DOI: 10.5327/Z2176-947820160170

ENVIRONMENTAL VALUATION OF AN ARTIFICIAL LAKE IN BRAZIL: AN APPLICATION OF THE CONTINGENT VALUATION METHOD

VALORAÇÃO AMBIENTAL DE UM LAGO ARTIFICIAL NO BRASIL: UMA APLICAÇÃO DO MÉTODO DE VALORAÇÃO CONTINGENTE

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ABSTRACT

This paper estimates the value of environmental damage generated by pollution in the artificial lake Salto Caveiras, evaluating the willingness to pay (WTP) of the local population for its recuperation and conservation. Environmental Concern Scale (ECS) was introduced, in addition to the socioeconomic variables, collected by the Contingent Valuation Method (CVM) and modeled by Logit regression and evaluated by multivariate statistics instruments, utilizing Principal Components Analysis (PCA). We demonstrate that 45.6% of the interviewed are willing to pay monthly. The others answered negatively: 18.9% because of payment incapacity, 12.8% would donate a smaller value than the one proposed and 22.8% gave a protest response.. The introduction of ECS as a new variable to CVM is significant as a unique and innovative variable provided by multivariate analysis indicated to be promising, what recommends such procedures to other studies.

Keywords: environmental concern; multivariate analysis; valuation economic; water resource; water pollution.

RESUMO

O objetivo deste trabalho foi estimar o valor dos danos ambientais gerados pela poluição ao lago artificial Salto Caveiras, a partir da mensuração da disposição a pagar (DAP) da população local pela recuperação e conservação do mesmo. Foi introduzida na análise uma Escala de Consciência Ambiental (ECA), além do perfil socioeconômico, obtidos com a aplicação do Método de Valoração Contingente (MVC) e modelados pela regressão Logit e avaliados por instrumentos da estatística multivariada, utilizando-se da Análise de Componentes Principais (ACP). Os resultados revelam que 45,6% dos entrevistados estão dispostos a contribuir. Os outros responderam negativamente: 18,9% devido à incapacidade de pagamento, 12,8% propuseram um valor menor do que o sugerido e 22,8% deram uma resposta com caráter de voto de protesto. A introdução da ECA como uma nova variável ao MVC se mostrou significativa, bem como a visão holística, inédita e inovadora proporcionada pela análise multivariada se mostrou promissora, recomendando-se tais procedimentos para outros estudos.

Palavras-chave: percepção ambiental; análise multivariada; valoração econômica; recurso hídrico; poluição da água.

INTRODUCTION

The population growth and the industrialization generated several negative impacts in the environment and the world, bringing considerable damage to ecosystems, uncertainty of resources to future generations and climate changes (SILVEIRA; CIRINO; PRADO FILHO, 2013). Those problems are directly related to the environmental and life quality of their populations (NASCIMENTO; RIBEIRO; SOUSA, 2013). Thus, the importance of having unspoiled natural resources was attested over the years, resulting in a higher environmental concern. From this eagerness arises the concept of sustainable development, which can be defined as a development that supplies the current necessities without compromising the possibility of future generations to achieve their needs (UNITED NATIONS, 1987). This concept has been used more and more ever since.

A way of improving the management of natural resources and bringing this matter to the decision-making processes is to pursue methods to evaluate these assets. In this way, the decision-maker has a range of comprehensive information about the environment (TURNER et al., 2003) which are able to aid other evaluations of the ecosystem functions and to understand the value of the ecosystem preservation (SILVA; REIS; FERREIRA, 2012). In this context, there are several methods which are available and can be used to environmental valuation.

One of the environmental valuation methods is the Contingent Valuation Method (CVM), largely used to identify the value of environmental services and goods. It is obtained by applying questionnaires in which people's preferences are evaluated (MITCHELL & CARSON, 1989). Econometric models are most commonly used in order to determine the willingness to pay (WTP), taking into account the respondent's profile characteristics, such as socioeconomic variables and other information related to the evaluated asset (SILVA & LIMA, 2004; MAJUMDAR et al., 2011; OLIVEIRA & MATA, 2013; LO & JIM, 2015). In the present work, environmental concern is introduced as an explanatory variable in the application of the CVM.

