

**“Compensation Schemes for Negative Externalities:
A Field Experiment”**

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David Brookshire, Don Coursey and Howard Kunreuther

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COMPENSATION SCHEMES FOR NEGATIVE EXTERNALITIES:

A FIELD EXPERIMENT

David S. Brookshire, Don L. Coursey, and
Howard Kunreuther

I. INTRODUCTION

In recent years the expressions "not in my backyard" (NIMBY) and "locally unwanted land use" (LULU) have become common expressions of residents faced with the potential intrusion into their domain of a noxious facility. Examples of such facilities include trash disposal plants or incinerators for treating hazardous waste. Typically, a community favors such facilities at other locations so that they can obtain the benefits from these facilities without having to incur any of the environmental costs or risks associated with operating the facilities (Popper 1983).

An economic approach to the problem of siting of these facilities is the use of compensation. A compensation arrangement would share the benefits from those

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communities that do not have the facilities with those communities that do. Although economists have been sympathetic to this approach because of the potential ability to improve resource allocation, policymakers have been reluctant to consider compensation as a solution to NIMBY and LULU problems. This reluctance to use compensation stems from several sources. Compensation may be viewed as a bribe. Compensation may also be seen as inequitable, because the poorest communities are often likely to be chosen as sites. And finally, compensation may lead to strategizing because communities will exaggerate the amount they would require to have a facility in their backyard.

The facility siting problem is conceptually analogous to a collective arrangement such as a food cooperative. In the latter situation one person drives to the market, purchases some commodity for all the members of the cooperative, and then delivers the requested amounts to each home. Under this type of arrangement one individual or family bears the entire costs associated with pick-up and delivery of the goods, while the other members benefit from this service. In this situation it becomes appropriate to ask each individual who agrees to join such a cooperative what their maximum willingness to pay (WTP) would be to have someone else undertake these pick-up and delivery chores. One would also want to know their minimum personal willingness to accept (WTA) to assume this burden. The individual who delivers is analogous to the community that bears the cost of waste disposal, while the individuals who receive the goods are analogous to the communities that benefit from the waste disposal.

Such a collective arrangement mirrors the properties of a larger class of problems. In these problems economies of scale in the production of a collectively valued resource dictate that one individual should provide the public good. However, this provision generates local disutility for the providing individual. And, because the other individuals in the collective may enjoy the benefits of this good's provision without suffering any local disutility themselves, there are spillover effects associated with the selection of a single individual chosen to provide the public good. In other words, a single individual or community is able to prevent the negative externalities associated with a particular good by assuming the entire burden. The relevant economic question to ask in this setting is whether a compensation system can be constructed that will Pareto optimally select the providing individual.

This paper reports on the results of a field experiment conducted with community residents that examines the performance of a procedure for sharing the benefits from the winners to the loser(s). We explore a situation similar to a food cooperative in a field setting. An experiment using various methods for allocating flowers was conducted. Initially, each individual in these field experiments was asked to specify a WTP value to have flowers delivered to their home and a WTA value to perform this service for N other households. This approach was based on previous work that attempted to collect WTP and WTA values through contingent valuation methods (see Brookshire, Coursey, and Schulze 1986, for

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an overview). Delivery of the flowers was subject to economies of scale. That is, in our experimental design one individual should provide this service and be compensated for his or her effort by the other individuals. Then, an alternative sealed-bid auction procedure developed by Kunreuther et al. (1987) was utilized to elicit a comparative set of WTP and WTA values.

The next section characterizes the elements of the cooperative arrangement problem and discusses the auction procedures. Sections 3 and 4 describe the methodology utilized in the field experiment and analyze the data in relationship to hypotheses regarding the auction procedure. The concluding section suggests extensions of the analysis. Particular emphasis is placed on the integration of results obtained from controlled laboratory experiments and field implementation of the auction procedure. Our goal in this paper is to investigate the properties of the sealed-bid auction procedure in comparison to the values obtained using contingent valuation methods. In our present research we consider the flower delivery problem as a paradigm for the larger class of allocating a *riskless* negative externality. Because risks generate their own problems in the field, in future research we plan to extend our results to the more general case of allocating a *risky* negative externality such as the potential impacts from a hazardous waste site.

II. A SEALED-BID MECHANISM FOR A COOPERATIVE ARRANGEMENT

The specific problem we are considering is classified by economists as an externality. An individual desiring flower delivery, for example, has the option of participating in a cooperative arrangement with a set of N other individuals with the intent of identifying an individual who will perform the task of delivering the flowers. If an individual decides not to enter into this cooperative arrangement, they can be excluded from cooperative delivery arrangements.

For the case of delivering flowers, economies of scale argue for allowing one individual to serve N other individuals in a given region. The person who delivers flowers to other homes will not derive any direct benefits from undertaking this activity, and thus must be paid for this service.

There is no reason why WTA and WTP values should be the same for this problem. An individual may only be willing to pay one dollar to have freshly cut flowers delivered to their home. This amount may reflect the opportunity cost of time to travel to the florist. On the other hand, if the individual is asked to deliver flowers to N other homes in their community, the WTA value for undertaking this task is likely to be considerably higher than their WTP amount.

