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# Testing Whether Field Auction Experiments Are Demand Revealing in Practice

**Jay R. Corrigan and Matthew C. Rousu**

Recent evidence suggests that participants' misunderstanding of experimental auction mechanisms can systematically bias auction results. We present a simple technique for testing whether field auction participants fully understand the demand-revealing nature of the auction mechanism and, by extension, whether auction bids provide an unbiased estimate of participants' willingness to pay.

*Key words:* demand revealing, experimental auctions, field experiments

## Introduction

Experimental auctions conducted in a carefully controlled laboratory setting are now widely used in agricultural economics and other economic subfields (see Lusk and Shogren, 2007, for an extensive review). Because these auctions are nonhypothetical, participants are directly and immediately confronted with the consequences of their actions. Therefore, experimental auctions are generally viewed as a more reliable valuation tool than stated-preference techniques such as hypothetical choice experiments or contingent valuation surveys. In fact, researchers often use experimental auctions to assess the validity of hypothetical valuation instruments (e.g., Fox et al., 1998; List, Margolis, and Shogren, 1998; List and Shogren, 1998).[1] However, recent evidence has shown that small changes in how an auction is explained can result in profound differences in studies' conclusions (Plott and Zeiler, 2005).

Recently, experimental auctions conducted in a field setting have become increasingly popular both for testing behavioral hypotheses (e.g., List and Lucking-Reiley, 2000) and for estimating the value of new products (e.g., Lusk, Feldkamp, and Schroeder, 2004). List (2002) argues that these field studies "give up some of the controls of a laboratory experiment (such as induced values) in exchange for increased realism" (p. 1637). With this tradeoff in mind, it is imperative that researchers be able to test whether a field auction is designed such that it is demand revealing both in theory and in practice. However, there is currently no straightforward way for researchers to test whether participants' bids in experimental field auctions accurately reflect their willingness to pay (WTP).

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[1] See List and Gallet (2001) for a meta-analysis comparing hypothetical and actual value estimates.

We attempt to fill this void by proposing a straightforward method for testing whether participants' actual bidding behavior is consistent with the behavior theory predicts for participants who understand the demand-revealing nature of a given auction design. Specifically, we compare participants' bids with their self-reported perception of a good's "field price" (i.e., the price at which the good can be purchased outside of the experimental auction), while also controlling for participants' intent to purchase that good on the day of the auction. As predicted by theory, if participants truly understand that a field auction is demand revealing, those who arrived at the field location intending to buy the focus good should submit bids equal to the perceived field price, while those *not* intending to buy the focus good should submit bids *less than* the perceived field price. In contrast, if participants do not understand that bidding truthfully is in their best interest but instead rely on an ingrained rule of thumb like "buy low and sell high," theory predicts both buyers and nonbuyers will submit bids less than their perceived field price.[2] Therefore, comparing bids with field prices allows the researcher to test whether a theoretically demand-revealing auction motivates demand-revealing behavior in practice.

## Demand-Revealing Auctions in Practice

While demand revealing in theory, there is now overwhelming experimental evidence that theoretically incentive-compatible auction mechanisms do not necessarily motivate incentive-compatible responses in practice. For example, Kagel's (1995) review of the induced-value, second-price auction literature finds that participants' bids on average exceed their induced values.

More sensationally, Plott and Zeiler (2005) conclude that the widely heralded disparity between willingness to accept compensation (WTA) and WTP may simply be an artifact of participants' "misconceptions" regarding the demand-revealing nature of widely used auction mechanisms. Using theoretically demand-revealing auction procedures similar to those of Kahneman, Knetsch, and Thaler (1990), Plott and Zeiler find that mean WTA exceeds mean WTP by roughly a factor of three. This is inconsistent with neoclassical theory's prediction that the two value measures should differ little in the absence of large income effects (Willig, 1976).

However, Plott and Zeiler (2005) note, "... given bargaining instincts of sellers to inflate asks and buyers to deflate bids, those endowed with a good likely will bid more than their nonstrategic valuations. This behavior could be especially likely if subjects do not fully understand experimental procedures" (p. 538). To eliminate any such misconceptions, the authors go on to conduct another set of theoretically demand-revealing auctions preceded by a detailed training session. This training provides numerical examples demonstrating how the auction worked and why it is in a participant's best interest to bid truthfully, as well as two unpaid practice rounds.[3] When participants receive this training, Plott and Zeiler report mean WTA is no longer significantly different from mean WTP.

