Article **Journal of Quantitative and Statistical Analysis**
December, 2022 Vol.9 No.25 7-16

Analysis of the income elasticity of demand for recreational and environmental of three ecosystems in Mexico

Análisis de la elasticidad ingreso de la demanda de servicios recreativos y ambientales de tres ecosistemas en México

BLAS-CORTES, Jonatan†[1], OMAÑA-SILVESTRE, José Miguel*[2], QUINTERO-RAMIREZ, Juan Manuel[3] and MONTIEL-BATALLA, Blanca Margarita[4]

[1]*Postdoctorante del Posgrado en Socioeconomía, Estadística e Informática-Economía. Colegio de Posgraduados, Campus Montecillo, Texcoco, Estado de México, México.*
[2]*Profesor Investigador Titular. Posgrado en Economía del Colegio de Posgraduados, Campus Montecillo, Texcoco, Estado de México, México.*
[3]*Investigador por México del 3Consejo Nacional de Ciencia y Tecnología. Ciudad de México, México.*
[4]*Profesora de tiempo completo. Instituto de Ciencia Agrícolas de la Universidad Autónoma de Baja California.México.*

ID 1st Author: *Jonatan, Blas-Cortés* / **ORC ID**: 0000-0001-5357-6968, **CVU CONACYT ID**: 325455

ID 1st Co-author: *José Miguel, Omaña-Silvestre* / **ORC ID**: 0000-0002-5356-549X, **CVU CONACYT ID**: 59890

ID 2nd Co-author: *Juan Manuel, Quintero-Ramírez* / **ORC ID**: 0000-0002-1040-2690, **CVU CONACYT ID**: 292056

ID 3rd Co-author: *Blanca Margarita, Montiel-Batalla* / **ORC ID**: 0000-0003-0959-5365, **CVU CONACYT ID**: 216550

DOI: 10.35429/JQSA.2022.25.9.7.16 Received September 05, 2022; Accepted December 30, 2022

Abstract

The objective of this research is to estimate the income elasticity of demand for environmental services of three ecosystems in Mexico. In the three studies of stated preferences about the willingness to pay for an environmental quality improvement project, we used a sample size of 289 observations for the Primas Basalticos ecosystems and 150 for the La Michilía Biosphere Reserve and the Molino de Las Flores National Park. The selection of interviewees was random among visitors. To carry out the estimation, a cluster analysis was carried out to determine the income strata, where the indicator was formulated and calculated in each ecosystem for three income strata (high, medium and low) based on a segmentation of the consumers of recreational services through the two-stage clustering method. In this way, the recreational services of the three ecosystems in both cases behave as a normal good; that is, if the income of the high and middle income consumer increases, the demand for recreational services will increase less than proportionally.

Normal good, Inferior good, Willingness to pay, Two step cluster analysis

Resumen

Estimar la elasticidad ingreso de la demanda de servicios ambientales de tres ecosistemas de México; es el objetivo de esta investigación. En los tres estudios de preferencias declaradas acerca de la disponibilidad a pagar por un proyecto de mejora de la calidad ambiental, se utilizó un tamaño de 289 observaciones para los ecosistemas de los Primas Basálticos y de 150 para la Reserva de la Biosfera La Michilía y del Parque Nacional Molino de Las Flores. La selección de los entrevistados fue aleatoria entre sus visitantes. Para realizar la estimación se realizó el análisis de clúster para la determinación de los estratos de ingresos, donde se formuló y calculó el indicador en cada ecosistema para tres estratos de ingreso (alto, medio y bajo) a partir de una segmentación de los consumidores de servicios recreativos a través del método de conglomerados en dos etapas. De esta manera, los servicios recreativos de los tres ecosistemas en ambos casos se comportan como un bien normal; es decir, si el ingreso del consumidor de ingreso alto y medio se incrementa, la demanda por servicios recreativos se incrementará menos que proporcionalmente.