At first glance the literature on demand revealing mechanisms relating to this problem appears to be appropriate for inducing individuals to specify accurate WTA and WTP values. Specifically, Clarke (1971) has developed a procedure

that leads individuals to declare their true preferences for a pure public commodity by charging a tax that is dependent, in part, on how their responses affect the final outcome. On closer inspection, however, one finds that the Clarke preference revelation mechanism requires that the public commodity being allocated has a positive value to each of the individuals, so that there is a net surplus after the commodity tax is levied. This will not be the case for the class of problems associated with public bads, and hence the truth-telling property of the Clarke mechanism fails to hold.¹

Kunreuther et al. (1987) have developed a sealed-bid auction model for eliciting WTA values when a single community or individual is chosen as the "winner" from among $N+1$ possible candidates. The key idea is to create a limited incentive for misrepresentation of individual preferences by stipulating that each individual announces a WTA value with the understanding that if another individual is selected the tax payment for not hosting this facility is $(1/N)$ of WTA. A regional agency assembles the information from all the sealed-bids and announces which of the individuals is chosen on the basis of the *lowest* WTA. Let $X_i > 0$ represent the WTA value for individual i . If individual j is the lowest bidder, then i must pay an amount $t_i = -X_j/(N)$ to help compensate the host site. If budget balancing is also a criterion, the regional agency's problem is then simply to determine: $\text{Min}\{X_j\}$.

The above procedure, which will be termed the *low-bid auction*, has several appealing features. It is a coalition-free mechanism because each individual's WTP value is independent of any other individual's WTA value. Thus two or more individuals cannot strategically link their bids in order to extract mutual gain from the procedure.² In addition, the procedure not only is budget balancing because the lowest bid "wins" but, in fact, will very likely generate a tax surplus. It is also designed to be equitable by making the tax on any one individual inversely proportional to the number who participate in the program.³ The procedure should be easy to understand because an individual only has to specify a single value (WTA) and there is an intuitive rationale for determining the WTA as a function of N .

The procedure is not strictly incentive compatible because an individual may want to misrepresent their preferences by overstating WTA and understating WTP if they believe that they will not be penalized by this action. However, individuals are dissuaded from grossly exaggerating their compensation requirements because their tax is directly proportional to their bid. It is also unclear whether the property of incentive compatibility is an important feature for these types of problems. An individual who bids above his WTA because he knows that the second lowest bidder has a much higher value is simply capturing the consumer surplus. If this individual is the poorest person then such strategizing has desirable equity properties while not taking away from efficiency considerations associated with the decision rule that the lowest bid "wins."

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competing for flower delivery would specify a WTA of \$100 or more. Suppose individual i would be willing to accept the delivery task for only \$50. The individual would want to bid as high as \$99, given the criteria of lowest bid.⁴ If, on the other hand, the individual is uncertain about the other 10 individuals' preferences, then the individual might be concerned about bidding more than \$50, particularly if that individual's WTP value was approximately \$5. The above bidding procedure generates several hypotheses which can be examined in a field setting.

Hypothesis 1. When individuals know their own preferences, but have no information about others' preferences, then they will utilize a maxi-min bidding strategy.

This hypothesis has received strong support in a series of controlled laboratory experiments conducted by Kunreuther et al. (1987). In these experiments, true willingness to pay and willingness to accept values were known because values were induced in the laboratory. Thus, actual deviations from maxi-min strategy could be measured. It should also be noted that individuals volunteered to participate in these experiments and always participated in the auction process. The results from these experiments indicate that most individuals will use strategies that deviate only about ten percent from maxi-min bidding behavior.

Use of a maxi-min strategy can be described as follows for an individual. Let WTA_{CVM} and WTP_{CVM} represent unconstrained willingness to accept and willingness to pay value measures obtained by traditional contingent valuation methods. If we assume that these figures correctly measure the true values for individual i , then the maxi-min bid using the low bid auction for the individual is:⁵

$$X_i^* = \frac{N}{N+1} [WTP_{CVM} + WTA_{CVM}] \quad (1)$$

To illustrate, suppose Ms. Rose has a $WTA_{CVM} = \$14$ for delivering flowers to $N = 5$ other households and a $WTP_{CVM} = \$4$ for having the flowers delivered to her home by someone else. If she uses a maxi-min strategy then $X_i = \$15$ as given by (1). If she were the lowest bidder, then she would be \$1 better off than implied by her WTA_{CVM} bid. If another individual bid lower, then she would have to pay $X_i/5 = \$3$, which would be \$1 less than her WTP_{CVM} value.

Hypothesis 2. The only individuals willing to participate in the low bid auction will be those with $WTP_{CVM} > X_i^*/N$ given that a maxi-min strategy is used.

In the above example, Ms. Rose would be willing to participate in the low bid auction because $WTP_{CVM} = \$4 > X_i/5 = \$3$. Had her $WTA_{CVM} = \$26$ and $WTP_{CVM} = \$4$, then $X_i = \$25$ and the implied willingness to pay ($X_i/5$) would

be \$5 if she used a maxi-min strategy. The low bid auction would then be unattractive to her based on her WTA_{CVM} and WTP_{CVM} values and she would prefer to pick up the flowers on her own.

Hypothesis 3. The WTA value for each individual will be directly proportional to the opportunity cost of time.

The field experiment described in the next section will enable us to test these three hypotheses. At the same time it provides a vehicle for accumulating other socioeconomic data such as education, age, race, and sex. Some of these factors may also influence individual bids and willingness to participate in the auction. We have not formulated any specific hypotheses regarding the impact of these socioeconomic variables, but they are potentially important considerations in the transition from experimental analysis to implementation in actual settings.

III. METHODOLOGY

The performance of the low-bid auction mechanism outlined in the previous section was examined in Laramie, Wyoming using groups of households. Each individual member of a group, consisting of either $N = 5$, $N = 10$, or $N = 20$ households, was surveyed and asked how much they would have to be compensated to deliver bunches of fresh cut flowers to the N other individuals. At the same time, each member of the group was asked how much they would be willing to pay to have the fresh cut flowers delivered to their home by one of the other households. (See Appendix A for a copy of the actual survey).

