure. Finally, we discuss the findings and their implications for providers of name-your-own-price mechanisms.

Thereby, our results show that observed bidding behavior at a name-your-own-price mechanism allows us to estimate consumers' individual WTP and frictional costs. The results indicate a rather large heterogeneity across consumers that allows sellers to segment the market and indicates the opportunity for the seller to further increase profit by price

discrimination. Further, we find that restricting consumers to a single bid may reduce the seller's revenues. Thus, our results show that providers of name-your-own-price mechanisms should be very concerned about the particular design of the mechanism.

CONCEPT OF THE NAME-YOUR-OWN-PRICE MECHANISM

Figure 1 illustrates the decision-making process of a consumer at a name-your-own-price mechanism. The two major design possibilities which predominate in practical applications of name-your-own-price mechanisms are the restriction to a single bid and the possibility of repeated bidding. In Figure 1, a consumer decides simultaneously on the submission of a bid to a seller and on the amount of such a bid. If the j th consumer submits the i th bid $b_{j,i}$, the seller decides on its acceptance. In equation (1), J is the total set of consumers and I_j the set of all bids the j th consumer submits. A transaction takes place in both of these designs ($Trans_{j,i} = 1$) if the bid $b_{j,i}$ is greater than or equal to a (secret) threshold price p_T determined by the seller. This threshold price is unknown to the consumer who can only make assumptions about the distribution of the threshold price. Note that we drop *product*-specific indices for the ease of exposition.

$$Trans_{j,i} = \begin{cases} 1 & \text{if } b_{j,i} \geq p_T, \\ 0 & \text{otherwise,} \end{cases} \quad (j \in J, i \in I_j). \quad (1)$$

If the seller accepts the consumer's bid, the purchase occurs because consumers' bids are binding. If the seller rejects the bid, two specific major design possibilities can be differentiated:

1. Single bid: In this case, the consumer just has the possibility of bidding once for a certain product. If

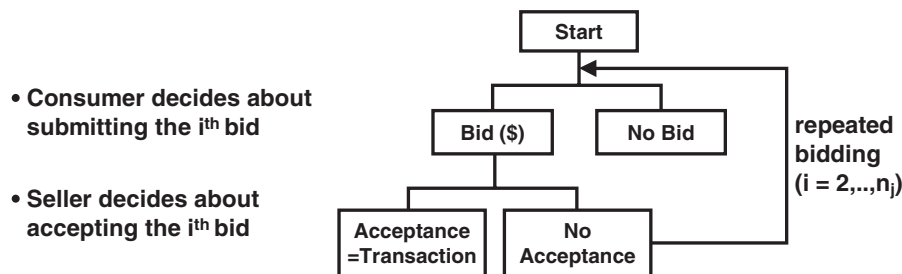


FIGURE 1

Consumer Decision About Submission of the Bid

a bid is unsuccessful, then a renewed bid for the product is not possible for a longer period of time. Priceline uses this design of a name-your-own-price mechanism. Hereby, the consumer can only bid once for a certain flight within 7 days. The only alternative that exists in this case is to bid for another arrival (respectively departure) airport or different flight data (different date), i.e., to bid for a different product.

2. Repeated bidding: The second design possibility is to allow consumers to rebid for the same product. As a result, the decision-making process of the consumer and seller is repeated until either a transaction takes place or the consumer ceases to bid (see Figure 1). For example, two German online sellers used this design of a name-your-own-price mechanism.

PREVIOUS RESEARCH AND ECONOMIC EXPLANATIONS OF BIDDING BEHAVIOR AT A NAME-YOUR-OWN-PRICE MECHANISM

Literature Review

Current literature dealing with the explanation of bidding behavior at name-your-own-price mechanisms is limited to few papers, some of them not published yet (Hann & Terwiesch, 2003; Ding et al., 2002; Chernev, 2003; Fay, 2003). These papers differ with respect to their research goal and with respect to which major design possibility of a name-your-own-price mechanism they analyzed.

Chernev (2003) examines the case of a single bid and analyzes consumers' preferences for a name-your-own-price mechanism in a paper-and-pencil experiment. Basically, he compares the situation in which consumers can bid any amount they wish ("price generation") with a situation, in which consumers have to select the amount of their bid from an available list of possible prices ("price selection"). Chernev reaches the conclusion that consumers prefer a price selection to a price generation task. The estimation of WTP and frictional costs as well as the examination of a possible repeated bidding are not discussed.

Ding et al. (2002) study the case that only a single bid is possible and that consumers acquire the product

via "traditional" sales channels when their bid was not successful. Hereby, they consider several sequential periods. Consumers act in a manner that maximizes their utility and realize utility from saving money if their bid is successful, as well as an additional utility from the aspect of winning ("excitement"). However, if their bid is rejected, they suffer a utility loss ("frustration"). Hereby, Ding et al. show theoretically and in laboratory experiments that the amount of the bid alters in the sequential periods depending on the success of previous bids and the change of the consumer's sensitivity regarding winning or losing the bids. However, no statement about the direction of the sensitivity change is made, which inhibits the derivation of forecasts on consumer's bidding behavior.

Fay (2003) develops an analytical model for a name-your-own-price seller's profit under varying restrictions for the possible number of bids consumers can submit. Thereby, he compares the single bid model with a model where experienced consumers can submit multiple bids at Priceline by applying various "tricks" such as the use of different "identities" via multiple credit cards. Further, he considers different types of consumers and the possibility of limited capacity, which can lead to an adaptation of the threshold price. However, the exact effect of different restrictions on the number of bids a consumer can submit on profit depends on various assumptions which are not tested empirically by Fay (2003).