Environmental concern, from an ecological perspective, was first developed by Dunlap and Liere (1978) through the New Ecologic Paradigm (NEP), a 12-item scale focused on the respondent's attitudes toward environmental problems caused by human influence in nature's balance, on human population's limits and on when humans should have dominance over nature. Weigel and Weigel (1978) also developed the Environmental Concern Scale (ECS), a scale with 17 items which measured the environmental optimism, the importance of environmental problems compared to technological and economic progress and the personal impacts and attitudes toward specific environmental problems. Subsequently, Kara and Chan (1996) achieved an adaptation of the ECS, with 11 original items of environmental attitudes and 4 modified ones (about behavior) in order to better serve the intentions of the student's devoted questionnaire. Dunlap et al. (2000) achieved an overhaul of the 1978's NEP, creating a new 15-item scale to approach population growth limits, nature's balance and human domination over it. Other examples of ECS uses, with terminology adaptations, can be seen in García (2000) and Borges et al. (2013).

The mountainous region of Santa Catarina, Brazil, has abundant natural resources. Nevertheless, the population growth induced environmental pressure upon some of its resources, including hydric resources, mainly in Caveiras River. In some of Lages' urban rivers, such as Carahá and Ponte Grande, studies make clear that high levels of environmental pollution occur after the rivers cross into the city (RAFAELI NETO; BECEGATO; CABRAL, 2013; ANTUNES et al., 2014). Those rivers end in Caveiras River, upwind a dam where Salto Caveiras — an important touristic attraction in the city — takes place, causing local environmental pollution. In this context, the aim of the present study was to quantify the WTP of the local population for the recovery and conservation of Salto Caveiras from Lages, Santa Catarina, through the use of the ECS and the CVM.

MATERIALS AND METHODS

The survey was conducted in Lages, Santa Catarina State — a mountainous area in Southern Brazil —, studying Salto Caveiras, the environmental good (Figures 1A and 1B), defined trough a preliminary research consider-

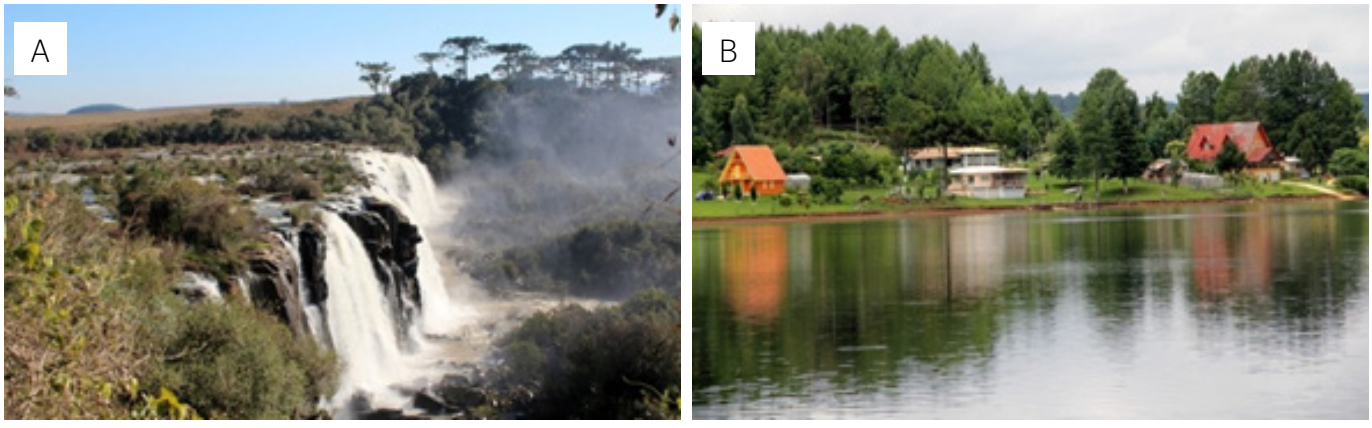
ing their degree of importance and relevance to the municipality. Salto Caveiras is located 20 km from the downtown area of Lages, where there is an artificial lake, with a surface of about 12 km² and formed by the Caveiras River Dam and a Small Hydropower Plant (SHP). The place has natural beauty, especially the waterfalls, and is surrounded by an extensive green area. It is used for water sports, leisure and rest, and its infrastructure includes restaurants, piers, places for camping, fishing and for the promotion of events (sports competitions and festivities), providing income for the communities installed in the area.