Bien normal, Bien inferior, Disponibilidad a pagar, análisis de conglomerados en dos etapas

Citation: BLAS-CORTES, Jonatan, OMAÑA-SILVESTRE, José Miguel, QUINTERO-RAMIREZ, Juan Manuel and MONTIEL-BATALLA, Blanca Margarita. Analysis of the income elasticity of demand for recreational and environmental of three ecosystems in Mexico. Journal of Quantitative and Statistical Analysis. 2022. 9-25: 7-16

* Correspondence to Author (e-mail: miguelom@colpos.mx)
† Researcher contributing as first author.

Introduction

Despite the development of several proposals to define environmental goods and services, there is no commonly accepted definition or single criterion for their classification. The Organization for Economic Cooperation and Development (OECD) and the European Statistical Office (Eurostat) propose a fairly comprehensive definition, stating that this sector is composed of "activities that produce goods and services aimed at measuring, preventing, limiting, minimizing or correcting environmental damage to water, air and soil, as well as problems related to waste, noise and ecosystems. This includes cleaner technologies, products and services that reduce environmental risk and minimize pollution and resource use". This universe would include equipment and its components, final consumption products, the provision of services and the construction or operation of facilities; ECLAC (2005).

There are currently several factors that stimulate the growth of demand and willingness to pay for environmental and recreational services. The same trend can be seen in public awareness of the value of this type of services and the costs of reducing them.

For traded products and services, market prices indicate the value for which buyers and sellers agree to exchange. However, for many environmental services there are no market prices and, consequently, it is difficult to quantify their importance or estimate their value. There is a lack of sufficient information that takes into account the underlying process that generates environmental services and their consequences for human well-being. In many cases, benefits may be uncertain and, if anything, occur only in the future.

A common approach to estimating environmental values is the concept of total economic value, which includes the full set of economic values that people attach to each form of land use. The aggravation of many environmental and natural resource use problems, together with the development of institutional and technological capabilities to respond to them, have led in recent decades to the search for possible solutions, including the market for environmental goods and services.

There are currently a large number of documentary references that address the problem of the deterioration of natural resources; some of these are the reports of the United Nations Intergovernmental Panel on Climate Change and the Framework Convention on Climate Change, as well as the American Journal of Climate Change and the International Journal of Global Warming, among others, which address the serious environmental problems worldwide and, where appropriate, the possible solutions proposed through consensus.

In relation to this, Mexico faces major environmental challenges that can be divided into three main groups: lags in infrastructure (notably potable water and drainage, and sanitary landfills for waste); environmental imbalances associated with structural problems and socioeconomic heterogeneities (for example, deforestation linked to problems of poverty and low productivity in the primary sector); and problems associated with industrialization processes under unsustainable patterns of production and consumption (for example, vehicle emissions) (ECLAC 2005).

In relation to the above, environmental goods and services constitute an important support element for environmental policy. Although it is true that measures for the effective protection of the environment and the sustainable use of natural resources require much more than technological solutions and physical infrastructure, particularly in countries with high levels of heterogeneity and socioeconomic complexity, as in the case of Mexico, their contribution to the diagnosis and monitoring of the state of ecosystems and the effects of pollution is unquestionable; in the prevention and attention to natural disasters; in the planning, instrumentation and verification of a series of provisions established for environmental care; in the reduction of environmental impacts and risks and in the increase of the efficiency rate in the use of natural resources.

These last two characteristics give environmental goods and services an economic significance, in the sense of their direct contribution to the maintenance of natural capital. They also generate, directly or indirectly, a significant number of sources of employment and a wide range of satisfiers. Their contribution to the economy, in terms of value added, is relatively modest but growing.

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The valuation of environmental assets is not a subject that is currently being exhaustively addressed in Mexico. This is an arduous and not very simple task, since there is no market for this type of assets, and it is even more necessary and indispensable nowadays in order to allocate the necessary resources for their delimitation, conservation and adequate use, due to the demand to protect and provide these spaces and resources to the countries as an important asset for their wealth and quality of life.

In a market society, giving monetary value to environmental assets is very important as a guiding axis in decision making regarding the allocation of the necessary resources for their conservation and improvement and, therefore, for the implementation of a public policy aimed at a culture of conservation, which can result in welfare for citizens, and thus the destination of spaces and the conservation of environmental assets can justify their value in relation to other uses of these land areas.