Hann and Terwiesch (2003) are the only ones who analyze empirically the specific bidding behavior in a repeated bidding model. They develop an economic model to explain the bidding behavior and apply it with the objective of measuring the frictional costs for empirical data of a name-your-own-price seller. However, they only consider a repeated bidding model and do not compare this model analytically with a single bid model. Moreover, they do not estimate individual consumers' WTP, which is important from a marketing research point of view. Further, they do not derive closed form solutions for the optimal bids in their estimation procedure.

Compared with these approaches, the contribution of our paper is threefold. First, we develop and empirically test a model to simultaneously estimate individual

WTP and frictional costs based on consumer's bidding behavior at a name-your-own-price seller. Second, we derive closed form solutions and an algorithm for the determination of optimal bids, which we can use for analytical comparison as well as for our estimation procedure. Third, we analytically and empirically compare bidding behavior and profit implications of the single bid model to the repeated bidding model.

Economic Explanation of Search Behavior

A comparable situation to the decision-making process of bidding at name-your-own-price mechanisms is the problem of consumer search behavior. The latter also requires a sequential decision on engaging in initial and possible further search steps (Ratchford, 1982). For this reason, we briefly summarize the basic idea of economic models of consumer search behavior.

Models of consumer search behavior observe the problem of a (potential) consumer who faces varying and unknown prices at different sellers for the product she wants to buy (Stigler, 1961). Because of this, the consumer has to search for the best price at different sellers, with the search process being costly (Stigler, 1961). Based on the tradeoff between the additional revenue of search in the form of a lower price and the additional costs associated with search, the basic economic decision rule is as follows: The consumer performs an additional search step if the expected revenue of the search step is greater than the costs which occur in this search step (Goldman & Johansson, 1978; Weitzman, 1979).

In the context of this model, the consumer assumes that prices at different sellers follow a certain distribution (for example, a uniform distribution), enabling her to calculate the expected revenue of the search step (Ratchford, 1982). The basic model assumes that the expected distribution of prices at different sellers is independent of the price information obtained in previous search steps (Weitzman, 1979). An extension of the basic model relaxes this assumption of an identical price distribution across search steps. This can take place by updating the assumed price distribution based on the prices found in the previous search steps (Rothschild, 1974; Weitzman, 1979). Therefore,

consumers determine the expected revenue of an additional search step based on the knowledge of their WTP and their assumptions about the price distribution. They carry out the additional search step if the expected revenue is positive and exceeds the cost of search.

MODELING BIDDING BEHAVIOR AT NAME-YOUR-OWN-PRICE MECHANISMS

Single Bid Model

Economic models of consumer search behavior can serve as a theoretical basis for the models explaining bidding behavior at name-your-own-price sellers. The model of Hann and Terwisch (2003) is based on such economic models, which we extend in this paper by developing closed form solutions and an algorithm for the determination of optimal bids, comparing the single bid and repeated bidding model and simultaneously estimating individual frictional costs and WTP.

Our model rests on an economic rational decision process on the part of the consumer. We assume that consumers correctly expect an *exogenous* and constant threshold price of the seller. Instead of deciding on performing an additional search step, consumers decide on submitting a bid and on the amount of the bid. By submitting the bid they incur costs for its transfer, the mental input to determine the optimal amount of the bid, and also the waiting time involved before receiving information on the acceptance or rejection of their bid. We will refer to these costs $c_{j,i}$ as frictional costs (Shugan, 1980; Hann & Terwiesch, 2003).

The single bid model corresponds to the model applied by Priceline. The decision rule for the single bid is that the j th consumer submits a bid if the expected consumer surplus of the bid $ECS_{j,1}$ (accounting for the costs which incur by submitting the bid) is not negative [see equation (2)]. The amount of the bid influences the surplus and the success probability. The success probability depends on the j th consumer's assumption regarding the probability distribution $g_{j,1}(p_T)$ of the unknown threshold price. Hereby, the consumer increases her success probability by increasing the amount of the bid. However, at the same time, the consumer surplus decreases in case of

a successful bid. The consumer optimizes the expected consumer surplus of the (single) bid $ECS_{j,1}$ over the bid amount.

$$\begin{aligned} \max_{b_{j,1}} ECS_{j,1} &= E(WTP_j - b_{j,1}) - c_{j,1} \\ &= \int_0^{b_{j,1}} (WTP_j - b_{j,1}) \cdot g_{j,1}(p_T) dp_T - c_{j,1} \\ \text{s.t. } ECS_{j,1} &\geq 0 \quad b_{j,1} \leq WTP_j \quad (j \in J). \end{aligned} \quad (2)$$

For further analysis and clarification of the model, we assume, in line with Stigler (1961), Hann and Terwiesch (2003), and Ding et al. (2002), for all consumers a uniform distribution of the expected threshold price on the interval $[\underline{p}_{j,T}, \bar{p}_{j,T}]$ with $\bar{p}_{j,T} \geq WTP_j$. The latter ensures that consumers' WTP determine the value of the optimal bids. In this case, the (unrestricted) optimization of the expected consumer surplus of the (single) bid ($ECS_{j,1}$) leads to the following optimal single bid $b_{j,1}^*$ of the j th consumer (see Appendix A for details):

$$b_{j,1}^* = \frac{WTP_j + \underline{p}_{j,T}}{2} \quad (j \in J). \quad (3)$$

The consumer will submit the bid $b_{j,1}^*$ if $ECS_{j,1}$ is not negative and the optimal bid does not exceed the consumer's WTP.

