The Contingent Valuation Method Applied to the Mining Heritage of Extremadura (Spain)

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Abstract
In this study, the contingent valuation method is used to appraise the value and market potential of mining heritage, serving as a means to evaluate these heritage assets for the society, for the purposes of entertainment, culture or recreation. The method has been applied to the specific case of the region of Extremadura (Spain), an area with a prevalent mining tradition that dates back to prehistoric times, boasting countless mining-related remains of recognised value. Among those vestiges, 20 enclaves were selected for use in this study following research carried out by the Institute of Geology and Mining in Spain. A survey has been used to estimate the public willingness to pay for the conservation, restoration and protection of mining heritage assets that could be visited by both local people and others. Three payment values (7, 13 and 20 euros) were established to classify respondents' responses and thus estimate the degree of interest expressed in currency units, which were shown by the mining heritage of Extremadura as a possible destination for a tourist trip. While a high percentage (43%) of respondents did not know what the mining heritage is, after the introduction to the survey included in the surveys, it is concluded that most would be willing to pay an amount to visit it. The results reveal a market potential of more than €130 million without bearing in mind the indirect value generated by these resources, underscoring the high value that society attaches to these mining remains.

Keywords Extremadura · Mining heritage · Contingent valuation method

Introduction

Among other objectives, environmental economics analyses the manner in which the economy impacts the environment. The importance of the environment for the economy was studied by the most suitable means to regulate economic activity to achieve a balance among the objectives of environmental conservation, economic growth and other social goals, including, for example, economic development and intergenerational equality (Kolstad 1999; Munasinghe 1992). This discipline sets out to appraise assets that have no market, such as natural sites, and it was born out of the theories that initially set out to interpret limited resources (Hartwick 1977). According to Hartwick's rule, the income from natural resources should be reinvested into some form of capital, whether human or physical. These theories were later further developed by dividing capital into three categories: infrastructure and manufacturing capital, human capital and natural capital (Solow 1988).

Through the years, the absence of the economic valuation of natural places has led to the lack of protection, as their deterioration was not previously associated with any economic loss in the past (Sueiras and Martínez 2010). Nevertheless, the increase in society's environmental awareness has helped to spur the development of diverse measures with the ultimate aim of protecting those nature sites. The concern to minimise the decline of the environment has been combined with other strategies that now form part of the discipline of environmental economics. Such strategies include the measurement of the protection of nature in terms of monetary units, which makes it possible to objectify the decisions taken and, above all, to promote protection policies and strategies and to justify them with regard to public opinion. Hence, for example, within its

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operative strategy, the World Bank sets forth that environmental costs and profits must be quantified as precisely as possible, and the economic values must be included wherever possible. The institution further adds that the recommendations and conclusions stemming from environmental economics-based studies must be taken into account in the overall evaluation of the project and in the subsequent cost-profit analysis (World Bank 1998).

The contingent valuation method (CVM) is one of the methods utilised within the areas of environmental cost-benefit analysis and environmental impact assessment (Bateman and Turner 1992; Carson and Hanemann 2005; Venkatachalam 2004; Dixon and Pagliola 1998; Pagiola 1996; Carson 2012; Arrow et al. 1993; Mitchel and Carson 1998). The CVM is employed to estimate the value of assets—products or services—for which there is no existing market, and as such, assets do not fit into the classic mechanisms for the assignment of price (Azqueta 1996). The origins of this method date back to the 1940s, when it was applied to determine the advantages of preventing soil erosion (Ciriacy-Wantrup 1947). Later on, the first academic paper on CVM was published about the benefits of goose hunting (Davis 1960).

The subsequent years, as of the 1970s, bore witness to a major social awakening as regards care for the environment, which, primarily in the USA, meant, at the same time, a boom in the use of the CVM and other environmental economic valuation methods (Water Resource Council 1979, 1983). Even still, in the 1990s, the CVM was subject to a certain degree of controversy, as some academic and research sectors cast doubt on its practical validity, particularly following its application in the study of the Exxon Valdez oil spill in Alaska (Carson and Hanemann 1992; Carson et al. 1998; Carson et al. 2001; Carson et al. 2003). For this reason, the National Oceanic and Atmospheric Administration of the US Ministry of Commerce set up a committee of experts to decide on whether the CVM could be considered a valid technique in practice for the measurement of non-use values in environmental externalities (Carson et al. 1996). The main conclusion of this committee was as follows: "The panel concludes that contingent valuation studies can produce estimates reliable enough to be the starting point of a judicial process of damage assessment". It was in this manner that the CVM ultimately became the most widely used method to estimate well-being in cases in which there was no existing market (Hanemann 1994).

The CVM was primarily put to use for valuations of the rural environment, with special emphasis on protected nature sites such as natural parks and biosphere reserves (Kriström and Riera 1997; Carson et al. 1995; Cheung 2016; García-Rodríguez and Fernández-Escalante 2016). But, it was also applied in other areas such as evaluating historical and cultural ruined properties (Del Guidice and De Paola 2016; Báez and Herrero 2012; Thompson et al. 2002; Hansen 1997), the advantages of atmospheric visibility (Randall et al. 1974), urban planning ordinances (Riera 1993; Riera 1994), the protection of endangered flora and fauna (Carmona and Calatrava 2004), health economics (Thompson et al. 1984; Johannesson et al. 1992) and others (Ferreira and Cunha Marques 2015; Gaglias et al. 2016; Marella and Raga 2014; Damigos et al. 2016; Botelho et al. 2016; Sun and Zhu 2014; Lin and Tan 2017).

The CVM follows a simple procedure, as it aims to simulate a market by conducting surveys among potential consumers (Venkatachalam 2004; Thanh and Viet Huynh 2017). The questionnaires play the role of a hypothetical market, the supply is represented by the interviewer and the demand is embodied by the interviewee. In this fashion, based on the data obtained, the idea is to estimate the maximum sum of money that people would pay for the chosen asset and to understand how the descriptive population-related variables (level of education, income, age, place of residence, etc.) influence such price.

Brief History of Extremadura Mining

This research focuses on the application of CVM in the mining heritage of the Spanish region of Extremadura, which is located in the southwest of the Iberian Peninsula, along the Portuguese border. It has a total area of approximately 41,000 km^2, accounting for 8.25% of the surface of Spain, making it comparable in size to Switzerland or Denmark. Important metallic deposits are mainly generated during the Cadomian and Variscan orogenies, as well as in the distensive episode of the Upper Paleozoic.

Since the appearance of man, there is evidence of the exploitation of mineral resources in Extremadura. In the Maltravieso Cave, located in the same city of Cáceres, symbolic paintings are shown, made using inorganic pigments, from the Upper Paleolithic (21,000 B.C.) and Achelenses lithic tools, with skeletal remains dating back to 350,000 years ago. There are other prehistoric rock paintings in various places in Extremadura, such as Alburquerque, Arroyo de San Serván, Hornachos, Las Villuercas, Malpartida and Siruela.

In the Neolithic appear the polished stone and ceramics (use of clays), which is the case of habitats in caves: Bochique (Plasencia), Conejar (Cáceres) and Chameca (Oliva de la Serena), or in villages, such as La Horca Hill (Plasenzuela) and Los Barruecos, which sometimes appear fortified, and also case from Los Castillejo (Fuente Cantos) or El Jardinero (Valencia de Alcántara). These sets are built with geological materials.

In the Chalcolithic, the metallurgy of copper is generalised. The archaeological excavation has shown the existence of villages, some already existing in the Neolithic, with the

presence of metallic elements and in cases of bell-shaped ceramics (Late Chalcolithic), such as those occur in the Hill of La Horca (Plasenzuela), Guadalperal (Campo Arañuelo), La Nava (La Serena), La Palacina (Alanje), La Pijotilla (Solana de los Barros), La Sierrecilla (Santa Amalia) and San Blas (Cheles). There are two characteristics of the Age of Metals, therefore of the Chalcolithic, in Extremadura: the scarcity of excavations in mining deposits and the almost absence of metallurgical data. Exceptions are as follows: slag found in La Pijotilla (Hurtado and Hunt 1999) or La Sierrecilla, where pot furnace remains and an ingot mold has been found (Berrocal et al. 2006). Also note, in this period, the use of laminated gold, on a small scale.