In addition to quantifying the monetary amount that consumers would be willing to pay to access the referred recreational services, it is necessary to define whether for different consumer strata (based on their economic and socio-demographic characteristics) the goods and services can be considered as normal, inferior or luxury goods. Within this main framework, the objective of the research was to determine the income elasticity of demand for recreational or environmental services in the ecosystems of La Michilía Biosphere Reserve (Durango, Durango), Molino de Las Flores National Park (Texcoco, State of Mexico) and the Basaltic Prisms (Santa María Regla, Hidalgo), in order to establish whether these behave as inferior goods, normal goods or luxury goods.

The working hypothesis was that the recreational services offered by the aforementioned ecosystems behave as a normal good, so that their demand grows when income increases, although in a smaller proportion; also, that the estimation of income elasticities by stratum can show elasticities greater than unity or less than zero in any of the three ecosystems, so that in the first case the environmental services behave as a normal good and in the second as inferior or superior goods.

Methodology

In the three studies of stated preferences about the willingness to pay for an environmental quality improvement project, a size of 289 observations was used for the Basaltic Primas ecosystems and 150 for the La Michilía Biosphere Reserve and Molino de Las Flores National Park. The selection of interviewees was randomized among visitors in the period from March to April 2019.

Cluster analysis

Cluster analysis was used to determine the income strata; a data exploration tool complemented by data visualization techniques (Jain and Dubes, 1988). Cluster analysis is basically about solving the following problem: given a set of n individuals characterized by the information of p variables Xj, (j = 1, 2, ..., p), the aim is to classify them in such a way that the individuals belonging to a group (cluster) are as similar as possible to each other and the different groups are as dissimilar as possible.

The two-stage clustering tool through SPSS software was developed by Chiu, Fang, Chen, Wang and Jeris (2001) for the analysis of large data sets. Two distance measures can be used: Euclidean distance and Log Likelihood distance. The latter can handle mixed type attributes. The log likelihood distance between two clusters i and s is defined as:

$$d(i,s) = \xi_i + \xi_s - \xi_{\langle i,s\rangle} \quad (1)$$

Where:

$$\xi_i = -n_i \left[\sum_{j=1}^{p} \frac{1}{2}\log\left(\hat{\sigma}_{ij}^2 + \hat{\sigma}_j^2\right) - \sum_{j=1}^{q} \sum_{l=1}^{mj} \hat{\pi}_{ijl}\log(\hat{\pi}_{ijl})\right]$$

$$\xi_s = -n_s \left[\sum_{j=1}^{p} \frac{1}{2}\log\left(\hat{\sigma}_{sj}^2 + \hat{\sigma}_j^2\right) - \sum_{j=1}^{q} \sum_{l=1}^{mj} \hat{\pi}_{sjl}\log(\hat{\pi}_{sjl})\right]$$

$$\xi_{\langle i,s\rangle} = -n_{\langle i,s\rangle} \left[\sum_{j=1}^{p} \frac{1}{2}\log\left(\hat{\sigma}_{\langle i,s\rangle j}^2 + \hat{\sigma}_j^2\right) - \sum_{j=1}^{q} \sum_{l=1}^{mj} \hat{\pi}_{\langle i,s\rangle jl}\log(\hat{\pi}_{\langle i,s\rangle jl})\right]$$

ξ_v can be interpreted as a type of dispersion (variance) within cluster $v\,(v = i, s, \langle i, s \rangle$. $\xi_v$consists of two parts. The first, $-n_v \sum \frac{1}{2} \log (\hat{\sigma}_{vj}^2 + \hat{\sigma}_j^2$ measures the dispersion of the continuous variable x_j within cluster *v*. If only were used $\hat{\sigma}_{vj}^2$, $d\,(i, s)$ would be exactly the decrease in the log likelihood function after the merging of clusters *i* and *s*. The term $\hat{\sigma}_j^2$ is added to avoid the degeneracy situation of $\hat{\sigma}_{vj}^2 = 0$. The entropy $-nv \sum_{j=1}^{q} \sum_{l=1}^{mj} \hat{\pi}_{vjl} \log (\hat{\pi}_{vjl})$used in the second part as a measure of dispersion for categorical variables. Similar to hierarchical clusters, those clusters with the smallest distance $d\,(i, s)$are merged at each step. The log likelihood function for the step with *k* clusters is computed as:

$$l_k = \sum_{v=1}^{k} \xi_v$$

The function l_k is the exact likelihood function. The function can be interpreted as the dispersion in the clusters. If only categorical variables are used, l_k is the entropy within the *k* clusters.

