RIPARIAN ZONE PROTECTION: THE USE OF THE WILLINGNESS-TO-ACCEPT FORMAT IN A CONTINGENT VALUATION STUDY

by

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A dissertation submitted in partial fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY in Economics

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ABSTRACT

Riparian Zone Protection: The Use of the Willingness-to-Accept Format in a Contingent Valuation Study

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The contingent valuation method (CVM) is used to evaluate the minimum compensation landowners require to forego production on farm riverbank areas. The elicitation format used in the survey is a yes-no participation question followed by an open-ended question.

Chapter 2 presents the results of the survey. The Heckman approach is used in the econometric analysis to take care of the self-selection problem arising with this formatting of the questions. Chapter 3 is devoted to further examining the potential for undertaking valuation exercises using the willingness-to-accept format (WTA).

WTA estimates obtained with open-ended format are compared to WTA estimates obtained when respondents are placed in a "contingent first-price sealed-bid auction" setting. Results indicate that WTA values obtained in the two different settings were not statistically different. More generally, this chapter shows that the use of auctions
can be successfully applied to the provision of public goods in the case of compensation demanded.

(100 pages)
DEDICATION

For Piers, Pierre, and Yvonne
The great thing in this world is not where we stand as in what direction we are moving.

Oliver Wendell Holmes
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I would like to take this opportunity to thank some of the individuals and organizations that helped me carry out this project and write this dissertation.

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CHAPTER 1
INTRODUCTION

The United Nations conference at Rio de Janeiro in 1992 encouraged participating countries to be more aware and eager to tackle environmental problems they all faced, including global warming, forest preservation, and animal and plant preservation. At approximately the same time in Europe, the Common Agricultural Policy took a new turn by attempting to incorporate environmental issues such as pollution problems associated with farming practice as policy. The reform it produced was based on a system of direct payments to farmers to either reduce pollutants or to cease production on selected lands.

In 1997, a study was financed by the French Ministry of the Environment to evaluate the costs of preserving riparian habitat on the banks of the Garonne River, in the southwest of France. This study was undertaken to assess the cost through foregone harvests and site management to landowners resulting from the implementation of the preservation program along the river that would require landowners to leave more idle land on the riverbanks.

The contingent valuation method (CVM) was used to study households that currently own land on the banks of the river. The CVM is an empirical technique used to measure environmental benefits or costs due to a change in a nonmarket good or environmental quality. This method has become one of the most widely used nonmarket valuation techniques over the past years. Its predominance is due to its
flexibility and ability to estimate total value, including nonuse value. It was necessary to use this nonmarket technique to evaluate both out-of-pocket and psychological costs included in the overall cost to owners participating in the preservation program.

Another important aim of this study was to evaluate the accuracy of the willingness-to-accept (WTA) format in the CVM by comparing simple WTA estimates with WTA values obtained in a contingent first-price, sealed-bid auction.

The first essay presents the results of this study, which found that the CVM can be successfully applied in the case of offered compensation. In effect, respondents give very "reasonable values" close to the market rental cost of land. The econometric analysis undertaken reveals a systematic association between various socioeconomic variables of interest and the expressed WTA format for foregone land use.

The second essay takes us one step further, as we evaluate the use of the WTA format in the CVM. We compare mean WTA estimates obtained with the simple open-format model with those obtained with a first-price, sealed-bid auction.

Results indicate that respondents placed in the auction setting gave lower WTA measures for both farmers and nonfarmer groups. The mean WTA measures, however, do not appear to be statistically significantly different. In other words, the "simple" open-format WTA measures determined in this study were very close to individuals' true values as measured by the auction format setting.
The Contingent Valuation Method (CVM) is used to study households that currently own land on the banks of the river. More precisely, a willingness-to-accept (WTA) format was used to estimate the loss to owners for no longer being able to farm riverbank areas. Results indicate that the CVM can be successfully applied in the case of offered compensation. The econometric analysis undertaken reveals a systematic association between various socioeconomic variables of interest and the expressed WTA format for foregone land use.

Introduction

The United Nations conference at Rio de Janeiro in 1992 encouraged participating countries to be more aware and eager to tackle environmental problems they all faced, including global warming, forest preservation, and animal and plant preservation. At approximately the same time in Europe, the Common Agricultural Policy took a new turn, by attempting to incorporate environmental issues, such as pollution problems

\[1\] Coauthored by Catherine Broadhead and John Keith.
associated with farming practice as policy. The reform it produced was based on a system of direct payments to farmers to either reduce pollutants or to cease production on lands deemed to be environmentally sensitive (Bonnieux and Rainelli, 1996).

In 1997, a study was financed by the French Ministry of Environment to evaluate the costs of protecting riparian habitat on the banks of the Garonne River. The Contingent Valuation Method (CVM) is used to study households that currently own land on the banks of the river. More precisely, a willingness-to-accept (WTA) format was used to estimate the loss to owners for no longer being able to farm riverbank areas. Results of this study are reported and analyzed in this paper.

The CVM is an empirical technique often used to measure environmental benefits due to a change in a nonmarket good or environmental quality. This method has become one of the most widely used nonmarket valuation techniques over the past years. Its predominance is due to its flexibility and ability to estimate total value, including non-use value. Most of the time, the willingness-to-pay (WTP) approach is chosen, though often in different formats (i.e., closed-ended, open, iterative bidding). Due to the nature of the allocation of property right in this case, WTP fails to measure the costs of foregone use on privately owned land. In effect, the pre-survey used to determine how land-use rights were distributed indicates that those rights were strongly perceived by landowners. It would have been politically very difficult to ask owners their WTP for an imposed foregone use on land they considered their own. This formatting of the question would have led owners to believe that they were not free to
use their land the way they choose to. The alternative measure of WTA allows us to capture this cost.

Relatively few CVM studies have been conducted using this format (Kunreuther et al., 1987; Shyamsundar and Kramer, 1996), primarily because of lack of upper bound in the minimum compensation demanded. This problem is handled in the current study by using a discrete/continuous choice model. The questionnaire is designed in such a way that extreme values are automatically screened out. This paper seeks to explore further the potential for undertaking valuation exercises using the WTA format.

Study Site

Ecologists agree on the important role played by riparian forests along rivers. Important functions include flooding mitigation, temporary reservoirs, stock of water surplus the river is unable to evacuate at any given time, bank erosion prevention, water quality improvement by filtering nitrates and other compounds from run-off, and preserve habitat for plant and animal species (Buckley, 1989; Cattan and Laurans, 1996).

Expanded urbanization, as well as some current farming practices, has resulted in deforestation along the Garonne River (DeCamps, 1987). The site under study begins north of Toulouse and continues approximately 100 km downstream in the direction of Bordeaux (see map in Appendix A). This is mainly a rural zone, except along the outskirts of Toulouse. There are approximately 300 households who own land along the length of the river. These households typically sub-rent, farm, or live on the land, or some combination of the three. Often a small strip of land along the river is already
left unused. Since the Garonne River is part of France's "Domanial Rivers" (meaning they are in the State's eminent domain), owners are legally required to leave a strip of land of 3 meters unused as a right of way. Sometimes owners leave more than 3 meters along the river's edge in order to reduce land flooding or bank destruction, which effectively reduces their lot size. The preservation program in this study suggests that owners expand that strip of land left untouched.

For those who utilize the land right up to the river bank, any widening of the right-of-way due to the proposed preservation program may represent an important economic loss, while this economic loss may be insignificant for those who do not use it. Thus, we would expect the latter group to indicate lower WTA values.

Theory and Method

Theoretical Framework

In our model, we consider that agricultural land provides a variety of "non-market" services, including wildlife habitat, scenic vistas, and recreation. While landowners can obtain revenue from the use, sale, or development of agricultural land, no revenue can normally be derived from the externalities provided by agricultural land. As a consequence, it may be undervalued by the market (Halstead, 1984). Therefore, we take into account the dual characteristic of land as a production factor (farming) and as a consumption good (collecting minor products like dead wood for heating, but also as residential space, garden, yard), and consider that owners derive an
economic rent from the services by this factor for which there is a positive market demand (Just et al., 1982).

For simplicity, we assume that there are only two ways an individual can allocate the land they own--they can either leave it idle or else produce. Idle land provides utility to the individual, such as the enjoyment of the sight and the protection of riparian habitat for animals and plants. If, on the other hand, the owner decides to use the land for production, the individual gets rent in return, which allows for the purchase of goods and services. We make the assumption here that the preservation program cannot represent an increase in welfare. Accepting to widen the strip of land left untouched would result in a loss of welfare for landowners. If it did not, landowners interested in riparian preservation would have widened the unused portion of land on their own. The total amount of land is assumed to be fixed. The individual is faced with the choice of buying different bundles of goods \((C)\) at a given price \(p\) (normalized to one) and enjoying her idle land \((H)\) with the rent on land \((w)\) as its price.

\[
H = L - R_L
\]  

(1)

where \(L\) represents the total amount of land owned by the river, and \(R_L\) represents productive land.

Let the utility function be:

\[
\text{utility} = U(C, H)
\]  

(2)

The individual can purchase consumption items \((C)\) by allocating some land to
productive use. The income comes from productive land, as well as from some exogenous income \((N)\). If the yearly rental price on productive land (per hectare) is given by \(w\), the income constraint is then given by

\[
C = wR_L + N
\]  

(3)

Rewriting the budget constraint directly in terms of \(C\) and \(H\), we have

\[
C = w(L - H) + N
\]  

(4a)

or

\[
C + wH = wL + N = V
\]  

(4b)

The quantity \(wL + N\) represents the total purchasing power available to individuals. It is often called their "full income" (Deaton and Muellbauer, 1980).

Individuals can allocate their land to productive use (for real income and consumption \(C\)) or leave it idle and get benefits from it, like sightseeing for example. They get utility from the benefits associated with owning a lot by the river. Equation 4 shows that the opportunity cost of enjoying idle land is \(w\) per year and per hectare—it is equal to earnings foregone by not producing on the lots. Further, we assume that productivity on the land is homogenous. In other words, land is found to be as productive on the river's edge as it is deeper in the lot and therefore \(w\) is constant.

Setting up the Lagrangean,
\[ U(C, H) = \lambda (wl + N - C - wH) \]  

The first-order condition for a maximum solution is

\[ \frac{\delta L}{\delta C} = \frac{\delta U}{\delta C} - \lambda = 0 \]  
\[ \frac{\delta L}{\delta H} = \frac{\delta U}{\delta H} - w \lambda = 0 \]

Combining Eqs. (6) and (7),

\[ \frac{\delta U}{\delta C} / \frac{\delta U}{\delta H} = (\delta U / \delta C) / (\delta U / \delta H) = w \]

In order to maximize utility, given the real rental price, \( w \), the individual will, therefore, choose to produce on that amount of land for which the marginal rate of substitution (MRS) of idle land for consumption (C) is equal to \( w \). We will assume for convenience that the MRS of idle land for consumption is diminishing (second derivative is negative).

Solving for Eqs. (6) and (7), we obtain the Marshallian demand functions for idle land. A change in \( w \) can then be analyzed in a manner identical to a change in price in the consumer case. By totally differentiating the demand functions, we are able to show the two effects at work: the substitution and the income effects. When \( w \) increases, the opportunity cost of idle land rises. The individual must give up more in lost rent for each hectare of land being idle. The substitution effect of an increase in \( w \) on the amount of idle land will therefore be negative. As idle land becomes more expensive, there is reason to supply less of it. Assuming that idle land is a normal
good, the income effect of an increase in \( w \) on idle land is positive. As \( w \) increases, the individual can afford having more of it. Thus the substitution and income effects work in opposite directions.

Since the total amount of land \( L \) is assumed to be fixed, deriving the demand for idle land is equivalent to deriving the supply for productive land \( R_p(w,N) \). The amount of land for production depends on both the rent and on the amount of real exogenous income received. Since idle land is considered as being a normal good, as \( N \) increases, the demand for idle land \( H \) increases, and therefore the supply of productive land decreases or, more formally, \( \delta R_p/\delta N < 0 \).

To study the effect of rent change on productive land supply \( (\delta R_p/\delta w) \) we can also consider the dual problem to the individual's primary utility-maximizing problem. We minimize the "full" expenditure (Deaton and Muellbauer, 1980).

\[
C = w(L - H) + N = V
\]  

or

\[
V = C - wR_L = N \quad \text{(see Eq. 3)}
\]

s. to

\[
U = U(C, H) \quad \text{(11)}
\]

Solving this minimizing problem will yield to the same results as solving the utility-maximizing problem.
\[ \mathcal{C} = C - wR_L + \lambda(U(C,H)) \] (12)

We can now apply the envelope theorem to the minimum value for these extra expenditures calculated in the dual problem, and we obtain the compensated demand for idle land.

\[ \frac{d\mathcal{C}}{dw} = \delta V/\delta w = - R_L \] (13)

The idle land demand Eq. is given by (13) using \( H = L - R_L \). Since utility is held constant in the dual expenditure minimizing approach, Eq. 13 should be interpreted as a "compensated" (constant utility) productive land supply function, which we will denote by \( R'_p(w,U) \) to differentiate it from the uncompensated productive land supply function \( R'_p(w, N) \).