The dolmens, structures built with large blocks of stone for burials, are frequent in the region, especially in the central and southern parts. They appear in the Neolithic and continue during the Age of Metals, highlighting the megalithic assemblies of Valencia de Alcántara, with 41 dolmens, and Cedillo, with 23, as well as Barcarrota, Lácara, Magacela, Toriñuelo (Jerez de los Caballeros), etc.

In the Bronze Age, it is necessary to mention the exploitation of new metals, and such is the case of tin and lead, acquiring great development gold. Of this last metal, they are the torques of Sagrajas (beginnings of I millennium A.C.), also to emphasise the torques of gold and silver, as well as golden bracelets, of Orellana the old one, both treasures of Atlantic influence, etc. In this period, the settlements of the Solana del Castillo (Alange), Cerro San Cristóbal (Logrosán), Guadajira, Las Minitas (Almendralejo), Plasencia, Villafranca de los Barros, etc., were reviewed. Mining and metallurgy reach their maximum splendor in the Late Bronze Age, where the orientalising influence coming through the Tartessian culture is present. The Hill of San Cristóbal (ninth century/VIII-VII-VI A.C.) is the only exploitation of tin known in Tartessian times, although surely there were many more. Crucibles and other remains of metallurgical activity have appeared there (Rodríguez Díaz et al. 2014). In the Late Bronze, also the heel axes, typical of the northwest, and bronzes with greater content in lead appear.

Towards the tenth century A.C. (Final Bronze) appears Tartessos, which is the name with which the Greeks knew the civilisation settled in the southwest of the peninsula: part of the south of Portugal, Western Andalusia and Badajoz. In Extremadura highlight the archaeological sites of Cancho Roano (Zalamea de la Serena), El Castrejón de Capote (Higuera la Real) or Siruela. The maximum splendor of Tartessos took place in the seventh to sixth centuries A.C. Of this time is the Book of Ezekiel, 27, where it states: "Tarsis supplied you with everything: in exchange for (your) iron, silver and tin ...". We are in a mining territory, with large surpluses for export. In this context highlight treasures, as is the Aliseda (sixth century B.C.).

The Iron Age appears in the seventh century B.C., but the crisis of Tartessos (the end of trade with Greece, at the end of the sixth century B.C.) is going to be a blow to Extremadura mining. In Extremadura after the Tartessian period, we have the settlement of people of Celtic origin, invaders from Central Europe (Lusitanians, Vettones and Celtics), as well as Iberian people, native, descendants of Tartessos, installed in the east and southeast of Badajoz (turdetanos and túrdulos). These towns, also located in much of Andalusia, maintain mining: to mint bronze and silver coins, as well as to make weapons and iron tools, among others.

In the year 237 A.C., Amílcar Barca, coming from Cartago, disembarks in Gadir (Cádiz) to take over the mining wealth of Turdetania. Local troops, with the help of Celtiberian mercenaries, resisted in the Guadalquivir valley, but Amílcar managed to control some productive zones, particularly in Sierra Morena. With the Punic Wars, the Romans would conquer the Iberian Peninsula. The Turdetans established agreements with the Romans, but Lusitanians and Vettones clashed with them. After the death of the Lusitanian leader Viriato, in 139 A.C., the Romanisation of the Extremadura territory took place.

With the Romans, there was a great development of mining. Tin, necessary to produce bronze objects, was mined in mines such as Pedroso de Acim. Also, there are mining-metallurgical settlements in Las Hazas (Casas de Millán), El Judío (Mérida), etc. (Fernández Corrales 1988).

The gold was exploited initially in paleoplaceres (Casas de Don Pedro, Talarrubias, etc.) and in the alluvial deposits of the rivers Alagón, Erjas, Jerte, Server or Tralgas. This mining, in Roman times, gave way to underground works, in the case of El Chibote (Calzadilla) and others (Anonymous, s/f).

The iron was extracted in the municipalities of Aliseda (mine of Navalayegua), Burguillos del Cerro (mines of Caldereros, enclosure of the hermitage of San Vicente, Dehesa Boyal and Las Herrerías), Cabeza del Buey, Cañamero El Noque de Abertura, Fuente the Arc (La Jayona mine), Jerez de los Caballeros (La Bóveda), Zalamea de la Serena (La Nava), Leoncillo, etc. (Fernández Corrales 1988).

The main Roman lead exploitations were Azuaga, Berlanga, Berzocana, Castuera, Garlitos, Las Gazulas, Llerena, Plasenzuela, Peñalsordo, Santi Espiritu, Trujillo, Zarzacapilla and others (Llanderas 1998). Most of the silver was obtained from the argentiferous galenas. In the case of copper, highlight the mines of La Lapa and Villagarcía de la Torre. Regarding the ornamental rocks, mention, among others, the granites of Mérida and Cáceres, as well as the Cambrian marble of Alconera, used in Augusta Emérita (Mérida), Itálica (Seville) or Málaca (Málaga) (Puche and Ortiz, in litt).

In the fifth century, Extremadura was first conquered by the Alans and then by the Swabians. Rome had to ask for help from the Visigoths for his expulsion, being founded at the beginning of the sixth century the Visigothic Kingdom of

Toledo. It is usually noted that Visigothic invasions paralysed mining activity, which is impossible because of the necessary consumption of mineral resources in coinage, manufacture of ornaments or cult, jewelry, weapons or tools, among others. There are Visigothic settlements in mining areas, such as Aliseda and Burguillos del Cerro.

After the Muslim invasion of Spain (Mérida was conquered by Muza in 713), much of Extremadura became the Cora of Mérida until the fall of the Caliphate of Córdoba, where the Taifas de Badajoz Kingdom was established. In the thirteenth century, Christians definitely reconquer the territory. There is a shortage of archaeological-mining data, but in Burguillos del Cerro, there is the Guruviejo deposit, next to an iron mine, and this allows to establish the occupation-exploitation connection from the II Iron Age to the Islamic period. There are also Arab mining toponimics, such as Almagrera Hill (Cabeza del Buey), La Almagrera (Talarrubias) and Almadenes Hill (Granja de Torrehermosa).

Later, the Reconquest, we have scarce sources on mining. Extremadura was a sparsely populated frontier territory, where military orders had a great presence, which were not interested in the industry. The kings, seeking military support or compensating favours and for other reasons, gave the real mining rights to individuals, and this is what is known as "mining Mercedes". Thus, Lorenzo Galíndez de Carvajal, in 1513, received as mercy the mines of the bishopric of Badajoz. In 1560, the mines of Azuaga were yielded by a mercy to the widow of Francisco de los Cobos, who had built a refining coal mine to extract silver (Sánchez Gómez 1989). If the mining of a large territory is in the hands of an individual, this does not favour the search and exploitation of mines. The Ordinances of Mines of Felipe II, of 1559 and later, came to put order in these subjects, eliminating the Mercedes. With these laws, all the mines were reincorporated to the state. Thanks to this, there are annotations of numerous mining records, lawsuits, inspections and other data of the sixteenth, seventeenth and eighteenth centuries, as observed in the Archive of Simancas, as recorded: Larruga (1795), González (1832) and others.