a) Number of clusters

The number of clusters can be determined automatically by two steps: the Akaike Information Criterion, defined as:

$$AIC_k = -2l_k + 2r_k$$

where $r_k$is the number of independent parameters of the Bayesian Information Criterion:

$$BIC_k = -2l_k + r_k \log n$$

Computed in the first phase. BIC_k or AIC_kgives a good initial estimator of the number of clusters (Chiu *et al*., 2001). The maximum number of clusters is set equal to the number of clusters where the ratio BIC_k/BIC_1 is less than c_1 (currently $c_1 = 0.04$)) for the first time.

The second phase uses the rate of change $R\,(k)$ in distance for *k* clusters, defined as:

$$R(k) = d_{k-1}/d_k$$

where $d_{k-1}$is the distance if *k* clusters are merged into $k-1$ clusters. The distance d_k is defined similarly. The number of clusters is obtained for the solution where a large jump in the change ratio occurs.

The change ratio is calculated as:

$$R(k_1)/R(k_2)$$

For the two largest values of $R(k)(k = 1, 2, \ldots, k_{max}$ obtained from the first stage). If the rate of change is larger than the threshold value c_2 (currently $c_2 = 1.15$)) the number of clusters is set equal to k_1, otherwise the number of clusters is set equal to the solution with $\max(k_1, k_2)$.

b) Assignment of cluster members

Each object is deterministically assigned to the nearest cluster according to the distance measure used to find the cluster. The deterministic assignment may result in biased estimates of cluster profiles if the clusters overlap (Bacher and Wenzig, 2004).

The variables used for cluster formation in the Basaltic Prism ecosystem were: Willingness to Pay; Price; Household Income; Age; Schooling; Family Size; Gender and Marital Status. In the case of Molino de Las Flores National Park, the following variables were used: Willingness to Pay; Household Size; Age; Income; Gender; Education; and Preception of environmental quality.

The variables used to segment the sample of environmental consumers of the Michilía de Durango ecosystem were: Probability of answering YES to the question about willingness to pay to improve the recreational services of La Michilía (dependent variable); Estimated price to pay to access La Michilía Biosphere Reserve; Monthly family income of the head or person in charge of the household; Age of the interviewee; Gender of the interviewee; and, Preferences of the interviewee to visit or not to visit La Michilía Biosphere Reserve.

Income elasticity

Microeconomics defines income elasticity of demand as the percentage change in demand for a good in response to a percentage change in consumer income. The expression for its calculation is as follows:

$$\eta_I = \beta \frac{I}{Q}$$

ISSN 2410-3438

In this case β is the (linear) parameter estimated from the multiple linear regression model associated with the independent variable income.

The ease of calculation and interpretation of income elasticity does not occur with the discrete choice model, in which the dependent variable is no longer continuous but of the dichotomous type; that is, it assumes only values of zero and unity. In the case of the independent variables these can be of the continuous or qualitative type (dichotomous or polychotomous). In this case the expression for the calculation of income elasticity is:

$$\eta_I = \theta \times \frac{I}{0.5} = 2\theta I$$

In this case θ it is the marginal effect of the variable and is given by $\vartheta = \frac{\beta_{Ing} e^{\beta' x}}{(1+e^{\beta' x})^2}$ in whose expression β_{Ing} the parameter associated to the income variable; I represents the average income of the respective cluster or sample. Regarding the denominator, whose value is 0.5, it represents the probability used in the calculations shown in this research. This is due to the fact that the regression model that is estimated corresponds to estimating the probability that the event under study takes the value of zero or unity.