Proposition 1: Given the assumption of a uniform distribution of the threshold price on the interval $[\underline{p}_{j,T}, \bar{p}_{j,T}]$ with $\bar{p}_{j,T} \geq WTP_j$, the optimal bid amount $b_{j,1}^*$ for the single bid model increases with increasing values of WTP and the interval's lower bound $\underline{p}_{j,T}$ (see Appendix A for proof).

Repeated Bidding Model

In the repeated bidding model, the information gain of an unsuccessful bid is included in the expected consumer surplus of the bid. A consumer updates her assumption about the distribution of the threshold price, since an unsuccessful bid signals a threshold price that is greater than the bid. Therefore, the expected distribution $g_{j,i}$ of the threshold price of the j th consumer for the i th bid is dependent on her previous $k_{j,i}$ unsuccessful bids ($n_j = |I_j|$ is the maximum number of bids of the j th consumer):

$$\begin{aligned} g_{j,i}(p_T | b_{j,i-1}, \dots, b_{j,i-k_{j,i}}) \quad \text{with} \\ k_{j,i} = |I_j \setminus \{i, i+1, \dots, n_j\}| \quad (j \in J, i \in I_j). \end{aligned} \quad (4)$$

The expected consumer surplus of a first bid has two components in this model:

$$ECS_{j,1} = \int_0^{b_{j,1}} (WTP_j - b_{j,1}) \cdot g_{j,1}(p_T) dp_T + \int_{b_{j,1}}^{\infty} ECS_{j,2} \cdot g_{j,1}(p_T) dp_T - c_{j,1}$$

$$\begin{aligned} \text{with } ECS_{j,2} &= \int_{b_{j,1}}^{b_{j,2}} (WTP_j - b_{j,2}) \cdot g_{j,2}(p_T | b_{j,1}) dp_T \\ &+ \int_{b_{j,2}}^{\infty} ECS_{j,3} \cdot g_{j,2}(p_T | b_{j,1}) dp_T - c_{j,2} \quad (j \in J). \end{aligned} \quad (5)$$

The first component represents the expected consumer surplus in the case of a successful bid. The second component illustrates the expected consumer surplus of a second bid $ECS_{j,2}$. $ECS_{j,2}$ consists of the expected consumer surplus of a second bid and further bids beyond the second, if the previous bids are not successful and if it is beneficial for the bidder to make these bids. Both components are weighted with the probability, respectively, the counter probability of a successful first bid. Thus, the consumer surplus of further bids beyond the i th bid is recursively included in the formula for the consumer surplus of the i th bid.

We illustrate the model for the case that consumers can submit a maximum number of two bids, because this describes the simplest model for the possibility of repeated bidding and its procedure can be extended analogously for a possible third bid or more repeated bids. Assuming a uniform distribution of the threshold price on the interval $[\underline{p}_{j,T}, \bar{p}_{j,T}]$ with $\bar{p}_{j,T} \geq WTP_j$ results in the following equations for the optimal first and second bid $b_{j,1}^*$ and $b_{j,2}^*$ (see Appendix B):

$$b_{j,1}^* = \frac{2}{3} \underline{p}_{j,T} + \frac{2}{3} c_{j,2} + \frac{WTP_j}{3} \quad (j \in J), \quad (6)$$

$$b_{j,2}^* = \frac{1}{3} \underline{p}_{j,T} + \frac{1}{3} c_{j,2} + \frac{2}{3} WTP_j \quad (j \in J). \quad (7)$$

Hereby, the consumer will submit a first bid, if the expected consumer surplus is not negative. If the consumer anticipates a nonnegative expected consumer surplus for the first bid, but a negative expected consumer surplus for the second bid, then she will not

TABLE 1

Example for Consumer With $WTP_j = 350, c_j = 5, [\underline{p}_{j,T}, \bar{p}_{j,T}] = [150, 500]$

MODEL	b_1^*	b_2^*	b_3^*	b_4^*	b_5^*	ECS_1	ECS_2	ECS_3	ECS_4	ECS_5	ΣECS
1 Bid	250					23.57					23.57
2 Bid	220	285				29.07	10.09				39.16
3 Bid	206.25	257.5	303.75			30.10	14.29	3.82			48.21
4 Bid	199	243	282	316		29.39	15.40	5.58	0.30		50.67
5 Bid	195	235	270	300	325	27.86	14.84	5.47	-0.11	-1.87	46.19

submit a second bid irrespective of the outcome of the first one. Hence, this situation is equivalent to the single bid model where the consumer determines the optimal bid amount according to equation (3).

Proposition 2: The optimal bid amounts $b_{j,1}^*$ and $b_{j,2}^*$ in the two-bid model increase with increasing values of WTP, the interval's lower bound $\underline{p}_{j,T}$, frictional costs of the second bid $c_{j,2}$ and the value of the first bid (see Appendix B for proof).

Corresponding to the procedure for the case that exactly two bids are possible, the optimal bid amount is derived for exactly three, respectively more bids (see Appendix B).

