

STATISTICAL APPLICATION OF THE CONTINGENT EVALUATION FOR CONSERVATION OF AGRICULTURAL SOILS IN BENIN

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Abstract. Land degradation is an environmental problem that constitutes a serious threat and endangers food production and rural livelihoods. Thus, where water and wind erosion, reinforced by human activities, can have negative impacts on soils, there are methods to restore or maintain soil fertility in a context of financial constraints. (Dossa, 2016). The contingent evaluation method is the mathematical tool used to model the willingness to pay (CAP: WTP) of farm households to invest financially in soil conservation techniques in the commune of Kérou in the north-west and on the ADJA Plateau in the south-east of Benin. Its formalisation made it possible to calculate the average CAP E (CAP) on a sample by the following formula: $E(CAP)=m(\alpha/\sigma)/(\beta/\sigma)$. Thus, in estimating the average CAP using the probit model, the tobit model (Tobin, 1958) is tested by the two-step method of Heckman (1979) to control for selection bias in the sample of 385 farm households in Kérou and 267 on the ADJA Plateau. The results of the econometric regression give an average CAP of 1,260.92 FCFA/month/hectare for the adoption of SCTs (soil conservation techniques) in Kérou and 1,557 FCFA/month/hectare on the ADJA Plateau.

Keywords: *contingent evaluation, agricultural soil conservation, selection, probit*

Introduction

The mathematical application of models of monetary valuation of the environment is one form of response that the social sciences provide to the environmental problems with which society is increasingly confronted. These methods help to fill the gaps related to market and public policy failures. They also make it possible to penalize actions that result in negative externalities on the environment. In addition, the evaluation methods of natural assets include: the Displacement Cost Method (DCM), the Hedonistic Price Method (HPM) qualified as indirect methods and the Contingent Method of Evaluation (CME), qualified as a direct method. The "soil" being the main object of the "land", it is immediately considered as an asset or natural heritage. According to this nature, its value will therefore be estimated by the willingness to pay (WTP), based on the Contingent Evaluation Method (CEM). It uses, on the basis of surveys, the reconstitution of a contingent market to encourage households to reveal the value they place on their quality of life or natural resources, their improvement or the damage that has been caused to them.

Contingent evaluation seeks to bring out perfectly determined values buried within them (the individuals surveyed). The choice of MEC for financing agricultural soil conservation techniques is based on its frequency of use (70% compared to other economic evaluation methods), the credibility of its users (Reveret et al., 2008) and above all its scientific recognition through the report of the National Oceanic and Atmospheric Administration (NOAA) panel (Arrow et al., 1993). Its implementation is

based on surveys of a representative sample of the population concerned, during which respondents are presented with different scenarios to estimate the monetary value they place on agricultural land. The contingent evaluation method is the mathematical tool used to model the willingness to pay (WTP) of farm households to invest financially in soil conservation techniques in the commune of Kérou in the north-west of Benin and on the ADJA Plateau in the south-east of Benin.

Materials and Methods

Methods for determining WTP in term of price and consumer surplus

Individual preferences are revealed in the market and are expressed in terms of willingness to pay (CAP) and willingness to receive (CAR). Willingness to pay can be represented as follows (Eq. 1);

$$CAP = expense (Price) + consumer surplus \quad (Eq. 1)$$

Within the framework of the survey in Kérou and on the ADJA Plateau, the agricultural household's willingness to pay (WTP) would be the expenditure it would be willing to make for the adoption of soil conservation techniques (SCT), and in return obtain an improvement in the quality (fertility) of its soil in order to increase the yields of its agricultural production. Author has (Eq. 2);

$$CAP = expense (SCT) + soil fertility \quad (Eq. 2)$$

On the one hand, merchant goods represented by $X = (X_1, X_2, X_3, \dots, X_n)$, and on the other hand, a certain quality of the environment Z_0 representing non-merchant goods. The utility function is written as follows: $U = U(X, Z_0)$ under the constraint of revenue Y and price $P = p (P_1, P_2, \dots, P_n)$ of merchant goods and services. Consumers maximise their utility level by choosing a certain level of consumption, given their income and market price constraints. The level of environmental quality is exogenous to choice. Its programme is therefore written;

$$Max (U(X, Z_0)) \text{ s/c } Y = PX; Z_0 \text{ being fixed} \quad (Eq. 3)$$

A formal presentation leads us to consider an indirect utility function (we substitute the demand function in the direct utility function);

$$U(X (P, Y, Z) Z) = V (P, Y, Z) \quad (Eq. 4)$$

where, X means all the consumer goods; P means their price; Y means the revenue; and Z means the condition of the agricultural soils in the environment, related to the quality of the environment with $Z_1 > Z_0 > Z'_1$.