The economic activities of tourism and leisure developed in Salto Caveiras are threatened by the pollution load the river receives upstream, brought by rivers crossing the city of Lages, as a result of urbanization and industrial activities. According to Rafaeli Neto, Becegato and Cabral (2013), the stretch between the city of Lages and Salto Caveiras is the most critical in terms of pollution, and the improvement of water quality indicators after the jump may be associated, as reported by the authors, to the retention of pollution load by the dam.

The studied population was restricted to people residing in Lages, Santa Catarina State, Brazil, for at least five years, who were older than 16 years of age and who had an income. According to the Brazilian Institute of Geography and Statistic (IBGE) (2014), the population of Lages, in 2014, was 158,846 inhabitants. Thus, the sample size was determined considering a maximum error of 8% and at a confidence level of 95%, with an estimate of the proportion from a pre-sample (SILVA et al., 1997). During the months of November and December 2014, there were interviewed 191 residents , of which 11 interviews were discarded for not presenting one or more variables of interest in the analysis, resulting in 180 valid samples.

In order to adequately represent the perception of population about the natural resources investigated, the data collection instrument was applied randomly, considering the proportional stratification of the population according to the main neighborhoods. The data collection instrument was a questionnaire structured based on the work of Freitas et al. (2010), Gullo (2010), Oliveira and Mata (2013), noting the recommendations of Arrow et al. (1993) to minimize the biases caused by the questionnaire's design and sample.

The CVM was used for environmental valuation purposes, based on the WTP of people for the recovery and conservation of Salto Caveiras, which was the dependent variable in the analysis. To identify the WTP, the first procedure adopted was the specific formulation of the scenario involving the environmental good. Then, the person interviewed was asked if they would accept or reject a financial contribution to the preservation of the environmental good analyzed. For this, the referendum method was used in accordance to Arrow et al. (1993), in which a value option was available, previously set from open answers from a pilot sample that was used in order to identify monetary parameters. In case of a negative answer, the respondent was asked how much would be the maximum amount



Source: Correio Lageano newspaper.

Figure 1 – View of Salto Caveiras waterfall (A) and the artificial lake (B), in Lages city, Santa Catarina State, Brazil.

they would be willing to contribute. If the answer was "zero", there was an attempt to identify the reason so, in order to verify whether it was a reflection of inability to pay or a "protest responses", seeking to adapt the answer found to the scope, as suggested by Desvousges, Mathews and Train (2012).

For the identification of the value given to the environmental good, preliminary data were analyzed using descriptive statistics. After that, the data were also undergoing the construction of a logistic regression model (logit) to perform predictions for dichotomous dependent variables from a set of explanatory variables. With the logistic regression model, it was possible to identify which variables increase the likelihood of individuals to contribute on improving the environmental quality of Salto Caveiras. The probability estimation is set within the range of zero and one, and it is not linear, considering that the marginal effect of one variable on the probability depends on the behavior of other variables. The logit regression model is specified by Equation 1:

$$\text{logit}: p = \Pr[Y=1] = \frac{1}{1 + e^{-X'\beta}} \quad (1)$$

In which:

Y is the dependent variable and indicates whether the individual agrees or not with the WTP value proposed by the referendum method (0 = no, 1 = yes);
X is a set of independent variables (parameters);
Pr is the probability of an individual presenting a positive WTP; and β is the coefficient of the estimated parameters.