According to Vaughan (2010), in the case of probability models (as in the dichotomous logistic regression model) the use of the conventional microeconomics expression to calculate elasticity is inadequate, because the dependent variable is itself a unitless number between 0 and 1:

$$\eta_x = x \frac{\partial \Pr(x)}{\partial x}$$

Since

$$Ln\left(\frac{\Pr(x_i)}{1-\Pr(x_i)}\right) = \beta_0 + \beta_1 x_{i1} + e_i$$

From where the elasticity can be calculated as follows:

$$\frac{\partial\left[ln\left(\frac{\Pr(x_i)}{1-\Pr(x_i)}\right)\right]}{\partial x} = \beta_1$$

Therefore, the quasi-elasticity is:

$$\eta(x_i) = \beta_1 x_i P(x_i)(1 - P(x_i))$$

It measures the percentage change at a point in the probability due to an increase in x. The result depends on the point at which the change is evaluated. The quasi-elasticity evaluated at the mean is given by:

$$\eta(\bar{x}) = \beta_1 \bar{x} P(\bar{x})(1 - P(\bar{x}))$$

where:

$$\Pr(\bar{x}) = \frac{e^{\beta_0+\beta_1\bar{x}}}{1+e^{\beta_0+\beta_1\bar{x}}}$$

Assuming that $\Pr(\bar{x}) = 0.5$, the formula for calculating the quasi-elasticity is:

$$\eta(\bar{x}) = \beta_1 \bar{x} P(\bar{x})\big(1 - P(\bar{x})\big) = \beta_1 \bar{x}(0.5)(1 - 0.5) = \beta_1 \bar{x}(0.25)$$

Therefore:

$$\eta(\bar{\chi}) = (0.25)\beta_1 \bar{x}$$

Where $\beta_1$is the estimated parameter in the logistic regression and $\bar{x}$ is the average value of the corresponding independent variable, e.g., average household income.

Results

Once the relevant variables in the formation of the clusters of consumers of recreational services had been defined, the SPSS runs were carried out. Since the number of existing clusters was unknown a priori, the computational algorithm determined them automatically based on the statistical criteria referred to above. The self-clustering criterion was the Bayesian Information Criterion (BIC), which is computed for each potential number of clusters. The smaller the value of the BIC, the better the model and, therefore, the better solution for determining the number of clusters. The optimal number of clusters occurs when there is the lowest change in the Bayesian Information Criterion (BIC) and the highest ratio of distance measures (Ramirez, 2013).

Basaltic Prisms

The lowest BIC clustering criterion is 1.351 which occurs when the ratio of distance measures is maximum at 2.134. Therefore, the optimal number of clusters of consumers of recreational services in this ecosystem is three (Table 1).

No. of cluster	Schwarz Bayesian Criterion (BIC)	Change of BIC	Exchange Ratio in BIC	Distance Measurement Ratio
1	1,831			
2	1,565	-265.897	1.000	1.184
3	1,351	-213.959	0.805	2.134
4	1,287	-64.238	0.242	1.591

Table 1 Result of the self-aggregation of the Basaltic Prism ecosystem
Source: Adapted from Ramírez (2013)

The consumer of environmental services of the Basaltic Prisms ecosystem (cluster 1) is characterized by being the youngest (29.25 years old), the one with the highest schooling (years of study) and the one with the highest income. In the second cluster is the oldest consumer (41.07 years old), with the lowest schooling (12.93 years of study) and the lowest number of family members (Table 2).

Conglomerate	Price ($)	Income Family Income ($/mont)	Age (years)	Schooling (years)	Size of Family (members)
1	24.30	9,295	29.25	14.51	4.08
2	25.80	8,751	41.07	12.93	3.54
3	24.64	8,689	40.56	13.30	4.08
Combined	24.84	8,934	36.46	13.65	3.93

Table 2 Centroids of continuous variables
Source: Adapted from Ramírez (2013)

More than two thirds of those demanding recreational services from basaltic prisms are willing to pay for improvements that could be made to the site (68.4%) (Table 3).

DAP	Absolute	Relative (%)	Genre	Absolute	Relative (%)	Edo. civil	Absolute	Relative (%)
yes	195	68.4	Man	151	53	Married	114	40
	90	31.6	Woman	134	47	Single	171	60
Total	285	285	Total	285	100	Total	285	100

Table 3 Frequency distribution of categorical variables.
Source: Adapted from Ramírez (2013)

Molino de Las Flores National Park

The lowest BIC is 1,042.212 which occurs when the ratio of distance measures is maximum at 1.390 so the optimal number of clusters is three (Table 4).