The four (4) cases of consumer surplus measurement previously presented will thus be found (Voltaire, 2011). Suppose an improvement in the quality of the environment leading to an improvement in the conservation of household agricultural soils. The compensatory variation of an individual who pays for an improvement in environmental quality can be specified as follows;

$$V(P, Y - CAP, Z1) = V(P, Y, Z0) \quad (\text{Eq. 5})$$

In this case, the willingness to pay represents the offsetting variation in the surplus. How much does a household that is indifferent to an improvement in environmental quality receive for giving up its environmentally destructive occupation.

$$V(P, Y + CAR, Z0) = V(P, Y, Z1) \quad (\text{Eq. 6})$$

In this case, the consent to receive represents the equivalent change in surplus. Assuming a degradation of the quality of the environment, what compensation makes the household indifferent to this degradation?

$$V(P, Y + CAR, Z'1) = V(P, Y, Z0) \quad (\text{Eq. 7})$$

In this case, the consent to receive represents the offsetting variation of the surplus. Assuming a potential deterioration in the quality of the environment, how much is a household willing to pay to avoid this deterioration?

$$V(P, Y - CAP, Z'1) = V(P, Y, Z0) \quad (\text{Eq. 8})$$

In this case, the willingness to pay represents the equivalent change in the surplus. The following table summarizes the definition of consents based on the state of nature (Table 1).

Table 1. Definition of CAP and CAR based on different surplus.

Nature of willingness	Improvement	Deterioration
Willingness to pay (CAP)	Offsetting surplus	Equivalent surplus
Willingness to receive (CAR)	Equivalent surplus	Offsetting surplus

Source: Dossa (2016).

The study model

The generalised Tobit model (Tobin, 1958) the structure of which is very similar to that of the selection model popularised by Heckman (1979) is used to model average WTP. This model is preferable to Maximum Likelihood Method (MMV) modelling in order to control the problem of sample selection bias that often arises because individuals self-select through their decisions to adopt soil conservation techniques (SCTs). It consists in assuming a sequential behaviour with two (2) stages.

Results and Discussion

Estimation of the CAP (WTP)

The estimation of WTP is an econometric model that falls within the domain of qualitative variables, more precisely sample selection models in contingent evaluation (Garcia et al., 2009). A two-stage sequential behaviour is assumed. In the first stage the individual decides whether or not to pay for soil conservation techniques (SCTs). This decision can be represented by a dichotomous qualitative model based on a certain criterion Y_1^* .

If $y_{1,i}^* > 0$, the individual i decides to pay
 If $y_{1,i}^* \leq 0$, the individual i decides not to pay

(Eq. 9)

In a second step, the individual decides how much he or she is going to spend on the SCT, after deciding to pay. We then have a censored data model since, if we note $y_{2,i}$ the actual payment of household i , this is defined by $\forall i = 1, 2, \dots, N$:

$$y_{2,i} = \begin{cases} y_{2,i}^* & \text{if } y_{1,i}^* > 0 \\ 0 & \text{if } y_{1,i}^* \leq 0 \end{cases}$$

(Eq. 10)

This formulation generalises the simple Tobit model to the extent that the simple Tobit model is found by putting $y_{1,i}^* = y_{2,i}^*$. The advantage of this modelling is that it makes it possible, in particular, to show the more or less strong correlation that may exist between the two decisions (Tobin, 1958): willingness to pay (WTP) and amount of willingness to pay (MCAP). We do have a generalised Tobit model, since only the sign of the variable $y_{1,i}^*$ represented by the dichotomous variable $y_{1,i}^* = I(y_{1,i}^* > 0)$ is decisive.