Each individual was asked two questions regarding these willingness to accept and willingness to pay value measures using traditional contingent valuation methods (see Cummings, Brookshire, and Schulze 1986). Specifically, after it was determined that the household satisfied the joint requirements of having access to an automobile for purposes such as running errands and did indeed like fresh cut flowers, the following question was asked:

Suppose now that your task was to drive to the old Safeway parking lot at a time convenient for you, pick up $N+1$ bunches of flowers such as these [an example bunch of flowers was presented], place them at the doorstep, without ringing the bell of each of the N houses, and then drive immediately back to your house with one bunch for yourself. It would take you approximately M minutes to accomplish this task. This includes the total time from when you leave your home to the time you return.

What is the minimum dollar payment which you would require to perform the above task?

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Specific values of N and M were given to each household. In other words, each individual was queried as to the dollar amount of compensation necessary to participate in the plan with N other households. This WTA value represents the M minutes of labor time associated with performing the task. These costs were designed to be as constant as possible over all sampled households in a single group. The surveyed houses were all located in a circle of approximately one mile in radius around the old Safeway store. Therefore the value of M was approximately constant for all households as determined by delivery distance. Second, there was no interpersonal communication allowed between the deliverer and the households where flowers were to be left. This eliminated any possible positive or negative effects associated with such interactions. In this way the WTA value should reflect only the time associated with delivering flowers.

The household was then questioned about willingness to pay to have the flowers delivered to their home. Again, no mention was made concerning any joint group process for determining which household would actually deliver the flowers:

Suppose that the flowers were like this bunch and were free. Suppose someone from the other N houses were delivering the flowers to the doorsteps of all $N+1$ households. What is the maximum dollar amount that you would be willing to pay to be included in this delivery service?

Once these two contingent valuation responses were collected, we then asked the question in the context of the low-bid auction process. This was accomplished by modifying the compensation question as follows:

Now, consider the following proposal. You and the other N households indicated on the map [a map of the city with the individual's house, the location of the old Safeway parking lot, and the other N houses indicated] determine who will deliver flowers to everyone. You and the other N households will each state the minimum dollar amount required to deliver all the flowers. However, this time only the household which requests the lowest dollar amount would have to deliver the flowers to everyone. That household would receive the amount requested. All other households would have to pay $1/N$ of their request to have the flowers delivered.

After a numerical example was provided to the household, the following question was asked:

What is the *minimum* dollar amount using this procedure which you would require to deliver the flowers to the other households?

Using this process, one household would be compensated for the public delivery task while each of the other households would pay for the performed delivery

service. Let WTA_A represent the individual's bid in response to the above low bid auction question. If $WTA_A = X_i$ from (1) then the person is consistent with a maxi-min strategy. The survey was completed by collecting standard socioeconomic data about the household.

We measure maximum willingness to pay and minimum willingness to accept values in both settings. Previous work that has considered measuring these joint values assumed that these values would not differ for economic reasons unless individuals behaved strategically (see for example Coursey, Hovis, and Schulze 1987; Brookshire and Coursey 1987). However, as mentioned above, there is no reason to believe that these values should be theoretically identical to begin with. The auction process attempts to reduce any strategic bias by linking willingness to pay directly to willingness to accept. It is possible to design an auction that may further eliminate any strategic bias (see note 4). However, as will become apparent in the next section, we find little evidence to support the hypothesis that individuals did strategize when using the low-bid auction process.

We measured the behavior of individuals in household groups of sizes $N = 5$, $N = 10$, and $N = 50$. The amount of time required to perform the task was estimated beforehand as $M = 40$ minutes for $N = 5$, $M = 50$ minutes for $N = 10$, and $M = 90$ minutes for $N = 50$. Thirty complete surveys were completed for each of these three classes, yielding a total of 90 surveyed households.

The procedure for choosing the 90 homes to be sampled began with Census block data. The city was stratified into primary sampling units based upon income. Each primary sampling unit in the city was then randomly included in the sample with a probability proportional to primary sampling unit population size. Thus, a random sample of Laramie's population was obtained. Two survey teams were utilized for the field data collections. Surveys were conducted on two consecutive days in the Summer of 1985 in the late afternoon and early evenings.

None of the proposed delivery schemes were actually implemented. However, each household was provided with a complimentary bunch of flowers for their participation in the study.

IV. RESULTS FROM THE STUDY

Table 1 reports the contingent valuation willingness to accept, the contingent valuation willingness to pay, the low-bid auction willingness to accept, and the implied willingness to pay (equal to $1/N$ times the low bid willingness to accept bid) values for the three different group sizes. Table 2 tabulates summary socioeconomic responses for the households which participated in the study.

As is evident from Table 1, median contingent valuation willingness to accept bids increases as group size increases. Also, as expected, median contingent valuation willingness to pay bids are roughly constant over group size. Addi-

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Table 1. Summary Bidding Statistics

		<i>N</i> = 5	<i>N</i> = 10	<i>N</i> = 50
Q6 Contingent Valuation WTA (Dollars)	$\bar{x}$	8.66	34.82	32.60
	Median	5.08	9.96	19.64
	σ	9.01	90.42	43.66
	# Cases	30	30	30
Q7 Contingent Valuation WTP (Dollars)	$\bar{x}$	1.94	3.45	2.18
	Median	1.93	2.05	1.58
	σ	1.28	5.40	1.67
	# Cases	30	30	30
Q8 Low Bid WTA (Dollars)	$\bar{x}$	14.15	23.97	71.00
	Median	10.04	19.00	49.63
	σ	10.80	17.60	78.62
	# Cases	30	29	29
Implied Low Bid WTP (Q8/Type) (Dollars)	$\bar{x}$	2.83	2.40	1.42
	Median	2.01	1.90	.99
	σ	2.16	1.76	1.57
	# Cases	30	29	29

tionally, in all three cases contingent willingness to pay median bids are all greater than $N-1$ times contingent willingness to accept medians.