We recommend the following algorithm to determine the values of WTP_j , $c_{j,i}$, $\underline{p}_{j,T}$, and $\bar{p}_{j,T}$ and, thus, the optimal amount and number of bids for a certain consumer. This algorithm sequentially examines all cases to see if they fulfill the constraints beginning with the single bid model, which is subsequently increased by a further possible bid in each round. If a specific number of bids $|I_j|$ violates a constraint, the exact previous number of bids ($|I_j| - 1$) represents the optimal bidding behavior of the respective consumer:

Algorithm:

- Step 1. $|I_j| = 1$
- Step 2. Calculate $b_{j,i}^*, ECS_{j,i} \forall i \in I_j$
- Step 3. If $ECS_{j,|I_j|} < 0 \vee b_{j,|I_j|} > WTP_j \Rightarrow$ Stop. Consumer submits exactly $|I_j| - 1$ bids and the optimal bids $b_{j,i}^*$ are calculated according to the equations for this model
- Step 4. $|I_j| = |I_j| + 1$, go to Step 2.

Table 1 displays an example of the results for a consumer with constant frictional costs per bid of 5, a WTP of 350, and the assumption of a uniform distribution of the threshold price on an interval [150,500]. This consumer submits a maximum number of four bids, since the case of a five-bid model leads to a violation of the constraints in the form of a negative expected consumer surplus of the fourth and fifth bid. The amount of the first (and second, third and fourth) bid is determined based on the equations for the four bid model (see Table B.1 in Appendix B).

Comparison Between Models for Single Bid and Repeated Bidding

The aim of the following section is to compare the consumer's bidding behavior and the seller's profit margin in the two major design possibilities, i.e., the single bid and the repeated bidding model. Both models differ insofar as the single bid model predicts only the amount of such a single bid and whether it will take place whereas the repeated bidding model predicts the optimal number of bids and the optimal amount of each bid as well as whether these bids will take place. Therefore, we analyze whether the repeated bidding model can lead to higher bids than the single bid model and might therefore contribute to a higher profit margin for the seller. Thereby, we assume an unlimited capacity for the product being sold and a constant threshold price. The relationship between the amount of the single bid is formally compared with the first and final bid when repeated bidding is possible. Obviously, the consumer only submits a bid if the expected lower bound of the interval for the threshold price is less than her WTP ($WTP_j > \underline{p}_{j,T}$).

We analyze the relationship between the amount of the single bid in the first model and the first and final bid of repeated bidding based on the optimal bids in the single- and two-bid model. The latter case constitutes the simplest model of repeated bidding and is sufficient to derive general statements.

Proposition 3: The final (that means second) bid in a two-bid model is for positive values of WTP_j , $\underline{p}_{j,T}$, and $c_{j,2}$ always higher than the only bid in the single bid model. The relationship between the first bid in a two-bid model and the only bid in the single-bid model is undetermined (see Appendix C for proof).

Therefore, repeated bidding can result in a higher profit margin for the seller than when only one bid is allowed.

EMPIRICAL STUDY

The aim of this empirical study is the calibration of the repeated bidding model. We estimate individual WTP, frictional costs, and the assumptions about the distribution of the threshold price for the empirical data of a name-your-own-price seller. Therefore, we test the applicability of the model as well as analyze the difference between the observed maximum bid and an estimated optimal single bid based on the parameter estimates of individual consumers.

In order to estimate the four consumer specific parameters, we need at least an equal number of observations per consumer for the model to be identified. Therefore, the application of the single-bid model is not possible, because it only provides a single observation in the form of the single bid. Therefore, we can only use the repeated bidding model for these estimation purposes. By assuming constant frictional costs across all search steps of a consumer, the number of unknown parameters of an individual consumer reduces to four and thus requires at least four observed bids per consumer.

Description of the Data

We examine bidding data from a German name-your-own-price seller for flights from Germany to Majorca (Spain) in the period between February and December 2000. At this name-your-own-price seller, consumers are allowed to submit an unlimited number of bids if their previous bids are rejected. They have to wait, on average, about 15 minutes for information about the acceptance or rejection of their bids. In the period between February and December 2000, a total number of 987 bids were submitted by 449 different consumers for flights to Majorca. Figure 2 presents the distribution of the bids of the individual consumers.

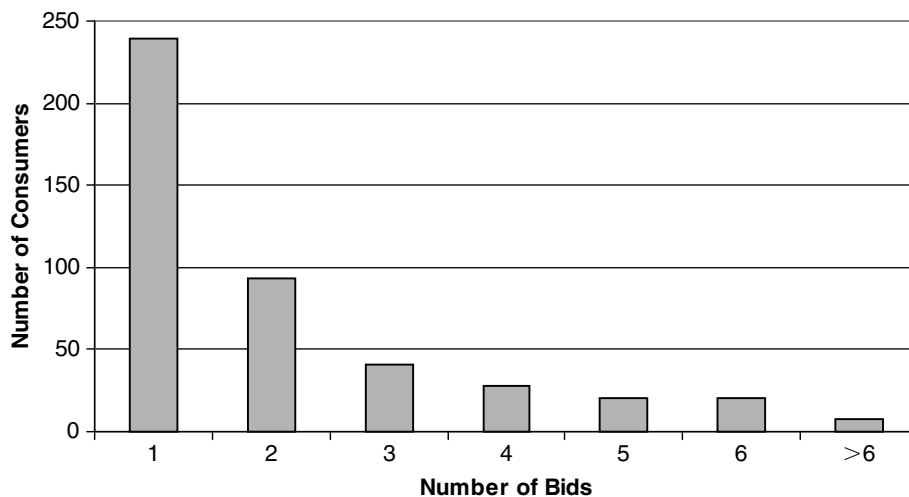


FIGURE 2

Distribution of the Bids for a Flight From Germany to Majorca (Number of Different Consumers Who Submitted Bids for a Flight From Germany to Majorca Between February and December 2000)