Mathematical formalisation of the model

The model can be formalised as follows for each agricultural household i ;

- (1) *Selection equation*: Participates in the soil quality improvement programme.
 Let Z be the qualitative variable, such that $Z = 1$ if household i participates in the programme and 0 otherwise;

$$Z = w_i \beta_i + \mu_i$$

(Eq. 11)

μ_i , follows a normal law $N[E(\mu_i), V(\mu_i)] = N[0,1]$.

- (2) *Substantial equation*: Estimate of the announced willingness to pay (CAP) (observable only if $Z = 1$);

$$Y = x_i \alpha_i + \varepsilon_i$$

(Eq. 12)

ε_i follows a normal law $N[E(\varepsilon_i), V(\varepsilon_i)] = N[0,1]$.

w_i and x_i are observable socio-economic variables. Assuming a normal distribution $N(0, 1)$, the error terms of the two equations (selection and substantial) are therefore absolutely continuous and admit $f(x)$ as density, such that;

$$f(x) = \frac{1}{\sqrt{2\pi}} e^{-x^2/2}$$

where, avec $x = \mu_i, \varepsilon_i$. (Eq. 13)

This kind of model is normally estimated by the Maximum Likelihood Method (MMV). However, as convergence is sometimes difficult, the two-step estimator of

Heckman (1979) is sometimes preferred. The selection equation is first estimated by a Probit model, then a Least Ordinary Square (LOS) regression is used to obtain the coefficients of the second equation. The selection equation is based on the work of Mäler (1974). By considering the primal programme of a respondent that maximizes his or her utility function U for a given price vector P and income level Y . His programme is written as follows;

$$\text{Max } U(X, Q), \text{ sous contrainte de : } PX = Y \quad (\text{Eq. 14})$$

This program admits a solution which is an indirect utility function defined by;

$$u_{ij} = u_i(p, y_j, q^i, m_j) \quad (\text{Eq. 15})$$

Let j be a given surveyed household, and $i = 1$ corresponding to the quality of the environment after soil conservation and $i = 0$ to the status quo (the current situation). P , the price vector, the income of j is denoted y_j ; m_j represents a vector of the individual characteristics (gender, age, income,...), and q the quality of the environment which depends on the quality of the agricultural soils. For an improvement in the quality of the environment between situations 0 and 1 corresponding to an improvement in soil quality from q_0 to q_1 (with $q_1 > q_0$), there will be an improvement in agricultural production yields due to an improvement in soil fertility. The farmer's utility increases from u_0 to u_1 . Author have;

$$u_{1j} = u_1(p, y_j, q^1, m_j) \quad (\text{Eq. 16})$$

The measure of household welfare due to a change in soil quality is the compensatory surplus ($SC = \Omega$). Let;

$$\Omega = u_{1j} - u_{0j} = u_1(p, y_j, q^1, m_j) - u_0(p, y_j, q^0, m_j) \quad (\text{Eq. 17})$$

In order to have better soil quality (q_1) to avoid land degradation and declining fertility, the household would be willing to participate financially in the programme by reducing its consumption of private goods in favour of environmental goods (agricultural soil quality). The WTP equation of an agricultural household j to be estimated is therefore;

$$CAP_j(q^1 - q^0) = f(m_j, u_0, q^1 - q^0) + \mu_j \quad (\text{Eq. 18})$$

With μ_j the random component of preferences unknown to the surveyed farm household. Since the random component of preferences is unknown, one can only make probabilistic assumptions about 'yes' and 'no' responses. Let Y_j be the answer to these questions: $Y_j = 1$ corresponds to the answer 'yes', i.e. agrees to contribute financially to the programme. The probability of answering yes is therefore;

$$Pr(Y_j = 1) = Pr(u_1(y_j - CAP_j, m_j, q^1, \mu_{1j}) \geq u_0(y_j - CAP_j, m_j, q^0, \mu_{0j})) \quad (\text{Eq. 19})$$

In this linear random utility model, the utility function is in an additively separable form. It thus breaks down into a linear deterministic part (v_i) and a stochastic part (μ_{ij}).

$$u_j(y_j, m_j, \mu_{ij}) = v_j(y_j, m_j) + \mu_{ij}; \text{ avec } v_j(y_j, m_j) = m_j\alpha + y_j\beta \quad (\text{Eq. 20})$$