The independent variables and their hypotheses were:

- Age: it is the age, in years, of the person interviewed. A positive marginal effect of this variable is expected, i.e., people with higher age have a life course and financial stability that increase the likelihood of a WTP contribution;
- Education: the variable was measured considering the respondent's educational level, by assigning zero (0) for cases in which the respondent has not studied; one (1) for those who had not completed elementary school; two (2) for complete primary education; three (3) for incomplete high school level; four (4) for complete high school education; five (5) for an incomplete graduation; six (6) for a complete graduation; and seven (7) for those with incomplete or complete post-graduation. A positive marginal effect of this variable is expected, indicating that a high education level improves the understanding of the need of environmental preservation, thereby increasing the probability of a WTP contribution;
- Income: it represents the gross monthly family income, by assigning zero (0) for cases in which the respondent does not have an income; one (1) for families with up to one minimum wage (MW); two (2) for incomes of one to two MW; three (3) for incomes of two to five MW; four (4) for incomes of five to ten MW; five (5) for incomes of 10 to 20 MW; 6 (six) for incomes of 20 to 30 MW; and seven (7) for families with incomes above 30 MW. A positive marginal effect is expected, indicating that higher incomes increase the probability of WTP contributions;
- People: it represents the number of respondent family members. A positive effect on the acceptance of contribution to the suggested value is expected, due to the higher number of people who enjoy the benefits generated by the increase in family income;
- ECS: it was obtained from a set of 15 assertions, some positive and some negative, and in response to a range of 5 to 1, where: 5 - totally agree; 4 - agree; 3 - indifferent; 2 – disagree; and 1 - totally disagree (Chart 1). The scale presents results that can vary from 15 to 75 points, and with higher environmental consciousness, the greater the ECS. In order to obtain the scores of the interviewed, the responses of the negative assertions were reversed; that is, 1 became 5, 2 became 4, and so on. As observed in education, a positive marginal effect is expected, since a higher consciousness results in a greater likelihood to agree to contribute with the suggested amount;
- Visit: it is the degree of importance of Salto Caveiras to the respondent, attributing one (1) when the fifth most important environmental good is nominated; two (2) when it was indicated as the fourth most important one; three (3) when it is the third one; four (4) when it is the second one; and five (5) when it is indicated as the most important one

from a list of five environmental goods of Lages, Santa Catarina. A positive effect is expected, i.e., the greater the importance attached to the environmental good, the higher their likelihood to agree to contribute with the suggested amount;

- Use: it is a categorical variable, assuming zero (0) when the respondent does not use Salto Caveiras and one (1) when they use it, even if occasionally. A negative effect is expected for this variable, since individuals tend to have the free-rider behavior, a result of recognition is that you can use the resource without having to pay for it, once it is a public good; and
- Price: the value (R$ 2.00; 5.00; 10.00; 20.00 or 50.00) is presented to the respondent by the referendum method. A negative effect is awaited, therefore, the higher the price suggested by the referendum method, the lower the probability for individual with positive WTP.

The logit regression model was conducted by the forward stepwise method (likelihood ratio), where the independent variables are sequentially added to the model.

In order to complement the regression model, the data were submitted to a multivariate analysis in order to identify, giving equal emphasis to all at once, independent variables that contribute to explain the behavior of individuals when expressing their WTP. The same independent variables employed in the logit regression models were also used in order to obtain the gradient length and for selecting the response model according to the methodology described by Ter Braak and Smilauer (1998). As this gradient was lower than 3 (linear response), the Principal Component Analysis (PCA) was adopted.

Chart 1 – Assertions for the obtaining of the Environmental Concern Scale.