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[2] Plott and Zeiler (2005) suggest that inadequately trained auction participants may mistakenly "operate under familiar auction rules (i.e., highest bidder takes the good and pays the amount he offered)" (p. 537). Under this first-price sealed-bid framework it is in participants' best interest to understate their true WTP (Mas-Colell, Whinston, and Green, 1995).

[3] The authors also took steps to ensure anonymity and, in some cases, conducted paid practice rounds before the round of interest.

While there are several possible interpretations of these results, the most relevant for the auction valuation literature is that theoretically demand-revealing auctions do not necessarily motivate demand-revealing behavior in practice without careful training. But whether a specific auction experiment's design includes sufficient training to motivate participants to bid truthfully in practice remains an open question. This is a particularly important issue for field auction experiments because they sacrifice some of the control of the laboratory and researchers generally have less time to work with field auction participants than they would in a laboratory auction.

In the following section we develop a theoretical model explaining how well-trained participants would be expected to behave in a field auction. This will allow us to better understand whether a theoretically demand-revealing auction design actually motivates demand-revealing bidding in practice.

## Theoretical Model

Assume that participant $i$'s utility is defined over wealth and good $X$, which is for sale in the experimental auction. Let $W_i > 0$ represent participant $i$'s wealth endowment and $X_i \geq 0$ her home endowment of $X$. Her WTP for one additional unit of $X$ is implicitly defined as:

$$U(W_i - WTP_i, X_i + 1) = U(W_i, X_i).$$

This can be seen graphically in figure 1. Given participant $i$'s endowments, she is initially at point A on the budget constraint $BC_i$. Assuming the field price of $X$ is $p$, the slope of $BC_i$ is $-p$. If this participant indicates she came to the store where the field auction takes place intending to purchase $X$, her indifference curve $IC_{Buyer}$ must be such that she would enjoy a higher level of utility by purchasing more of $X$ at price $p$. In the absence of a field market outside of the experimental auction, this participant's true WTP for one additional unit of $X$ is depicted as the absolute value of the slope of line segment AB. However, recognizing that $X$ can be purchased outside of the auction at field price $p$, this participant's *stated* WTP will be censored at $p$ in the absence of transaction costs (Harrison, Harstad, and Rutström, 2004).[4]

If, however, the participant indicates she did not come to the store intending to purchase $X$, her indifference curve $IC_{Nonbuyer}$ must be such that she would not enjoy a higher level of utility by purchasing more of $X$ at price $p$. Assuming $X$ cannot be resold outside of the experimental auction, this participant's WTP for one additional unit of $X$ is depicted as the absolute value of the slope of line segment AD.

## Experimental Design

A total of 150 shoppers at two Weis Markets grocery stores in Harrisburg, Pennsylvania, took part in this study in October 2005. The experimental auction had six steps:

[4] Cherry et al. (2004) find evidence of this kind of bid censoring in an induced-value auction that explicitly incorporates an outside option.