Estimation of Individual Willingness-to-Pay and Frictional Costs

We estimate consumer's individual WTP, frictional costs, as well as the expected lower and upper bounds of a uniform distribution for the threshold price. Thereby, we assume that the observed number of bids of a consumer $|I_j|$ corresponds to the optimal number of bids $|I_j^*|$ [see equation (8)]. Thus, if a consumer submits, e.g., five bids, we assume that it is optimal for this consumer to submit a maximum number of five bids. This assumption is necessary because we have no information on the success of a bid. Hereby, this assumption can result in an underestimation of the maximum number of bids and thus in an underestimation of the willingness-to-pay. Additionally, the departure airport in Germany is unknown. However, the price differences between German departure airports for flights to Majorca are neglectable.

The observed number of submitted bids determines the corresponding equations for the optimal bids (see Table B.1). The estimation of the model (8) and (9) determines those parameters of a consumer which lead to the best fit by minimizing the sum of squared residuals $e_{j,i}$ according to equation (9). Hereby, we assume constant individual frictional costs c_j for each consumer across multiple bids. Moreover, the constraints of a nonnegative expected consumer surplus of a bid as well as bids not exceeding WTP for all $|I_j|$ bids have to be fulfilled. We apply our model for consumers who submitted at least four bids, because we

estimate four unknown parameters:

$$|I_j^*| = |I_j|, \tag{8}$$

$$\min_{WTP_j, c_j, \underline{p}_{j,T}, \bar{p}_{j,T}} \sum_{i \in I_j} e_{j,i}^2 = \sum_{i \in I_j} (b_{j,i}^* - b_{j,i})^2$$

with $b_{j,i}^* = f(WTP_j, c_j, \underline{p}_{j,T} | |I_j^*|)$,

$$\text{s.t. } ECS_{j,i} \geq 0 \quad \forall i \in I_j, \quad b_{j,i} \leq WTP_j \quad \forall i \in I_j, \\ \bar{p}_{j,T} \geq WTP_j, \quad WTP_j, c_j, \underline{p}_{j,T}, \bar{p}_{j,T} \geq 0 \quad (j \in J). \tag{9}$$

Table 2 presents the estimation results for consumers with four, five, or six bids. Hereby, the consumers display a mean WTP of 353.07 DM for a flight to Majorca as well as average frictional costs per bid of 6.23 DM (1 DM was equivalent to approx. 0.50\$ USD). Hann and Terwiesch (2003) calculated average frictional costs of 5.51 Euros (approx. 5.50\$ USD) in their survey. Apparently, individual WTP and frictional costs vary considerably among individual consumers (see standard deviations). The assumption about the uniform distribution of the threshold price varies, as well, with mean interval bounds of [177.94 DM, 441.25 DM]. The average fit of the estimated bids according to the model obtained an explained variance of 67.88%.

Discussion

The estimated considerable variation in individual WTP, the individual frictional costs as well as the assumptions about the distribution of the threshold price enables a seller to price discriminate. Hence,

TABLE 2

Parameter Estimates for Consumers With Four, Five, or Six Bids for a Flight to Majorca

PARAMETER*	WTP_j [in DM]	$\bar{p}_{j,T}$ [in DM]	$\underline{p}_{j,T}$ [in DM]	c_j [in DM]
Mean	353.07	441.25	177.94	6.23
Standard Deviation	90.68	282.97	68.40	7.95
Minimum	129.00	212.30	0.00	0.00
Maximum	614.00	1788.61	346.15	36.13

Model fit: R^2 -mean = 67.88%; R^2 -median = 80.00%; N = 68

* Results for 68 consumers with four, five, or six bids for a flight from Germany to Majorca. Without eight consumers with seven or more bids (= outliers).

TABLE 3

Willingness-to-Pay, Actual Maximum Bid, and Predicted Single Bid for Consumers With Four, Five, or Six Bids for a Flight to Majorca

PARAMETER*	WTP_j [in DM]	$\max_{i \in I_j} b_{j,i}$ [in DM]	$b_{j,1}^{* a)}$ [in DM]
Mean	353.07	341.69	265.51
Standard Deviation	90.68	88.62	60.36
Minimum	129.00	125.00	105.00
Maximum	614.00	614.00	408.15

* Results for 68 consumers with four, five, or six bids for a flight from Germany to Majorca. Without eight consumers with seven or more bids (= outliers).

a) Predicted only bid in a single bid model.

consumers' individual bids lead to an individualized pricing at a name-your-own-price seller. However, consumers' bids are below their WTP. Table 3 shows that the average estimated WTP has a mean value of 11.38 DM (3.33%) above the maximum bid of the consumers. For the 68 consumers analyzed here, the resulting total consumer surplus would be 774.05 DM if all maximum bids had been successful.

Moreover, the calculation of the optimal bid in a single bid model on the basis of estimated parameters of the consumers (WTP_j , c_j , $p_{j,T}$, and $\bar{p}_{j,T}$) shows that its mean value of 265.51 DM is 76.18 DM (22.30%) less than the observed average maximum bid of 341.69 DM. Thus, the possibility of rebidding can have a positive impact on the profit of a name-your-own-price seller.