With the Law of Mines of Fausto Elhuyar (1825), foreign companies are admitted to mining. If we add to this the need for metals that in Europe generated the First Industrial Revolution, we will see how this sector reaches a great momentum. In 1833, the government entrusted to the French mining engineer Frédéric Le Play the geological and statistical map of the mineral wealth of the Peninsula, publishing, in 1834, the sketch of a geological map of Extremadura and Northern Andalusia, in whose memory are considered the mines of the territory. The peak of Extremadura mining will occur between the mid-nineteenth and twentieth centuries (Llaneras López 1998). In the case of iron, there will be numerous mines in the southern part of Badajoz, between Monasterio and Olivenza, highlighting Burguillos del Cerro, Fregenal de la Sierra, Fuente el Arco, Jerez de los Caballeros, etc. Also mention Aliseda in Cáceres. The maximum activity occurred in the area of Jerez de los Caballeros, between 1959 and 1963, where there were up to 32 mines in operation (Fig. 1). Mina Monchi (Burguillos del Cerro) closed in 1978, and La Bóveda and La Bilbaína (Jerez de los Caballeros) stopped in 1984 and 1987. Regarding lead, the area of Azuaga-Berlanga (Fig. 2), Castuera, etc., stand out, as well as Aldea Centenera, with high zinc contents. The period of maximum splendor was late nineteenth–early twentieth centuries, reaching the decline in the late twenties. There was a small resurgence between 45 and 55 years, a time called autarchy, since the isolated country internationally needed resources and many mines emerged.

In the case of tin-tungsten, the exploitation of innumerable deposits is noteworthy, a situation that reached its maximum splendor during World War II, where German technicians directed numerous mines. Also, part of the ore was smuggled, via Portugal to England. Highlight the great mine Casteria (Sn)–scheelita (W) of La Parrilla (Almoharín), which was the last exploitation of these substances, closing in 1987. Now, it is starting its activity again. Regarding antimony, highlight San Antonio mine (Alburquerque), which closed in 1986. Regarding uranium, highlight the La Haba mine, which was active between 1966 and 1990. Likewise, mercury was exploited in Usagre and had its highest peak in the twenties of the twentieth century. The Aguablanca (Monasterio) copper, nickel and platinum mine that started operations in 2005 closed definitively in 2016. Now, they are trying to reopen the operation. Regarding industrial minerals, mention the historical phosphate deposits of Aldea Moret (1864–1960, Fig. 3) or Logosán, active until 1956. At present, mention the barites, of Jerez de los Caballeros and Llerena, or the attapulgitas of Torrejón el Rubio. With regard to ornamental rocks, it should be noted that Extremadura was the largest

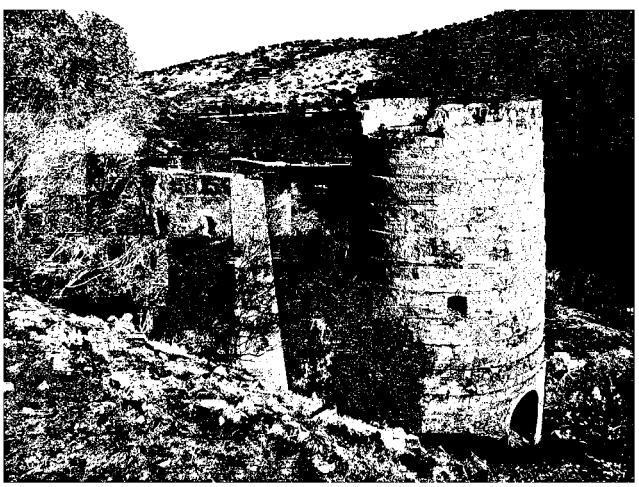

Fig. 1 Toasting ovens. Santa Justa Mine (Jerez de los Caballeros, Badajoz). Source: IGME

Fig. 2 Cornish-type machine house. Lead mine Sta. Catalina (Berlanga, Badajoz). Source: IGME

national producer of block granites in the years 2002–2005, when Spain was the world's largest producer. Highlight the areas of Alburquerque, Burgillos-Zafra, Cabeza del Buey, Cáceres and Quintana de la Serena, among others. In the case of marble, mention Alconera and Villar del Rey slate.

Nowadays, Extremadura has more than 100 research permits and more than 200 exploitations. There has always been a great mining activity in the region, which has left innumerable remains. In modern times, some mines and associated facilities have been rehabilitated for tourism, such as Aldea Moret, Azuaga, Fuente el Arco, La Aliseda, Logrosán and Santa Marta de los Barros.

Methodology

The CVM is considered a form of direct estimation, since it is directly asked to a sample of the population in how much it values a certain environmental good. The methodology of the CVM includes five phases: (a) delimitation of the study area, (b) selection of the relevant population, (c) market simulation, (d) selection of survey type: structure of the questionnaire and (e) conduction of the surveys.

Fig. 3 Mining well in San Salvador and barracks. Phosphates. Aldea Moret (Cáceres). Source: IGME

Delimitation of the Study Area

The first phase is to define exactly what you want to measure with monetary units. This study consisted of applying the CVM to estimate the value placed on the mining heritage of Extremadura by a sample of the local population and its neighbouring provinces (Fig. 4). Here, mining heritage is defined as the set of the cultural assets related with the mining and metallurgy industry (Puche et al. 2011; Marchán and Sánchez 2013).

The Institute of Geology and Mining of Spain (IGME) carried out an inventory on this subject (IGME 2009; Sánchez 2010), classifying the mining remains of Extremadura into several categories, in keeping with the era in which mining had been active and the minerals that had been extracted during that period (Table 1). In the study, 184 points of interest were initially selected, including mines, quarries and public baths that could be revaluated.

Given that most of these vestiges of mining heritage are not protected by legislation, and in view of the high number of such remains, the IGME decided to select those that had at least three of the four groups of characteristics used in the initial inventory: (a) mining, (b) archaeological and historic, (c) technological and social and (d) environmental and landscape. The final sample included a total of 20 geographic points made up of 50 elements of mining heritage interest (Table 2).

Definition of a Statistical Sample

The next step is the definition of the statistical sample representative of the population of users that is subject to study market simulation. Besides, the size of the sample is given by the degree of reliability and adjustment that is desired for the values to be obtained. Once the objective of the study has been defined (mining heritage of Extremadura), it is necessary to select the population that turns out to be the most interesting to answer the questions posed in the beginning of the investigation (what is WTP—"willingness to pay"—to visit the remains of old mines of Extremadura?). If what is intended is to know the value of recreational use of a national park, the relevant population would be visitors to the park. However, in this investigation, the mining remains are inventoried but it has not yet been put into value. The objective is to estimate the interest that may have (estimation of the WTP) for the population in the case of avoidance of its destruction, and in addition, some action is developed so that they can be visited. For