Now we can use these concepts to derive a Slutsky-type Eq. for the supply of productive land \( R_L \) that reflects the substitution and income effects that result from changes in the real rent.

Since utility maximization and expenditure minimization must imply the same choice, the outlay in the original problem must be the expenditure minimum in the dual problem (Deaton and Muellbauer, 1980). Therefore, we have:

\[ R'_p(w,U) = Rp(w, V(w,U)) \] (14)

Quantity supplied is identical for the compensated and uncompensated supply functions when the individual's income is exactly what is needed to attain the required utility.
level. Above that point, the individual’s income is increased with the compensated supply curve, so more is supplied than with the uncompensated supply curve.

Partial differentiation of both sides of Eq. (14) with respect to $w$ yields

$$\delta R_p' / \delta w = \delta R_p / \delta w + \delta R_p / \delta V \cdot \delta V / \delta w$$  \hspace{1cm} (15)

using the envelope theorem from (10), we have:

$$\delta R_p' / \delta w = \delta R_p / \delta w - R_L \cdot \delta R_p / \delta V$$  \hspace{1cm} (16)

Introducing a slightly different notation for the compensated productive land function,

$$\delta R_p' / \delta w = \delta R_p / \delta w \bigg|_{U=U_0}$$  \hspace{1cm} (17)

and rearranging terms gives the final Slutsky Eq. for productive land supply:

$$\delta R_p' / \delta w = \delta R_p / \delta w \bigg|_{U=U_0} + R_L \cdot \delta R_p / \delta V$$  \hspace{1cm} (18)

where $\delta R_p / \delta w \bigg|_{U=U_0}$ represents the substitution effect in which utility is held constant, and $R_L \cdot \delta R_p / \delta V$ represents the income effect, which is analytically equivalent to an appropriate change in exogenous income. The substitution effect was negative for idle land, and hence is positive for productive land. Higher rent leads to an increase in amount of productive land being supplied. Similarly, the income effect, positive for idle land, is now negative, a higher rent allowing the individual to supply less productive land.
So far, we have looked at the effects of a change in price (w). However, this
preservation program, as often do environmental policies, implies a change in the
quantity of idle land supplied (an increase in H). By totally differentiating

\[ V(w) = C - wR_L \quad \text{and} \quad U. = U(C,H) \]  \hspace{1cm} (19)

We get:

\[ dV = dC - wdR_L - R_L dw \]  \hspace{1cm} (20)

\[ dU. = (\delta U/\delta C)dC + (\delta U/\delta H)dH \]  \hspace{1cm} (21)

To see how a change in idle land H can be compensated by a change in
expenditure V, so that the individual's utility stays constant (dU. = 0), we can write:

\[ dC = dV + wdR_L \]  \hspace{1cm} (22)

\[ dC = [-(\delta U/\delta H)/(\delta U/\delta C)]dH \]  \hspace{1cm} (23)

Therefore,

\[ dV = -wdR_p \ - (\delta U/\delta H)/(\delta U/\delta C)dH \]  \hspace{1cm} (24)

In the case of an imposed increase in H, \(-(\delta U/\delta H)/(\delta U/\delta C)dH\) in Eq. 24 is negative
[both C and H being normal goods, (\delta U/\delta H)>0 and (\delta U/\delta C)>0], and \(-wdR_p\) is also
negative. Change in expenditures must be equal to loss in revenue associated with
change in the amount of productive land supplied and the value the individual attributes
to the imposed change in quantity of idle land (H). Participating in a preservation
program means a loss in utility for the individual, since some land is "taken away" from production or personal use. The individual is now on a lower level of utility (i.e., $U_1$).

Fig. 2.1 describes such a situation. If the individual is currently using the total amount of land to produce marketable commodities, she is at point A with utility level $U_0$ and gets $Y_0$ amount of revenue. If, on the other hand, the individual prefers to enjoy more idle along the river, there is less revenue generated and the individual is at point B and utility level $U_1$.

Considering that the supplier faces an imposed increase in $H$ (from $H_0$ to $H_1$), the compensating surplus (CS) is defined as being the amount of income that must be given to the individual after the change in quantity for her to still be on her original indifference curve $U_0$.

In the case of this imposed increase in quantity of idle land, the CS represents the individual's WTA to stay on the original level of welfare $U_0$, in spite of change in quantity. Equivalent surplus (ES) is the maximum amount one is willing to pay (WTP)

![Fig. 2.1. Utility maximization for individuals owning riparian land.](image)
to keep getting $H_0$ (or to keep producing $L - H_0$) on the lower indifference curve $U_1$.

Let us define $w = w_H(p, H^h, U^*)$ the inverse compensated supply function for $H^h$; $w$. $H(.)$ is the rent that would induce the individual to supply $H^h$ amount of idle land in order to attain a utility level of $U^*$, given that she could buy private goods ($C$) at $p$ (numeraire).

Let $w^0 = w_H(p, H^h_0, U^*_0)$, and $w^1 = w_H(p, H^h_1, U^*_1)$ denote the rent that would have supported $H^h_0$ and $H^h_1$, respectively.

$$CS = E(p, w, H_0, U_0) - E(p, w, H_1, U_0) = \int_{H_0}^{H^h_0} w^*(p, H^h, U^*_0) dH^h$$

$$ES = E(p, w, H_0, U_1) - E(p, w, H_1, U_1) = \int_{H_0}^{H^h_1} w^*(p, H^h, U^*_1) dH^h$$

(25) (26)

By asking individuals their WTP/WTA to participate in the program, we are trying to estimate the change in the utility level implied by accepting to defer personal use or productive use of the land to a preservation program of the riverbanks. As shown in Fig. 2.2, the two estimates may have different values.

The disparity between WTA and WTP measures has been extensively documented and several explanations have been suggested. It is sometimes attributed to certain psychological factors. For example, Boyce et al. (1992) explain it using the concept of intrinsic values. Individuals may want to preserve an environmental amenity for moral (or other) reasons. These values would appear more easily in WTA estimates than in WTP measures.

Kahneman et al. (1990) based their argument on an endowment or the "loss aversion" effect. The endowment effect states that an individual attributes a subjective
value to gains and losses—winning 50 USD does not have the same value as losing 50 USD. This effect exists when "an individual becomes attached to the good because he or she is often rewarded for doing so in many contexts" (Shogren et al., 1994). This attachment leads the respondent to overestimate the minimum WTA compared to the WTP. Shogren et al. (1994) tested and rejected the hypothesis of an existing endowment effect. Rather, their results seem to support the economic explanation of difference between WTA and WTP, provided by Hanemann (1991), who explained the divergence between the two measures in terms of substitution and income effects. The greater the income effect, and/or the smaller the substitution effect, the greater the disparity between WTP and WTA measures. As substitutability decreases, the trade-off between two goods $x$ and $y$ becomes less desirable, implying a greater disparity between the two estimates (see Shogren et al., 1994).
The Contingent Valuation Format

The overall cost to owners of participating in the preservation program includes both out-of-pocket and psychological costs. The results of the Van Kooten and Schmitz (1992) project indicate that "current economic incentives offered to agricultural producers are inadequate because they ignore non-market costs." A positive attitude toward habitat preservation cannot be used as a substitute for monetary incentives. In order to capture both the market and the non-market costs of the proposed preservation program, it was necessary to use a non-market technique to evaluate the costs of leaving the land idle. The CVM was chosen for its flexibility and its ability to measure total value.

The nature of the privately held property rights by landowners has an important implication as to how the survey should be composed. A pre-survey was used to determine how land-use rights were distributed. It was found that land-use rights were strongly perceived by landowners. This provided the primary motivation for utilizing the WTA format. In effect, it would have been politically very difficult to ask owners their WTP for an imposed foregone use on land they considered their own.

We will cite here, for illustration purposes, some examples to shed light on the sociopolitical situation in France when it comes to subsidizing farmers. In 1998, approximately 1,500 farmers demanded greater government subsidies by blocking the runway of a local airport in western France, by vandalizing train equipment, causing delays throughout the region, and by keeping up barricades on a major highway. The four-day blockade ended after France's agriculture minister promised to soften the blow.
of cauliflower falling prices. In early 1999, large numbers of French farmers converged on the European parliament building in Strasbourg, to protest against proposed cuts in European Union farm subsidies. The proposed cuts were a consequence of the French government's commitment to keep down the budget deficit to qualify for the new single European currency. Finally, no later than at the beginning of December 1999, chicken farmers protested in Paris streets to ask for greater financial aid. In recent years, the differentiation of compensation based on animal density per forage area or permanent grassland area, for example, has been added to direct payment distribution in favor of extensive farming. This measure aimed to prevent oversupply by means of a disincentive for intensive production and to give an incentive for the maintenance of less productive land, which will contribute to the preservation of landscape and biodiversity. Our approach in this study follows the current tendency in France.

Using the WTA format, respondents were first asked if they were interested or not in participating in a program. This allowed us to screen out high WTA estimates. In effect, we can think of respondents not being interested in participating in the program as having high WTA bids. In other words, the compensation needed for them to accept to participate would be high. If the respondents' answer was positive to the participation question, they were then asked their minimum WTA.

The elicitation method used was the open format model. The open format method was chosen for several reasons. First, since respondents were geographically situated close to each other, often including strong family ties, we wanted to avoid suggesting values that they would have been able to compare with one another. The second reason
is more pragmatic. Suggesting values would have been difficult. If the suggested values were perceived as being "too low," owners would be upset and suspect the political organizations themselves of mischief (i.e., Chamber of Agriculture, Ministry of Environment, etc.). On the other hand, suggesting large values would have meant that the study and programs proposed were not credible, or it might have encouraged them to give high WTA estimates.

It is useful at this point to step back a little and reflect on how the binary question preceding the open format one relates to the economic modeling of an individual maximizing utility.

We have seen that by asking individuals their WTA estimate to participate to the preservation program, we were effectively trying to estimate the supplier surplus (i.e., the area above the supply curve). In practice, however, this question is preceded by a binary question asking respondents whether or not they would be willing to participate in the program. The problem formulates as follows. The maximum utility that an individual can obtain by choosing alternative $i$ (in the set of alternatives $J$) depends on the price of the good and the person's income (as well as some characteristics of the person). This maximum-attainable utility, given alternative $i$, can be written (Train, 1993)

$$ Y_i = Y_i(p_i, y, z_i, s, w_i) $$

where $z_i$ represents the observed characteristics of each alternative $i$ in $J$, $x$ is the quantity of the good, $y$ is the person's income, $s$ represents the observed characteristics of the person, $p_i$ is the price of the good, and $w_i$ represents all unobserved factors.
This function is called the indirect utility function, that is, it is the maximum utility an individual can attain given that she has chosen alternative \( i \). She will choose alternative \( i \) if and only if

\[ Y_i(p_i, y, z_i, s, w_i) > Y_j(p_j, y, z_j, s, w_j) \quad \text{for all } j \text{ in } J, j \neq i \tag{28} \]

Considering the random utility approach, the individual is assumed to always choose the alternative with the highest utility. However, the utilities associated with each alternative are not known to the analyst with certainty. The indirect utility is therefore decomposed into observed and unobserved parts,

\[ Y_i(p_i, y, z_i, s, w_i) = V_i(p_i, y, z_i, s) + e_i \tag{29} \]

where \( e_i \) is a function of unobserved variables, and \( V_i \) is simply the difference between \( Y_i \) and \( e_i \).

With this approach, utilities are treated as random due to observational deficiencies resulting from different factors such as: unobserved attributes, unobserved tastes variations, measurement errors, and use of proxy variables (Ben-Akiva and Lerman, 1997). The researcher looks at the probability that for any individual, the utility of an alternative will exceed the utilities of all other feasible alternatives.

Therefore, the probability of alternative \( i \) being chosen is

\[ P_i = \text{prob}[Y_i(p_i, y, z_i, s, w_i) > Y_j(p_j, y, z_j, s, w_j) \text{ for all } j \text{ in } J, j \neq i] \tag{30} \]

\[ P_i = \text{prob}[V_i(p_i, y, z_i, s) + e_i > V_j(p_j, y, z_j, s) + e_j \text{ for all } j \text{ in } J, j \neq i] \tag{31} \]
\[ P_i = \text{prob}[e_j - e_i < V_i - V_j (p_i, y_i, z_i, s) - V_j (p_j, y_j, z_j, s)]. \]  

(32)

(In effect, as utilities are ordinal only, only the difference matters.)