No. of clusters	Schwarz Bayesian Criterion (BIC)	Change of BIC	Exchange Ratio in BIC	Distance Measurement Ratio
1	1216.009			
2	1115.662	-100.347	1.000	1.187
3	1042.212	-73.450	0.732	1.390

Table 4 Self-grouping result for Molino de Las Flores Park
Source: Prepared from SPSS outputs

Table 5 shows the centroids (means) of the continuous variables of Molino de Las Flores and their standard deviation.

Conglomerate	DAP		TAH		ING	
	Media	Typical deviation	Media	Typical deviation	Media	Typical deviation
1	19.46	8.834	4.78	2.412	6,608.41	4,336.206
2	18.40	8.598	4.90	1.669	8042.34	4,703.966
3	15.46	7.787	4.00	1.530	5,864.24	2,863.57
Comb.	17.67	8.507	4.54	1.916	6,818.49	4086.823

Table 5 Centroids of the continuous variables Molino de Las Flores National Park
Source: Elaborated from SPSS outputs

Table 6 shows the frequency distribution of the perception of the environmental quality of the recreational services provided by Molino de Las Flores National Park.

Conglomerate	Not deteriorated		Deteriorated and badly deteriorated	
	Frequency	%	Frequency	%
1	17	81.0	29	22.5
2	0	0.0	50	38.8
3	4	19.0	50	38.8
Combined	21	100	129	100

Table 6 Frequency distribution of Environmental Perception
Source: Elaborated from SPSS outputs.

La Michilía Biosphere Reserve

According to the two criteria used to define the segmentation of the La Michilía sample by stratum, the optimal number of clusters is three (Table 7).

Number of clusters	Schwarz Bayesian Criterion (BIC)	Change of BIC	Exchange Ratio in BIC	Distance Measurement Ratio
1	781.988			
2	657.536	1.000		1.128
3	552.331	0.845		1.866
4	516.867	0.285		1.387

Table 7 Results of self-grouping La Michilía
Source: Prepared from SPSS outputs

Table 8 shows the centroids (means) and standard deviations of the continuous variables used for the analysis of the results of La Michilía.

Conglomerate	DAPC		AGE		ING	
	Media	Typical deviation	Media	Typical deviation	Media	Typical deviation
1	44.70	4.25	38.81	16.22	1,820.00	716.57
2	55.12	11.14	37.69	13.82	3,239.52	1,880.37
3	45.42	4.34	35.14	14.15	1,940.88	732.65
Comb.	48.43	8.78	37.10	14.88	2,447.83	1,482,70

Table 8 Centroids of the continuous variables La Michilía Biosphere Reserve
Source: Prepared from SPSS outputs

Table 9 shows the distribution of the categorical variable gender used for the segmentation of the La Michilía sample.

Conglomrd	Woman		Man	
	Frequency	%	Frequency	%
1	12	16.9	25	31.6
2	8	11.3	54	68.4
3	51	71.8	0	0.0
Combined	71	100.0	79	100.0

Table 9 Distribution of gender frequencies
Source: Prepared from SPSS outputs

Microeconometric indicators of income elasticity

The willingness to pay was estimated for the three ecosystems through dichotomous logistic regression by posing to consumers a hypothetical scenario of improved recreational services reflected in improvements in their welfare (Table 10).

Stratum	La Michilía (2014)			Molino de Flores (2010)			Prismas Basalticos (2012)		
	Ingreso	DAP	ElasticidadIngreso	Ingreso	DAP	EI	Ingreso	DAP	EI
I	1,820	42.3	-0.44	5,864	6.8	7.64	8,634	47.8	0.17
II	1,941	49.9	0.28	6,608	17.6	0.44	8,751	36.9	0.18
III	3,239	174.24	0.15	8,042	26.9	0.74	9,295	43.3	0.56
Total	2,448	48.4	0.27	6,818	23.6	0.59	8,934	42.0	0.27

Table 10 Estimated income elasticities of the three ecosystems
Source: Own elaboration based on the outputs of the statistical runs

When considering the total sample, the elasticity of demand for the three ecosystems shows that the recreational services offered by the three ecosystems behave as a normal good as the respective income increases. The income elasticities are greater than zero and less than unity. Thus, if the respective income increases by 10 percent, the demand for recreational services in La Michilia Biosphere Reserve will increase by 2.27 percent. In Molino de Flores National Park the demand for recreation will increase by 5.9 percent and in the Basaltine Prisms ecosystem the demand will increase by 2.7 percent.