SUMMARY, IMPLICATIONS, AND LIMITATIONS

In this article we demonstrate that willingness-to-pay (WTP) and individual frictional costs can be derived from individual bids in the context of a name-your-own-price mechanism. We describe the fundamental concept of a name-your-own-price mechanism and develop two models to explain the bidding behavior in both major design possibilities of name-your-own-price mechanisms. We estimate individual WTP and frictional costs based on the empirical data of a name-your-own-price seller. The estimation results indicate a considerable variation of individual WTP and frictional costs of consumers. Moreover, on average the maximum bid amount of consumers is 11.38 DM less

than their WTP. Further, we show that the possibility of rebidding leads to higher amounts of the maximum bid than in the single-bid model.

Naturally, the validity of these results depends on the validity of our assumptions. An important assumption is that the seller's threshold price is exogenous and constant. Such an exogenous threshold price is implemented at Priceline and the name-your-own-price seller in our empirical study. However, adapting this threshold can be advantageous if the seller knows consumers' optimal bidding strategies which would require that the seller is able to identify the individual consumer. Such an identification could rely on the estimation of his or her parameters based on previous bidding behavior (e.g., for similar products) or on the current bidding sequence if enough bids are already observed in order to classify the consumer. If the seller can correctly identify a consumer, then it would be optimal to reject all consumer's bids except the last bid the consumer submits according to his or her optimal bidding strategy. However, if consumers were anticipating this identification, they would have an incentive to conceal their true characteristics, e.g., by deliberately deviating from their optimal bidding strategy.

Another limitation is our assumption of constant individual frictional costs c_j for each consumer across multiple bids for our estimation procedure. Especially the frictional costs for the first bid could be higher than for the second and further bids, because the consumer also decides with her first bid on her bidding

strategy and assumptions on the distribution of the seller's threshold price. Thus, frictional costs may be decreasing in the order of the bid. Hence, the assumption of constant frictional costs results in the estimation of the average value of frictional costs across bids. Differences in frictional costs between the first and later bids cannot be detected. Higher frictional costs for the first bid than for later bids affect the expected bidding behavior in the single and repeated bidding model indirectly. The values of the optimal bids for different bidding strategies do not depend directly on the value of frictional costs of the first bid. However, high frictional costs of a first bid can lead to a negative expected consumer surplus of the first bid and thus inhibit a consumer from starting to bid.

Given the validity of our assumptions, the results of the procedure presented in this paper allow name-your-own-price sellers to segment consumers based on their WTP, frictional costs, or assumptions about the distribution of the threshold price. Such a seller could identify similar consumers for example via socio-demographic data, estimate their WTP and frictional costs, and thus offer them an individualized price closer to their WTP ("Buy Now") at the beginning of the bidding process or in completely different situations. Moreover, the insights about the individual frictional costs of consumers could be used for the price or the threshold price of a different product if her parameters were already estimated on the basis of earlier bids. Therefore, besides using the name-your-own-price mechanism as a price discovery mechanism for transactions, this mechanism provides an opportunity to generate a rich data source and thus might be used as a marketing research instrument as well. Further, our results show that sellers should think carefully about the specific design of the name-your-own-price mechanism, because restricting consumers to a single bid may reduce their revenues.

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APPENDIX A

OPTIMAL BID AND EXPECTED CONSUMER SURPLUS IN THE SINGLE BID MODEL

For a uniform distribution of the threshold price on the interval $[\underline{p}_{j,T}, \bar{p}_{j,T}]$, equation (2) can be stated as follows:

$$\begin{aligned}
 ECS_{j,1} &= \int_{\underline{p}_{j,T}}^{b_{j,1}} (WTP_j - b_{j,1}) \cdot \frac{1}{\bar{p}_{j,T} - \underline{p}_{j,T}} dp_T - c_{j,1} \\
 &= \left[(WTP_j - b_{j,1}) \cdot \frac{p_T}{\bar{p}_{j,T} - \underline{p}_{j,T}} \right]_{\underline{p}_{j,T}}^{b_{j,1}} - c_{j,1} \\
 &= \left[(WTP_j - b_{j,1}) \cdot \frac{b_{j,1}}{\bar{p}_{j,T} - \underline{p}_{j,T}} \right. \\
 &\quad \left. - (WTP_j - b_{j,1}) \cdot \frac{\underline{p}_{j,T}}{\bar{p}_{j,T} - \underline{p}_{j,T}} \right] - c_{j,1} \\
 &= (WTP_j - b_{j,1}) \cdot \frac{b_{j,1} - \underline{p}_{j,T}}{\bar{p}_{j,T} - \underline{p}_{j,T}} - c_{j,1} \\
 \text{with } \frac{b_{j,1} - \underline{p}_{j,T}}{\bar{p}_{j,T} - \underline{p}_{j,T}} &= \text{Prob}(b_{j,1} \geq p_T) \quad (j \in J).
 \end{aligned} \tag{A.1}$$