**The Econometric Modeling**

Dealing with the first question (discrete choice), we have to decide on the functional forms of \( V \) and \( e \). As is often the case, we will assume that \( V \) is linear in parameters, while the disturbances will be assumed to follow a Probit model. The reasons for this choice will be explained later when we look at the Heckman (1979) model.

The disturbances are viewed as the sum of a large number of unobserved but independent components. As the sample size increases, the disturbances tend to be normal. Assuming that \( e_i \) and \( e_j \) are both normal with mean zero and variances \( \sigma_{ii} \) and \( \sigma_{jj} \), respectively, the term \( e_j - e_i \) is also normally distributed with mean zero and variance \( \sigma_{ii} + \sigma_{jj} - \sigma_{ij} = \sigma^2 \) (which can, for simplicity, be assumed to be equal to 1). We can use this result to solve for the choice probabilities as follows (Kmenta, 1986)

\[
P_i = \text{prob}[e_j - e_i < V_i - V_j]
= \int_{e_j - e_i}^{V_i - V_j} \frac{1}{\sqrt{2\pi}\sigma} \exp\left[-\frac{1}{2} \left( \frac{e_j - e_i}{\sigma}\right)^2\right] \, de, \sigma > 0
= \frac{1}{\sqrt{2\pi}\sigma} \int_{e_j - e_i}^{V_i - V_j} \exp\left[-\frac{1}{2} \left( \frac{\mu}{\sigma}\right)^2\right] \, du = \Phi\left(\frac{V_i - V_j}{\sigma}\right)
\]

(33)

As shown above, respondents were given the opportunity to select for themselves whether they participated in the survey or not. Moreover, only respondents the most
interested in the preservation program gave their WTA bids. In other words, those not
interested in the program screened themselves out by refusing to participate—we will
examine later the reasons for such refusal. In other words, we are dealing with the
problem of limited dependent variable (Kmenta, 1986). We only observe the WTA
measure over a positive range. In other words, our sample is censored.

This phenomenon is often described in the economic literature as the self-
selection bias, or sample selection bias. The non-responses to the survey or the WTA
question hold different expected values for the amenity than comparable individuals
who do respond. The potential for sample selection bias in mail surveys is particularly
high compared to in-person surveys and phone surveys. This problem stems from the
self-administered character of mail surveys and the concomitant lack of control the
researchers have over the process of getting the respondent's cooperation in eliciting
answers (Mitchell and Carson, 1989).

It is useful at this point to define sample selection bias more precisely in
mathematical terms. To do this, we use Heckman's (1979) steps.

To match the survey design for estimating the respondents' WTA, the simplest
idea would be to fit the following Eqs. for each individual:

\begin{align*}
Y_{1i} &= X_{1i} \beta_1 + u_{1i} \\
Y_{2i} &= X_{2i} \beta_2 + u_{2i}
\end{align*}

\[ (34) \]

\[ (35) \]

where \( X_{ji} \) is a \( 1 \times K_j \) vector of exogenous regressors, such as income, size of the
property, number of lots owned by the river etc.; \( \beta_j \) is a \( K_j \times 1 \) vector of parameters; and
$Y_{1i}$ and $Y_{2i}$, respectively, represent the acceptance to participate to the program, and the WTA estimate.

\begin{align}
E(u_{ii}) &= 0 \quad (36) \\
E(u_{ji}, u_{ji'}) &= \sigma_{ji'}, i = i' \quad (37) \\
= 0, i \neq i' \quad (38)
\end{align}

The final assumption is a consequence of a random sampling scheme. The regressor matrix is of full rank so that if all data were available, the parameters of each Eq. could be estimated by least squares.

The population regression function for Eq. (34) could be written as

$$E(Y_{2i} \mid X_{2i}) = X_{2i} \beta_2 \quad (i = 1, \ldots, I) \quad (39)$$

However, since we do not observe all $Y_2$ of our sample, the regression function for the subsample of available data is

$$E(Y_{2i} \mid X_{2i}, \text{sample selection rule}) = X_{2i} \beta_2 + E(u_{2i} \mid \text{sample selection rule}) \quad (40)$$

If the conditional expectation of $u_{2i}$ is 0, then there is no bias, the regression function for the selected sample is the same as the population regression function, and least square estimation can be used to estimate the parameters $\beta_2$. The only cost of having an incomplete sample would then be a loss in efficiency.

If, however, $E(u_{ji}) \neq 0$, as in the case of sample selection bias, then we face more serious problems. In our case, data are available only on $Y_{2i}$ if $Y_{1i} > 0$, while if $Y_{1i} = 0$, 

there are no observations on $Y_{2i}$. In other words, we face the problem of censored data on $Y_{2i}$.

$$E(Y_{2i} \mid X_{2i}, \text{sample selection rule}) = E(u_{2i} \mid X_{2i}, Y_{1i} > 0)$$

$$= E(u_{2i} \mid X_{2i}, u_{1i} > -X_{1i} \beta_1)$$

If $u_{1i}$ and $u_{2i}$ are not independent, then

$$E(Y_{2i} \mid X_{2i}, Y_{1i} > 0) = X_{2i} \beta_{2i} + E(u_{2i} \mid u_{1i} > -X_{1i} \beta_1)$$

The selected sample regression function depends on $X_{1i}$ and $X_{2i}$. The final term of Eq. (43) is omitted in the estimation of Eq. (35). The bias resulting from non-randomly selected samples (here self-selection) to estimate behavioral relationships is similar to the problem of omitted variables.

The Heckman's approach takes care of this problem. Its procedure makes use of the information contained in the yes/no responses ($Y_{1i}$) and corrects for the sample bias that would otherwise be caused by using only the subset of quantitative responses in the regression estimation (Howe et al., 1994).

We assume that $p(u_{1i}, u_{2i})$ is a bivariate normal density. Its density function can be written as

$$p(u_{1i}, u_{2i}) = \frac{1}{2\pi \sigma_1 \sigma_2 (1 - \rho^2)^{1/2}} \exp \left(-\frac{1}{2(1 - \rho^2)} \left[ \frac{u_{1i}^2 - \zeta_1}{\sigma_{11}} + \frac{u_{2i}^2 - \zeta_2}{\sigma_{22}} - 2\rho \frac{(U_{1i} - \zeta_1)(U_{12} - \zeta_2)}{\sigma_1 \sigma_2} \right] \right)$$

where $\xi_j = E(u_{ji})$, $\text{Var}(u_{ji}) = F_{ji}$ for $j = i$, and the correlation between $u_{1i}$ and $u_{2i}$ is $\rho$.
The joint normal distribution can be standardized \((0, 1)\) by setting \(\sigma_1 = \sigma_2 = 1\), and

\[ \xi_1 = \xi_2 = 0 \]

\[
p(U_{1i}, U_{2i}) = \left[ \frac{1}{2\pi(1-\rho^2)^{1/2}} \right] \exp \left( -\frac{1}{2(1-\rho^2)} \right) \left\{ U_{1i}^2 + U_{2i}^2 - 2\rho U_{1i}U_{2i} \right\}
\]

(45)

It is assumed to be fully characterized by

\[
E(u_{ji}) = 0 \\
E(u_{ji}^2) = \sigma_{ji} \quad \text{for } j=i \\
E(u_{ji}u_{kj}) = \sigma_{jk} = \rho \sigma_1 \sigma_2
\]

The joint cumulative distribution of random variables \(Y_{1j}\) and \(Y_{2i}\) having the above joint bivariate density is

\[
\Phi(h, k; \rho) = \frac{1}{\sqrt{2\pi}(1-\rho^2)^{1/2}} \times \left[ \int_{-\infty}^h \int_{-\infty}^k \exp \left( -\frac{1}{2(1-\rho^2)} \right) [U_{1i}^2 - 2U_{1i}U_{2i} + U_{2i}^2] dU_{2i} dU_{1i} \right]
\]

(46)

where \(u_{1i} = h\) and \(u_{2i} = k\). We consider that the distribution is truncated from below (i.e., only the values of \(u_{1i}\) that exceed \(h\) is used). The resulting joint distribution has density function (Johnson and Kotz, 1972)

\[
P_{u_{1i}u_{2i}}(U_{1i}, U_{2i}) = \frac{1}{1 - \Phi(h)} \exp \left[ -\frac{1}{2(1-\rho^2)} \left( U_{1i}^2 - 2U_{1i}U_{2i} + U_{2i}^2 \right) \right]
\]

\(u_{1i} > h\)

(47)
If the error terms have a bivariate normal distribution, then the conditional mean of $u_{2i}$ with respect of $u_{1i}$ can be written as (Greene, 1990, theorem 22.4)

$$E(u_{2i}|X_{1i} > X_{1i} \beta_1) = \rho \sigma_2 \lambda_i$$

(48)

$$E(u_{2i}|u_{1i} > X_{1i} \beta_1) = (\sigma_{12}/\sigma_1) \lambda_i$$

(49)

$$E(u_{1i}|u_{1i} > X_{1i} \beta_1) = [\sigma_{12}/\sigma_1] \lambda_i$$

(50)

$$E(u_{1i}|u_{2i} > X_{1i} \beta_1) = [\sigma_{12}/\sigma_1] \lambda_i$$

(51)

where, $\lambda_i = \phi(Z_i)/1 - \Phi(Z_i)$

(52)

where, $\phi$ and $\Phi$ are, respectively, the density and distribution function for a standard normal variable, and

$$Z_i = - [X_{1i} \beta_1/\sigma_1]$$

(53)

"\lambda_i" is the inverse of Mill's ratio, also called the hazard rate; the greater "\lambda_i" the greater the selectivity bias.

The full statistical model for normal population disturbances can now be developed. The conditional regression function for selected samples may be written as

$$E(Y_{1i}|X_{1i}, Y_{1i} > 0) = X_{1i} \beta_1 + [\sigma_{22}/\sigma_1] \lambda_i$$

(54)

$$E(Y_{2i}|X_{2i}, Y_{1i} > 0) = X_{2i} \beta_2 + [\sigma_{12}/\sigma_1] \lambda_i$$

(55)

Adding disturbances to our Equations (24) and (25), we reach the model

$$Y_{1i} = E(Y_{1i}|X_{1i}, Y_{1i} > 0) + v_{1i} = X_{1i} \beta_1 + [\sigma_{22}/\sigma_1] \lambda_i + v_{1i}$$

(56)
\[ Y_{2i} = E(Y_{2i}|X_{2i}, Y_{1i} > 0) + v_{2i} = X_{2i}\beta_2 + [\sigma_{12}/\sigma_1] \lambda_i + v_{2i} \]  
\quad (57)

where

\[ E(v_{1i}) = E(v_{2i}) = 0 \]

\[ E(v_{1i}|X_{1i}, \lambda_i, u_{1i} > -X_{1i}\beta_i) = 0 \]  
\quad (58)

\[ E(v_{2i}|X_{2i}, \lambda_i, u_{1i} > -X_{1i}\beta_i) = 0 \]  
\quad (59)

\[ E(v_{1i}v_{2i}|X_{1i}, X_{2i}, \lambda_i, u_{1i} > -X_{1i}\beta_i) = 0 \]  
\quad (60)

for \( i \neq i' \).

In summary, we took the "omitted" variable \( \lambda_i \) out of the error term \( u_{2i} \) and put it back in the Eq., \([\sigma_{12}/\sigma_1]\) being the coefficient of \( \lambda_i = \Phi(Z_i)/1 - \Phi(Z_i) \). If \([\sigma_{12}/\sigma_1]\) is significant, then we can conclude that there was no selection bias (we test for the hypothesis \( H_0: [\sigma_{12}/\sigma_1] = 0 \)). We do, however, still have the problem of heteroscedasticity, as shown by Eq. (61c).