More insight into the choice process used by individuals can be gained by categorizing individual bids by the relationship between WTA and WTP_{CVM} as illustrated in Figure 1. If $WTA_A/N \geq WTP_{CVM}$ then, if a person follows a maxi-min strategy, she would prefer not to participate in the low bid auction. Here WTA_A implies that she would either break even or lose money if she were not the lowest bid. Of the 47 individuals in this category, 72 percent were not interested in taking part in the low-bid auction.

Let us turn now to the 43 individuals with $WTA_A/N < WTP_{CVM}$. Figure 1 indicates that 15 individuals chose a value of $WTA_{CVM} < WTA_A < NWTP_{CVM}$, a bid that is consistent with a maxi-min strategy. A graph of the difference between WTA_A and the X_i^* is depicted in Figure 2. In all 15 cases the low-auction bids were in excess of the maxi-min bid, suggesting that individuals are more concerned with the consequences of delivering flowers than paying to have flowers brought to their house. They require a special bonus if they are chosen as the lowest bid. This causes them to raise their WTA_A above X_i^* .

Turning again to Figure 1, one notes that there are 22 persons whose $WTA_A = WTA_{CVM} < NWTP_{CVM}$. All of these people appear to have determined their low auction bid by anchoring on their willingness to accept value. Because the amount they would have to pay if they were not the lowest bid is below their

Table 2. Summary Statistics

	Sample Size	N = 5 30	N = 10 30	N = 50 30	All Surveys 90
Q3 How are fresh-cut flowers obtained? (Percent)	Grocer	13.3	20.0	26.7	20.0
	Florist	36.7	13.3	30.0	26.7
	Gift	10.0	23.3	10.0	14.4
	Garden	36.7	40.0	33.3	36.7
	Other	3.3	3.3	—	2.2
Q4 How many times/year buy fresh-cut flowers? (Number times)	$\bar{x}$	7.97	4.90	5.63	6.17
	Median	5.83	3.50	3.10	3.68
	σ	7.78	4.98	9.44	7.65
Q5 How long round trip from house to Safeway? (Minutes)	$\bar{x}$	12.63	13.40	14.53	13.52
	Median	10.28	11.50	13.00	11.70
	σ	6.11	6.55	7.06	6.56
Q9 Would you participate? (Percent)	Yes	60.0	26.7	23.3	36.7
	No	40.0	73.3	76.7	63.3
Q10 Is this procedure reasonable? (Percent)	Yes	83.3	73.3	90.0	82.2
	No	16.7	26.7	10.0	17.8
Q11 Sex (Percent)	Male	43.3	30.0	40.0	37.8
	Female	56.7	70.0	60.0	62.2
Q12 Age (Years)	$\bar{x}$	37.83	40.55	44.23	40.88
	Median	32.50	38.25	43.50	38.13
	σ	15.84	14.94	15.33	15.43
	# Cases	30	29	30	89

Q13 Race (Percent)	White	90.0	90.0	93.3	91.1
	Black	3.3	—	—	1.1
	Hispanic	3.3	10.0	6.7	6.7
	Amer. Indian	—	—	—	—

Q12 Age (Years)	$\bar{x}$	37.83	40.55	44.23	40.88
	Median	32.50	38.25	43.50	38.13
	σ	15.84	14.94	15.33	15.43
	# Cases	30	29	30	89
Q13 Race (Percent)	White	90.0	90.0	93.3	91.1
	Black	3.3	—	—	1.1
	Hispanic	3.3	10.0	6.7	6.7
	Amer. Indian	—	—	—	—
	Asian	3.3	—	—	1.1
Q14 Education (Percent)	Grade 0-5	3.3	6.7	—	3.3
	6-8	—	6.7	3.3	3.3
	9-11	3.3	—	—	1.1
	HS Grad	16.7	6.7	16.7	13.3
	Vocational	—	—	3.3	1.1
	Some College	30.0	20.0	26.7	25.6
	BS/BA	13.3	16.7	13.3	14.4
	Some Graduate	20.0	10.0	20.0	16.7
	Advanced Degree	13.3	33.3	16.7	21.1
Q15 Employment (Percent)	Employed	63.3	80.0	80.0	74.4
	Unemp/Retired	36.7	20.0	20.0	25.6
Q17 Are you paid an hourly wage? (Percent)	Yes	52.6	29.2	50.0	43.3
	No	47.4	70.8	50.0	56.7
	# Cases	19	24	24	67
Q17A If yes, what is it? (Dollars)	$\bar{x}$	4.92	4.26	5.33	4.93
	Median	4.60	4.00	4.73	4.52
	σ	2.35	2.45	2.94	2.57
	# Cases	10	7	12	29
Q18 Weeks/Year you work? (Number weeks)	$\bar{x}$	42.74	40.96	46.46	43.47
	Median	48.33	48.00	50.21	49.79
	σ	13.75	14.16	11.03	13.00
	# Cases	19	23	24	66

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Figure 1.

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Table 2. (Continued)

Sample Size		<i>N</i> = 5 30	<i>N</i> = 10 30	<i>N</i> = 50 30	All Surveys 90
Q19 Monthly take-home for household per month? (Dollars)	$\bar{x}$	1888.24	2351.43	1999.57	2089.67
	Median	1800.00	2000.00	1500.00	1991.67
	σ	1022.18	1555.92	1261.39	1306.75
	# Cases	17	21	23	61
Q20 What % do you earn?	$\bar{x}$	46.17	59.36	55.26	54.10
	Median	31.00	50.25	49.33	49.86
	σ	37.35	29.28	34.52	33.53
	# Cases	18	22	23	63