So author have;

$$\begin{aligned} Pr(Y_j = 1) &= Pr(v_1(y_j - CAP_j, m_j, \mu_{1j}) \geq v_0(y_j, m_j, \mu_{0j})) \\ &= Pr(v_1(y_j - CAP_j, m_j, \mu_{1j}) - v_0(y_j, m_j, \mu_{0j}) \geq 0) \end{aligned} \quad (\text{Eq. 21})$$

The indirect utility function is specified as the sum of a deterministic and a random component. The difference between the two random components can be identified in a single error term such as;

$$\mu_j = \mu_{1j} - \mu_{0j} \quad (\text{Eq. 22})$$

In the deterministic part of the indirect utility function author have;

$$v_{1j} - v_{0j} = m_j(\alpha_1 - \alpha_0) + (y_j - CAP_j)\beta_1 - y_j\beta_0 \quad (\text{Eq. 23})$$

It is assumed that the marginal utility of income is constant between the two states. As a result $\beta_1 = \beta_0 = \beta$, and noting that $\alpha = \alpha_1 - \alpha_0$, The probability of answering "yes" is then given by the following equation;

$$Pr(Y_j = 1) = Pr(m_j\alpha - CAP_j\beta + \mu_j) > 0 \quad (\text{Eq. 24})$$

It is assumed that the random terms μ_{ij} are independent and identically distributed according to the same law, with zero expectation. Two laws are possible for μ_j : the normal law and the logistic law. When the reduced centred normal law is used, we speak of the **Probit** model and when the logistic law is used, we speak of the **Logit** model (Maddala, 1983). The Probit model is the one for which F is the distribution function of the reduced centred normal law;

$$F(w) = \Phi(w) = \int_{-\infty}^w \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}} dt \quad (\text{Eq. 25})$$

The result is;

$$P(Y = 1) = \int_{-\infty}^{X\beta} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}} dt = \Phi(X\beta) \quad (\text{Eq. 26})$$

The Logit model is the one for which F is the distribution function of the logistic law;

$$F(w) = L(W) = \frac{e^w}{1 + e^w} = \frac{1}{1 + e^{-w}} \quad (\text{Eq. 27})$$

The result is;

$$P(Y = 1) = \frac{1}{1 + \exp(-X\beta)} = L(x\beta) \quad (\text{Eq. 28})$$

L (distribution function of the logistic law) and Φ (distribution function of the reduced centred normal law) are both symmetrical with respect to 0, and between 0 and 1 (which is perfectly suitable for representing a probability). The logistic distribution function L has an average of 0 and a variance $\pi^2/3$. It is therefore natural to compare to $\Phi(w)$, a distribution function of N (0,1), the function $L_1(w)$ where;

$$L_1(w) = \frac{1}{1 + \exp(-\pi w/\sqrt{3})} \quad (\text{Eq. 29})$$

In most cases, one can choose one or the other model indifferently, as these laws are close to each other. The Logit model has the advantage of greater numerical simplicity. The Probit model, on the other hand, is closer to the usual Least Ordinary Squares (LOS) regression model. However, the choice between the two models for the residuals of the latent regression is truly arbitrary. However, this choice generally leads to different estimators of the parameters. Which model to choose?

The two models can be tested to decide between them. Testing the logit against the probit, is like testing $\alpha = 1$ against $\alpha = 0$. To do this, a score test is used which has the advantage: (1) of not requiring the general model to be estimated (the model is estimated under the null hypothesis only), (2) of having a standard distribution despite the fact that the test is done at the border of the domain (since $0 \leq \alpha \leq 1$). There is therefore very little difference between the estimated parameters ($\hat{\beta}$) under the two models. Marpsat and Trognon (1992) have shown that the estimators obtained with the Logit model are $\pi/\sqrt{3}$ times larger than those obtained by the Probit model; i.e. $\hat{\beta}_{\text{logit}} \approx 1,8\hat{\beta}_{\text{probit}}$. As for Amemiya (1981), he proposes as a first approximation to use the relationship $\hat{\beta}_{\text{logit}} \approx 1,6\hat{\beta}_{\text{probit}}$ between logit and probit estimates. In practice, the results of the two methods are similar, and both methods are indifferently chosen except for very large samples. If μ_j follows a normal law $N(\theta, \sigma^2)$, $\Theta_j = \mu_j/\sigma$ follows a reduced centred law. Then author have;