In the analysis by cluster, the same behavior is observed for cluster three, which is the highest income cluster in the respective ecosystems.

Thus, if income increases by 10 percent, the demand for recreational services increases 1.5 percent for La Michilía; 7.4 percent for Molino de Las Flores and 1.7 percent for Prismas Basálticos. Note that this stratum can be considered the high-income recreational consumer stratum.

The analysis of stratum two or middle income indicates that recreational services also behave as a normal good. Thus if income increases by 10 percent the elasticity increases by 2.8 percent for La Michilía, 4.4 percent for Molino de Las Flores and 1.8 percent for Prismas Basálticos.

In stratum one or low income, the analysis shows contrasts in demand for recreational services in La Michilía and Molino de Las Flores with clusters two and three and with the recreational services of Prismas Basálticos in the same stratum. Consumers in stratum one of La Michilía have by far the lowest income while La Michilía is the ecosystem where consumers have on average the lowest income.

The income elasticity of demand for cluster one in La Michilia is -0.44, which implies that if income increases by 10 percent, the demand for recreational services in this Biosphere Reserve will decrease by 4.4 percent. In other words, recreational services behave as an inferior good for this consumer stratum. Therefore, when the consumer's income increases, its demand or consumption decreases as the consumer's income increases.

The finding described in the previous paragraph although it does not contradict the research of the vast majority of studies that have shown that environmental services behave as a normal good (Kriström, and Pere, 1996; Freeman, 2013; Pereyra and Rossi, (n/d)) and in some cases as a luxury good (Ghalwash, n/d) does not rule out its behavior as an inferior good especially for poorer strata. This is reflected in the concern of some authors who have studied in depth the effects of the implementation of environmental policies that charge a fee for access to the enjoyment of the recreational services of public goods, the privatization of the ecosystems that offer them, and the disappearance of such sites for the purpose of achieving development by exploiting resources of economic importance located within such ecosystems, among others.

It is argued that such measures have regressive effects against the poorest (Flores and Carson, 1997). In contrast to such behavior of the low-income consumer of La Michilía is the low-income consumer of Molino de Las Flores. According to the estimated income elasticity of 6.8, it implies that, if their income increases by 10 percent, the demand for recreational services in that ecosystem increases by 68 percent. This is a common finding in research on the income elasticity of demand for environmental quality (Hökbya and Söderqvist, 2003).

The analysis of the WTP of each of the ecosystems does not allow comparison between the three ecosystems studied, but does allow comparison between strata of each ecosystem. Between clusters of the Basaltic Prisms it is possible to observe that the low-income consumer has a higher willingness to pay than the middle and high-income stratum. Thus, the former has a WTP of $47.8 versus $36.9 and $43.3 for strata two and three.

This finding is not confirmed by the cases of La Michilía or Molino de Las Flores. In the La Michilía ecosystem, WTP increases as consumer income increases. The same occurs in the case of Molino de Las Flores, i.e. the two higher income clusters also have a higher WTP as their income increases.

Although the finding that the poorest have a greater willingness to pay than those with higher incomes is not verified, this concern has been studied by a large number of researchers given the potential regressive effects on lower income consumers that may occur due to policy prescriptions that suggest the privatization of public environmental goods or the disappearance of an ecosystem where this type of consumer has free access.

Calculation of probabilities

In econometric terms, the income elasticity of demand for recreational services in the Basaltic Prisms shows that if the average income for the entire sample ($8,934) increases by 10%, the probability that the consumer of recreational services in this ecosystem will be willing to pay $42.0 pesos for an ecosystem improvement project will increase by 2.7%.

