On the Use of Multi-Unit Auctions in Measuring Consumers' Willingness to Pay for Food Products

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1. INTRODUCTION

Experimental auctions have become a popular tool used by applied economists to assess consumers' willingness to pay (WTP) for food products. Their popularity partly stems from their incentive compatibility property where people have the weakly dominant strategy of revealing their true valuation for a good.

Up to now, researchers in agricultural economics and marketing used single-unit auctions to carry out their experiments. In single-unit auctions participants are asked to report their WTP only for a single unit of the auctioned product, since it is assumed that people are interested in purchasing one unit during the auction.

However, consumers can be interested as well in purchasing not just one but multiple units of a product. Also, due to increasing time constraints, many consumers are becoming increasingly concerned about optimizing shopping efficiency by purchasing multiple units of products to save several trips to the store.

Using single-unit auctions to assess consumer behavior in multiple units shopping scenario is misleading and biased, since results are only applicable for the first unit a consumer is willing to buy and cannot provide information on consumers' WTP for subsequent units of the product beyond the first unit.

Due to the limitations of single-unit experimental auction, we propose here the use of multi-unit auctions where multiple identical units are auctioned and participants are asked to report their WTP for each unit.

Among several multi-unit auction mechanisms, we propose the use of an incentive compatible multi-unit auction mechanism, the so called multi-unit Vickrey auction. Multi-unit Vickrey auction is a generalization of the second price auction. Each participant is asked to bid on multiple units of the same product and the winner pays an amount corresponding to the sum of the bids (excluding his or her own bids) that are displaced by his or her successful bids (Krishna, 2002).

2. OBJECTIVES

1. **Showing the usefulness of multi-unit auctions in the valuation of food products by determining:**
   - Demand curve.
   - Consumer surplus.
   - Determinant factors of consumer's WTP for multiple units of the same product.
2. **Showing the usefulness of multi-unit auctions in Marketing research by:**
   - Examining the effect of varying the distribution of the amount of price discount in multi-unit price promotion on consumer's WTP.

- Uniform distribution (same discount per unit)
- Concentrated distribution (all the discount is applied on the last unit)
- Increasing distribution (increasing discount in the number of units)

3. EXPERIMENTAL DESIGN

Sample: 90 subjects were randomly drawn from a list of people who are responsible for food shopping in their household.

Participation fees: 15€

Sessions: 9 sessions, 10 subjects per session.

Product: 6 identical units of organic milk (1 liter/unit).

Rounds: 2 rounds

Steps: 4 steps

Software: Z-Tree, collects bids and determines the winner(s) and the clearing price

Step1: After taking a seat, each participant received an envelope which contained 15€ as compensation for their participation, his or her identification number and a questionnaire. We then asked participants to complete the questionnaire.

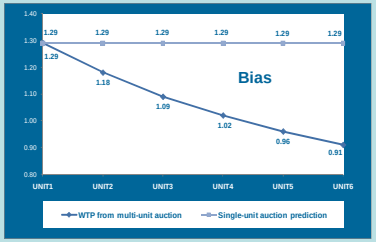
Step2: We gave each participant a printed material that included an explanation of how the specific auction works and some examples to illustrate the auction. After reading and discussing the instructions, participants were given an oral explanation supported by some examples in the board. to permit a better understanding of the auction mechanism we carried out a training session, auctioning six identical items of organic milk without economic exchange.

Step3: Each participant had to submit, again through the computer, how much he or she was willing-to-pay for each of the six units of organic milk. Once all participants finished reporting their bids, the software determines the winner(s) and the clearing price but this information was not revealed to participants.

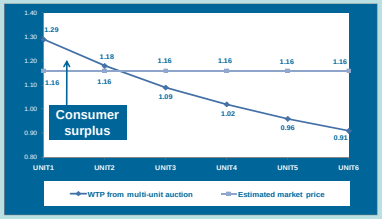
Step4: We provided the participants information about the price discount after the first round. One third of participants were offered the ***uniform price discount***; those from the second third were offered the ***"buy six and pay five"*** promotion; and subjects from the last third of the sample were offered the ***increasing price discount.*** Than subject were asked to bid again. At the end of the auction, one round was chosen randomly to determine the binding round. The winner(s) in the binding round was (were) appointed as the winner(s) of the auction.