$$\begin{aligned} Pr(Y_j = 1) &= Pr(\mu_j < m_j\alpha - CAP_j\beta) \\ &= Pr(\Theta_j < m_j \frac{\alpha}{\sigma} - CAP_j \frac{\beta}{\sigma}) \\ &= \Phi(m_j \frac{\alpha}{\sigma} - CAP_j \frac{\beta}{\sigma}) \end{aligned} \quad (\text{Eq. 30})$$

If μ_j follows a logistic law with null average and variance $\frac{\pi^2 \sigma_L^2}{3}$, the probability that j answers « yes » is;

$$Pr(Y_j = 1) = \frac{1}{1 + \exp[-(m_j \frac{\alpha}{\sigma_r} - CAP_j \frac{\beta}{\sigma_r})]} \quad (\text{Eq. 31})$$

In order to calculate the willingness to pay (CAP) for a random utility model, it is theoretically defined as a sum of money that leaves the respondent indifferent between the status quo and the proposed situation. CAP is thus defined as;

$$m_j \alpha_1 + (y_j - CAP_j) \beta + \mu_{1j} = m_j \alpha_0 + y_j \beta + \mu_{0j} \quad (\text{Eq. 32})$$

and the CAP of household j is therefore;

$$CAP_j = m_j \frac{\alpha}{\beta} + \frac{\mu_j}{\beta} \quad (\text{Eq. 33})$$

To calculate the average CAP E (CAP) on the sample, the formula is as follows;

$$E(\text{CAP}) = \bar{m} \frac{(\alpha/\sigma)}{(\beta/\sigma)} \quad (\text{Eq. 34})$$

With \bar{m} , the vector of averages of individual household characteristics. The coefficient of the variables in the matrix m corresponds to the estimate α/σ and the coefficient associated with the proposed amount corresponds to an estimate of β/σ (In fact, logit or probit models provide an estimate of $-\beta/\sigma$). The analysis of the distribution of CAP, theoretically shows that it is between 0 and the income of the respondent. How then can we ensure that this is the case in practice? In other words, how can the willingness to pay be 'limited'? Haab and McConnell (2002) propose a model that correctly limits CAP. This model is written as follows;

$$CAP_j = G(m_j \gamma + \mu_j) y_j; \text{ où } 0 \leq G(m_j \gamma + \mu_j) \leq 1 \text{ et } G(m_j \gamma + \mu_j) \geq 0 \quad (\text{Eq. 35})$$

Function G expresses willingness to pay as a fraction of income. The most widely used version of this model is;

$$CAP_j = \frac{y_j}{1 + \exp(-m_j \gamma - \mu_j)} \quad (\text{Eq. 36})$$

Suppose that the error term follows a normal law, then the model becomes;

$$Pr(Y_j = 1) = \Phi\left(\frac{m_j \gamma + \text{Log} \frac{y_j - CAP_j}{CAP_j}}{\sigma}\right) \quad (\text{Eq. 37})$$

On the other hand, if the term error follows a logistic law, then the model is written;

$$Pr(Y_j = 1) = \frac{1}{1 + \exp\left(-\frac{m_j \gamma + \text{Log} \frac{y_j - CAP_j}{CAP_j}}{\sigma}\right)} \quad (\text{Eq. 38})$$

With the vector of the terms "amount/income": $\text{Log} \frac{y_j - CAP_j}{CAP_j}$. The coefficient of the variables in the matrix m corresponds to the estimate γ/σ and the coefficient associated with the variable "amount/income" corresponds to an estimate of $1/\sigma$.

Determinants of the CAP in Kerou and on the ADJA Plateau

Table 2 presents the econometric results of Heckman's estimate. In K erou, the model estimates the inverse of the Mills ratio whose significance shows that the substantial equation is not independent of the selection equation, i.e. the decision to reveal the amount to be paid is not made independently of the decision to be available to contribute financially to the agricultural soil quality improvement programme. Furthermore, the results in Table 2 indicate that the inverse of the Mills ratio is not significant. There is therefore no selection bias, and this makes it possible to state that the Heckman model is better suited to this work in K erou, unlike on the ADJA Plateau.