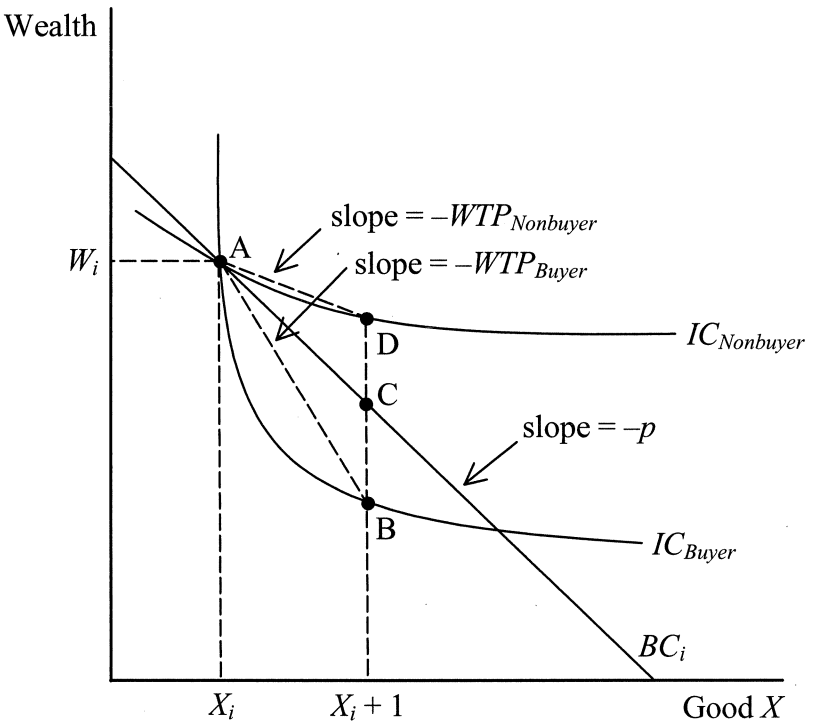


**Figure 1. Preferences of buyers and nonbuyers**

- *Step 1.* As shoppers entered the store, they were invited to take part in a "consumer research project" that would take about 15 minutes, and for which they would be paid $10. Between one and seven participants took part in the study simultaneously.

- *Step 2.* The monitor provided participants with both written and oral instructions on the workings of the Becker-DeGroot-Marshak (BDM) auction mechanism to be used.[5] In particular, the monitor explained that the participant(s) would place separate bids on a number of different goods, but only one of these goods would actually be sold and this would be determined at random. The monitor went on to explain that the binding price for this good would be determined at random by drawing a number from a jar containing 60 tickets marked with prices ranging from $0.10 to $6.00 in 10¢ increments. Participants who submitted a bid greater than or equal to the binding price would purchase the good at the binding price; participants who submitted a bid less than the binding price would purchase nothing. Participants were explicitly informed that it was in their best interest to bid

[5] We chose the demand-revealing BDM auction mechanism over other demand-revealing auction mechanisms (e.g., Vickrey auction, random *n*th-price auction) because we knew the number of participants would vary. The BDM auction is appropriate for either one participant or multiple participants, while the other common auction mechanisms will not work with only one participant.

truthfully.[6] Participants were given the opportunity to ask questions and they then took part in a practice auction.

- *Step 3.* The monitor revealed the products for sale: a 2-pound bunch of bananas, a 2-pound bunch of fair trade bananas, a 3.5-ounce chocolate bar, and a 3.5-ounce fair trade chocolate bar.[7]

- *Step 4.* The monitor explained that participants would place bids on several products, but only one of the bidding opportunities would be binding, and the binding bid would be determined at random after all bids were submitted. Participants submitted their first set of four bids; then, depending on the treatment, they were provided with objective information about fair trade certification before submitting another set of four bids, or were simply asked to submit another set of bids.[8]

- *Step 5.* The monitor randomly determined which of the eight bidding opportunities was binding, then randomly determined the selling price.

- *Step 6.* Participants completed a survey about whether they had intended to purchase bananas or chocolate when they arrived at the store that day, the price they would expect to pay for those products outside of the experimental auction, as well as other demographic and background information. Participants were then dismissed one by one, at which point any individual with a winning bid purchased the product. (The auction instructions are available from the authors upon request.)

The timing of this survey deserves special attention. Field auction practitioners have been known to survey participants either before or after collecting bids (see, respectively, Lusk et al., 2001; Rousu et al., 2005). We chose to administer the survey at the end of the auction experiment to avoid both anchoring participants' bids to their perceived field price, and revealing too much about the study's objectives. However, one possible criticism of our design is that auction winners might rationalize their purchase by indicating they had arrived at the field location intending to purchase bananas when, in fact, they had not.[9] If these individuals further rationalized their purchase by indicating a field price equal to their bid, this would make it more difficult to reject the null hypothesis that WTP equals perceived field price among buyers. While future research would be necessary to determine the magnitude of this effect, the best solution in most

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[6] In auctions designed to estimate the value of goods with homegrown values, researchers commonly inform participants that bidding truthfully is in their best interest (e.g., Kahneman, Knetsch, and Thaler, 1990; Shogren et al., 2001; Corrigan, 2005; Plott and Zeiler, 2005). Research on non-auction experiments has also shown that informing participants of their optimal strategy can bring their behavior more in line with the predictions of economic theory (e.g., Lusk and Hudson, 2004).