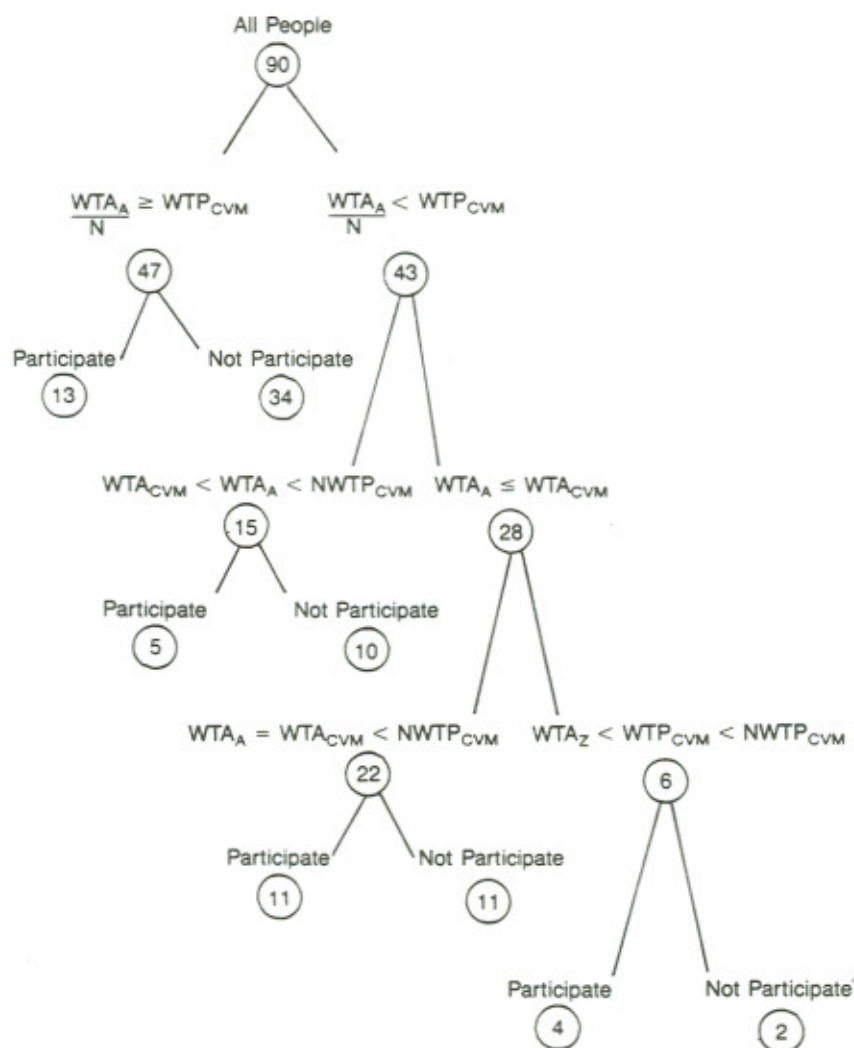


Figure 1. Analysis of Bids by Individuals Using Field Survey Data

WTP_{CVM} , they should all want to play. Yet only one-half agreed to participate in the auction, presumably because there were other attributes influencing their decision. Finally, there were six individuals with $WTA_A < WTA_{CVM} < NWTP_{CVM}$, which implies that these people may be anxious to deliver flowers, since they entered a lower bid in the auction than their WTA_{CVM} . Indeed, four out of the six people in this category indicated that they were willing to participate in the low-bid auction.

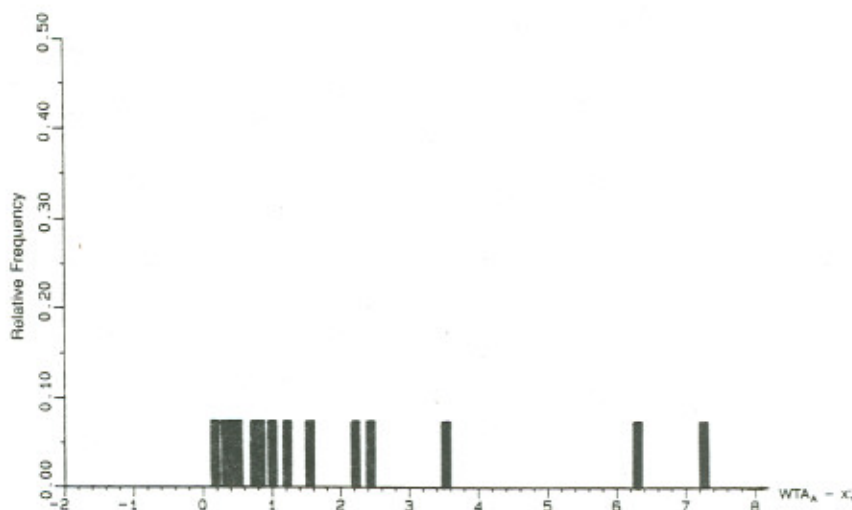


Figure 2. Difference Between $WTA_A - X_i^*$ for Individuals where $WTA_{CVM} < WTA_A < NWTP_{CVM}$

These data suggest that bidding behavior in this situation is somewhat more complicated than that implied by a maxi-min strategy (Hypothesis 1). The results differ from controlled laboratory experiments on the low-bid auction, where experienced subjects utilized strategies which were consistent with maxi-min behavior (Kunreuther et al. 1987). There are several factors that may explain these differences. In the laboratory experiments subjects typically made bids during the first trial, which differed significantly from maxi-min bids. Over time they learned from experience and modified their bids so they eventually converged to maxi-min predictions. Those participating in the flower auction were inexperienced subjects and received no feedback (which in this case would have required the low bid "winner" to deliver flowers and the others to pay WTA_A/N for having someone else deliver to them). Second, in the laboratory experiments a Lotus interactive computer program enabled the subjects to experiment with different bids before selecting a final one. In our field survey individuals had to do the computations in their head. Finally, the flower delivery context undoubtedly introduced other factors that were not present in the laboratory experiments, where the outcomes were simply monetary amounts.