4. RESULTS

4.1. Demand curve (WTP for organic milk)



4.2. Consumer surplus



4.3. Determinants of the WTP for organic milk

VARIABLES	TOBIT1 UNIT1	TOBIT 2 UNIT2	TOBIT 3 UNIT3	TOBIT 4 UNIT4	TOBIT 5 UNIT5	TOBIT 6 UNIT6
CONSTANT	0.334	0.052	0.128	0.264	0.414	0.409
1UNIT	**0.654*** **	-0.200	**-0.355** **	**-0.581*** **	**-0.637*** **	**-0.585*** **
2UNITS	**0.795*** **	**0.873*** **	-0.194	-0.223	-0.260	**-0.308***
3UNITS	**0.704*** **	**0.821*** **	**0.732*** **	0.160	-0.147	-0.142
4UNITS	**0.985*** **	**1.003*** **	**0.809*** **	**0.775*** **	-0.245	-0.197
5UNITS	**0.916*** **	**1.106*** **	**0.984*** **	**0.857*** **	**0.818*** **	0.394
6UNITS	**1.034*** **	**1.181*** **	**1.099*** **	**1.046*** **	**1.027*** **	**1.012*** **
WEEKLY	**0.165***	**0.170***	0.116	0.046	-0.020	0.024
QUANTITY	**0.232*** **	0.136	0.064	0.039	-0.051	-0.021
INFORMED	**-0.227*** **	**-0.339*** **	**-0.305*** **	**-0.321*** **	**-0.308*** **	**-0.300*** **
FREQUENCY_OF	**0.212** **	**0.168***	0.143	**0.215** **	0.140	0.106
FAVORABLE	-0.003	0.113	**0.202** **	0.126	**0.256** **	**0.276*** **
PRICE_OF	0.034	-0.058	-0.043	-0.111	-0.136	**-0.166***
ENVIRONMENT	0.083	0.047	0.003	-0.034	-0.021	-0.066
AVAILABILITY	0.019	0.004	0.122	**0.160** **	**0.184** **	**0.134***
HOUSEHOLD	0.004	0.003	0.015	-0.041	-0.069	-0.034
GENDER	0.061	0.049	0.018	-0.016	-0.011	-0.009
AGE	-0.004	-0.001	-0.002	-0.002	-0.004	-0.005
CHILDREN	-0.058	-0.095	-0.107	-0.017	-0.029	0.030
PSEUDO R^2	0.43	0.52	0.54	0.56	0.54	0.55

*** (**) (*) Statistically significant at 1% (5%) (10%) level

4.4. Price-discount effect (Buy six and pay five)

VARIABLES	UNIT1	UNIT2	UNIT3	UNIT4	UNIT5	UNIT6
CONSTANT	1.532***	1.326	0.828**	-0.179	-0.508	-0.669
DISCOUNT	0.019	0.028	0.031	-0.014	**0.134***	**0.184***
QUANTITY	0.178	0.306	0.137	0.623	0.900**	0.941**
FREQ_OF	0.442**	0.453**	0.135	0.234	-0.150	-0.153
HOUSEHOLD	-0.267	-0.235	-0.612	-0.378	-0.762	-0.645
GENDER	0.146	0.260	0.279	0.324	0.217	0.231
AGE	-0.013	-0.017*	0.000	0.001	-0.004	-0.003
EDUCATION	-0.181	-0.158	-0.242	-0.229	0.231	0.277
CHILDREN	0.374	0.246	0.578*	0.825*	1.213***	1.176**
INCOME	0.381*	0.473**	0.470	0.455	0.657	0.626
Loglikelihood	-2.22	-19.62	-28.28	-43.99	-41.06	-41.85
Wald chi2	12.71	15.08	7.08	8.37	16.51	17.94
Prob > chi2	0.08	0.08	0.62	0.49	0.05	0.03