[7] According to the Fairtrade Labelling Organizations International (2006), fair trade certification guarantees that agricultural producers who meet certain minimum quality standards receive a price "that covers the cost of sustainable production and living." The bids for the fair trade products are being used as part of a separate study estimating consumers' WTP for the fair trade designation (Rousu and Corrigan, forthcoming).

[8] When placing their bids in the first round, participants did not know they would receive a second opportunity to bid on the four items. Data from this second round of bidding are being used as part of a separate study examining the effect of objective information on bidding behavior (Rousu and Corrigan, 2008), and are therefore not reported here.

[9] See Levitt and List (2007) for an outstanding discussion of the effects of scrutiny, anonymity, and context in economic experiments. See List, Sinha, and Taylor (2006) for an example of how differences in the way field experiments are administered can significantly impact value estimates.

circumstances would be to survey participants after bids are collected but *before* the winning price is announced.

## Analysis and Results

Because bananas are nondifferentiated, a participant will likely place the same value on a unit purchased in an experimental auction as she would on a unit purchased from a conventional retail outlet. Assuming bids are censored at the field price, any participant who intended to purchase the good should, in the absence of transaction costs, submit a bid equal to her perceived field price.

Because bananas are perishable, a participant may not be able to take full advantage of them during their limited shelf life. Therefore, a participant who did not intend to purchase bananas the day of the field auction should submit a bid less than her perceived field price.

Given this framework, we predict that for a perishable, nondifferentiated good such as bananas: (*a*) there will be no statistically significant difference between perceived field price and WTP bids among participants who planned to purchase the good the day of the auction, and (*b*) WTP bids submitted by participants who did not plan to purchase the good that day will be significantly less than their perceived field price.

Figures 2 and 3 present the relationship between WTP bids and perceived field price for bananas. Among participants who intended to purchase bananas that day (i.e., buyers), bids appear to be centered around the perceived field price. Among participants who did not intend to purchase bananas that day (i.e., nonbuyers), bids appear centered below the perceived field price. Table 1 reports summary statistics for the 147 participants who submitted both a bid and a perceived field price for bananas. These summary statistics confirm the observations from figures 2 and 3. The median difference between perceived field price and WTP among buyers was \$0.00. We cannot reject the null hypothesis that bids equal perceived field price using a Wilcoxon sign-rank test ($p = 0.39$). The median difference between perceived field price and WTP among nonbuyers was \$0.15. We reject the null hypothesis that bids equal perceived field price using a Wilcoxon sign-rank test ($p < 0.01$). Comparing the median difference between WTP for bananas and perceived field price across buyers and nonbuyers, we reject the null hypothesis that these two median differences are equal using a Wilcoxon rank-sum test ($p < 0.01$). All of these results are consistent with the behavior theory predicts for participants who understand that bidding truthfully is in their best interest. Therefore, we can be more confident that participants are not systematically over- or understating WTP. This suggests our field auction was designed such that the median bid accurately reflects the central tendency of participants' (censored) WTP.[10]

The choice of the good sold as part of this test for demand-revealing behavior is critical. Participants in our study also bid on conventional chocolate bars—a nonperishable, differentiated good. Because the market for chocolate bars is highly segmented and participants have different preferences for different brands, even participants who

[10] When data come from a normal population, *t*-tests are more efficient than the nonparametric Wilcoxon tests reported here. However, a Shapiro-Wilk test of normality rejects the null hypothesis that the difference between perceived field price and bids is normally distributed for both buyers and nonbuyers ($p < 0.01$ in both cases). Therefore, we choose to report the results of the nonparametric test in the body of the paper. Comparing mean differences using paired-sample and two-sample *t*-tests yields qualitatively similar results ($t = 0.39$, 5.34, and 3.39, respectively).