Since we are dealing with a truncated bivariate normal distribution, the variance can be written as (Greene, 1990, Theorem 22.4)

\[ E(v_{2i}^2|X_{2i}, \lambda_i, u_{1i} > -X_{1i}\beta_i) = \sigma_{22}[1 - \rho^2(\lambda_i (\lambda_i - Z))] \]  
\quad (61a)

\[ E(v_{2i}^2|X_{2i}, \lambda_i, u_{1i} > -X_{1i}\beta_i) = \sigma_{22}[1 - \rho^2(\lambda_i Z - \lambda_i^2)] \]  
\quad (61b)

\[ E(v_{2i}^2|X_{2i}, \lambda_i, u_{1i} > -X_{1i}\beta_i) = \sigma_{22}[1 - \rho^2 + \rho^2(1+\lambda_i Z - \lambda_i^2)] \]  
\quad (61c)

where
and

\[ 0 \leq 1 + Z_i \lambda_i - \lambda_i^2 \leq 1. \]  

The least squares estimators of \( \beta_{12} \) and \( \sigma_{12} / \sigma_1 \) are unbiased but inefficient. This is due to the heteroscedasticity apparent from the above Eq. Further, we have (Heckman, 1979)

\[ \text{E}(v_{1i} | X_{1i}, \lambda_i, u_{1i} > -X_{1i} \beta_1) = \sigma_{11} (1 + Z \lambda_i - \lambda_i^2) \]  

In our censored sample, we do not know \( Y_{1i} \) if \( Y_{1i} = 0 \), but we know \( X_{1i} \) for the observations \( Y_{1i} = 0 \). Therefore, we first estimate the parameters of the probability that \( Y_{1i} = 1 \) (i.e., \( \beta_1 / \sigma_1 \)) using a Probit analysis. This is the first step of Heckman’s two-step procedure. It enables one to obtain consistent estimates of knowing \( \beta_1 / \sigma_1 \) (= \( \beta^* \)). We can then estimate \( Z_i \) and hence \( \lambda_i \). The second step involves going back to our regression function (56) and replacing \( \lambda_i \) by our new estimated (\( \hat{\lambda}_i \)) and applying the ordinary least squares method using the \( n \) observations for which \( i_i = 1 \).

In summary, the first step is to estimate a Probit model where the dependent variable is 1 or 0, depending on whether \( y_{1i} \) is observed or not. This is done on the whole sample. This provides a consistent estimator of \( Z_i \) and \( \lambda_i \). The consistent estimator of \( \lambda_i \) is then inserted in Eq. (56) and the second step of the two-step procedure is the application of least squares to the resulting Eq. The estimator of \( \beta_1 \) produced by this
process is consistent and asymptotically normally distributed. The weighted least squares method can be successfully used to address the remaining heteroskedasticity problem.

Survey Design

The questionnaire (see Appendix B) was first refined and critically examined by ecologists and lawyers from the Departmental Chamber of Agriculture, to see if the questionnaire was realistic. A pretest was then conducted in the winter of 1997 with five landowners with property adjacent to the river.

A list of landowners was obtained from the Office of Land Titles, and they were all contacted by mail in the spring of 1997. The questionnaire was originally constructed for face-to-face interviews. However, due to organizational and financial constraints, a mail survey was used.

To encourage their response, a lottery was organized. A lot of 200 USD (1,000 francs) was to be won among those who answered the questionnaire, even partially. One month following the mail survey, respondents were contacted by phone and were asked if they wanted help in clarifying any questions or problems they could have in answering the questionnaire. A meeting was organized if they desired. Three people requested a meeting.

Three programs of habitat preservation were suggested to respondents, each involving different degrees of involvement. The duration of the program was 10 years, and subsequently renewable. These programs are described below.
1. **No upkeep**: You provide the land. The strip of land allocated to the program is not to be maintained. Its width is between 10 and 50 meters. This protected zone would allow for preservation and reproduction of different species.

2. **Upkeep of a trail**: You provide the land. You maintain a 3 meters wide trail. This trail may be used by hunters, fishermen, or hikers. The upkeep of the trail is your responsibility. The width of this strip of land is between 10 and 50 meters.

3. **Upkeep + wood**: You provide the land. You maintain a 3 meters wide trail at your charge. You plant the trees and bushes, which are supplied to you, and you are responsible for the upkeep of the land twice a year. The upkeep consists of clearing brushwood, getting rid of dead wood and garbage. The heavy upkeep work (e.g., cutting trees) is also your responsibility, but the wood belongs to you.

Respondents first stated if they were interested in any of the programs, and then gave their WTA as well as the width of strip of land they would be willing to provide (see Fig. 2.3).

11. To which one of these program(s) would you accept to participate?

   program 1  program 2  program 3

12. (You accept to participate in several programs) Which program do you prefer?

   program 1  program 2  program 3

13. You accept to participate in a program. What would be the strip of land width you would accept to allocate to this program? ________ meters

14. What is the minimum compensation that you would have to receive to participate in this program? ________ francs

Fig. 2.3. Form respondents were asked to complete.
Discussion of the Sample

Socioeconomic Status of the Surveyed Population

The results indicated in this part are explained in more details in Broadhead (1997). The total population surveyed was 315 households. The response rate was 30% completed survey. This response rate is comparable to other mail surveys. The sample size is also comparable to other CV surveys. Van Kooten and Schmitz (1992), for example, conducted 66 interviews. Mitchell and Carson (1989) made a review of different CV surveys and the size of the samples surveyed (see Appendix C).

As shown by Harrison and Lesley (1996), a small sample can be as effective as a larger one in that it leads essentially to the same conclusions (and is less costly). The authors obtained the same damage estimates using a model of the behavior of students to predict the behavior of all of the adult citizens of the United States, in the case of the Exxon Valdez 1989 oil spill.

Our sample is consisted of 40% farmers and 60% non-farmers. Among non-farmers, a major portion of them is represented by retirees (56). The average age for our sample is 57 years (with a maximum of 92 years and a minimum of 26 years). This tendency is common in the rural community both at the regional and the national level (see Table 2.1). This average is slightly higher for non-farmers.

Almost all respondents were male, and 87% of them were married. On average, they had 2.1 children. This result is slightly greater than the average for France. It is worth noting that farmers often lived with a member of their family other than children.
Table 2.1
Age distribution

<table>
<thead>
<tr>
<th>Variable</th>
<th>&lt; 35 years</th>
<th>35-59 years</th>
<th>&gt; 59 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
<td>12.5%</td>
<td>60.5%</td>
<td>27.0%</td>
</tr>
<tr>
<td>Region</td>
<td>18.0%</td>
<td>52.0%</td>
<td>30.0%</td>
</tr>
</tbody>
</table>


This is particularly true as they often became farmers after their parents and the business is of family type, as we will see in a subsequent chapter.

One question in the survey asked respondents for the household monthly net income. It is interesting here to note that beside the expected reservations this question triggered, farmers had often a genuine difficulty in indicating what their revenue amounted to. This is most likely due to complicated tax and subsidy measures. Fifty-five percent of the individuals surveyed indicated earning less than 2,000 USD per month/year and per household, and 29% indicated a revenue comprised between 2,000 USD and 3,600 USD.

**Characteristics of the Property**

Let us first consider the characteristics of the farms. Results show that 68% of them are of family type. In other words, the farm is legally run by one or more family members, in opposition with a business-like legal status. Moreover, farmers tend to be farmers from one generation to another. Only 4% of farmers indicated that they represented the first generation of farmers in their family.
The average size of the farms is 57 hectares. More precisely, 81% of farmers own more than 20ha. This result are on the higher side of results observed at the regional level, where 55% of farmers are found to own more than 20ha (see Table 2.2).

For non-farmers, the average size of the property is 11ha. The majority of them (81% as well) owns less than 10ha.

For the purpose of our study, and to better understand the current situation on the banks of the Garonne River, respondents were asked different questions on the current situation of the lots that they owned lining the river. Those questions were related to the current activity on the lots, their geographical situation, and their size.

On average, farmers own between 3 and 4 lots by the river, while non-farmers own 2. The average area for those lots is close to 4ha (farmers = 5, non-farmers = 3). More precisely, a large majority of farmers own between 1 and 5ha of land by the river (50% for non-farmers). However, since there is a large number of non-farmers owning some land by the river, the total amount of land owned by this group is less than the total amount of land owned by farmers on the riverbanks. This may be of high interest policy wise.

Table 2.2
Property size, in hectares (ha)

<table>
<thead>
<tr>
<th>Variable</th>
<th>&lt; 5ha</th>
<th>5-10ha</th>
<th>11-20ha</th>
<th>21-50ha</th>
<th>&gt; 50ha</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers</td>
<td>3.0%</td>
<td>3.0%</td>
<td>12.0%</td>
<td>37.0%</td>
<td>44.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Non-farmers</td>
<td>61.0%</td>
<td>20.0%</td>
<td>5.0%</td>
<td>7.0%</td>
<td>7.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Region</td>
<td>18.0%</td>
<td>10.4%</td>
<td>16.7%</td>
<td>35.2%</td>
<td>19.6%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
We obtained the same tendency when dealing with the lots linear (i.e., the measure of the length, in meters, of the lot running along the river). Individually, farmers own more land by the river, but they are under represented compared to non-farmers when considering the overall size of the land owned on the river’s banks.

The linear of the lot owned by farmers is generally larger per household (75% of farmers own more than 100 meters, while only 34% of non-farmers fit in this category), but the total linear is larger for non-farmers than for farmers. Interestingly enough, many owners were not able to indicate the size (or the exact location) of their lots. This can be explained by the very dynamic nature of the riverbed. It must be added here that frequently flooded areas become state property. Therefore, the ownership of the landscape is subject to frequent and unexpected changes.

For farmers, irrigated crops such as corn, soybeans, and sorghum, along with poplar plantations, remain the main activities (51%). Often, several activities are conducted on the same lot (e.g., corn in the field and poplar on the edge of the river). For non-farmers, poplar farming represents an important activity (39%). One reason explaining the success of the poplar plantation (not specific to this area) is the design of the tax system in France. In effect, such plantations are subject to a 30-year levy on property taxes.

Thirty-four percent of non-farmers also indicated renting the lots out for agricultural use. Finally, 30% own a house on those lots. This last information leads us to expect that the preservation programs may incite stronger reservations among
non-farmers (about public access to their backyard, or depending on the exact location of their house on the lot).

As mentioned previously, a large proportion of owners indicated not using their lots up to the river's edge (78%). The main reason given to explain such a situation is geographical (e.g., steep banks, existing trails, etc.). But also, some respondents indicated doing this to either protect the banks, or because their lot was too small to manage effectively.

Among people who declared not producing on those lots, almost half of them also indicated that they were not maintaining the lots. The average width of strips not maintained is 18 meters, with a minimum of 3 meters, and a maximum of 80 meters.

Results

Empirical Results

Thirty-eight people answered positively to the CV question and gave their minimum WTA bid for at least one program. The average WTA we obtained for Program 1 is 275 USD/hectare (1373.5 francs/ha). Farmers indicated a greater minimum compensation. The average WTA for farmers was indeed 546 USD/hectare (2731 francs/ha), while it was only 38 USD/hectare (192.5 francs/ha) for non-farmers.

The first program received the most favorable responses. Consistently with what we expected, Programs 2 and 3 revealed larger WTA because they require more involvement from respondents. This result reflects the boundaries of the market rental rates for this area (e.g., between 26 USD and 500 USD (130 and 2,500 francs),
depending on the potential productivity of the lot). The values are also consistent with payments being made for existing conservation (e.g., from 20 USD to 340 USD for the Midi-Pyrénées region).

For simplicity, we will now focus on the results obtained for Program 1. It is important to mention here that 19 persons (over 33 total who agree to participate in program 1) agreed to participate in the program for zero compensation. This can be seen in Fig. 2.4, which shows the distribution of the WTA bids.

It is also worth noting that 70 respondents indicated that they were not using the banks of the river, among which 33 also indicated not keeping up that land. Comparing now the minimum compensation demanded by those among them who also accepted to participate in a preservation program (14 people), we observe a significantly lower result. They demanded smaller compensations. One reason that may explain why they do ask for compensation, however, comes from the fact that they are willing to widen

![Fig. 2.4. Distribution of willingness to accept bids.](image-url)
the existing strip of land not being used. The amount of compensation demanded would therefore account for this additional part they would be willing to allocate to the preservation program.

Econometric Estimation

The LIMDEP software program was used to run the estimations (Greene, 1991). The Probit model for distinguishing between those who did and those who did not accept to participate in the preservation program (ACC) was initially estimated. The regression results are presented in Table 2.3. They indicate that being a farmer (FAR), not using the parcels up to the river’s edge (USE), and the total size of the lot(s) adjacent to the river (SUP) are the major factors determining whether a landowner accepts to participate in the preservation program. We obtained significant t-statistics for each of these variables (at 5 and 10%).