Table 2. The determinants of CAP in the study setting.

Variables	Department of ATACORA: Commune of KEROU				ADJA Plateau (APLAHOUE, DJAKOTOMEY, DOGBO, LALO, KLOUKANMEY, TOVIKLIN)			
	Obs.	Coef.	Z	p> Z	Obs.	Coef.	Z	p> Z
1st step: Selection equation (Willingness to pay – CAP)								
TM	385	0,008***	5,50	0,000	267	0,2282***	6,56	0,000
INCOME	385	0,03238	0,38	0,702	267	-5,56e-***	-2,61	0,009
NONAG	385	0,16645**	2,04	0,041	267	1,6898***	5,42	0,000
ACCMAR	385	0,2186***	3,59	0,000	267	-0,265778	-0,70	0,483
AGE	385	0,1440***	3,66	0,000	267	-0,009655	-0,95	0,343
EDUC	385	0,0577921	1,20	0,229	267	0,68987**	2,55	0,011
2nd step: Substantial equation (Amount of the willingness to pay – MCAP)								
TM	385	-115,0***	-10,89	0,000	267	0,020**	2,18	0,029
INCOME	385	0,0032***	4,24	0,000	267	-0,6839*	-1,65	0,099
AGE	385	-552,5***	-4,67	0,000	267	0,000***	4,71	0,000
EDUC	385	11,32648	0,80	0,425	267	-0,981***	-2,78	0,005
Mills_	385	-119,8337	-0,76	0,451	267	0,404***	4,58	0,000

Source: Based on Probit and MCO regressions in STATA, 2021.

Determinants of the CAP amounts in kerou and on the ADJA Plateu

Table 3 was used to calculate the willingness to pay amounts in the study setting. The results of the econometric regression give an average CAP of 1260.92 FCFA/month/hectare for the adoption of SCTs in K erou and 1557 FCFA/month/hectare on the ADJA Plateau. It should be noted that these results depend on the influence of agricultural production systems on land use, fertility and agro-biodiversity in Kerou, as demonstrated in Kombi enou (2016).

Table 3. Calculation of the amounts of CAP in the study setting.

	Department of ATACORA: Commune of KEROU	ADJA Plateau (APLAHOUE, DJAKOTOMEY, DOGBO, LALO, KLOUKANMEY, TOVIKLIN)
Total area sowed	69 144 hectares	201 739 hectares
Average CAP/ month /hectare	1260,92 FCFA	1557 FCFA
Average annual CAP /hectare	15 131,04 FCFA	18 684 FCFA
Total annual CAP	1 046 220 630 FCFA/an	3 769 291 476 FCFA/an

Heckman (1979) two (2) step model for modelling CAP by MEC shows that the substantial equation ($Y = x_i\alpha_i + \epsilon_i$) is not independent of the selection equation ($Z = w_i\beta_i + \mu_i$). In other words, the decision to reveal the amount to be paid is not made independently of the decision to be available to contribute financially to the agricultural

soil quality improvement programme in the commune of Kérou and the ADJA Plateau. The average CAP E (CAP) on the sample was calculated by the following formula;

$$E(\text{CAP}) = \frac{\bar{m} (\alpha/\sigma)}{(\beta/\sigma)} \quad (\text{Eq. 39})$$

Thus, by estimating the average CAP using the **probit** model, the **tobit** model (Tobin, 1958) is tested by the two-step method of Heckman (1979) to control the selection bias in the sample of 385 farm households in Kérou and 267 on the ADJA Plateau. The results of the econometric regression give an average CAP of 1260.92 FCFA/month/hectare for the adoption of SCTs in Kérou and 1557 FCFA/month/hectare on the ADJA Plateau.