Assertions
The government must introduce drastic measures to stop pollution since few people respect the laws.
We should not worry about killing game animals, because in the future things will be balanced.
Would you be willing to make personal sacrifices to reduce the rate of pollution even if the immediate results seem not so significant?
The pollution does not affect your personal life.
The benefits of modern consuming products are more important than the pollution generated by their production and use.
We must prevent the extinction of any animal, even if it means sacrificing some things to ourselves.
Schools should have compulsory training courses on environmental conservation.
Although there is still contamination of lakes, rivers and air, the purification processes of nature will return to normal in a few years.
It is unlikely that power generation produces a large quantity of pollution (excessive pollution), because the government has good control of it and surveillance agencies.
The government should provide / publish a list of agencies and organizations (institutions) to society where every citizen could make their complaint about pollution incidents or harm to the environment.
Predators such as hares, lions, sorrel and wild boar that destroy crops and farm animals should be eliminated.
The current environmental organizations are more interested in bothering the society than to fight against pollution.
Even if public transport generates less pollution, you use cars or motorcycles.
Would you contribute with money, time (or both) for organizations like “SOS Mata Atlantica”, that works to improve the quality of the environment?
Would you accept to increase household expenditures to promote the proper use of natural resources?

Source: adapted from García (2000).

In this case, the analysis of the WTP obtained by referendum method was performed considering two groups of answers: "no", for those who did not agree with the suggested value (response equal to 0); and "yes", for those who agreed. The cases in which the response has not been identified refers to an inability to pay, representing a genuine true answer (0), a protest responses (Protest), or to a suggestion of a lower value, since the value proposed by the method referendum was very high (Small Price).

RESULTS AND DISCUSSION

The survey results showed that 45.6% of people interviewed were willing to contribute to the price proposed by the referendum method and 54.4% of them had chosen the "0" response. The negative response by 18.9% of the respondents was due to financial limitation function or inability to pay, 12.8% of people proposed a smaller value and 22.8% of the answers turned out to be a protest response. The preliminary analysis of the data is presented in Table 1, considering the participation percentage of respondents, according to the responses submitted to the price proposed by the referendum.

The data shows that people who responded "yes" are older and have greater environmental concern represented by higher values in the ECS range. The results of the ECS were submitted to the Alpha test Cronbach (CRONBACH, 1951) as a measure of reliability between responses, resulting in a coefficient of 0.5950 in this research. Those who already showed negative responses to the suggested WTP had higher education and income level, especially those who characterized their answers as protest responses. For all other explanatory variables, important differences between the evaluated groups were not observed.

The distribution of responses for each suggested price, by referendum method, is showed in Figure 2. It can be observed that the lowest price option (R$ 2.00) was accepted by almost 70% of respondents with WTP. As the value of the suggested price increases, the percentage of positive responses decreases, showing a clear inverse relationship between price and WTP, typically observed in the demand of analysis.

Table 1 – Average values of the explanatory variables according to the willingness to pay to Salto Caveiras – an environmental good in the city of Lages, Santa Catarina State, Brazil.

Variable	Answer		Zero Response		
	Yes (45.6%)	No (54.4%)	Zero (18.9%)	Small Price (12.8%)	Protest (22.8%)
Age	45.6	41.1	42.5	37.1	42.1
Education	3.7	4.0	3.9	3.5	4.4
Income	2.8	3.2	3.0	2.9	3.5
People	2.9	3.0	2.9	3.2	2.9
ECS	59.3	57.0	55.5	59.0	57.1
Visit	0.9	0.9	0.9	1.0	0.9
Use	0.3	0.3	0.3	0.4	0.3
Price[a]	9.1	23.4	18.3	37.0	20.0

a: values in reais and the average of exchange rate for the period of the interview was $ 1.00 = R$ 2.60.

After successive estimates, the results obtained by the logit regression with the protest responses (Table 2), showed statistical significance by the Wald test ($p<0.05$) to the variable income, ECS and Price. By removing the protest responses of the analysis, the income variable was not significant and, therefore, removed from the analysis.

The individual benefit was estimated considering the models generated by the logit regression and the average values of the explanatory variables. Considering all the answers, including the protest responses, the individual benefit was R$ 12,217/month. The exclusion of the protest responses from the analysis resulted in an increase to R$ 21.040 per person/month.