Table 2.3
Results of the Heckman 2-step procedure estimation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimated coefficient</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probit</td>
<td>.22</td>
<td>2.2</td>
</tr>
<tr>
<td>FAR</td>
<td>.19</td>
<td>2.6</td>
</tr>
<tr>
<td>USE</td>
<td>.02</td>
<td>1.8</td>
</tr>
<tr>
<td>SUP</td>
<td>2868</td>
<td>2.0</td>
</tr>
<tr>
<td>Two-stage least square</td>
<td>2962</td>
<td>2.1</td>
</tr>
<tr>
<td>IN1</td>
<td>288.4</td>
<td>2.3</td>
</tr>
<tr>
<td>Lambda</td>
<td>-2406.0</td>
<td>-1.8</td>
</tr>
</tbody>
</table>
Both the USE and the FAR variables were dichotomous variables, which took the value of one if the lots were not being used up to the river's edge, and if respondents were farmers, respectively.

The obtained variables, such as income, education level, number of dependents, and type of activity on the lots could not explain landowners' acceptance to participate. The likelihood ratio index for the Probit estimation was \([1-(55.9/58.3)] = 0.043\).

The second step, the least-squares estimation of the minimum compensation demanded by respondents, corrected for heteroskedasticity, was then estimated. The variables income (IN1, IN2), and the number of parcels they own by the river (PAR) are significant in determining the amount of WTA demanded. Results are indicated in Table 2.3.

\[
\text{WTA} = 2868 \text{ IN1} + 2962 \text{ IN2} + 288.4 \text{ SUP}
\]

The variable IN1 included respondents with a net monthly income per household of less than 2,000 USD (10,000 francs), while the variable IN2 included respondents with a net monthly income per household comprised between 2,000 USD and 3,600 USD (10,000 to 18,000 francs). They are positively related to the amount of compensation demanded. The PAR variable is also positively correlated with the amount of compensation demanded. The R^2 obtained for the second step of the estimation was .27.
The coefficient of lambda estimated in the Heckman procedure was significant at 95%. As explained in the next section, this indicates that there is no selection bias.

**Reasons for Refusal to Participate**

Thus far, we have concentrated our discussion on respondents who indicated that they would accept offers to participate in a program. However, given the important number of households who refused to participate in a program (55 households), it is at least equally important to understand the reasons for their refusal to participate (only two respondents refused to answer whether they were interested or not in a preservation program).

Based on survey comments, we distinguished four main reasons for refusal to participate.

1. **Geographical**: people refused to participate because their lot was too small, there existed some buildings, or else the banks were too steep.

2. **Personal**: people indicated that they were too old, too busy, or else that they wanted to sell their land.

3. **Protest**: people indicated that they opposed the programs themselves (i.e., would refuse hikers' access, etc.), the idea of being compensated, or because they do not trust the government.

4. **Other**: for example, the respondents did not know exactly the location of their lots.
As can be seen from Table 2.4, the main reason for refusal invoked by respondents is geographical (39.5%). One possible interpretation here is that respondents did not feel "concerned" by the program, either because the compensation would need to be unrealistically high, for example, where buildings exist on the lot, or else because the lot is so small that compensation would be insignificant. Given the fact that farmers, on average, own larger lots by the river, it is consistent that they had a low percentage of responses in this category (17%).

For farmers, the main reason for refusal was "protest" (34.5%). It may be important to add that farmers represent a group that often suffers under environmental programs to conserve water or control pollutants. As a result, they typically oppose such programs. Moreover, they are often presented a wide variety of programs (environmental or not). Similarly, recall that non-farmers are mainly represented by retirees, 41% of whom are older than 65. This would explain why the "personal" reason comes second for this latter category. They may, for example, feel too old to participate in a 10-year preservation program; thus, they may be unwilling to tie their heirs to their decision.

<table>
<thead>
<tr>
<th>Landowner</th>
<th>Protest</th>
<th>Personal</th>
<th>Geographical</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer</td>
<td>34.5 (8)</td>
<td>22.0 (5)</td>
<td>17.5 (4)</td>
<td>26.0 (6)</td>
<td>100 (23)</td>
</tr>
<tr>
<td>Non-farmer</td>
<td>17.5 (7)</td>
<td>27.5 (11)</td>
<td>52.5 (21)</td>
<td>2.5 (1)</td>
<td>100 (40)</td>
</tr>
<tr>
<td>Total</td>
<td>24.0 (15)</td>
<td>25.5 (16)</td>
<td>39.5 (25)</td>
<td>11.0 (7)</td>
<td>100 (63)</td>
</tr>
</tbody>
</table>

Number of persons responding in parentheses.
It is also interesting to note that among respondents who indicated that they did not maintain or use the banks, 19 still refused to participate in the program. In other words, they refused to be compensated for a program they essentially are already in compliance with.

**Discussion**

Parallel to this study, Desaigues and Gauthier (1997) conducted a survey evaluating the benefits associated with the protection of the riverbanks. They used the CVM to ask the general public in the region how much they would be willing to pay to have a program of protection implemented. The proposed program was similar to Program 1 of this study. It was also added that access to the riverbanks would then most probably be restricted, if not forbidden to the general public. In other words, a large portion of the value attributed to the program would be non-use value. The average WTP they obtained is 30 USD (150 francs) per year, and for 5 years. The total budget it represents is approximately 3 million USD (15 million francs) per year. On the cost side, we estimated that the total cost of implementing such a program would amount to 280,000 USD (1.4 millions francs) per year. In other words, costs were smaller than benefits.

**Conclusions**

This study was undertaken with the primary purpose of assessing the welfare loss to landowners resulting from the implementation of a preservation program along the
Garonne River. Several conclusions can be drawn. The analysis indicates that the WTA format can be effectively used to estimate welfare loss. Moreover, the binary/continuous model appears not to lead to exaggerated estimates, since WTA figures elicited existing market values. This result is also confirmed by the rather large number of zero bids obtained. However, it is important to add that the use of the WTA measure has been possible for two main reasons: respondents had a thorough knowledge of the good itself and its value to them--this is particularly true for farmers--and the proposed preservation program was realistic. Respondents believed in the applicability of the program, which then does not represent a vague and improbable possibility.

One interesting question is to ask if, in the case where respondents do not know the good very well, the divergence between WTA and WTP should be attributed not as much to substitution and income effects, but rather to some "strategic" behavior. In other words, would respondents minimize their bid in a WTP format if they were uncertain of its utility, while exaggerating their WTA value not having anything to lose? It seems therefore very important in any welfare loss estimation to be able to link the good, or the event, to already known factors or situations. This topic will be studied more in depth in our next paper, where we analyze the effect of a "contingent first-price sealed-bid auction" on the WTA estimates.

Finally, this study sheds some light on the reasons why some respondents refused to participate in the preservation program. We were able to differentiate those who were indifferent to the program from those who opposed it. This information provides some important policy insights. For instance, many respondents admitted being
interested in the program, but suggested some variations, or else preferred some other means of compensation (for example, technical advice on how to maintain riparian land). Similarly, protest responses may, in some cases, be of valuable interest in future studies as they indicate that respondents' refusal to participate is not as much linked to the good itself but to the "administration" part of it. This is particularly true for respondents who emitted strong reservations toward the governmental agency or the feasibility of the program itself. It would of valuable interest in any WTP study to be able to differentiate these answers from other zero WTP bids.

References


CHAPTER 3
APPLICATION OF AN HYPOTHETICAL AUCTION SETTING TO WILLINGNESS-TO-ACCEPT MEASURE IN A CONTINGENT VALUATION STUDY

Abstract

This paper is devoted to examining further the potential for undertaking valuation exercises using the WTA format, by comparing WTA estimates obtained in an open-question format with a 'contingent first-price sealed bid auction' setting. Results indicate that WTA values obtained in the two different settings were not statistically different. We conclude that WTA estimates in the open question format were not exaggerated. More generally, this paper shows that the use of auctions can be successfully applied to the provision of public goods in the case of compensation demanded.

Introduction

When using the contingent valuation method, researchers generally agree that the use of the willingness-to-accept format often leads to one important bias: the lack of upper bound in the minimum compensation demanded. Respondents tend to inflate their minimum compensation demanded (Cummings et al., 1986). This conclusion has

\(^1\)Coauthored by Catherine Broadhead and Basudeb Biswas.
traditionally been reached by comparing willingness-to-pay (WTP) and willingness-to-accept (WTA) measures. Several explanations have been suggested to explain this difference, such as a psychological (Kahneman et al., 1990) and economic one (Hanemann, 1991). As pointed out by Hanemann, there is no evidence that both measures should, in theory, be equivalent.

This paper is devoted to examining further the potential for undertaking valuation exercises using the WTA format, by comparing WTA estimates obtained in an open-ended question format with a "contingent first-price sealed bid auction" setting. A game theory approach is used to analyze respondents' strategies, and the Bayesian Nash equilibrium is defined.

We first explain the different types of auctions and the types of response they lead to. We then analyze the first-price sealed bid auction as a direct application of game theory. Finally, we apply the analysis to our survey (Chapter 2).

Results indicate that respondents' mean WTA measures are not statistically different. This result is confirmed when a Heckman model regression (Broadhead, 1997), including whether or not respondents were placed in an auction setting, is run. The auction setting did not lead respondents to indicate lower compensation values. This result is consistent with the List and Shogren (1998) findings. In other words, the estimates obtained with the simple open-ended question format reflected individuals' true values.
Auctions

The practice of auctioning takes us back to a very long time. Cassady (1967) tracks it to 500 BC, in Babylon, for the sale of women to be married. The study of auctions, however, is more recent. The origin of the subject is the seminal work by Vickrey (1961) and later the important contributions by Griesmer et al. (1967), who initiated formulations in terms of games with incomplete information, later specified as Bayesian games (Harsanyi, 1967; Myerson, 1985; Gibbons, 1992).

In many markets, transaction prices are determined in auctions. It is the case, for example, for the sale of timber, antique objects, farming products or animal stocks. In the most common form, prospective buyers compete by submitting bids to a seller. Each bid is an offer to buy, which states a quantity and a maximum price. The seller then allocates the available supply among those offering the highest prices exceeding the seller's asking price (Wilson, 1992). Auctions can also exhibit one buyer and several sellers, in which case only sellers offering a minimum price will be selected.

There exist a variety of auctions. We can classify them based on the relationship between different buyers' valuations of what is being auctioned. Rasmussen (1989) describes the difference between a private-value auction, a common-value auction, and a correlated-value one. Following the author, we will call the dollar value of the utility that player i receives from an object its value to her, $v_i$, and we will call her estimate of its value her valuation $V_i$.

In a private-value auction, each player knows the true value they attribute to the
a auctioned object, even though they may not know the values of the other players. Very importantly, a player cannot extract any information about their own value from the valuations of the other players. One example, mentioned above, is the sale of timber. Knowing all the other bids would not change player i's value for the lot, although it may change their strategy.

In contrast, a common-value auction is characterized by the fact that players have identical values. In this case, private information plays a considerable role as the other players' valuations affect player i's own value. The new issue of corporate bonds and stocks in the US, which are usually sold to investment bankers, belongs to that category of auctions. Each bidder is eager to know the others' valuations in order to form a more accurate idea of the true value of the good.

However, the majority of auctions in everyday life is situated between the private-value auction and the common-value one. That is, we are dealing with what is called the correlated-value auction, in which the valuations of the different bidders are correlated but their values may differ. For modeling purposes, however, private-value versus common-value auctions is an appropriate simplification. As we will soon see, the case studied in this paper deals with private-value auction.

If it is true that all auctions have set rules, imply given strategies, and then define payoffs, they often vary greatly. It is therefore interesting to classify auctions based on the different rules they imply. Typically, the types of auctions often described are: (a) English (ascending, first-price open), (b) first-price sealed bid, (c) second-price sealed bid, and (d) Dutch (descending).
English

The seller offers an item and they accept the highest bid offered above their asking price. Each bidder is free to revise their bid upward. A player's strategy is their series of bids as a function of their value, their prior estimate of other players' valuations, and the past bids of all other players. Their bid can, therefore, be updated as their information set changes. The winner's payoff is their value minus their highest bid. The English auction is the most common type of auction in the United States. Cassady (1967) estimated that 78% or more of all auctions in the world are conducted on the ascending-bid basis.

First-Price Sealed Bid

Each bidder submits one bid, in ignorance of the other bids. The highest bidder pays their bid and wins the object. A player's strategy is their bid as a function of their value and their prior beliefs about the other players' valuations. The winner's payoff is their value minus their bid.