Conclusion

MEC's modelling of CAP has multiple benefits for a country's socio-economic and environmental development. It enables decision-makers in environmental economics to take decisions to improve the environment and living conditions of populations. In Benin, for example, the contingent evaluation method (MEC) was used to analyse the determinants of rural households' consent to pre-finance their primary health care in Sèmè-Podji (Yaya et al., 2013). Avocè (2012) used it to determine the health costs of air pollution in the city of Cotonou. It was used to assess the financing of household waste management in Cotonou (Gbinlo, 2010). It was also used to reveal the CAP of the price per cubic metre (m³) of gravels by operators in the district of Dévé in the commune of Dogbo (Dato, 2010). It was also used to reveal consumers' willingness to pay (CAP) for healthy vegetables in urban and peri-urban areas in Cotonou and Porto-Novo (Amadou, 2008). The contingent evaluation method was used to capture the willingness to pay (CAP) of farmers in Atacora department to conserve the soil both financially and through labour (Alinsato, 2006).

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Conflict of interest

The authors of this paper confirm that there is no conflict of interest. They have fully contributed to its development and drafting.

REFERENCES

- [1] Alinsato, A.S. (2006): Analysis of the determinants of willingness to pay for soil conservation. – Faculty of Economics and Management, University of Abomey-Calavi 25p.
- [2] Amadou, I. (2008): Consent to pay consumers for healthy vegetables in urban and peri-urban areas: the case of southern Benin. – University of Abomey Calavi 85p.
- [3] Amemiya, T. (1981): Qualitative Response Models: A Survey. – Journal of Economic Literature 19 (4): 481-536.
- [4] Arrow, K., Solow, R., Portney, P.R., Radner, R., Schuman, H., (1993): Report of the NOAA panel on contingent valuation. – Federal Register 58(10): 4602- 4614
- [5] Avocè, V.F. (2012): Health costs of air pollution in the city of Cotonou in Benin. – University of Abomey-Calavi 245p.
- [6] Dato, P. Z. (2010): Policies for the sustainable management of non-renewable natural resources in Benin: the case of gravel exploitation in the municipality of Dogbo. – University of Abomey-Calavi 21p.
- [7] Dossa, A. (2016): Assessment and financing of environmental expenditures: case of willingness to pay for the conservation of agricultural soils in Kérou, Benin. – University of Abomey-Calavi 303p.
- [8] Garcia, S., Harou, P., Montagné, C., Stenger, A. (2009): Models for sample selection bias in contingent valuation: Application to forest biodiversity. – Journal of Forest Economics 15(1-2): 59-78.
- [9] Gbinlo, R. E. (2010): Organization and financing of household waste management in the cities of Sub-Saharan Africa: Case of the city of Cotonou in Benin. – University of Orleans 237p.
- [10] Haab, T.C., McConnell, K.E. (2003): Valuing Environmental and Natural Resources: The Econometrics of Non-Market Valuation (New Horizons in Environmental Economics series). – Edward Elgar Pub 352p.
- [11] Heckman, J. (1979): Sample Selection Bias as a Specification Error. – Econometrica 47(1): 153- 162.
- [12] Kombiénou, P.D. (2016): Influence of agricultural production systems on land use, soil fertility and agro-biodiversity in mountainous areas in the department of Atacora in Benin. – University of Abomey-Calavi 283p.
- [13] Maddala, G.S. (1983): Limited dependent and qualitative variables in econometrics. – Cambridge University Press 401p.
- [14] Mäler, K.G. (1974): Environmental Economics: A Theoretical Inquiry. – John Hopkins University Press 267p.
- [15] Marpsat, M., Trognon, A. (1992): Overview of the Logit model. – Journées de Méthodologie Statistique 32p.
- [16] Reveret, J.P., Charron, I., St-Arnaud, R.M. (2008): Reflections on methods for estimating the economic value of wildlife habitat loss. – AGEKO Group for the Ministry of Natural Resources and Wildlife, Department of Socio-Economic Development, Partnerships and Education, Quebec 54p.
- [17] Tobin, J. (1958): Estimation of Relationships for Limited Dependent Variables. – Econometrica 26(1): 24-36.
- [18] Voltaire, L. (2011): Contingent valuation method and economic valuation of a nature reserve project in the Gulf of Morbihan (France). – University of Western Brittany 281p.
- [19] Yaya, S., Nouatin, G.S., Singbo, S.J. (2013): Community pre-financing: the willingness to pay of households for primary health care in the commune of Sèmè-Podji. – Department of Ouémé, Benin 7p.