The multivariate analysis (Figure 3) represents the average value of the main components represented by the centroid of the dependent variable (WTP) and shows the clear separation between the groups evaluated. In

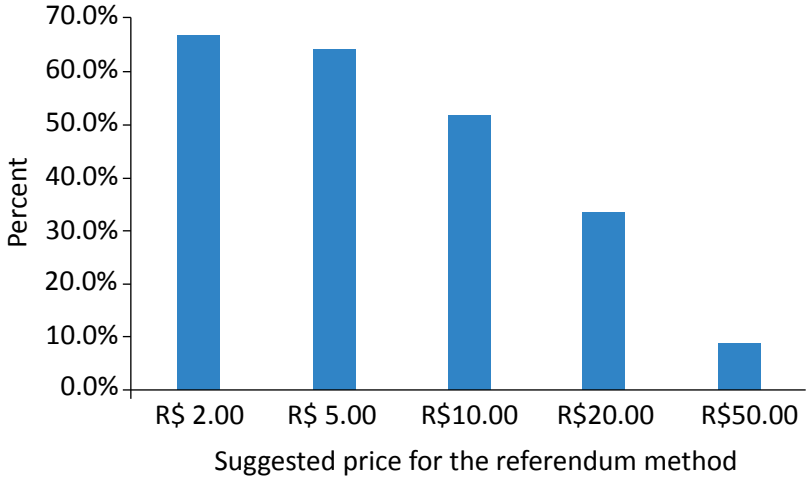


Figure 2 – Participation percentage of positive according to the willingness to pay suggested retail price by referendum.

Table 2 – Coefficients and significance of the variables of the logit regression.

Regression logit with the protest responses (n=180)				
Variable		**S.E**	**Wald**	**Sig**
Income	-0.330	0.149	4.871	0.027
ECS	0.096	0.030	10.308	0.001
Price	-0.069	0.014	24.629	0.000
Constant	-3.735	1.676	4.969	0.026
Regression logit without the protest responses (n=139)				
Variable		**S.E**	**Wald**	**Sig**
ECS	0.094	0.034	7.421	0.006
Price	-0.074	0.015	25.030	0.000
Constant	-3.925	1.953	4.039	0.044