Regarding Hypothesis 2, the decision to participate in the low-bid auction appears to be more complicated than a simple comparison of the individual's WTA_{CVM} bid to WTP_{CVM} . Table 3, which summarizes the participation data found in Figure 1, suggests that an individual's bid in the auction has some power to explain participation. There were, however, a significant number of individuals who were not interested in participating in the low-bid auction. A more

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Table 3. Comparison of Expected and Actual Decision to Participate in Low-Bid Auction (Number of Persons)

Expected	Actual	Wanted to Participate	Did Not Want to Participate
Should Not Participate ($WTA_A \leq NWTP_{CVM}$)		10	37
Should Participate ($WTA_A > NWTP_{CVM}$)		20	23

encouraging finding is that 82 percent of the households surveyed found the process to be a reasonable one.

In order to test Hypothesis 3 and to analyze in detail the nature of comparative bidding behavior between the contingent valuations survey and the low-bid auction, an econometric labor supply function was estimated. Two labor supply functions using individuals' responses to the survey were estimated.

Model 1 examined the shifts in required compensation that occurred as the survey format was changed from contingent valuation to the low-bid auction. The estimation procedure regressed the log of the willingness to accept bids in both regimes on the log of wages, the log of the number of individuals in the proposed group, the log of total household income, a set of demographic variables, and a single dummy variable (Kun) that captured the effects of the auction. The results of this estimation are reported in Table 4.

The signs on the economic variables result in failure to reject Hypothesis 3. Individuals with higher opportunity costs of time reflected by higher wage rates require more compensation. As expected, when N , the number of people the individual has to deliver to increases, the compensation required increases significantly. However, the value of the coefficient on log of number (group size) is less than one, indicating that individuals perceive a large increasing returns to scale effect in delivery. Income is insignificant in the model, but its sign indicates that individuals from families with higher levels of total income will request larger amounts of compensation.

The demographic variables in the regression indicate that sex, age, and education level also significantly affect bidding behavior. Women request more than men, everything else constant. Older individuals and more educated individuals also request more to perform the delivery task.

Finally, the effects of the auction process are significantly positive. That is, when faced with bidding in the auction, individuals request a significantly higher amount of compensation over their requests in the contingent valuation survey.

The second model estimated attempted to differentiate the economic and de-

Table 4. Model 1: Effects of Auction Mechanism
Included as Single Shift Factor
(Dependent Variable: Natural Log of WTA Bid)

Independent Variable	Estimated Coefficient	T-Ratio of Coefficient
Constant	-1.29	-1.26
Log of Wage (\$/Hour)	0.132	1.02
Log of Number (Group Size: $N = 5$, 10, or 50)	0.450	4.97
Log of Income (\$/Month)	0.103	0.66
Sex (Male = 0; Female = 1)	0.415	2.03
Age (Years)	0.0231	2.63
Race (White = 0; Nonwhite = 1)	-0.314	-0.93
Education Level (Eight categories were used)	0.0988	1.68
Kun Dummy Variable (If Contingent Valuation Survey = 0; Auction Mechanism = 1)	0.527	3.30
R^2 (Percent)		42.2
Adjusted R^2 (Percent)		38.2
F-statistic		10.1
Number of observations		196

mographic effects of the auction. In this model the total effect of the auction process remains the same as in Model 1. However, each variable was entered both alone and then again as itself multiplied by the dummy variable (Kun) in an alternative attempt to capture low bid auction effects. In this manner the *interaction effects* of the socioeconomic variables estimated in Model 1 under the low-bid procedure can be discerned. The results of this examination are reported in Table 5.

The overall performance differs only slightly from Model 1: the signs on the own effects (not the cross effect variables) maintain their general qualitative pattern and significance. Again, the most significant independent variable is the number of individuals in the group.

However, the significance of a subset of the cross-effect, explanatory-variables indicates that the auction affects certain types of individual's behavior more strongly. In particular, individuals with higher wages and with higher levels of education tend to significantly lower their willingness to accept bids over their reported contingent valuation responses in the auction process. Second, but to a smaller extent, there are cross effects between the income level of the family and the age of the respondent. All other dependent variables' effects change little in the cross effect model.

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Table 5. Model 2: Examination of Cross Effects
Associated with Auction Mechanism
(Dependent Variable: Natural Log of WTA Bid)

Independent Variable	Estimated Coefficient	T-Ratio of Coefficient
Constant	-1.03	-1.03
Log of Wage (\$/Hour)	0.364	2.07
Log of Wage $\times$ Kun (If Contingent Valuation Survey Kun = 0; Auction Mechanism = 1)	-0.463	-1.90
Log of Number (Group Size: $N = 5, 10, \text{ or } 50$)	0.440	3.63
Log of Number $\times$ Kun	0.0212	0.13
Log of Income (\$/Month)	-0.0061	-0.04
Log of Income $\times$ Kun	0.217	1.27
Sex (Male = 0; Female = 1)	0.312	1.11
Sex $\times$ Kun	0.208	0.52
Age (Years)	0.0148	1.24
Age $\times$ Kun	0.0168	1.01
Race (White = 0; Nonwhite = 1)	-0.17	-0.39
Race $\times$ Kun	-0.27	-0.43
Education Level (Eight Categories were utilized)	0.177	2.22
Education Level $\times$ Kun	-0.15	-1.42
R^2 (Percent)		48.2
Adjusted R^2 (Percent)		41.2
F-Statistic		6.86
Number of Observations		196

V. CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

The above findings are illustrative with respect to the use of an auction procedure that explicitly relates WTP bids to WTA bids. The vast majority of the participants found the low-bid procedure to be a reasonable one, although one should note that only one-third were willing to participate after completing the survey. The empirical results reported for the two willingness to accept bid functions are also illustrative with regard to actual application of the auction procedure in the field.