The (unrestricted) optimization of equation (A.1) leads to the following optimal single bid $b_{j,1}^*$ of the j th consumer, in case that equation (A.1) is not negative (and

the optimal bid does not exceed the consumers' WTP):

$$\begin{aligned}
 \frac{dECS_{j,1}}{db_{j,1}} &= \frac{1}{\bar{p}_{j,T} - \underline{p}_{j,T}} \cdot [(-1) \cdot (b_{j,1} - \underline{p}_{j,T}) \\
 &\quad + (WTP_j - b_{j,1}) \cdot 1] \stackrel{!}{=} 0 \\
 \Leftrightarrow b_{j,1}^* &= \frac{WTP_j + \underline{p}_{j,T}}{2} \quad (j \in J).
 \end{aligned} \tag{A.2}$$

The expected consumer surplus of the optimal single bid according to equation (A.2) yields:

$$\begin{aligned}
 ECS_{j,1}(b_{j,1}^*) &= \left(WTP_j - \frac{WTP_j + \underline{p}_{j,T}}{2} \right) \cdot \frac{(WTP_j + \underline{p}_{j,T})/2 - \underline{p}_{j,T}}{\bar{p}_{j,T} - \underline{p}_{j,T}} - c_{j,1} \\
 &= \frac{WTP_j - \underline{p}_{j,T}}{2} \cdot \frac{(WTP_j - \underline{p}_{j,T})/2}{\bar{p}_{j,T} - \underline{p}_{j,T}} - c_{j,1} \\
 &= \frac{(WTP_j - \underline{p}_{j,T})^2}{4 \cdot (\bar{p}_{j,T} - \underline{p}_{j,T})} - c_{j,1} \quad (j \in J).
 \end{aligned} \tag{A.3}$$

Proof of Proposition 1:

$$\frac{\partial b_{j,1}^*}{\partial WTP_j} = \frac{\partial b_{j,1}^*}{\partial \underline{p}_{j,T}} = \frac{1}{2} > 0 \quad (j \in J). \tag{A.4}$$

APPENDIX B

OPTIMAL BIDS IN THE REPEATED BIDDING MODEL

The Two-Bid Model

For a uniform distribution of the threshold price on the interval $[\underline{p}_{j,T}, \bar{p}_{j,T}]$, equation (5) can be reformulated:

$$\begin{aligned}
 ECS_{j,1} &= (WTP_j - b_{j,1}) \cdot \frac{b_{j,1} - \underline{p}_{j,T}}{\bar{p}_{j,T} - \underline{p}_{j,T}} \\
 &\quad + ECS_{j,2} \cdot \frac{\bar{p}_{j,T} - b_{j,1}}{\bar{p}_{j,T} - \underline{p}_{j,T}} - c_{j,1} \\
 &= (WTP_j - b_{j,1}) \cdot \text{Prob}(b_{j,1} \geq p_T) \\
 &\quad + ECS_{j,2} \cdot \text{Prob}(b_{j,1} < p_T) - c_{j,1} \quad (j \in J).
 \end{aligned} \tag{B.1}$$

According to equation (B.1), the expected consumer surplus of a possible second bid is also included in the expected consumer surplus of the first bid. Since the expected consumer surplus of the second bid is decisively determined by the amount of the second bid, the consumer determines simultaneously the optimal amount for both bids:

$$\begin{aligned}
 \max_{b_{j,1}, b_{j,2}} ECS_{j,1} &= (WTP_j - b_{j,1}) \cdot \text{Prob}(b_{j,1} \geq p_T) \\
 &\quad + [(WTP_j - b_{j,2}) \cdot \text{Prob}(b_{j,2} \geq p_T | b_{j,1} < p_T) - c_{j,2}] \\
 &\quad \cdot \text{Prob}(b_{j,1} < p_T) - c_{j,1}
 \end{aligned}$$

(Continued)

Proof of Proposition 2: From equations (B.7)–(B.9) we can derive the marginal effects, i.e., show that bids are increasing in the value of WTP_j , $c_{2,j}$, $\underline{p}_{j,T}$, and the value of the first bid:

$$\frac{\partial b_{j,1}^*}{\partial WTP_j} = \frac{1}{3}, \quad \frac{\partial b_{j,1}^*}{\partial \underline{p}_{j,T}} = \frac{\partial b_{j,1}^*}{\partial c_{2,j}} = \frac{2}{3} > 0 \quad (j \in J), \quad (\text{B.10})$$

$$\frac{\partial b_{j,2}^*}{\partial b_{j,1}^*} = \frac{1}{2} \quad \text{and} \quad \frac{\partial b_{j,2}^*}{\partial WTP_j} = \frac{2}{3}, \quad \frac{\partial b_{j,2}^*}{\partial \underline{p}_{j,T}} = \frac{\partial b_{j,2}^*}{\partial c_{2,j}} = \frac{1}{3} > 0 \quad (j \in J). \quad (\text{B.11})$$

Optimal Bids in the Three- to Six-Bid Model

See Table B.1.