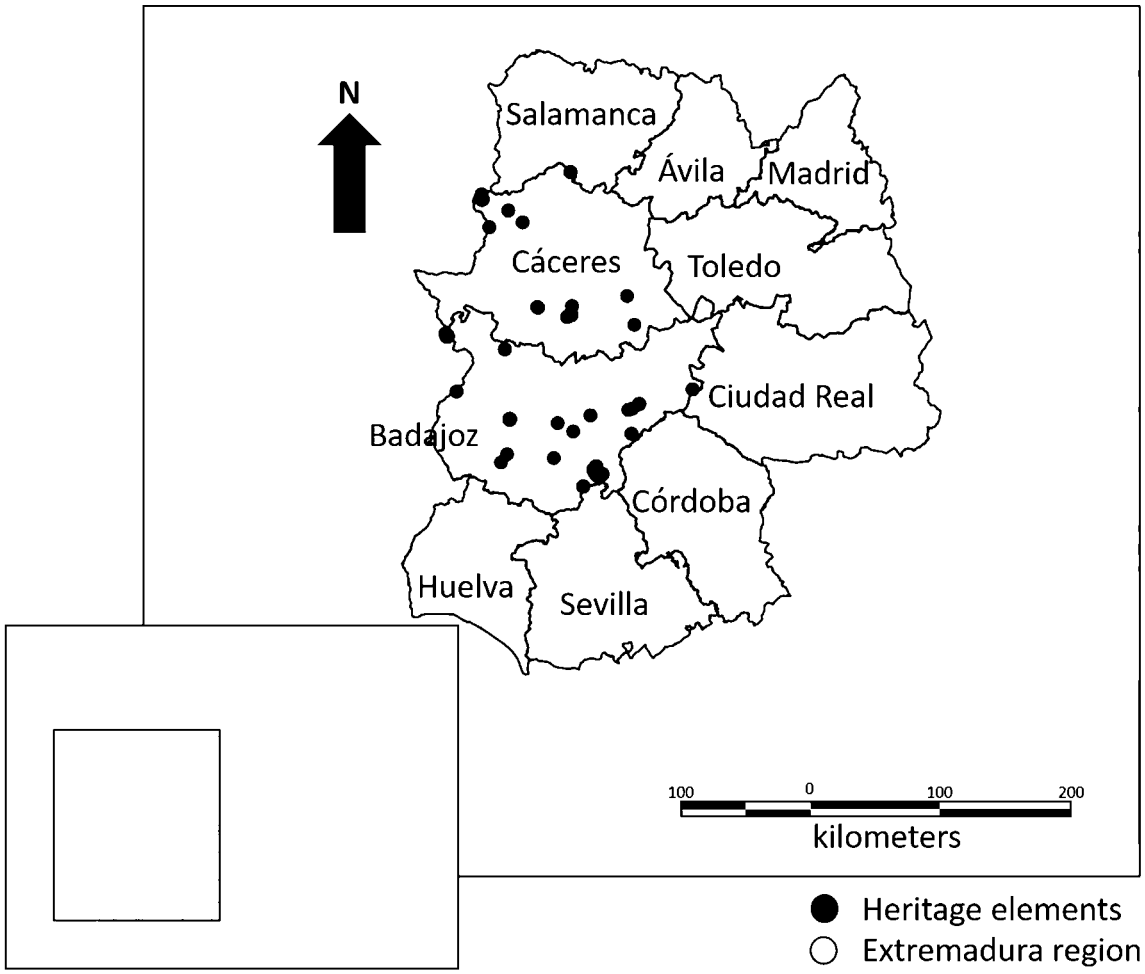

Fig. 4 Location of the region of Extremadura, adjacent provinces and Madrid, and example of the heritage analysed (point 18, G.M. San Nicolás)

Table 1 Classification of the mining remains of Extremadura (adapted from IGME 2011)

Historic period	Heritage elements
Prehistory	Traces of copper
	Discovery of stone tools and works
Roman Hispania	Metallurgical centres and settlements
	Mills, remains of ceramics, etc.
Mining of the 19th century (zinc-lead and phosphates)	Derricks
	Mills
	Extraction and drainage installations
	Chimneys
	Mineral concentration installations
Mining of the 20th century (lead, iron, tin-wolfram, medicinal waters, uranium and other resources)	Derricks
	Mills
	Extraction and drainage installations
	Chimneys
	Mineral concentration installations
	Public baths

this reason, the population can be anyone. Obviously, we have to put limits on this first study on the subject and, therefore, it was decided that the relevant population is the one who lives in Extremadura or in the Spanish provinces bordering Extremadura (Table 3). In this way, the scale of application is reduced and the study is concretised. Ultimately, the study took into account the people of full legal age living in Extremadura, as well as in the neighbouring provinces (Salamanca, Ávila, Toledo, Ciudad Real, Córdoba, Seville and Huelva) and the Autonomous Community of Madrid, who might attach an *option value* other than zero to the mining heritage of Extremadura. In addition, the dispatch of the survey was directed towards people who were linked to some professional activity that could offer an estimation of the value that is possible to give to the mining patrimony of Extremadura. In this way, journalists, mining engineers, geologists, politicians, public officials, policy officers, doctors, local guides, politicians, environmentalists, Institute National Heritage, IGME, etc., were chosen to live in some of the

Table 2 Elements of mining heritage contemplated in this study

Point	Name
1	Azuaga-Berlanga
2	Plasenzuela
3	Aldea Moret
4	Garlitos
5	Castilletes metálicos
6	Castuera
7	Logrosán
8	Calzadilla
9	Chimeneas metalúrgicas
10	Santa Marta
11	Los Vieros
12	Mina Monchi
13	Usagre
14	Hornachos
15	Río Erjas
16	G.M. San Roque
17	El Calvo
18	G.M. San Nicolás
19	Río Ladrillar
20	La Codosera

Spanish provinces listed above. The objective was to know the opinion of people who, for their professional activity, could offer a proposal related to the mining heritage and even to carry it out or promote it if the results so endorsed.

Market Simulation

Having selected the objective of the CVM study, it should be decided whether to measure the maximum disposition to pay of the respondent or its minimum availability to be compensated (Shogren et al. 1994). In our case, the question is whether the objective is to know what a potential tourist would be willing to pay to visit an old mine (preserved, restored and protected) or what would be compensated economically if no action is made to avoid the destruction of this mining heritage. Since the mining patrimony is not, in the majority, in the phase of tourist exploitation, it was decided to choose the estimation of WTP since from the administration and universities and research centres, there is interest in preserving it. Besides, the question is to evaluate the differences between preserving and protecting or not preserving or protecting the mining heritage of Extremadura. The relevant population, that is to say, the one that could visit these places still knew practically nothing of the result that it can represent to put in value this part of the mining history.

Table 3 Mean distance between the enclaves under consideration and the main cities around the region

	Distance (km)
Caceres	81
Badajoz	99
Madrid	312
Salamanca	309
Ávila	335
Toledo	276
Ciudad Real	213
Córdoba	198
Seville	230
Huelva	280

The approach focused on a hypothetical admission payment for the preservation and improvement of the mining heritage of Extremadura, and the survey consisted of three mixed questions: two binary questions (with two possible answers; in this case "yes" or "no") and one open question (where the respondents were given the freedom to choose a value) (Fig. 5).

Being WTP, the variable that is to be estimated, it is necessary to decide on how it is going to be measured, with continuous values or discrete values. The method of continuous values is based on asking respondents how much they would be willing to pay for the preservation of a cultural or natural good. It is the most neutral in terms of skewed value revealed with respect to true value. However, it can pose uncertainties to the people who respond because they do not have any reference price. The second method (discrete values) is based on proposing an economic value for the good that is being investigated and asking whether they would be willing to pay it or whether they would pay more or less. The answer can only be affirmative or negative, regardless of abstention and null vote.

It is a more-demanding method because it needs larger samples to have errors similar to those of the continuous method. Still, it has been decided to use it for several reasons that are explained below. The application of CVM in the study of mining heritage in Spain is very scarce, and therefore, it is difficult to propose a study with fully open questions to estimate the WTP of respondents. There are no similar studies, and in addition, examples of mining heritage in Spain open to the public are hardly coincidences with the case of Extremadura.

In fact, the Spanish autonomous regions with the largest number of mining museums are Andalusia (14), Catalonia (14), Castilla-León (13), Asturias (11), Basque Country (10), etc. Extremadura has six mining museums. In terms of new projects, Andalusia (8), Castilla-León (12) and, being this last community which, in the short term, will occupy the first square in terms of museums, above the Andalusians (Puche et al. 2011). Somehow all