As discussed in the introduction, our research was designed to explore the performance of the low-bid auction mechanism in a more complicated environ-

ment than is usually considered in the laboratory. This environment consisted of a random sample of residents from the community with a wide spectrum of both economic and social characteristics. In our field experiment, the environment was selected so as to be similar in nature to an actual field setting, but not overly complicated by other factors such as safety standards, the actual financial compensation scheme used, developer problems, or other political problems that would make analysis of the auction process considerably more difficult. The advantage of field studies such as this lies in their ability to identify important variables that can affect the transition from the controlled laboratory to the more complex "real world." Our results indicate that there are significant differences in observed bidding behavior across individual characteristics as well as across economic incentive circumstances.

Field experiments such as this one should be viewed as a part of the broad effort to understand the potential as well as limitations of alternative procedures for allocating negative externalities. Future research can build on the results of these field experiments in the following ways.

1. Undertake additional controlled laboratory experiments to determine whether individuals utilize a maxi-min strategy in specifying their WTA values. Preliminary findings are encouraging in this regard.
2. Undertake either a field study or controlled laboratory experiment where candidates indicate their WTA and WTP values in an unconstrained manner and then are given the *option of participating* in the low-bid auction. By making the decision to join a consortium voluntary, one introduces an appropriate degree of realism into the picture. A default option for not participating in the auction could be introduced to determine the impact on final WTA values.
3. One could permit communication between individuals with the possibility of some of them forming coalitions. Theoretically, a coalition can be viewed as a single entity with its own internal sharing arrangements. The dynamics of the choice process will be somewhat different from a noncooperative game, because each individual will be trying to attract others to join them.⁶
4. Future experimental research might incorporate uncertain outcomes and risks into the design process. An appropriate starting point would be the elicitation procedures utilized by Smith et al. (1985) in a recent field survey. The purpose of their survey was to determine individual's valuation of the expected reduction in risk of hazardous materials. By incorporating uncertainty explicitly into the analysis, one could investigate the impact that context and framing effects may have on a community's bids.

Research also needs to consider some of the other stakeholders who are involved in the siting of noxious facilities, notably the developer. In a real-world setting these interested parties will play a critical role in determining final bids by eligible candidates. One way to implement a low-bid auction given these impor-

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tant considerations would be to provide each of the individual sites with complete information on the payments that would be made by the developer and other stakeholders to each one of the different communities, should they be chosen as a site. This matrix of costs and benefits would be an important input into the final bids by each of the eligible sites. In this sense the auction procedure is only one of the policy tools needed to deal with the siting process. In fact, one needs to recognize that compensation or benefit sharing must be combined with other mechanisms such as appropriate safety measures and standards as well as monitoring and control procedures so that communities and individuals feel that the facility is safe. There are also likely to be potential conflicts among individuals within a community as to what the required WTA value should be. This is not an insurmountable problem because referendum and voting procedures are utilized in a variety of issues that communities face today, such as locating industrial parks in their area, with a potential set of impacts offset directly by tax revenues and employment opportunities.

In conclusion, the above research agenda suggests that we are only beginning to recognize the opportunities and challenges for dealing with siting problems. Given the prominence of the words NIMBY and LULU in the media today there is a strong research incentive to look for alternative procedures to resolve this problem. Hopefully, some form of benefit sharing mechanism may be helpful in this regard.

APPENDIX: SURVEY QUESTIONNAIRE

1. Introduction

Hello, I am _____ and this is _____. We are a research team from the economics department at the University of Wyoming. We are studying how consumers, such as you and me, value the time required to perform certain tasks of daily living.

Q1 Do you have access to an automobile for purposes such as running errands?

Q1 ☐ YES ☐ NO

Q2 Do you like fresh cut flowers?

Q2 ☐ YES ☐ NO

IF NO TO Q1 OR Q2, EXCUSE YOURSELF.

We would like to ask you a few additional questions that will take only about ten minutes to answer. All of your responses will be kept completely confidential and for completing the survey, we will offer you a small gift for your household.

2. Preliminary Remarks: Dillman Warmup Questions

Q3 Typically, how are fresh cut flowers usually obtained by your household?

- Q3 Grocery Store _____
 Trips to florist _____
 Gift to household _____
 From Garden _____
 Other _____

Q4 Approximately how many times a year do you buy fresh cut flowers for your household?

Q4 _____TIMES/YEAR

Q5 Suppose that bunches of fresh cut flowers like these were available at a central location in Laramie such as the old Safeway parking lot on Grand Avenue. [SHOW RESPONDENT FLOWERS AND POINT TO SAFEWAY LOCATION] Suppose that you were to drive to the old Safeway parking lot where parking would be easy, pick up a bunch of flowers, and drive immediately back home. How many minutes round trip do you think it would take you to accomplish this task?

Q5 _____MINUTES

3. Survey Questions For Contingent Valuation Responses

Consider now the following task. Here is where you live. [SHOW SUBJECT MAP OF LARAMIE INDICATING WHERE THEY LIVE] Here is a set of _____ houses around the Laramie area. [INDICATE THE OTHER _____ HOUSES]

Suppose now that your task were to drive to the old Safeway parking lot at a time convenient for you, pick up _____ bunches of flowers such as these, place them at the doorstep, without ringing the bell, of each of the _____ houses, and then drive immediately back to your house with one bunch for yourself. It would take you approximately _____ minutes to accomplish this task. This includes the total time from when you leave your home to the time you return.

Q6 What is the minimum dollar payment which you would require to perform the above task? Q6 \$_____

Q7 Suppose that the flowers were like this bunch and were free. Suppose someone from one of the other _____ houses were delivering the flowers to the doorsteps of all _____ houses. What is the maximum dollar amount that you would be willing to pay to be included in this delivery service?