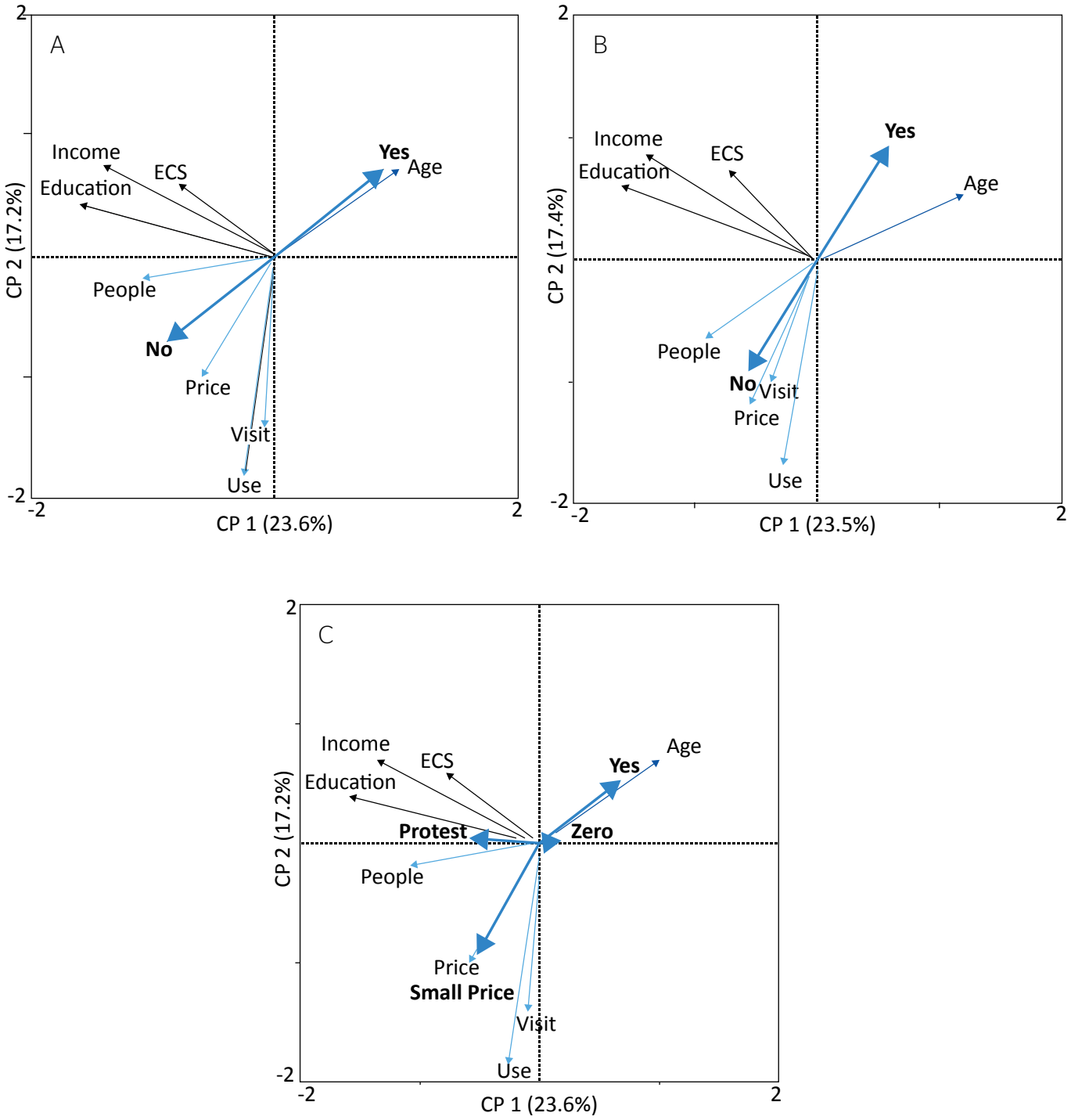


Figure 3 – Relationship between the main components broken down the response groups by referendum with all explanatory variables (Age, Education, Income, Environmental Concern Scale, People, Visit, Use and Price). In (A), with the protest responses; in (B) excluding the protest responses; and in (C) itemizing the answers zero to ZERO (for those who replied not due to inability to pay), PROTEST (protest responses) and SMALL PRICE (for those who answered no and suggested a smaller spontaneous willingness to pay).

accordance to Figure 3A, the WTP is positively associated with "Age" of the respondent and inversely associated with the "price", "people", "visit" and "use" variables. The analysis (Figure 3B) obtained the same results when excluding the protest responses. However, less positive WTP associations with "Age" and greater association of the variables "Price", "People", "Visit" and "Use" are observed for negative responses.

In Figure 3C — which discriminates negative answers into three groups ("Zero", "Protest" and "Small Price") —, note that "Price", "Use" and "Visit" are associated with the answer of respondents, but suggesting a smaller value than the proposed price. In addition, the PCA indicates the association between each variable: "Education", "Income", "ECS" and "People" with protest responses.

According to Mattos et al. (2007), valuing environmental goods that are directly used by population for recreation, as is the case of Salto Caveiras, usually receive a high number of positive answers for WTP. In this study, the level of negative answers (54.4%) was high when compared to other studies in Brazil; Gullo (2010), for example, obtained 34.8% of negative answers for the preservation of a dam, and in the study of Silva and Lima (2004) on the preservation of the Chico Mendes Park, in Rio Branco, 32% of the responses were "zero". Similar results were reported by Saz-Salazar and Guaita-Pradas (2013), which had 52% of "zero" answers and by the study of Dziegielewska and Mendelshon (2007), in which more than 65% of the answers were "zero".