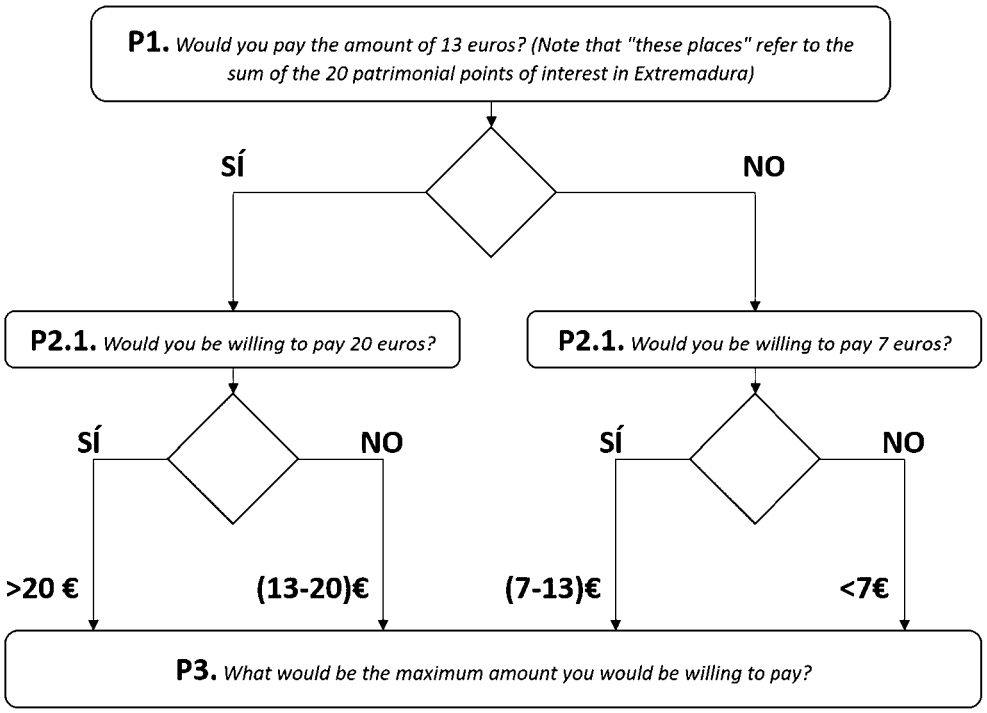

Fig. 5 Block diagram, based on the questions prepared in this survey; questions aimed to determine the value of the heritage

travel includes a cultural element, because by its very nature, the travel transports to the visitor from their cultural place to others with different cultural characteristics. In regions very historically linked to mining (Catalonia, Asturias, Almadén, Andalusia), it is easier to propose as a cultural visit the trip to a place characterised by an important mining heritage. In some ways, mining has been part of the development of that place and the neighbouring cities. However, although its mining history is important, Extremadura has not maintained this relationship with this industrial activity. The mining remains have been little used as a tourist offer, and that is why they are more unknown. For this reason, it was decided to choose the modality of discrete values to estimate the WTP.

Selection of Survey Type: Structure of the Questionnaire

A survey was prepared to minimise the two main limitations of this method: (a) the degree of unawareness of those surveyed regarding resources, in this case tied to mining heritage, with which they were unfamiliar, and (b) the generation of biased estimations related with the design of the contingent market and the selection of the sample. A questionnaire was the main instrument for this research. The questionnaire was structured into three essential parts: (a) description of the asset, (b) valuation of the asset and (c) data of the respondent. In addition, the interviewees were previously informed about the main elements of the mining heritage of Extremadura.

Table 4 Information on respondents, extracted from their answers

Questions	Yes (%)	No (%)	I do not know/no answer (%)
Do you know what mining heritage is?	56	43	1
Could you name the elements of Spain's mining heritage that have received UNESCO acknowledgement as World Heritage?	45	54	1
Have you visited any of the Spanish mining heritage sites recognised by UNESCO?	65	30	5
Do you know any mining heritage site abroad?	11	84	5
Would you travel to visit any of the 20 mining heritage sites of interest selected by the IGME in Extremadura?	52	28	20
If you would visit these sites, would you spend the night in any city other than that of your regular residence?	78	14	8

Table 5 Hours that the respondents residing in Extremadura would devote to visiting any of the 20 points of mining heritage interest in Extremadura

Visit time in hours	If you live in Extremadura, how many hours do you think you would be willing to spend on travelling to visit any of the 20 points of mining heritage interest? (%)
1–3	37
4–6	32
7–9	13
More than 10	18

The following relevant decision is the mode of interview. There are basically three possibilities: personal interview, telephone interview or send the questionnaire by mail. It was decided to propose a questionnaire in electronic format to access the information as quickly as possible.

Conduction of the Surveys

There was a control of the questionnaires received by email, and a maximum term of 7 weeks was set for receipt of the surveys. A total of 202 surveys were obtained, among which 196 were considered valid. The six eliminated replies failed to comply with some of the conditions designed at the beginning of the sampling campaign (minimum age of 18 years, minimum of replies answered in the questionnaire, not ambiguous answers).

Results

Information on the Respondents: Description of the Sample

An initial approach consisted of analysing the population to identify and break down the individuals interviewed by applying the following criteria: (i) location and other data (level of education, age, etc.), (ii) income and (iii) knowledge of the mining heritage (Table 4).

Table 6 Days that the respondents not residing in Extremadura would devote to visiting any of the 20 points of mining heritage interest in Extremadura

Days of visit	If you do not live in Extremadura, how many days do you think you would be willing to spend travelling to visit any of the 20 points of mining heritage interest? (%)
1–2	24
3–4	39
5–7	24
More than 8	12
No time	1

Table 7 Reasons to visit any of the 20 points of mining heritage interest in Extremadura

	What would spur you to visit any of the 20 points of mining heritage interest? (%)
Hiking	26.7
Sport	9.9
Enjoyment of the landscape	84.7
Seeing the remains of the mine	64.9
Others (gastronomy, art)	30.2
No answer	2.5

Among those surveyed, 56% knew what mining heritage was, 43% did not know what it was and 1% did not answer. This information is significant, as it reveals a considerable lack of knowledge of this heritage among those taking part in the study, which, in turn, appears to indicate that within a hypothetical revaluation plan, it would be necessary to set up a communication and marketing campaign.

Moreover, an analysis was carried out in relation to the length of the trip that each respondent would be willing to take to visit one or several of the 20 points of interest selected by the IGME. The lengths of such journeys were differentiated according to whether the respondent lived in Extremadura or elsewhere (Tables 5 and 6).

It was detected that the respondents residing in Extremadura would be willing to devote few hours to visit the heritage (69% would spend between 1 and 6 h). As to the non-residents of Extremadura, a balance was detected among those who would devote between 1 and 4 days and between 4 and 7 days (63% in both cases). Another 12% of the respondents would be willing to spend more than 8 days. To further define this information, the respondents were asked about other reasons to travel to and visit any of the 20 points of interest (Table 7), as well as their preferred means of transport (Table 8).

Table 8 Chosen means of transport for the visit to any of the 20 points of mining heritage interest in Extremadura

	What means of transport would you choose to visit any of the 20 points of mining heritage interest? (%)
Hiking	3
Public transport	4
Private transport	90
No answer	3

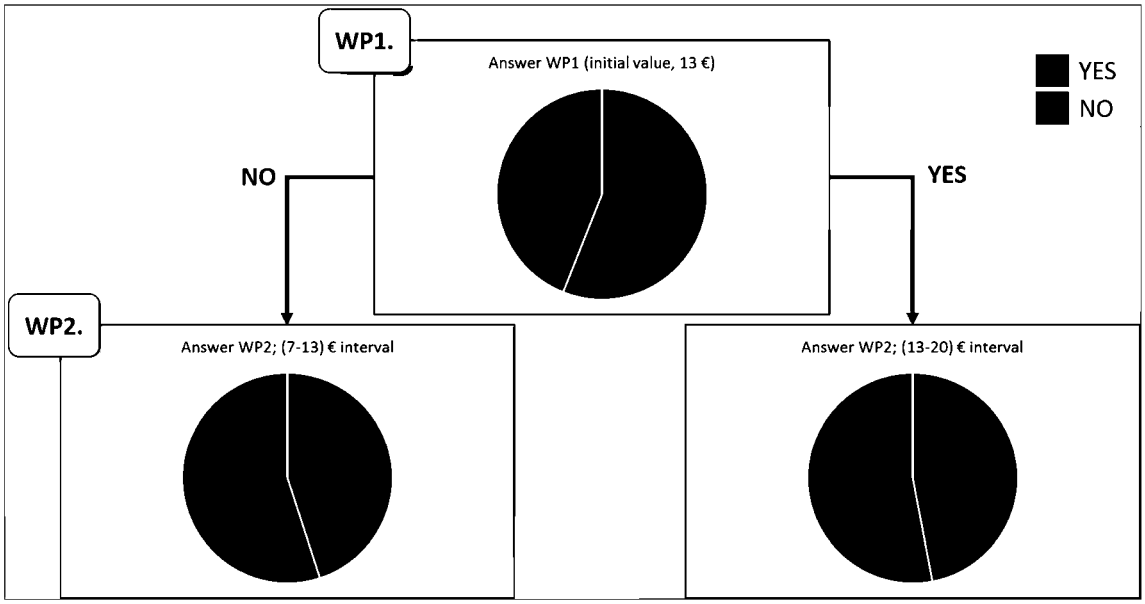

Fig. 6 Results of the survey, WTP-1 and WTP-2 (binary questions)