The probability that the consumer would answer yes when asked if he/she would be willing to pay $42.0 pesos for improvements in the recreational services of the Basalt Prisms is 71.0%. This probability increases by 2.7% if consumer income in this case were to increase by 10% (from $8,934 pesos to $9,827 pesos). Increasing the probability of an affirmative response by the consumer by 2.7% increases this probability from 71.0% to 72.9%.

The calculations of the procedure for this calculation are given by the multiple regression logistic model. Thus, for the Basaltic Prism ecosystem, the probability for the entire sample (n = 285), given an estimated WTP of $42 pesos, the estimation procedure is as follows:

$$P(Si/DAP) = \frac{1}{1+e^{-(\beta_0+\beta_1 X_1+\beta_2 X_2)}} =$$

$$P(Si/42) = \frac{1}{1+e^{-(\beta_0+\beta_1 PREC+\beta_2 IFAM)}} =$$

$$P(Si/42) = \frac{1}{1+e^{-(1.52484-0.05212 PREC+0.000074655 IFAM)}} =$$

$$P\left(\frac{Si}{42}\right) = \frac{1}{1+e^{-(1.52484-0.05212)(24.8421)+(0.000074655)*(8934.4))}} =$$

$$P(Si/42) = 0.7103$$

The interpretation of this expression is the following: the probability that the consumer accepts to pay $42 for a project to improve the recreational services of the Basaltic Prisms is 71.03%. Now, the income elasticity as a measure of sensitivity of the effect on the probability of a change in consumer income indicates that if income increases by 10% the probability will increase by 2.74%. That is, the probability increases from 71.03% to 72.45%.

The problem can be stated as follows: By how much will the probability of the consumer agreeing to pay $42 for an environmental services improvement project increase if the following data are available?

Concept	Initial value	Increase	Final value
Elasticity	0.274467		
Income	$8,934	$893 (10%)	$9,827
Probability	0.7103	ΔPr = ¿?	Pr_1 = ¿?

The calculation of the probability increment (ΔPr) is computed as follows: ΔPr = (0.7103) (0.0274467) = 0.019463, then:

Pr1 = 0.7103 + 0.0195 = 0.7298

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Pr1 = 0.7298

Thus the final table of figures is as follows (rounded to four decimal places).

Concept	Initial value	Increase	Final value
Elasticity	0.274467		
Income	$8,934	$893 (10%)	$9,827
Probability	0.7103	0.0195	0.7298

That is, if income increases by 10%, the probability that the consumer will be willing to pay $42 for improvements in recreational services will increase from 71.03% to 72.98% as indicated by the income elasticity of demand for recreational services.

Conclusions

Analysis of the results of the microeconometric estimation of the income elasticity of demand for recreational services in the three study ecosystems indicates that for the full sample recreational services behave as a normal good so that demand increases less than proportionally if income increases by 10 percent. The income elasticity for La Michilia Biosphere Reserve is 0.27, increasing demand by 2.7 if income increases by 10 percent, while the income elasticity for Molino de Las Flores National Park is 5. 9 so the demand for recreational services will increase by 5.9 percent if income increases by 10 percent and the income elasticity of Basalt Prisms is 0.27 so the demand for recreational services will increase by 2.7 if income increases by 10 percent.

The magnitude of the elasticity for the La Michilia ecosystem, which has the lowest income, and the Basalt Prisms ecosystem, the ecosystem with the highest income consumers, is equal. This finding is in line with the research results of theoretical and empirical authors. In addition, the intra-cluster analysis of each ecosystem shows similar behavior to the result obtained for the whole sample except for the lowest income cluster (stratum one). In the case of stratum three (high income), the elasticity shows that for consumers in this conglomerate recreational services behave as a normal good, since its calculated elasticity is greater than zero and less than unity, as suggested by economic theory. For stratum two (middle income), the income elasticity of the quality of recreational services behaves as a normal good while the low income conglomerate shows a mixed behavior.

For La Michilía as an ecosystem, whose visitor population has the lowest income, the income elasticity shows that for this group the enjoyment of recreational services is an inferior good. Therefore, as their income rises, ceteris paribus, the demand for this environmental service will decrease.

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ISSN 2410-3438