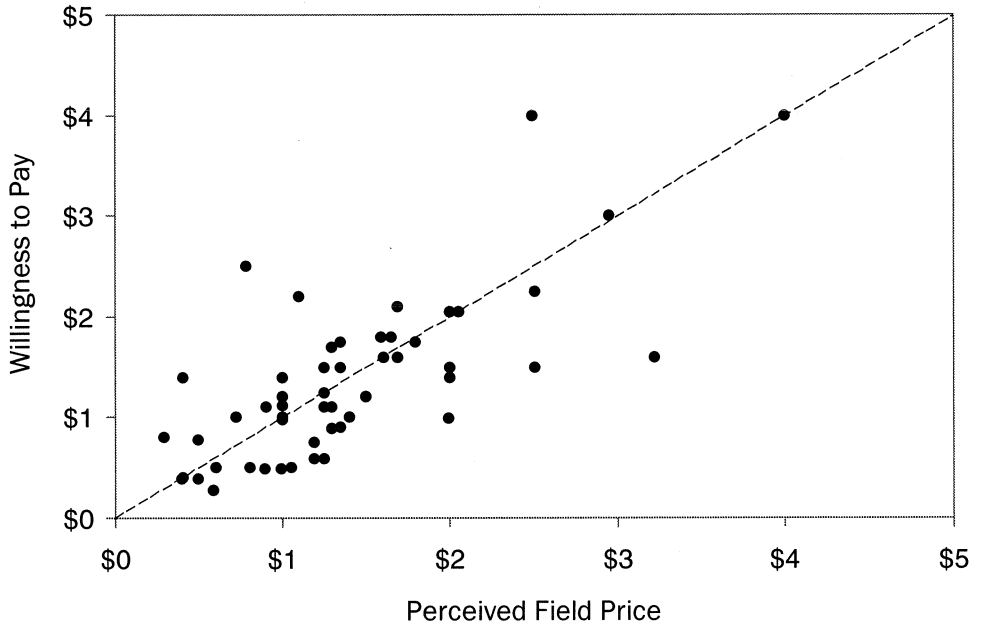


**Figure 2. Relationship between WTP for bananas and perceived field price among buyers**

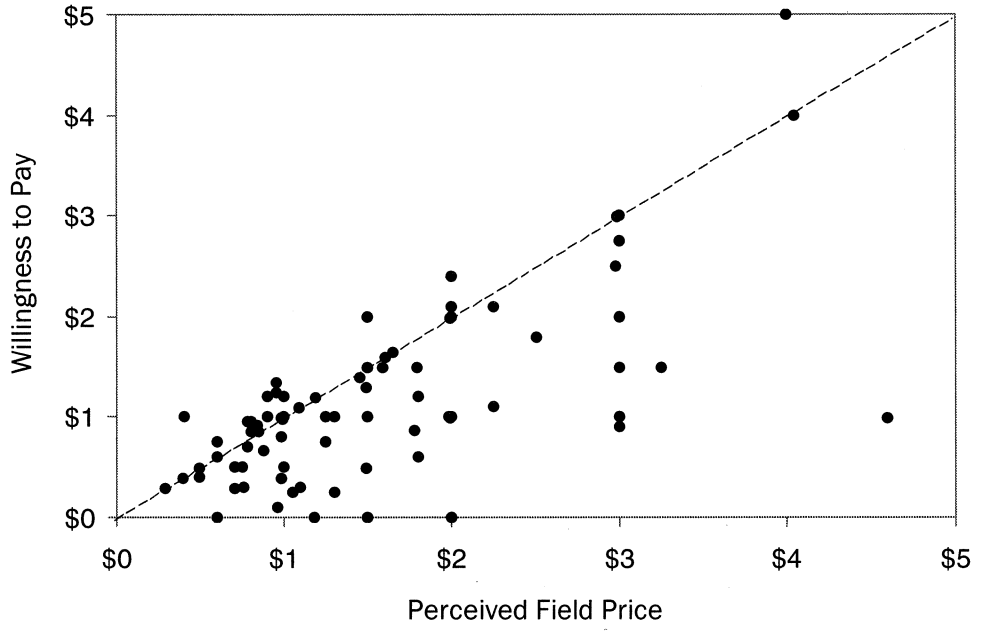


**Figure 3. Relationship between WTP for bananas and perceived field price among nonbuyers**

**Table 1. Difference Between Perceived Field Price and Bid Submitted for Bananas**

| Description | Mean ($) | Median ($) | Std. Dev. ($) |
|---|---|---|---|
| Participant planned to buy that day ($N$ = 54) | | | |
| Perceived Field Price | 1.36 | 1.25 | 0.75 |
| WTP Bid | 1.33 | 1.16 | 0.80 |
| Difference | 0.03 | 0.00 | 0.56 |
| Participant did not plan to buy that day ($N$ = 93) | | | |
| Perceived Field Price | 1.56 | 1.30 | 0.90 |
| WTP Bid | 1.17 | 1.00 | 0.83 |
| Difference | 0.39*** | 0.15*** | 0.70 |

Note: Triple asterisks (*) denote significantly different from zero at the 0.01 level; significantly different from difference for participants who planned to buy that day at the 0.01 level.