Results and Discussion

Results

Once the general characteristics of the sample were described, the next step was to estimate the maximum sum of money that the respondents would be willing to pay to visit any of the selected mining heritage sites in Extremadura, using WTP-type questions. As reference values (7, 13 and 20 euros) have been chosen, the average prices usually cost to visit other Spanish places with mines museum or centres of interpretation of the mining heritage.

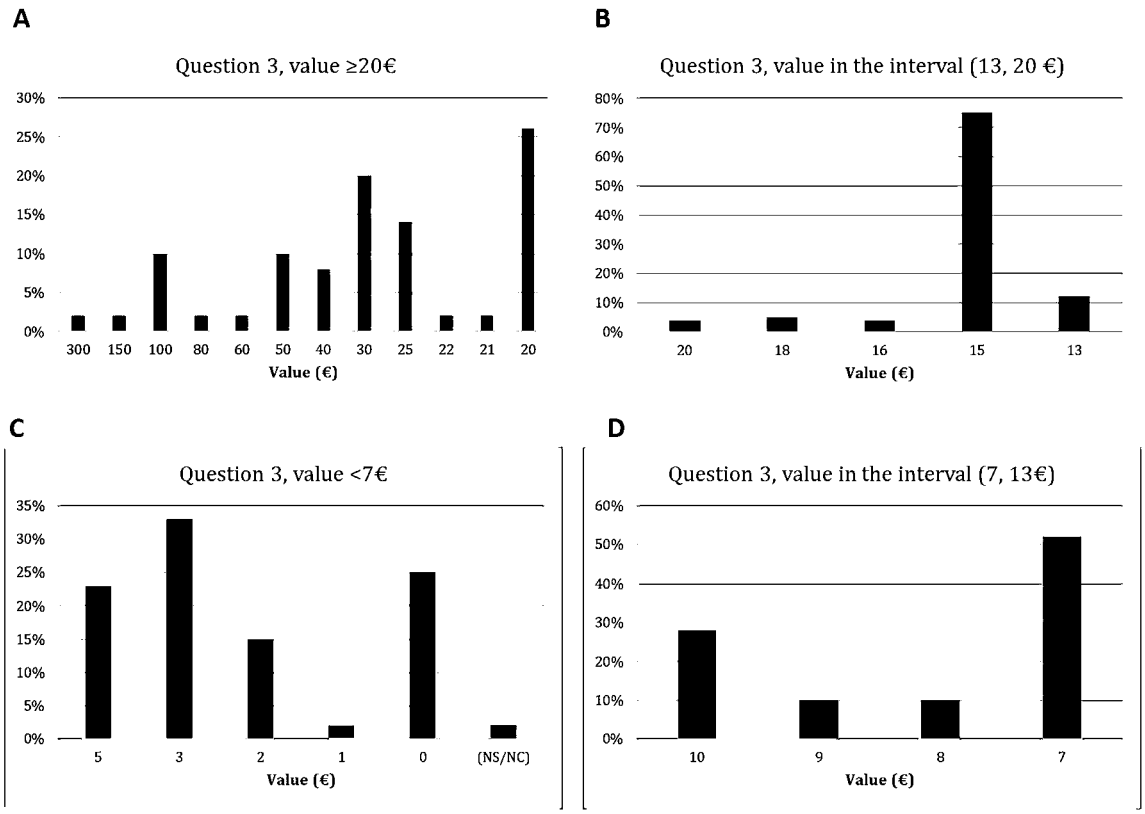

Fig. 7 Results of the survey for the different ranges established by means of questions WTP-1 and WTP-2

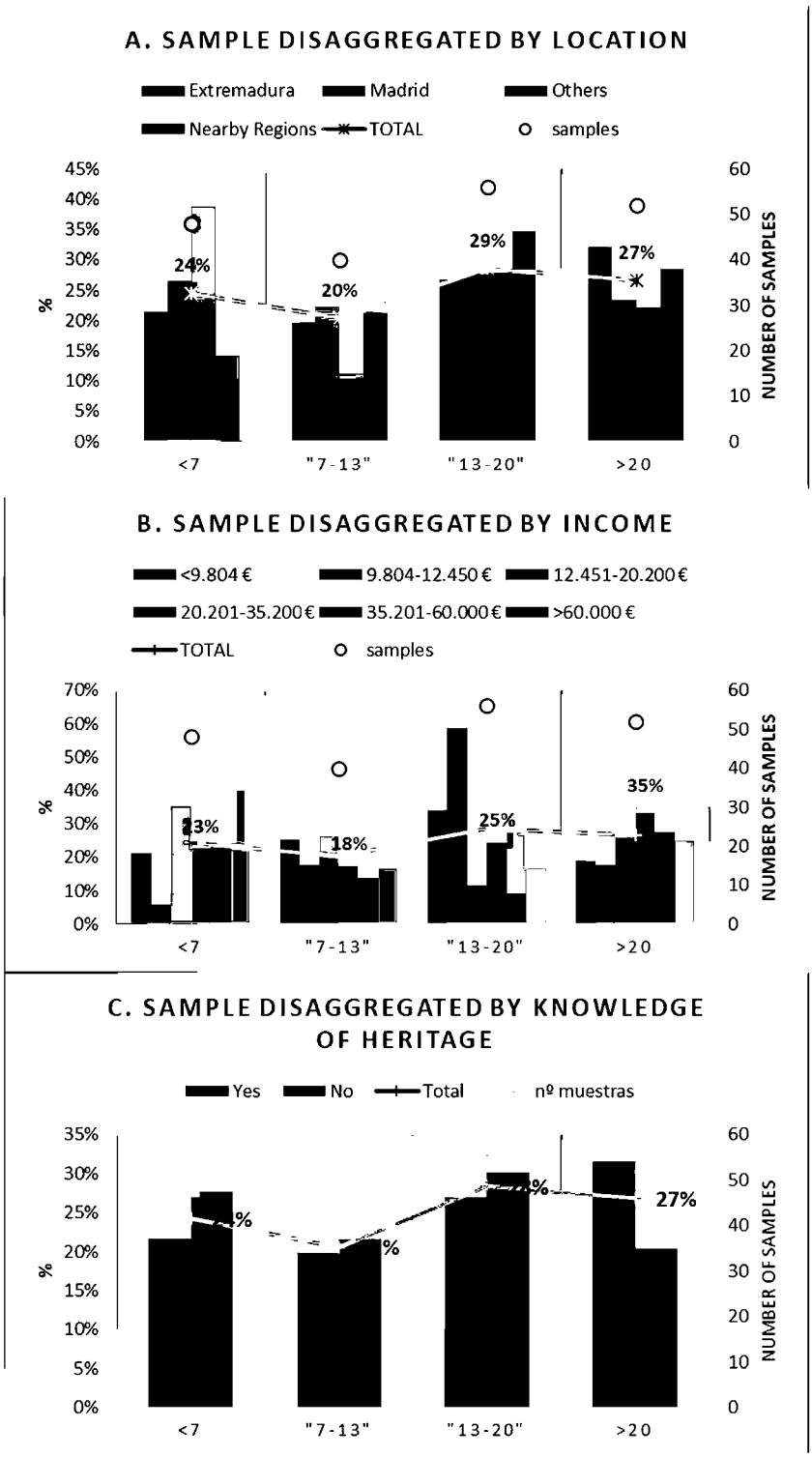

Fig. 8 Results of the WTP questions according to three criteria. **a** Origin of the respondent. **b** Income level. **c** Degree of awareness of mining heritage

Question WTP-1 ("If you were asked how much money, at most, you would be willing to spend for admission to one of the twenty mining heritage sites in Extremadura, would you pay €13?") generated a 56% affirmative response (yes).

