Demand Curve Shifts in Multi-Unit Auctions:

Evidence from a Laboratory Experiment[1,2]

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Abstract: Many auctions sell multiple units, but the effect of selling complementary or substitutable products on consumer bids is not known. We show that auction participants change their bids when presented with multiple units that are complements or substitutes.

JEL codes: C91, D44

Key words: multi-unit auctions, complements, laboratory experiments, substitutes, consumer demand

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[2]Partial funding for this study was provided by the Department of Economics at Iowa State University.

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Introduction

Economic theory and experimental evidence have shown that when presented with multiple units in many types of auctions, consumers bid less for all units of a product other than the first (Ausubel and Cramton, 2002; List and Lucking-Reiley, 2000). An unanswered question is how do consumer bids change when multiple units that are complements or substitutes are sold in an auction? That is, does a consumer's demand curve for a given good shift when we introduce the possibility of winning additional items that are either complements or substitutes? This is important because many government auctions sell multiple units, including auctions to sell treasury bills and spectrum licenses. Many Internet auctions also sell multiple units that are complementary or substitutable. We report the results of an experimental auction for three commonly consumed food products to test if consumers change their bidding behavior when multiple products that are complements or substitutes are sold.

Experimental Design

The data analyzed in this paper come from Corrigan and Rousu (2003) and are summarized briefly here. Ninety-four undergraduate students enrolled in principles of economics courses at a large Midwestern university participated in this experiment in June of 2002.[1] The participants bid on combinations of the following three food products in a series of 25 rounds: a 16-ounce jar of salsa, an 8-ounce bag of plain-labeled tortilla chips, and an 8-ounce bag of tortilla chips labeled "Made in America from American ingredients." We chose these specific products because we believed it was likely that the participants would be familiar with

[1] Note that to avoid the possibility of students attempting to behave in a way that might please the courses instructor, the experiments were not conducted by the instructors of the courses.

them. In addition, the two bags of chips are close substitutes, while the chips and salsa are complements.

We used two Vickrey-style auctions, the second-price, sealed-bid auction (Vickrey, 1961) and the random nth-price auction (Shogren et al., 2001).[2] While participants bid on products in multiple rounds, they were informed that only one of the 25 rounds conducted in the experiment would be binding (valid). Following Melton et al. (1996), we used this random binding round to eliminate the threat of participants reducing their bids because they could obtain the same product in a different round. The rounds were varied across groups to avoid ordering effects. In this paper we only describe the six rounds we use in the analysis.

In three rounds, participants placed individual bids for the 16-ounce jar of salsa, 8-ounce bag of plain-labeled tortilla chips, and 8-ounce bag of tortilla chips labeled "Made in America from American ingredients." If one of these first three rounds were chosen as binding, participants could only possibly win one product. In the other three rounds, participants bid for a bundle of two of the products. Participants placed one bid for both bags of chips (American-labeled and plain-labeled), one bid for the American-labeled chips and the jar of salsa, and one bid for the plain-labeled chips and the jar of salsa. If one of these three rounds were chosen as binding, the winning participants would purchase both products.[3] This experimental design allows us to explore how bidding changed when participants were bidding on multiple products that were complements or substitutes.

[2] We consider a Vickrey-style auction to be one where the price is set by a bid submitted by an auction participant (e.g., the fifth highest bid), and all those who submitted higher bids win the auction (e.g., the top four bidders).
[3] Participants were instructed to determine their bid for each product separately, but the total bid for the two products is what was used for determining who would win the bundle of two products.