**Table 2. Difference Between Perceived Field Price and Bid Submitted for Chocolate**

| Description | Mean ($) | Median ($) | Std. Dev. ($) |
|---|---|---|---|
| Participant planned to buy that day ($N$ = 28) | | | |
| Perceived Field Price | 1.85 | 1.50 | 1.55 |
| WTP Bid | 1.33 | 1.15 | 1.08 |
| Difference | 0.53** | 0.11*** | 1.28 |
| Participant did not plan to buy that day ($N$ = 117) | | | |
| Perceived Field Price | 1.72 | 1.50 | 0.87 |
| WTP Bid | 1.28 | 1.00 | 0.95 |
| Difference | 0.44*** | 0.39*** | 0.87 |

Note: Double and triple asterisks (*) denote significantly different from zero at the 0.05 and 0.01 levels, respectively.

planned to purchase chocolate the day of the auction may not be willing to pay the perceived field price for the particular chocolate bar for sale in the experimental auction. Further, because chocolate bars are nonperishable, they can be stored until a time when they have more consumption value. This means that regular chocolate consumers who, for whatever reason, did not plan to buy chocolate the day of the auction, may discount the good less heavily than regular banana consumers who did not plan to buy bananas that day.

Therefore, we predict that for a nonperishable, differentiated good such as chocolate bars: ($a$) the median difference between perceived field price and WTP will be greater than zero for both buyers and nonbuyers because of product differentiation, and ($b$) there will be less difference between the bidding behavior of buyers and nonbuyers than would be the case for a perishable good like bananas because a nonperishable good can be easily stored until its consumption value is higher.

Table 2 reports summary statistics for the 145 participants who submitted both a bid and a perceived field price for chocolate bars. The median difference between perceived field price and WTP among buyers was $0.11. We reject the null hypothesis that bids

equal perceived field price using a Wilcoxon sign-rank test ($p = 0.01$). The median difference between perceived field price and WTP among nonbuyers was \$0.39. We reject the null hypothesis that bids equal perceived field price using a Wilcoxon sign-rank test ($p < 0.01$).[11]

Comparing the bidding behavior of those who did and did not intend to purchase chocolate outside of the auction, a Wilcoxon rank-sum test fails to reject the null hypothesis that the median difference between perceived field price and WTP is the same for buyers and nonbuyers ($p = 0.52$).[12] This finding is in contrast with the results from table 1 where the median difference between perceived field price and WTP is significantly greater among buyers than among nonbuyers. Not surprisingly, purchase intent is less important when dealing with a nonperishable good that can be stored until its consumption value increases.

To take into account the panel nature of our data (i.e., each participant places bids on both bananas and chocolate), we consider the following random-effects specification:

$$Underbid_{ij} = \beta_0 + \beta_1 Nonbuyer_{ij} + \beta_2 Nonperish_j + \beta_3 Nonbuyer_{ij} \times Nonperish_j + u_i + \varepsilon_{ij},$$

where the dependent variable refers to the amount by which participant $i$'s perceived field price exceeds her WTP; $Nonbuyer_{ij}$ equals 1 if participant $i$ did not arrive at the auction planning to purchase good $j$ that same day; $Nonperish_j$ equals 1 if good $j$ is nonperishable (i.e., chocolate); $u_i$ is an individual-specific effect; and $\varepsilon_{ij}$ is a mean-zero error term.

Table 3 presents the results of the random-effects analysis.[13] The constant term is not significantly different from zero, providing no evidence that buyers bidding on the perishable good submit bids different than their perceived field price. The coefficient estimate associated with $Nonbuyer_{ij}$, on the other hand, is significantly greater than zero, suggesting nonbuyers bidding on the perishable good bid less than their predicted field price. The coefficient estimate associated with $Nonperish_j$ is significantly greater than zero, suggesting buyers bidding on the nonperishable, differentiated good bid less than their perceived field price. Finally, the coefficient estimate associated with the cross-term $Nonbuyer_{ij} \times Nonperish_j$ is of roughly equal magnitude to the coefficient estimate associated with $Nonbuyer_{ij}$. Indeed, an $F$-test fails to reject the null hypothesis that these two coefficients are equal in absolute value ($F_{1, 288} = 0.17$). Intuitively, this confirms our earlier finding that there is no significant difference between the behavior of buyers and nonbuyers when bidding on the nonperishable good.