TABLE B.1 Optimal Bids in the Three to Six Bid Models

3-BID MODEL		4-BID MODEL	
1st Bid	$b_{j,1}^* = \frac{3}{4} \underline{p}_{j,T} + \frac{WTP_j}{4} + \frac{3}{4} c_{j,2} + \frac{2}{4} c_{j,3}$	$b_{j,1}^* = \frac{4}{5} \underline{p}_{j,T} + \frac{WTP_j}{5} + \frac{4}{5} c_{j,2} + \frac{3}{5} c_{j,3} + \frac{2}{5} c_{j,4}$	
2nd Bid	$b_{j,2}^* = \frac{2}{3} b_{j,1}^* + \frac{WTP_j}{3} + \frac{2}{3} c_{j,3}$	$b_{j,2}^* = \frac{3}{4} b_{j,1}^* + \frac{WTP_j}{4} + \frac{3}{4} c_{j,3} + \frac{2}{4} c_{j,4}$	
3rd Bid	$b_{j,3}^* = \frac{WTP_j + b_{j,2}^*}{2}$	$b_{j,3}^* = \frac{2}{3} b_{j,2}^* + \frac{WTP_j}{3} + \frac{2}{3} c_{j,4}$	
4th Bid		$b_{j,4}^* = \frac{WTP_j + b_{j,3}^*}{2}$	
5-BID MODEL		6-BID MODEL	
1st Bid	$b_{j,1}^* = \frac{5}{6} \underline{p}_{j,T} + \frac{WTP_j}{6} + \frac{5}{6} c_{j,2} + \frac{4}{6} c_{j,3} + \frac{3}{6} c_{j,4} + \frac{2}{6} c_{j,5}$	$b_{j,1}^* = \frac{6}{7} \underline{p}_{j,T} + \frac{WTP_j}{7} + \frac{6}{7} c_{j,2} + \frac{5}{7} c_{j,3} + \frac{4}{7} c_{j,4} + \frac{3}{7} c_{j,5} + \frac{2}{7} c_{j,6}$	
2nd Bid	$b_{j,2}^* = \frac{4}{5} b_{j,1}^* + \frac{WTP_j}{5} + \frac{4}{5} c_{j,3} + \frac{3}{5} c_{j,4} + \frac{2}{5} c_{j,5}$	$b_{j,2}^* = \frac{5}{6} b_{j,1}^* + \frac{WTP_j}{6} + \frac{5}{6} c_{j,3} + \frac{4}{6} c_{j,4} + \frac{3}{6} c_{j,5} + \frac{2}{6} c_{j,6}$	
3rd Bid	$b_{j,3}^* = \frac{3}{4} b_{j,2}^* + \frac{WTP_j}{4} + \frac{3}{4} c_{j,4} + \frac{2}{4} c_{j,5}$	$b_{j,3}^* = \frac{4}{5} b_{j,2}^* + \frac{WTP_j}{5} + \frac{4}{5} c_{j,4} + \frac{3}{5} c_{j,5} + \frac{2}{5} c_{j,6}$	
4th Bid	$b_{j,4}^* = \frac{2}{3} b_{j,3}^* + \frac{WTP_j}{3} + \frac{2}{3} c_{j,5}$	$b_{j,4}^* = \frac{3}{4} b_{j,3}^* + \frac{WTP_j}{4} + \frac{3}{4} c_{j,5} + \frac{2}{4} c_{j,6}$	
5th Bid	$b_{j,5}^* = \frac{WTP_j + b_{j,4}^*}{2}$	$b_{j,5}^* = \frac{2}{3} b_{j,4}^* + \frac{WTP_j}{3} + \frac{2}{3} c_{j,6}$	
6th Bid		$b_{j,6}^* = \frac{WTP_j + b_{j,5}^*}{2}$	

If the final (that means second) bid in a two-bid model is higher than the only bid in the single-bid model, then the following relationship holds:

$$\begin{aligned}
 b_{j,1,|I_j^*|=1}^* < b_{j,2,|I_j^*|=2}^* &\Leftrightarrow \frac{1}{2} \underline{p}_{j,T} + \frac{1}{2} WTP_j \\
 &< \frac{1}{3} \underline{p}_{j,T} + \frac{1}{3} c_{j,2} + \frac{2}{3} WTP_j \quad (C.1) \\
 &\Leftrightarrow \frac{1}{6} \underline{p}_{j,T} < \frac{1}{6} WTP_j + \frac{1}{3} c_{j,2} \\
 &\Leftrightarrow \underline{p}_{j,T} < WTP_j + 2c_{j,2} \quad (j \in J).
 \end{aligned}$$

Inequality (C.1) is fulfilled for all positive values of WTP_j , $\underline{p}_{j,T}$, and $c_{j,2}$, if $WTP_j > \underline{p}_{j,T}$. Thus, the second bid in a two-bid model is always higher than the only bid in a single bid model.

If the first bid in a two-bid model is lower than the only bid in the single bid model, then

$$\begin{aligned}
 b_{j,1,|I_j^*|=2}^* < b_{j,1,|I_j^*|=1}^* \\
 &\Leftrightarrow \frac{2}{3} \underline{p}_{j,T} + \frac{2}{3} c_{j,2} + \frac{WTP_j}{3} < \frac{1}{2} \underline{p}_{j,T} + \frac{1}{2} WTP_j \quad (C.2) \\
 &\Leftrightarrow \frac{1}{6} \underline{p}_{j,T} + \frac{2}{3} c_{j,2} < \frac{1}{6} WTP_j \\
 &\Leftrightarrow \underline{p}_{j,T} + 4c_{j,2} < WTP_j \quad (j \in J).
 \end{aligned}$$

Inequality (C.2) is not fulfilled for all positive values of WTP_j , $\underline{p}_{j,T}$, and $c_{j,2}$. Therefore, no general statement can be made in this case about the relationship between the first bid in the two-bid model and the only bid in the single bid model. Especially for high frictional costs and small differences between $\underline{p}_{j,T}$ and WTP_j , the first bid in the two-bid model can be higher than the only bid in the single bid model.