*** (**) (*) Statistically significant at 1% (5%) (10%) level

4.4. Price-discount effect (Uniform price discount)

VARIABLES	UNIT1	UNIT2	UNIT3	UNIT4	UNIT5	UNIT6
CONSTANT	1.939***	2.064***	2.153***	2.071***	2.650***	2.562***
DISCOUNT	**0.171*** **	**0.231*** **	**0.166*** **	**0.166*** **	**0.181*** **	**0.191*** **
QUANTITY	-0.191	-0.026	0.140	0.165	0.179	0.197
FREQ_OF	-0.002	-0.121	-0.173	-0.143	0.093	0.137
HOUSEHOLD	-0.265	-0.216	-0.173	-0.169	-0.147	-0.164
GENDER	0.046	0.347	0.618	0.632*	0.830***	0.811***
AGE	-0.006	-0.015	-0.019	-0.019	-0.034***	-0.034***
EDUCATION	-0.264	-0.588***	-0.929***	-0.931***	-1.228***	-1.235***
CHILDREN	0.033	0.264	0.106	0.097	0.231	0.246
INCOME	-0.409**	-0.344	-0.462	-0.433	-0.642**	-0.606**
Loglikelihood	-24.90	-38.07	-36.98	-36.98	-35.56	-36.19
Wald chi2	21.10	32.17	21.60	21.60	29.40	29.56
Prob > chi2	0.01	0.00	0.01	0.00	0.00	0.00

*** (**) (*) Statistically significant at 1% (5%) (10%) level

4.4. Price-discount effect (Increasing price discount)

VARIABLES	UNIT1	UNIT2	UNIT3	UNIT4	UNIT5	UNIT6
CONSTANT	0.554	-0.258	0.946	0.791	1.616	1.371
DISCOUNT	**0.145*** **	**0.110*** **	**0.139*** **	**0.144*** **	**0.144*** **	**0.210*** **
QUANTITY	0.599	0.197	0.281	0.056	-0.053	0.021
FREQ_OF	0.751**	1.203***	1.424***	1.624***	1.428***	1.314***
HOUSEHOLD	0.392	0.152	0.158	-0.108	0.225	0.325
GENDER	0.164	0.374	-0.215	-0.123	-0.080	-0.128
AGE	-0.009	0.002	-0.031**	-0.030	-0.053***	-0.052***
EDUCATION	0.100	0.408	-0.041	0.011	-0.091	0.008
CHILDREN	0.135	-0.118	-0.091	0.081	-0.105	-0.124
INCOME	0.033	0.073	0.023	0.154	0.212	0.268
Loglikelihood	-19.67	-11.97	-29.34	-27.75	-31.28	-39.10
Wald chi2	28.56	71.95	49.71	51.90	34.06	28.29
Prob > chi2	0.00	0.00	0.00	0.00	0.00	0.00

*** (**) (*) Statistically significant at 1% (5%) (10%) level

5. CONCLUSIONS

- **As expected, the mean of the WTP for organic milk is decreasing as the number of units being auctioned increases.**
- **Participants can benefit from purchasing two units of organic milk (the consumer surplus is positive). The producer of the auctioned organic milk can, at most, introduce into the market packages of 2 units.**
- **The magnitude and the direction of the effect of some factors determining consumers' WTP are different from one unit to another.**
- **The distribution of price discount in price promotions matters. We found that price promotion increases consumers' WTP more when the distribution of the amount of price discount is increasing with the number of units than when it is uniform. However, when the amount of price discount is concentrated on the last unit as commonly practiced by some retailers, the response of consumers in terms of WTP is generally not statistically significant.**

REFERENCE

Krishna, V. 2002. Auction Theory (1st ed.) California: Academic Press San Diego.