Second-Price Sealed Bid

Each bidder submits one bid, in ignorance of the other bids. The bids are opened, and the highest bidder pays the amount of the second-highest bid and wins the object. A player's strategy is their bid as a function of their value and their prior beliefs about the other players' valuations. The winner's payoff is their value minus the second-highest bid that was made.
The seller announces a bid, which they continuously lower until some buyer stops them and takes the object at that price. One example is the Ontario tobacco auction, cited in Rasmussen (1989), which uses a clock four feet in diameter marked with quarter cent gradations. Each of six or so buyers has a stop button. The clock hand drops a quarter cent a time, and the stop buttons are registered so that ties cannot occur. The farmers who are selling their tobacco watch from an adjoining room and can later reject the bids if they feel they are too low (reserve price). This type of auction is also used for the sale of fish in England (Cassady, 1967). A player's strategy is when to stop the bidding as a function of their valuation and their prior beliefs as to other players' valuations. The winner's payoff is their value minus their bid.

Those different types of auctions tend to be associated with particular kinds of commodities. The sale of fish and the sale of real estate, for example, require different auctioning methods. Oral auctions, either English or Dutch, are favored for animal stock and perishable commodities, perhaps to ensure rapid consideration of many lots with variable quality attributes. Most auctions of art and antiques use the oral format also. On the other hand, in the United States, new issues of corporate bonds and stocks are usually sold via sealed bids, as is the sale of timber in France (Elyakime et al., 1994) as well as in the United States. Land and buildings are also often sold via sealed bids.

Each type of auction encourages a very specific type of response. In other words, these auctions lead to different strategies from bidders. For both the English and the
second-price sealed bid auctions, the player's dominant strategy is to keep bidding some small amount \( \varepsilon \) more than the previous high bid until they reach their valuation and then stop. This is optimal because they always want to buy the object if the price is less than its value to them, but they want to pay the lowest price possible. In the case of the second-price sealed bid auction, one's valuation is the dominant strategy since the players who bid less are more likely to lose the auction, but pay the same price if they do win. All bidding ends when the price reaches the valuation of the player with the second-highest valuation. The optimal strategy is independent of risk neutrality if players know their own values with certainty rather than estimating them, although risk-averse players who must estimate their values should be more conservative in bidding.

The Dutch and the first-price sealed bid auctions are strategically equivalent. The trade-off is between bidding high--thus winning more often--and bidding low--thus benefitting more if the bid wins. The optimal strategy depends on the players' risk preference and their belief about the other players. The equilibrium is therefore less robust than the equilibrium of English and second-price sealed bid auctions. The reason for the equivalence between the two types of auctions is that in both cases, the only disclosed information is the last bid. In the first-price sealed bid auction, a player's bid is irrelevant unless it is the highest. Similarly, in the Dutch auction, a player's stopping price is not disclosed unless it is the highest.
Finally, an analysis of auctions can consider whether the process is static or dynamic. In dynamic versions, the bidders observe others’ bids and they can revise their bids sequentially.

For the purpose of this paper, we will focus on the first-price sealed bid auction, in the frame of a private- (or independent-) value auction. Moreover it will be a static process.

Auctions As a Direct Application of Game Theory

Because auctions are stylized markets with well-defined rules, auctions are apt subjects for applications of game theory (Phlips, 1988). Moreover, they represent some interesting cases of strategic behavior. They also are useful to elicit preferences so that maximal gains from trade can be realized.

They are particularly valuable as illustrations of games of incomplete information because bidders’ private information is the main factor affecting strategic behavior. The simpler forms of auctions induce normal-form games that are essentially "solved" by applying directly the basic equilibrium concepts of non-cooperative game theory, such as the Nash equilibrium (Wilson, 1992).

We will concentrate here on the first-price sealed bid auction and the game form it takes. The first-price sealed bid auction represents a game of incomplete information also called Bayesian game.

In a game of incomplete information, the players' payoff functions are not common knowledge. There exists at least one player who is not sure about the other
players' payoffs functions. For the auction of interest in this paper, each bidder knows her own valuation for the good being sold, but does not know the other bidders' valuation. Since bids are submitted in sealed-envelopes, we can think of the players' moves as being simultaneous.

Harsanyi (1967) made the assumption that, in dealing with games of incomplete information, every player assigns a subjective probability to all variables not depending on the player's own strategy choice. Consequently, the situation can be redefined as a game of complete information on the probability functions from which each bidder draws her valuation and on everybody's payoff or utility (Gibbons, 1992).

We follow here Gibbons' representation of the normal form of a static Bayesian game. The normal-form representation of an n-player game of complete information is

\[ G = \{S_1, \ldots, S_n; u_1, \ldots, u_n\} \]  

(1a)

where \( S_i \) is player i's strategy space and \( u_i(s_1, \ldots, s_n) \) is player i's payoff when the players choose the actions \( (s_1, \ldots, s_n) \). This can also be written as

\[ G = \{A_1, \ldots, A_n; u_1, \ldots, u_n\} \]

(1b)

where \( A_i \) is player i's action space and \( u_i(a_1, \ldots, a_n) \) is player i's payoff when the players choose the actions \( (a_1, \ldots, a_n) \). In effect in a simultaneous-move game of complete information a strategy for a player is simply an action. In the case of a game of incomplete information, we first need to represent the idea that if each player knows their own payoff function, they are uncertain about the other players' functions. Let player i's
possible payoff functions be represented by \( u_i(\mathbf{a}_i, \ldots, \mathbf{a}_n; t_i) \), where \( t \) represents the type of player \( i \), and belongs to a type space \( T_i \). For example, if player \( i \) has two payoff functions, they are said to have two types, \( t_{i1} \) and \( t_{i2} \). Their payoff functions would be noted

\[
u_i(\mathbf{a}_i, \ldots, \mathbf{a}_n; t_{i1}) \text{ and } u_i(\mathbf{a}_i, \ldots, \mathbf{a}_n; t_{i2}),
\]

(2)

Writing that player \( i \) knows their payoff function is the same as saying that they know their type(s). Similarly, we can write that player \( i \) is uncertain about the other players types, denoted \( t_i \).

\[
t_i = (t_{i1}, \ldots, t_{i-1}, t_{i+1}, \ldots, t_n)
\]

(3)

We denote the probability distribution representing the player \( i \)'s belief about the other players' types, \( t_i \), \( p_i(t_i / t_i) \).

It is important here to note that we are in a private-value type of auction. In other words, players' types are independent. \( p_i(t_i / t_i) \) does not depend on \( t_i \). Therefore, we can write player \( i \)'s belief as \( p_i(t_i) \).

To define an equilibrium concept for this static Bayesian game, we first need to define the players' strategy spaces in the game. The central idea is that each player's strategy must be a best response to the other players' strategies. Therefore, a Nash equilibrium is simply a Nash equilibrium in a Bayesian game.

In the static Bayesian game, \( G = \{A_1, \ldots, A_n, T_1, \ldots, T_n; p_1 \ldots p_n; u_1, \ldots, u_n\} \), the strategies \( s^* = (s^*_1 \ldots s^*_n) \) are a (pure strategy) Bayesian Nash equilibrium if for each player \( i \) and for each of \( i \)'s types in \( T_i \), \( s^*_i(t_i) \) solves
max $\sum U_i(s_i^*(t_i),...,s_{i-1}^*(t_{i-1}),...,s_n^*(t_n),s_i^*(t_i),t_i)p_i(t_i / t_i)$

$a_i \in A, t_i \in T_i$

That is, no player wants to change his or her strategy, even if the change involves only one action by one type.

Having explained a Bayesian game, we now turn to the representation of the first-price sealed bid auction. We assume there are $n$ bidders ($i = 1, ..., n$). Bidder $i$ is said to have a valuation $v_i$ for the commodity sold. If $i$ gets the good and pays the price $p$, then $i$'s payoff is $v_i - p$.

It is necessary at this point to make some assumptions. Although each bidder does not know their rivals' bid functions, they can make informed guesses by supposing that the valuations of all bidders are drawn from the same probability distribution (Phlips, 1988). Following Vickrey (1961), this distribution is assumed to be rectangular, so that each value is equally likely. The bidders' valuations are uniformly distributed on the same interval $[0,1]$ by a suitable choice of scale and origin. Finally, the bidders' valuations are independent. In other words, a bidder's valuation conveys no information about the other bidders' valuations. To go back to our previous notation, this last assumption was written as $p_i(t_i / t_i) = p_i(t_i)$.

Bids are constrained to be non-negative. The bidders submit their bids simultaneously. The higher bidder wins the good and pays the price they bid; the other bidders pay and get nothing. In case of a tie, the winner is determined by the flip of a coin. We assume that all bidders have the same risk preferences, in order to concentrate
attention on the incomplete information aspect. In this case, and following Vickrey (1961), we assume that bidders are risk neutral. This is reflected by the linear form taken by their utility function (or payoff). Finally, all of the above information is common knowledge.

The action is the submitting of a (non-negative) bid, $b_i$. The valuation of player $i$ (or her type) is denoted $v_i$, following the previous example.

$$G = \{A_1, \ldots, A_n, T_1 \ldots, T_n; p_1 \ldots p_n; u_1, \ldots, u_n\}$$ (5)

The action space,

$$A_i = [0, \infty]$$ (6)

The type space,

$$T_i = [0, 1]$$ (7)

Because valuations are independent, player $i$ believes that $v_j$ is uniformly distributed on $[0,1]$, no matter what the value of $v_i$. Player $i$'s payoff function is:

$$u_i(b_1, \ldots b_n; v_1, \ldots v_n) = \begin{cases} v_i - b_i & \text{if } b_i > b_j \\ (v_i - b_i)/n & \text{if } b_i = b_j \\ 0 & \text{if } b_i < b_j \end{cases}$$ (8)

To derive a Bayesian Nash equilibrium of this auction, we begin by constructing the players' strategy space. In a Bayesian game, a strategy space is a function from the type and action spaces. Therefore, a strategy for player $i$ is a function $b_i(v_i)$ specifying
the bid that each of i's types or valuations would choose. Player i's \( b_i(v_i) \) is a best response to the other players' strategies \( b_j(v_j) \) and vice versa.

Formally, the pair of strategies \((b(v_i), b(v_j))\) is a Bayesian Nash equilibrium if for each \( v_i \) in \([0,1]\), \( b_i(v_i) \) solves

\[
\text{Max } (v_i - b_i) \text{ prob}\{b_i > b_j(v_j)\}
\]  

Each player tries to maximize the mathematical expectation of their own payoff in terms of their probability distribution \( p_i \). This assumption is called the Bayesian hypothesis. Each player i maximizes the expected payoff of the winning bid, that is the difference between their valuation \( v_i \) and the winning bid \( b_i \), since their utility is simply \((v_i - b_i)\) they win, and 0 otherwise, multiplied by the probability of making the highest bid. With a common rectangular distribution and independence, this probability is \( nb_i^{n-1} \) \(^2\). Each player thus maximizes

\[
H_i = (v_i - b_i) \, nb_i^{n-1}
\]  

Taking the first derivative with respect to \( b_i \), and setting it equal to 0, we have

\[
(v_i - b_i)n(n-1)b_i^{n-2} - nb_i^{n-1} = 0
\]  

This gives us

\[2\]With a rectangular distribution \( F(v) = v \) for \( v \in [0,1] \), the probability that the first \( n-1 \) players draw a value below \( b \) is \( b^{n-1} \). This has to be multiplied by \( n \), to allow for the possibility that any of the \( n \) players might have the top values (Philips, 1988)
This solution is the unique Nash equilibrium strategy to be played by each player.

The person with the highest valuation makes the highest bid and is thus the winner. Therefore, given the assumptions previously made, the first-price sealed bid auction leads to pareto optimal results. Because of the independence of bidders' valuations, we can see here that \( i \)'s bid does not depend on other players' valuations \( v_j \). Let us also notice here that as \( n \) increases, the equilibrium bids get closer to reservation values. If, for example, \( b_i = 0.5 \), and \( n = 2 \), then \( nb^{n-1} = 1 \). If \( n = 3 \), then the probability of winning the bid becomes 0.75 (Philips, 1988).

**Past Work**

The contingent valuation method (CVM) is an empirical technique often used to measure environmental benefits due to a change in a non-market good or environmental quality. This method has become one of the most widely used non-market valuation techniques over the past years. Its predominance is due to its flexibility and ability to estimate total value, including non-use value.
When using CVM, researchers generally agree that the use of the WTA format often leads to one important bias—the lack of upper bound in the minimum compensation demanded. Respondents tend to inflate their minimum compensation demanded (Cummings et al., 1986). The disparity between WTA and WTP measures has been extensively documented and several explanations have been suggested. It is sometimes attributed to certain psychological factors. For example, Boyce et al. (1992) explain it using the concept of intrinsic values. Individuals may want to preserve an environmental amenity for moral (or other) reasons. These values would appear more easily in WTA estimates than in WTP measures.