The respondents who answered "yes" to WTP-1 were then asked in the following terms (WTP-2): "So, would you be willing to pay €20?" Only 47% replied "yes" to this question. Those who answered negatively (no) to question WTP-1 were

given another question (WTP-3): "So, would you be willing to pay €7?"; 45% of the respondents answered affirmatively.

In cases in which respondents answered affirmatively to questions WTP-1 and WTP-2, they were then asked the following open question: "Bearing in mind that you would pay at least €20, what is the most that you would be willing to pay?" When the reply to question WTP-1 was affirmative and that of question WTP-2 was negative, respondents were then asked: "What is the most that you would be willing to pay?" Finally, when respondents answered question WTP-1 negatively, while answering question WTP-3 affirmatively, they were then asked the following question: "What is the most that you would be willing to pay?" Similarly, when those surveyed responded negatively to both WTP-1 and WTP-3, they were then asked the following question: "What is the most that you would be willing to pay?" (Fig. 6).

The analysis of the answers to the questions (Fig. 7) has given rise to the following assessments:

- The interval between €14 and €20 takes in the highest percentage of responses (32%), making €15 the most widely selected value (21% of all answers).
- The interval between €2 and €7 accounts for the next highest number of responses (28%). In this interval, the most widely selected value is €7.
- Finally, the third most important interval consists of the answers that were equal to or greater than €50 and those that were equal to or less than €1 and which were qualified as "protest responses" (29).

An examination of the values of willingness to pay, while bearing in mind the segmentation parameters of the sample (place of residence of the respondent, income level and degree of awareness of the mining heritage), generates the following conclusions (Fig. 8).

According to Fig. 8a, it is apparent that the value placed on the mining heritage of Extremadura does not diminish with distance. The number of people who responded no to question WTP-1 ("If you were asked how much money, at most, you would be willing to spend for admission to one of the twenty mining heritage sites in Extremadura, would you pay €13?") varies between 40 and 50%, regardless of the distance from the mining heritage asset(s).

An examination of the WTP shows that most of the respondents would accept an admission cost ranging between €13 and €20 (28% of the sample), although the differences between this and the other price intervals are minor: 24% show a WTP lower than €7, 21% display a WTP for values above €7 and up to €13 and the remaining 27% would be willing to pay sums of more than €20. Figure 5b suggests that for all of the income levels, with the exception of the €20,201–€35,000 income bracket, there is a prevalence of a WTP between €7 and €13. For this last income level mentioned, the most highly valued WTP entails an expense of more than €20.

As a result, the income-based analysis does not indicate any clear evolution based on the amounts earned by each person, nor does it serve to predict the group-based answers.

By analysing the results, which are broken down according to income level, it can be said that 24% of the sample displays a certain opposition to paying to visit the heritage site (interval < €7). With reference to the other price intervals, there is a

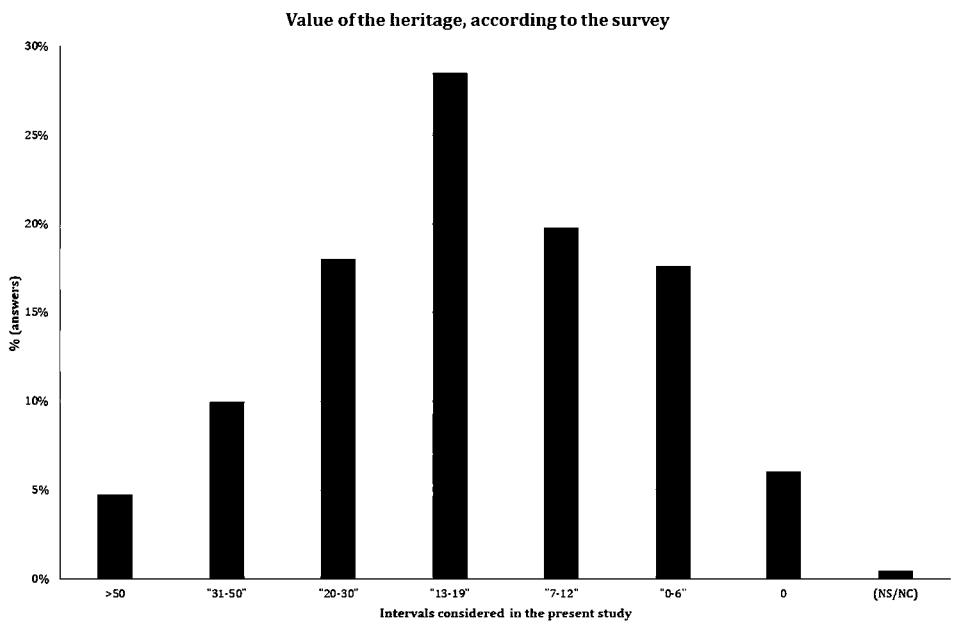

Fig. 9 Value of the asset under survey, in keeping with the contingent value method

Table 9 Value of the asset, by location of the respondents' residence

Location	Average	Median
Total	*€15.29*	*€15*
Extremadura	€16.87	€15
Adjacent regions	€16.10	€14
Madrid	€14.36	€13
Others	€13.94	€11

consistency among the different income brackets, which all tend to prefer the price range of €13–€20, as expressed by most of the respondents, with the exception of the respondents of the €20,201–€35,200 income bracket, who preferred (35% of those surveyed) a price range > €20 (Fig. 8b).

As to the influence of the *level of knowledge* of the mining heritage on the willingness to pay, it can be deduced that people with a greater understanding of mining heritage are willing to pay more to visit such sites. This is particularly apparent in the most extreme price values (less than €7 and more than €20), as the percentages of people opting for the average price values of €7 and €20 are nearly the same, regardless of their knowledge (Fig. 8c).

By consolidating the results discussed above in a single estimation of the asset (Fig. 9), it can be concluded that less than 7% of those surveyed were not willing to pay for admission. However, the vast majority opted for an admission cost ranging between €13 and €19, making €15 the value most repeated in the surveys (22.3% of the respondents gave this answer). Upon analysing this graph, it must also be pointed out that the vast majority of those surveyed (48.29%) felt it is suitable to pay an admission ranging between €7 and €19, placing greater consistency and value on the heritage site visited.

Economic Value

To make an estimation of an economic value for the mining heritage elements of Extremadura, the CVM takes the most conservative option, which means using the value of the median of the distribution (Table 9), which is multiplied by the number of people who comprise the relevant population (in this case, Extremadura, the neighbouring provinces and Madrid) and who are of full legal age, according to the data taken from the Official Census of Population.

Table 10 Intervals of confidence

Confidence (%)	Interval	Interval of confidence, IC
90	± 1.552	[13.738; 16.843]
95	± 1.849	[13.440; 17.140]
97	± 2.048	[13.242; 17.339]
99	± 2.431	[12.859; 17.720]

Table 11 Value of mining heritage in Extremadura according to the contingent valuation study

Location	Population (inhabitants)	Median (€)	Value ($€10^6$)
Extremadura	883,400	15	13.25
Adjacent regions	3,931,578	14	55.04
Madrid	5,085,266	13	66.11
Total	9,900,244	15	134.40

It is worth noting that as the distance between the respondents' residence and Extremadura increases, the willingness to pay admission slightly decreases, revealing a difference of €2.93 for the average and a difference of €3 for the median. By normalising the population, the typical deviation is estimated and the intervals of confidence are obtained (Table 10).