The results reported in this section clearly suggest that when testing whether an auction design is demand revealing in practice, a nondifferentiated, perishable good like bananas is a better choice than a differentiated, nonperishable good like chocolate bars. It is also important that a sizeable proportion of potential participants will have already intended to buy the good. Bananas are a natural choice in a supermarket environment, though other goods will be more appropriate in other settings.

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[11] Paired-sample $t$-tests yield qualitatively similar results ($t = 2.18$ and 5.53, respectively).

[12] A two-sample $t$-test assuming unequal variances fails to reject the null hypothesis that the two means are different ($t = 0.32$).

[13] A Hausman test fails to reject the null hypothesis that the individual effects are uncorrelated with the regressors ($p = 0.38$).

**Table 3. Random Effects Regression Results ($N$ = 292)**

| Variable | Parameter Estimate | Standard Error |
|---|---|---|
| Constant | 0.06 | 0.11 |
| $Nonbuyer_{ij}$ | 0.32** | 0.13 |
| $Nonperish_j$ | 0.44** | 0.17 |
| $Nonbuyer_{ij} \times Nonperish_j$ | −0.36* | 0.21 |

Notes: Single and double asterisks (*) denote statistically significant at the 0.10 and 0.05 levels, respectively.

## Discussion and Conclusions

Mounting evidence suggests that when participants do not receive adequate training, experimental auctions may produce systematically biased WTP estimates. For example, as Plott and Zeiler (2005) argue, even when bidding in theoretically demand-revealing auctions, participants may be influenced by a deep-seated desire to "buy low and sell high." It is not enough for researchers to design an auction experiment which is demand revealing in theory. We must also be confident that our design motivates demand-revealing behavior in practice. Unfortunately, the literature offers little guidance regarding how researchers can test whether participants' bidding behavior is compatible with an auction's demand-revealing incentives.

In this paper we develop a straightforward method for testing whether field auction participants understand the demand-revealing properties of a given auction by comparing their bidding behavior with the predictions of theory. Specifically, when participants understand that bidding truthfully is in their best interest, theory predicts those who had planned to buy the good up for auction should submit bids equal to the good's field price. Those who had not planed to buy that good should submit bids less than its field price.

We also present the results of a pilot study showing how this test can be put into practice. In particular, we asked participants to bid on a perishable, nondifferentiated good, then asked them whether they had previously intended to purchase the same good that day and the price they thought it would sell for. By comparing bids with perceived field prices, we find that, in aggregate, our participants' behavior is consistent with what theory predicts for participants who understand the auction is demand revealing, suggesting participants' bids provide an unbiased estimate of their (censored) WTP.

A test for whether a particular field auction's design is incentive compatible is useful even if researchers are ultimately interested in estimating the value of a product having no close substitutes in the field. This test allows the researcher to gauge whether participants are, on average, submitting bids consistent with theory's predictions *assuming participants understand the auction is demand revealing.* If participants demonstrate in preliminary rounds they understand the auction's demand-revealing properties, a researcher can be much more confident that bidding for the product of interest in later rounds is not contaminated by an ingrained desire to "buy low and sell high." Given that most field auction studies already include one or more practice auctions, our simple test of incentive compatibility could easily be incorporated as a check of whether a study's design motivates participants to truthfully reveal their WTP.

Finally, our findings reveal that purchase intent is a significant determinant of WTP for a perishable good. This suggests researchers who use field auctions to value perishable goods should be careful to control for purchase intent.

Ideas for future research include examining the effects of changing the timing of the survey eliciting purchase intent or announcing the field price at the beginning of the auction (Drichoutis, Lazaridis, and Nayga, forthcoming). The methodology developed here could also be used to test whether changing specific aspects of an experiment's design—e.g., whether participants are explicitly told that bidding truthfully is in their best interest—improves the performance of field auctions. (We thank an anonymous reviewer for this insight.)

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