Q7 \$_____

4. Survey Questions For Kunreuther Auction Responses

Now, consider the following proposal. You and the _____ households indicated on the map determine who will deliver flowers to everyone. You and the other _____ households

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will each state the minimum dollar amount required to deliver all the flowers. However, this time only the household that requests the lowest dollar amount would have to deliver the flowers to everyone. That household would receive the amount requested. All other households would have to pay _____ of their request to have flowers delivered.

For example, if you requested \$_____ and it was the lowest request, then you would receive \$_____ and would have to deliver the flowers. If you requested \$_____ and it was not the lowest request, then you would have to pay _____ of \$_____ that is \$_____ and would have the flowers delivered by someone else.

Q8 What is the *minimum* dollar amount using this procedure which you would require to deliver the flowers to the other _____ households?

Q8 \$ _____

Q9 Would you be willing to participate in this plan?

Q9 _____YES _____NO

Would you please explain your reasoning behind these answers?

NOTES: _____

Q10 Do you consider this a reasonable procedure for performing this task?

Q10 _____YES _____NO

Why or why not? _____

5. Socioeconomic Questions

We have just a few more questions. These questions are about your sex, race, education, occupation, and the amount of time you spend working. Your answers will be kept strictly confidential and only reported as statistical averages.

Q11 Sex: MALE _____
FEMALE _____

Q12 Age: _____

Q13 Race: WHITE _____
BLACK _____
HISPANIC _____
AMERICAN INDIAN _____
ASIAN _____

Q14 How much formal education have you completed?

0-5 GRADES 0
6-8 GRADES; FINISHED GRADE SCHOOL 1

- 9-11 GRADES; SOME HIGH SCHOOL 2
 12 GRADES; FINISHED HIGH SCHOOL 3
 VOCATIONAL PROGRAMS 4
 SOME COLLEGE 5
 COLLEGE DEGREE; BA OR BS 6
 SOME GRADUATE WORK 7
 ADVANCED COLLEGE DEGREE OR
 PROFESSIONAL DEGREE 8

Q15 Are you presently: EMPLOYED _____
 UNEMPLOYED _____

[IF UNEMPLOYED, GO TO END OF SURVEY]

Q16 What is your occupation? _____

Q17 Are you paid an hourly wage?

[IF NO, GO TO Q18]

[IF YES, CONTINUE WITH Q17a]

Q17a What is the hourly wage? \$ _____ PER HOUR

[CONTINUE WITH Q18]

Q18 How many weeks per year do you work?

_____ Weeks

Q19 What is your households monthly take home income after taxes?

\$ _____

Q20 Approximately what percentage of household income do you earn?

_____ %

For your trouble we would like to actually give you, at no cost to yourself, a bouquet of fresh flowers. [HAND FLOWERS.]

Thank you again for your participation.

Answer Sheet

SURVEY # _____

SURVEY TEAM # _____

ADDRESS _____

Q1: YES 0
 NO 1

Compensation

Q2: YES
 NO

IF NO TO Q1

Q3: Grocery
 Trips to
 Gift to h
 From Ga
 Other

Q4: Times/Y

Q5: Minutes

Q6:

Q7:

Q8:

NOTES: _____

Q9: YES
 NO

Reasoning: _____

Q10: YES
 NO

Why or

Q11: MALE
 FEMAL

Q12: AGE

Q13: WHITE
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Q2: YES 0
NO 1

IF NO TO Q1 OR Q2, EXCUSE YOURSELF

Q3: Grocery Store 0
Trips to Florist 1
Gift to household 2
From Garden 3
Other 4

Q4: Times/Year

Q5: Minutes

Q6:

Q7:

Q8:

NOTES:

Q9: YES 0
NO 1

Reasoning:

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Q10: YES 0
NO 1

Why or why not?

Q11: MALE 0
FEMALE 1

Q12: AGE

Q13: WHITE 0
BLACK 1
HISPANIC 2
AMERICAN INDIAN 3
ASIAN 4

Q14: 0-5 GRADES 0
6-8 GRADES: FINISHED GRADE SCHOOL 1
9-11 GRADES: SOME HIGH SCHOOL 2
12 GRADES: FINISHED HIGH SCHOOL 3
VOCATIONAL PROGRAMS 4
SOME COLLEGE 5
COLLEGE DEGREE: BA OR BS 6
SOME GRADUATE WORK 7
ADVANCED COLLEGE DEGREE OR PROFESSIONAL DEGREE 8

Q15: EMPLOYED 0 [IF UNEMPLOYED, GO TO END OF SURVEY]
UNEMPLOYED 1

Weeks

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Address _____

Survey type _____ Survey # _____

Time 1st call _____ Time 2nd call _____

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ACKNOWLEDGMENTS

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NOTES

1. See Kunreuther et al. (1987) for a more detailed discussion and a numerical example illustrating this point.
2. Individuals may have an incentive to collude if they were permitted to make side payments. The form of the externality may be different if bids can be strategically linked and side payments are permitted. In our experiments each individual was privately surveyed. Thus, they did not have the opportunity to collude in any fashion during the experiments.
3. The tax surplus can be utilized to provide common facilities to all the individuals participating in the program (e.g., a hospital). Rebates to all of the participants and the size of the rebates would have to be determined to reduce any incentives for misrepresenting one's preferences.
4. Binger and Hoffman have suggested that one could develop a slight variation on this approach that would have incentive-compatible properties. Specifically, candidates chosen to host the facility would receive the second lowest bid while all other communities would have to pay $1/(N-1)$ of the lowest bid. This procedure may occasionally yield a deficit if the lowest bid is considerably less than the second bid.
5. See Kunreuther et al. (1987) for derivation of this result.
6. See Kleindorfer (1984) for a discussion of experiments related to cooperative arrangements for siting a hazardous facility.

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