Kahneman et al. (1990) based their argument on an endowment or the "loss aversion" effect. The endowment effect states that an individual attributes a subjective value to gains and losses—winning 50 USD does not have the same value as losing 50 USD. This effect exists when an individual becomes attached to the good because he or she is often rewarded for doing so in many contexts (Shogren et al., 1994). This attachment leads the respondent to overestimate her minimum WTA compared to her WTP. Shogren et al. (1994) tested and rejected the hypothesis of an existing endowment effect. Rather, their results seem to support the economic explanation of difference between WTA and WTP, provided by Hanemann (1991), who explained the divergence between the two measures in terms of substitution and income effects. The greater the income effect, and/or the smaller the substitution effect, the greater the disparity between WTP and WTA measures. As substitutability decreases, the trade-off between two goods x and y becomes less desirable, implying a greater disparity.
between the two estimates. Cummings et al. (1986) document six cases in which survey values for commodities ranging from hunting permits to cleaner air show disparities from about three to one up to ten to one in the ratio of WTA to WTP.

This well-documented difference between the two measures has had the direct effect of trying to avoid, whenever possible, the use of the WTA estimate, especially in the case of public goods.

Theory suggests that one way of forcing down WTA estimates is to put respondents in an auction setting. Few studies have been conducted to test for the difference in WTA values obtained in an auction setting compared with another setting, such as open-ended or dichotomous formats. Kunreuther et al. (1987) tested the use of a low bid auction in the case of the noxious facility location process, where the host community indicating the lowest bid obtains the facility and receives its bid as compensation. This compensation is financed by the other communities. Their findings show that the sealed bid auction dissuades communities from greatly exaggerating their compensation requirements.

Coursey et al. (1987) explored the divergence in WTA values between two frames—the hypothetical WTA setting and the Vickrey, or second-price sealed bid auction setting. The commodity chosen for their experiment was a bitter-unpleasant taste experience, that of sucrose octa-acetate. Their result suggest that hypothetical measure of value obtained using WTA are likely to be biased upwards from values obtained from a market-like auction (Coursey et al., 1987). Bishop and Heberlein (1986) found that deer hunters understated their actual WTA to sell deer-permits in a
sealed bid auction setting, while hunters faced with simple dichotomous choice frame overstated their real WTA.

List and Shogren (1998) analyzed the effect of the use of an auction setting in the context of the selling price for Christmas gifts. Their results indicate that framing of the WTA estimates did not matter. Mean WTA estimates obtained with the hypothetical open-ended survey were not statistically different from estimates obtained form the hypothetical auction. Moreover, their findings suggest that respondents understated real WTA, whether in the hypothetical open-ended format or in the hypothetical auction setting.

Application to the Preservation Program of Humid Zones on the Garonne River

Description of the Situation

We used the Contingent Valuation Survey conducted in the south of France in spring 1997 to estimate the cost of preserving humid zones along the Garonne River (Broadhead, 1997). Landowners were asked the minimum compensation they would have to receive in order for them to stop farming along the river. The population surveyed was 96 people, among whom were 39 farmers and 57 non-farmers. Half of the population sampled was placed in a "contingent auction" market. In order for the researcher to encourage participants to give their true minimum willingness to accept, owners were told that only the "bidders" with the lowest value would be considered. The survey was conducted by mail, and, for practical reasons, was a sealed bid auction.
Moreover, it was a first-price sealed bid auction, as owners would receive their own bid (or compensation demanded) if they were selected. In the Kleindorfer and Sertel (1994) analysis of the auctioning of an indivisible public good, one agent of a community had to provide a public good, subject to compensation from the other agents. For each agent, the provision cost of the public good varied. This was also the case in the Kunreuther et al. (1987) study of noxious facility siting. However, in this study, and like a "real world auction," it is the buyer who compensates the selected sellers. It is, to my knowledge, the first time such an experiment has been conducted. We now turn to the analysis of this game.

Analysis

The model used earlier in this paper can be used here. We must, however, redefine a number of aspects of the analysis. For example, the model of first-price, sealed bid auction described previously dealt with one seller and many buyers. In our case, we have one buyer, represented by the government, and many sellers, or more precisely the owners of the lots. Only owners with the smallest bids were selected. Fig. 3.1 shows a sample of the questionnaire given to participants.

The compensation is paid by the French government. The use of the auction is very important since it helps the buyer to obtain more accurate information on the respondents' true willingness to accept values. As we have seen before, the use of the auction encourages respondents to give their lowest compensation possible. More formally, we are trying to get as close as possible to the equality $v_i = b_i$. 
A thorough study of the natural environment of the riverbanks has been conducted by biologists and ecologists. This study shows that converting only a part of the land along the Garonne River would suffice to restore an acceptable level of biodiversity and to protect the natural environment. More precisely, it seems that restoring about 50% of the lots along the River would be enough.

The effective compensation will be determined according to a threshold (chosen by considering the different costs indicated by all the owners concerned). We will give priority to the individuals asking for the minimum compensations, until we obtain those 50% of the lots, in the limit of the allocated budget.

Fig. 3.1. Sample questionnaire given to participants.

Following the previous notations, the payoff function for individual $i$ is $H_i(L) = b_i - v_i$, where $L$ represents the land considered.

In other words, the profit of player $i$ is the compensation $b_i$ he/she receives in exchange for not farming on the land (for example, $v_i$ representing the value of the production of corn on the lot).

Defining $b^*_i$ as the lowest bid, then each player is confronted with three possible payoffs:

If $b_i < b^*_i$, then player $i$ receives $b_i - v_i$

If $b_i > b^*_i$, then player $i$ receives 0

The expected payoff for player $i$ is

$$EH_i = (b_i - v_i) \text{ prob } (b_j < b_i, \quad j \neq i)$$ (13a)

$$EH_i = (b_i - v_i) \text{ n } b_i^{*_{-1}}$$ (13b)

Taking the first derivative with respect to $b_i$, we obtain
Rearranging, we have

\[(v_i - b_i) (1-n) n b_i^{n-2} - n b_i^{n-1} = 0\]  
\[v_i (1-n) + b_i (n-2) = 0\]

The equilibrium strategy is for player \(i\) to bid

\[b^*_i = \frac{(n-1) v_i}{(n-2)} \quad (i = 1, \ldots, n)\]

Equilibrium bids get closer to reservation prices, or valuations, as \(n\) increases. In other words, when placed in a first-price sealed bid auction, respondents are encouraged to announce a compensation closer to their true WTA value as the number of participants increases.

**Results**

The average WTA value for owners who were in a competitive setting is lower than the average WTA value for owners not placed in a competitive setting. Results are described in Table 3.1.

On average, farmers who were told only the lowest compensations would be considered indicated lower values. For farmers, the average compensation demanded amounted to about 500 USD, while the average compensation obtained with the other
half of the farmers' group was about 610 USD. Therefore, there was a difference of about 100 USD. For non-farmers, the difference amounted to 40 USD - 17 USD for those in the "auction setting," 57 USD for the others. However, these differences within each group (farmers and non-farmers, respectively) are not statistically significantly different at $\alpha = 0.10$.

We used the Heckman model and ran a regression using the binary variable "com," which stood for whether or not respondents were placed in the "auction setting."

\[
\text{ACC} = 0.27 \text{FAR} + 0.27 \text{USE} - 0.04 \text{COM}
\]

\[
\text{WTA} = 2403.7 \text{IN}1 + 2702.4 \text{IN}2 + 363.7 \text{PAR}
\]

where ACC represents whether or not respondents accept to participate in the preservation program, FAR represents whether or not respondents are farmers, USE represents the total size of the parcels owned by the river, COM represents whether or not respondents were placed in the auction setting, WTA represents the respondents' minimum compensation demanded, IN1, and IN2 represents income, and PAR represents the number of parcels owned by respondents.

Table 3.1
Average WTA demanded by respondents

<table>
<thead>
<tr>
<th>Respondent</th>
<th>WTA in competitive setting</th>
<th>WTA with open-ended format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers</td>
<td>610 (USD)</td>
<td>500 (USD)</td>
</tr>
<tr>
<td>Non-farmers</td>
<td>57 (USD)</td>
<td>17 (USD)</td>
</tr>
</tbody>
</table>
Table 3.2 shows the t-stats for the variable COM were not significant. Knowing that they participate in an auction did not influence respondents’ answers as to whether or not they wanted to participate in the preservation program of the riverbanks.

We then tested if the COM variable was significant in the second step, the least square regression of the Heckman model. Table 3.3 summarizes the findings.

The t-stats for the variable COM were not significant. In other words, the amount of compensation demanded by respondents was not affected by whether or not they were placed in an auction setting. It is consistent with our earlier findings, which indicate the absence of significant difference between mean WTA estimates when respondents are faced with the auction setting and those answering open-ended question.

These results would indicate that landowners gave their "true" WTA values when placed in the open-ended question format. This conclusion is consistent with List and

| Table 3.2 | Results of the Heckman 2-step procedure estimation for the COM variable |
| --- | --- | --- |
| **Heckman 2-step** | **Estimated coefficient** | **t-statistic** |
| **Probit** |  |  |
| FAR | .27 | 2.8 |
| USE | .27 | 2.7 |
| COM | -.04 | -.4 |
| **Two-stage least square** |  |  |
| IN1 | 2403.7 | 2.1 |
| IN2 | 2702.4 | 2.2 |
| PAR | 363.7 | 3.0 |
Table 3.3
Results of the Heckman 2-step procedure estimation using COM as a variable

<table>
<thead>
<tr>
<th>Heckman 2-step</th>
<th>Estimated coefficient</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FAR</td>
<td>.4</td>
<td>1.3</td>
</tr>
<tr>
<td>USE</td>
<td>-.7</td>
<td>-2.9</td>
</tr>
<tr>
<td>Two-stage least square</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IN1</td>
<td>2403.7</td>
<td>2.1</td>
</tr>
<tr>
<td>IN2</td>
<td>2702.4</td>
<td>2.2</td>
</tr>
<tr>
<td>COM</td>
<td>-582.2</td>
<td>-.4</td>
</tr>
<tr>
<td>PAR</td>
<td>318.3</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Shogren's (1998) findings. The framing of the question did not seem to affect individuals' behavior. In other words, CVM can be successfully used using the open-question format in the case of compensation demanded.

Conclusions

The majority of CVM studies involving WTA estimation indicate that individuals have a tendency to overestimate their minimum compensation. This conclusion has traditionally been reached when comparing WTA and WTP measures. Several explanations have been suggested, such as a psychological (loss aversion effect) and economic (substitution and income effects). As pointed out by Hanemann (1991), there is no evidence that both measures should, in theory, be equivalent.

This paper tested for the accuracy of the respondents' WTA values by comparing WTA estimates in two distinct settings. In the first setting, respondents were asked to state their minimum compensation demanded using an open question format, while in
the second setting, individuals were informed that only those indicating the lowest compensation would be selected to participate in the preservation program (auction setting).

This hypothetical auction mechanism is interesting in that it discourages respondents with high values to participate in the preservation program. In other words, the auction setting leads to a self-selection of the respondents. Moreover, theory predicts that the first-price sealed bid auction setting does lead respondents to ask for compensations closer to their true value. Moreover, it indicates that the greater the number of participants, the closer to their true value the compensation demanded will be.

Results indicate that even though lower average compensations were obtained for both groups (farmers and non-farmers), we fail to reject the hypothesis that revealed values in the two different settings are derived from the same parental population. This result is confirmed by the non-significance of the variable "competition" in both the first and the second-step of the Heckman procedure. The auction setting did not lead respondents to indicate lower compensation values, nor did it discourage respondents to participate in the preservation program.

These results lead to the conclusion that respondents gave their true WTA value in the open format and did not overestimate the compensation demanded. We must, however, reiterate that throughout the pages, we have made some rather strong assumptions, in particular symmetries among bidders, common knowledge of the probability distributions, and absence of risk aversion.
More generally, this paper shows that the use of auctions can be successfully applied to the provision of public goods. This finding is important in that it allows researchers to use the WTA measure whenever this format is the only one that can be applied for property rights issues or political reasons.

References


This study was undertaken with the primary purpose being to assess the welfare loss to landowners from the implementation of a preservation program along the Garonne River.

The analysis indicates that the WTA format can be used to estimate welfare loss. Moreover, the Heckman binary/continuous model appears not to lead to exaggerated estimates, since WTA figures elicited existing market values. This result is also confirmed by the rather large number of zero bids obtained. It is important, however, to add that respondents had a thorough knowledge of the good itself and its value to them -- this is particularly true for farmers--and the proposed preservation program was realistic. Respondents believed in the applicability of the program, which then does not represent a vague and improbable possibility.