A zero answer may be realistic, reflecting the payment incapacity. However, in several situations it reflects a protest response, normally motivated by political issues. In order to indentify these protest responses, it is recommended to investigate, through open questions, what are the reasons behind the answers. In our study, most of the reasons associated with protest responses (22.8%) referred to the allegation that natural resource preservation is a responsibility of the Government (55.7%), the existence of high taxes, represented by the phrase "we pay too much taxes" (11.5%), and by the mistrust of the effective use of resources for the preservation of the environmental good (8.2%). Similar reasons were also found in the study of Saz-Salazar and Guaita-Pradas (2013), where 32.6% of the answers were protest responses. According to Carson (1991), the level of protest responses found in these types of study are usually between 20 and 40%.

According to Silva and Lima (2004), protest behavior is problematic because it is a way in which people show the opinion that they have no responsibility in decision-making on natural resource management, with significant influence on society's well-being. Therefore, the introduction of a variable that measures the level of environmental awareness (ECS) in the models was in order to capture, in the same way, how individuals are concerned about environmental issues.

The Cronbach reliability measure for the ECS obtained a similar result to the one found by Borges et al. (2013), of 0.6118 with college students, and higher than Queiroga et al. (2006), of 0.51 to socially responsible consumers. Cronbach is an index that measures the degree of internal consistency and is between 0 and 1.

The variable income was not relevant to the logit model without protest responses, contrary to what was expected, once that, in this case, only answers that reflected inability to pay were considered as "zero". To Oliveira and Mata (2013), this variable acts only as a limiting factor, but does not influence in the decision of the respondents. The results of the logit regression were similar to those reported by Gullo (2010) and Oliveira and Mata (2013).

Considering the results of PCA, the association of the variables "Use" and "Visit" with positive WTP (Small Price) is consistent with the initial hypothesis, since people using the environmental good are aware of its importance and consider valid the idea of collaborating with its preservation, by experiencing the reality of the place and better understanding the influence that the environment has on the ecosystems connected to it and on the population's general well-being. However, given the financial limitations of those interviewed, their contribution is less than the suggested by the referendum method. Cirino and Lima (2008) also found a similar behavior pattern in their study regarding the variables "Use" and "Visit", since a significant percentage of people interviewed would accept helping, even though most of them were in financial problems. The inverse relationship between price and the WTP was also found in other studies, including Silva et al. (2011) and Volanova, Chichorro and Arruda (2010).

The connection of the number of family members and the answers "no" was also found by Pizaia (2010). This behavior can be explained, at least in part, by the fact that the greater the number of people in a residence, the greater is the family commitment with their income. On top of that, in a position of financial limitation, the supply of basic needs and family materials becomes priority at the expense of environmental causes.

The variables "Education", "Income" and "ECS" have shown to be related to the protest responses, and are also associated with each other. The correlation between education and income is classic in social studies and in this case, there is also an influence on environmental awareness. The level of education was also significant in the studies of Oliveira and Mata (2013) and Gullo (2010). As expected, people with higher education levels have a more critical attitude, and in this sense, it is understandable that they are not always favorable in making such decisions as to financially contribute to the maintenance of a public good, especially in the Brazilian scenario, where the welfare culture is intense, with high tax burdens and the presence of corruption.

The age of the respondents was strongly associated with the "yes" answer, which was also verified by Gullo (2010) and Silva and Lima (2004), justifying that this positive effect is due to the emergence of educational programs, policies and campaigns that are being created over time.

CONCLUSIONS

The ECS appeared to be significant in the logistic regression models used. In PCA, despite the ECS not being associated with positive WTP, it proved to be consistent as it was related to the education and the income of respondents, confirming the initial hypothesis. Therefore, the analysis of the results demonstrated the possibility of using ECS as an explanatory variable in the CVM, generating openness to a new range of possible results in future studies.

The introduction of the PCA as a multivariate analysis tool used in this study of CVM is innovative, proving to be an excellent tool to demonstrate the connection between the WTP and the profile of respondents, enabling a more holistic and comprehensive view of the different response groups. Therefore, these procedures are recommended to be used in future studies.

When critically analyzing the reasons for the negative response to the WTP, it becomes even more visible and concrete the use of PCA together with the CVM. By using a multivariate analysis, it was possible to visualize the different groups of "zero" answers and what explanatory variables were associated to them, resulting in more precise analysis, especially for protest responses.

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