Results

The mean bids for the products are shown in Table 1.[4] To better understand how movements of a bidder's demand curve could affect bidding behavior, consider equation (1), which would hold in the absence of demand curve shifts:

(1) $$Bid(A) + Bid(B) = Bid(A + B).$$

According to (1), if participants place separate bids on products A and B (when they know they cannot win both products), the sum of their bids to purchase both products individually should equal their bid to purchase both product A and B together. When products are complements, economic theory predicts that the right-hand side of (1) will be greater than the left-hand side. When the products are substitutes, economic theory predicts that the right-hand side of (1) will be less than the left-hand side.[5]

Table 2 compares the sum of the individual bids for two products with the bids for the pair of products sold together. This allows us to test equation (1), which will provide insight into how bidding behavior changes in the presence of multiple units that are complements or substitutes. When the two products sold are complements, the bid for the pair of items when sold together is greater than the sum of the bids for each item individually. A nonparametric, two-sided Wilcoxon signed-rank test shows that these results are statistically significant at the 1% level for the American-labeled chips and salsa, but only marginally significant for the plain-labeled chips and salsa (p value = 0.11).[6]

[4]We tested for differences in bids between those who participated in the second-price auction and those who participated in the random nth-price auctions, but the differences were not statistically significant at any conventional significance level. Because the participants were in separate, independent treatments, we pool the data together to look for demand curve shifts.

[5] Income effects could also explain why the right-hand side is less than the left-hand side, but given that the bids for these products are so small, income effects are likely negligible.

[6] Using a t-test we obtain similar results with p-values of 0.01 and 0.14, respectively.

When the two products are substitutes (the two bags of tortilla chips), the bids for the pair of products when sold together is smaller than the sum of the bids for each item individually. This result is statistically significant at the 1% level using a one-sided Wilcoxon signed-rank test (at the 5% level using a one-sided t-test). Our results show that both complementary and substitutable products affect consumer bids in the way that economic theory would predict. Further, more than 44% of participants shifted their demand when presented with multiple products.[7] These results have implications for government and Internet auctions, as many items sold are complementary or substitutable and the bidders' demand curves will shift when presented with these items. These results also have implications for those who wish to run experimental auctions and sell multiple units. With a large percentage of participants changing their bids in the presence of complements or substitutes, researchers who sell related products in an experimental auction run the risk of biasing their results either upward or downward.[8]

Conclusion and Significance

We use two Vickrey-style auctions to show that consumers' demand curves shift in the expected directions for both complementary and substitutable products. This has implications for the design of any auction that sells similar or complementary items. For example, the FCC spectrum auctions sell some licenses that can be considered substitutes and others that can be considered complements (Cramton, 2002). These results also have implications for those conducting experimental auctions where consumers could obtain multiple products. If the products are complements or substitutes, then bid prices can be confounded by the effects of demand curve shifts.

[7] The table that contains this result can be obtained from the authors upon request.

[8] Several experimental auctions have allowed participants to win multiple items, some of which were clearly substitutes for one another (e.g., Noussair et al., 2002; Van Wenchel et al., 2002). For an example of an experimental auctions where participants bid on multiple items that were not obvious substitutes or compliments, see Rousu et al. (in press).

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Table 1. Mean bids (N=94)

Product(s)	Mean	Median	Std. Deviation	Minimum	Maximum
1 jar of salsa	0.65	0.50	0.57	0	2.30
1 bag of plain-labeled chips	0.51	0.28	0.51	0	2.00
1 bag of American-labeled chips	0.58	0.48	0.56	0	2.25
1 bag of plain-labeled chips and 1 bag of American-labeled chips	1.03	0.95	0.95	0	4.25
1 bag of plain-labeled chips and 1 jar of salsa	1.24	1.00	1.10	0	5.50
1 bag of American-labeled chips and 1 jar of salsa	1.31	1.00	1.08	0	5.00

Table 2. **How do bids change in bundles of complements or substitutes? The value is the bid for the bundle of goods minus the sum of the individual bids for the products (N=94)**

Product(s)	Mean deviation
Plain-labeled chips and jar of salsa	0.09
Std Deviation	(0.58)
American-labeled chips and jar of salsa	0.16 **
Std Deviation	(0.57)
Plain-labeled chips and American-labeled chips	-0.06 **
Std Deviation	(0.30)

** Statistically significant at the 1% level (using a one-sided Wilcoxon signed rank test)