Finally, this study sheds some light on the reasons why some respondents refused to participate in the preservation program. We were able to differentiate those who were indifferent to the program from those opposed it. This information provides some important policy insights. For instance, many respondents admitted being interested in the program, but suggested some variations, or else preferred some other means of compensation (for example, technical advice on how to maintain riparian land). Similarly, protest responses may, in some cases, be of valuable interest in future studies as they indicate that respondents' refusal to participate is not as much linked to the good
itself but to the "administration" part of it. This is particularly true for respondents who emitted strong reservations toward the governmental agency or the feasibility of the program itself. It would be of valuable interest in any WTP study to be able to differentiate these answers from other zero WTP bids.

Another important aim to this study was to test for the accuracy of the respondents' WTA values by using an hypothetical auction setting. We tested for the accuracy of the respondents' WTA values by comparing WTA estimates in two distinct settings. In the first setting, respondents were asked to state their minimum compensation demanded using an open question format, while in the second setting, individuals were informed that only those indicating the lowest compensation would be selected to participate in the preservation program (auction setting).

This hypothetical auction mechanism is interesting in that it discourages respondents with high values to participate in the preservation program. In other words, the auction setting leads to a self-selection of the respondents. Theory predicts that the first-price, sealed bid auction setting does lead respondents to ask for compensations closer to their true value. Moreover, it indicates that the greater the number of participants, the closer to their true value the compensation demanded will be.

Results indicate that even though we obtained lower average compensations, for both groups considered (farmers and non-farmers), we fail to reject the hypothesis that revealed values in the two different settings are derived from the same parental population. This result is confirmed by the non-significance of the variable "competition" in both the first and the second step of the Heckman procedure. The
auction setting did not lead respondents to indicate lower compensation values, nor did it discourage respondents to participate in the preservation program.

These results confirm the conclusions we had reached in our first paper. We can conclude that respondents gave their true WTA value in the open format and did not overestimate the compensation demanded.

More generally, it shows that the use of auctions can be successfully applied to the provision of public goods. This finding is important in that it allows researchers to use the WTA measure whenever this format is the only one that can be applied for property rights issues or political reasons.
APPENDICES
Appendix A:

Map of France
Appendix B:

Restoration of the Riparian Forest Along the Garonne River Between Portet and Malause Questionnaire

(Contingent Evaluation)
Precise date of the survey: ________________________________
Place where the survey was conducted: ____________________________
Place of the lots you own along the Garonne River: ________________ (County)

The riparian forests along the Garonne River plays an important role in

- stabilizing the banks
- decreasing ground erosion
- decreasing water pollution
- the reproduction and migration of the different species, such as the salmon, the heron...

If we want that different animal and vegetal species prosper in their natural environment, we must recreate a natural habitat favorable to their development. It would therefore be of interest to convert a strip of land of sufficient size to that effect.

We can preserve sites by creating natural reserves, by limiting their access to the public on some sites, or by creating more or less accessible wooded areas.

The Ministry of the Environment conducted a survey on the benefits associated with maintaining natural habitat along the Garonne River, between Portet and Moissac. This study allowed us to predict an estimated budget for the preservation program of the habitat for ten years.

We are now trying to define some “maintenance contracts” in which you would voluntarily undertake to respect some practices on the riverbanks, in exchange for a financial compensation. This is precisely on the financial modalities of these contracts that we are presently asking for your help.

The information that you can give us is very important in that it will help us choose a particular preservation program.
First, we would like to know better your current use of the lots you own on the riverbanks.

Please cross the right answer(s) when necessary.

1. How many hectares of land do you own in total? ________________

2. How many lots do you own by the river? ________________

3. What is the total area of these lots? ________________ hectares

4. What is the linear of these lots? ________________ meters

5. Are those lots adjacent? Yes/no

6. Describe the general appearance of the riverbanks on these lots:
   - banks small
   - slope small
   - high steep

7. How do you use these lots?
   - Habitat/lending for farming/woods (which ones)/nothing/others

8. Do you currently use these lots up to the water level? Yes/no, why

9. (You don’t use these lots up to the water level.) Do you upkeep this strip of land unused?

10. (You don’t use these lots up to the water level.) What is the width of this strip of land?

We are interested in a strip of land that could be from 10 to 50 meters large on the riverbanks. Different programs of preservation are possible. Each one of these programs supposes different levels of participation from you, and therefore, different compensations.

The duration of these programs extends over a period of 10 years, renewable. The government, the owner and the eventual farmer commit themselves by written. The contract signed is attached to the land. In other words, even if the lot is sold, the next owner has to respect the contract. In the case where the lot is rented for farming, a contract is signed between the owner and the farmer. […]

If, at the end of this period, you wish to convert back that strip of land to its previous use, the costs associated to the conversion (investment in time and material) is taken care by
the government or its representative. If you are satisfied with the program and wish, at the end of 10 years, to keep it, a new contract is then signed. [...] 

We are now going to present to you three programs. We are asking you what would be the minimum compensation that you should receive for you to accept to participate to those programs. These programs would not question the existing rights of irrigation, and pumping.

MONETARY COMPENSATION

We envisage the payment of a compensation per hectare, conditional on the choice of a program.

Program 1: No upkeep

You provide the land. The strip of land allocated to the program is not to be kept up. Its width is between 10 and 50 meters. This protected zone would allow for preservation and reproduction of different species.

Program 2: Upkeep of a trail

You provide the land. You maintain a 3 meters wide trail. This trail may be used by hunters, fishermen, or hikers. The upkeep of the trail is your responsibility. The width of this strip of land is between 10 and 50 meters.

Program 3: Upkeep + wood

You provide the land. You maintain a 3 meters wide trail at your charge. You plant the trees and bushes which are supplied to you and you are responsible for the upkeep of the land twice a year. The upkeep consists of clearing brushwood, getting rid of dead wood and garbage. The heavy upkeep work (e.g. cutting trees) is also your responsibility, but the wood belongs to you.

11. To which one of this program(s) would you accept to participate?

   Program 1
   program 2
   program 3
   none
12. (You accept to participate to several programs.) Which program do you prefer?

- Program 1
- Program 2
- Program 3

13. (You accept to participate to a program.) What would be the strip of land width you
would accept to allocate to this program? ___________________ meters

14. What is the minimum compensation that you would have to receive to participate in
this program? ______ francs

15. (You refuse to participate to a program.) Can you briefly indicate the reasons of your
refusal? ________________________________________________________________

16. Is the duration of the program inconvenient to you?  Yes/no

17. If yes, what would be a more convenient duration of the program for you?______

____________________________________________________

18. (You refuse to participate in a program.) Let's suppose that the owners of the lots
adjacent to your(s) accept to participate in one of these programs. Will their decision
have an impact on your activity on your lot(s)?  Yes/no

19. (You refuse to participate in a program.) Let's suppose that the owners of the lots
adjacent to your(s) accept to participate in one of these programs. Would their
decision affect your choice?  Yes/no

If Yes, why? _________________________________________________________

To conclude this survey, we are now going to ask you some personal questions. These
questions are important because they allow us to improve the quality of the analysis. Your
answers will stay confidential and anonymous. They will be used to the sole purpose of
data treatment.

20. Have you already participated in agri-environmental programs? Yes/no

If yes, which ones? ___________________________________________________

21. Do you contribute to an association?  Yes (environmental; humanitarian; hunting,
fishing; others)/no

22. Do you sometimes undertake actions to clean the river or upkeep its banks? Yes/no
23. Do you own some land along some other riverbanks? Yes/no

24. Gender: female/male

25. Year of birth: ________

26. Current family situation: married, cohabitation; single; divorced; widow

27. Schooling: before high-school/high-school/ high-school + 2or +3; above

28. Number of persons living with you (including you): _______________________

29. Number of children: ______________________________________________

30. Number of dependents: ____________________________________________

31. Occupation: senior executive/ middle manager/ factory worker/ employee/ retired/ other

32. Total net monthly income of the household.

    less than 11000F
    11000-18000
    more than 18000-40000F
Appendix C:

CVM Studies
### Table C.1
Some of the CVM studies listed by Mitchell and Carson (1989)

<table>
<thead>
<tr>
<th>Study</th>
<th>Good being valued</th>
<th>Year survey conducted</th>
<th>Research procedure used</th>
<th>Sample size (usable sample in parentheses)</th>
<th>WTP or WTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anderson and Devereaux (1986)</td>
<td>Artificial fishing reef</td>
<td>1985</td>
<td>ML, TLP, PI</td>
<td>201 (55)</td>
<td>WTP</td>
</tr>
<tr>
<td>Burnes et al. (1983)</td>
<td>Disposal of toxic wastes</td>
<td>1982</td>
<td>PI</td>
<td>74, 84</td>
<td>WTP</td>
</tr>
<tr>
<td>Conrad and Leblanc (1979)</td>
<td>Development rights</td>
<td>-</td>
<td>PI</td>
<td>22</td>
<td>WTA</td>
</tr>
<tr>
<td>Dickie et al. (1979)</td>
<td>Price comparison information for supermarkets</td>
<td>1981</td>
<td>PI</td>
<td>85</td>
<td>WTP</td>
</tr>
<tr>
<td>Foster et al. (1982)</td>
<td>Agricultural land</td>
<td>1982</td>
<td>ML</td>
<td>300, 300 (193, 200)</td>
<td>WTP, WTA</td>
</tr>
<tr>
<td>Halstead (1984)</td>
<td>Non-market values of agricultural land</td>
<td>-</td>
<td>PI</td>
<td>85</td>
<td>WTP</td>
</tr>
<tr>
<td>Johnson et al. (1986)</td>
<td>White water recreation</td>
<td>1975</td>
<td>ML</td>
<td>30</td>
<td>WTP</td>
</tr>
<tr>
<td>Oster (1977)</td>
<td>Freshwater pollution</td>
<td>1985</td>
<td>ML, TLP, PI</td>
<td>144</td>
<td>WTP</td>
</tr>
</tbody>
</table>

ML = Mail
TLP = Telephone
PI = Personal Interview
WTA = Willingness to accept
WTP = Willingness to pay
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EDUCATIONAL BACKGROUND

- Ph.D., Economics, Major Professor: Basudeb Biswas
  Utah State University, 2000
  Dissertation Title: Riparian Zone Protection: The Use of the Willingness-to-Accept
  Format in a Contingent Valuation Study.

- M.S., Applied Psychology
  Institut de Psychologie et Sciences Sociales Appliquées, Université Catholique de
  l'Ouest, Angers, France, June 1992

- Bachelor's of Psychology
  Institut de Psychologie et Sciences Sociales Appliquées, Université Catholique de
  l'Ouest, Angers, France, June 1990

WORK EXPERIENCE

Economist and Research Associate, Early Intervention Research Institute, Utah State
University. Specialize in cost-benefit analysis and statistical analysis employed in
educational research. Work on diverse national programs. Design, conduct and analyze
surveys. Work on the evaluation of state public finance policies. September 1999 to present.

Lecturer, Department of Economics, Utah State University. Taught undergraduate
Microeconomics and Macroeconomics. Conducted research on environmental and resource
economics. Course evaluations above Department and college mean. January 1998 – June
1998.

Visiting Researcher, Institut National de Recherche Agronomique (National Agricultural
Research Center or INRA), France. Developed, administered, conducted and analyzed
survey using the Contingent Valuation Method. Conducted research on the costs of

Research Assistant, Department of Economics, Utah State University. Worked on cost allocation project. Translated documents and interpreted seminars to French speaking Senegalese, Malian and Mauritanian administrators, 1993-1997.

French Instructor, Department of Languages and Philosophy, Utah State University. Taught beginning, intermediate, advanced, and special topic French courses. Supervised students in summer program in south of France. Course evaluations above Department and college mean. 1992-1996.

PUBLICATIONS


Catherine Boulatoff Broadhead and John Keith, "Riparian Zone Protection: the Use of the Willingness to Accept Format in A Contingent Valuation Study," Ecological Economics, currently being revised.


PRESENTATIONS

Linda Goetze, Vonda K. Jump, Dan Judd, Catherine Boulatoff-Broadhead, "Do IFSP services Reflect the needs of the family or funding eligibility and constraints?" International Conference on Infant Studies, Brighton, England, July 2000.


GRANTS AND AWARDS


USU Women and Gender Research Institute, Graduate Student Research Award, 1996.

ASSOCIATIONS & ACTIVITIES

President, and Vice-President, Economic Graduate Student Association, USU 1993-1995.
Member of American Agricultural Economic Association (AAEA).
Member of Western Agricultural Economic Association (WAEA).

FOREIGN LANGUAGES

French (native), English (fluent), German (basic)

PERSONAL

Born May 8, 1968
French citizen, US permanent resident