Hence, the valuation is described in Table 11.

Conclusions

The fact that mining heritage is considered a general asset of the society makes it necessary to quantify its value. In this paper, the contingent valuation method is applied in order to determine not only the degree of public awareness of this heritage but also the willingness to pay to visit it. It is important to underscore that the concept of willingness to pay goes beyond the simple fact of paying a sum of money to visit a site, but it also takes in the acceptance that such funds would be used by the government or private bodies for the conservation and maintenance of the mining remains.

The application of this study in Extremadura, as a practical case, makes it possible to assess the value of the mining remains in a region with a prominent rural and environmental tourism sector. These mining remains could, moreover, further strengthen the interest of tourists in this region. The results of this study reveal that the potential market for these heritage assets is worth as much as €134 million. Three payment values (7, 13 and 20 euros) were established to classify respondents' responses and thus estimate the degree of interest expressed in currency units, which were shown by the mining heritage of Extremadura as a possible destination for a tourist trip. The interval between 14 and 20 euros (€) includes the highest percentage of responses (32%), with the value of €15 being the most chosen (21% of total responses). The interval between €2 and €7 is as follows in the number of responses (28%). In it, the most often selected value is €7. Finally, as the third most important interval, there are the responses that were equal to or greater than €50 and were equal to or less than €1. They are the so-called "protest responses".

It must be noted that this market study has centred strictly on the direct market; in other words, the hypothetical visit to this heritage has an admission cost. The indirect market, however, has not been contemplated here, making its research in a subsequent study recommendable.

Spain has been and still is a mining country. For this reason, some organisations (SEDPGYM, INCUNA, etc.) and universities and research centres (IGME) are investigating this important legacy from multiple perspectives (historical, social, patrimonial, etc.). This study will be continued with the completion of a doctoral thesis at the Polytechnic University of Madrid.

Acknowledgments We thank Alejandro Sánchez (IGME), Ester Boixerau (IGME) Juana Vegas (IGME), Monserrat Trío (IGME) and Carmen Marchán (Ministry of Industry, Spain) for their assistance and contributions in developing the ideas presented here and by the cession of the photographs of mining heritage of Extremadura that have allowed us to include in this investigation. We also want to thank Jade Santos for the help provided during the paper submission.

References

Arrow K, Solow R, Portney PR, Leamer EE, Radner R, Schuman H (1993) Report of the NOAA panel on contingent valuation. Fed Regist 58(10):4601–4614

Azqueta D (1996) Valoración económica del medio ambiente: una revisión crítica de los métodos y sus limitaciones. Información Comercial Española 75:37–46

Báez A, Herrero LC (2012) Using contingent valuation and cost-benefit analysis to design a policy for restoring cultural heritage. J Cult Herit 13:235–245

Bateman IJ, Turner RK (1992) Evaluation of the environment: the contingent valuation method. CSERGE working paper, GEC-92-18

Berrocal MC, Cuenca EC, Solano JAG (2006) Nuevos datos sobre el CalcolÃ -tico de Extremadura: El yacimiento de La Sierrecilla (Santa Amalia, Badajoz). Spal Revista de Prehistoria y ArqueologÃ a de la Universidad de Sevilla 15:51–70

Botelho A, Pinto L, Lourenço-Gomes L, Valente M (2016) Social sustainability of renewable energy sources in electricity production: an application of the contingent valuation method. Sustain Cities Soc 26:429–437

Carmona MC, Calatrava J (2004) Valor social de la conservación del lince ibérico. Comportamiento del mercado contingente. Conference paper. V Congreso de Economía Agraria. Santiago de Compostela (Spain)

Carson RT (2012) Contingent valuation: a practical alternative when prices aren't available. J Econ Perspect 26(4):27–42

Carson RT, Hanemann M (1992) A preliminary economic analysis of recreational fishing losses related to the Exxon Valdez oil spill. Report to the Attorney General of the State of Alaska

Carson RT, Hanemann MW (2005) Contingent valuation. Handbook of environmental economics. V. 2:821–936

Carson RT, Wright J, Carson N, Alberini A, Flores N (1995) A bibliography of contingent valuation papers and studies. NRDA (Natural Resource Damage Assessment, Inc.), La Jolla

Carson RT, Hanemann M, Kopp RJ, Krosnick JA, Mitchell RC, Presser S, Ruud PA, Smith VK, Conaway M, Martin K (1996) Was the NOAA panel correct about contingent valuation? Discussion paper 96–20. Resources of the future. 32 p

Carson RT, Hanemann M, Kopp RJ, Krosnick JA, Mitchell RC, Presser S, Ruud PA, Smith VK, Conaway M, Martin K (1998) Referendum design and contingent valuation. The NOAA panels no-vote recommendation. Rev Econ Stat 80(2):335–338

Carson RT, Flores NE, Meade NF (2001) Contingent valuation: controversies and evidence. Environ Resour Econ 19:173–210

Carson RT, Mitchell RC, Hanemann M, Kopp RJ, Presser S, Ruud PA (2003) Contingent valuation and lost passive use: damages from the Exxon Valdez oil spill. Environ Resour Econ 25:257–286

Cheung LTO (2016) The effect of geopark visitors' travel motivations on their willingness to pay for accredited geo-guided tours. Geoheritage 8:201–2019

Ciriacy-Wantrup SV (1947) Capital returns from soil-conservation practices. Am J Agric Econ 29(4):1181–1196

Damigos D, Menegaki M, Kaliampakos D (2016) Monetizing the social benefits of landfill mining: evidence from a contingent valuation survey in a rural area in Greece. Waste Manag 51:119–129

Davis R (1960) The value of outdoor recreation: an economic study of the Maine Woods. Doctoral dissertation in economics. Harvard University

Del Guidice V, De Paola P (2016) The contingent valuation method for evaluating historical and cultural ruined properties. Procedia Soc Behav Sci 223:595–600

Dixon D, Pagliola S (1998) Economic analysis and environmental assessment. Indicators and economic valuation unit, environment department. The World Bank

Elhuyar F (1825) Memoria sobre el influjo de la minería en la agricultura, industria, población y civilización de la Nueva España. Imp. Amarita

Fernández Corrales JM (1988) Minería y asentamientos romanos de Extremadura. Su problemática. Alcántara 15:107–115

Ferreira S, Cunha Marques R (2015) Contingent valuation method applied to waste management. Resour Conserv Recycl 99:111–117

Gaglias A, Mirasgedis S, Tourkolias C, Georgopoulous E (2016) Implementing the contingent valuation method for supporting decision making in the waste management sector. Waste Manag 53:237–244

García-Rodríguez M, Fernández-Escalante E (2016) Geo-climbing and environmental education: the value of La Pedriza Granite Massif in the Sierra de Guadarrama National Park, Spain. Geoheritage 9:141–151. https://doi.org/10.1007/s12371-016-0187-y

González T (1832) Registro y relación general de minas de la Corona de Castilla. Imp. M. Burgos. Madrid. 2 Tomos

Hanemann MW (1994) Valuating the environment through contingent valuation. Econ Perspect 8(4):19–43

Hansen TB (1997) The willingness-to pay for the Royal Theatre in Copenhagen as a public good. J Cult Econ 21:1–28

Hartwick JM (1977) Intergenerational equity and the investing of rents from exhaustible resources. Am Econ Rev 67(5):972–974

Hurtado V, y Hunt, M (1999) Extremadura, en Las primeras etapas metalúrgicas de la Península Ibérica. Delibe S, G. y Montero, I (Eds) Ed. Instituto Universitario Ortega y Gasset. Madrid, 241–274

IGME (2011) historia del Patrimonio Minero de Extremadura. 228 p

Instituto Geológico y Minero de España (2009) Estudio del Patrimonio Minero de Extremadura. 228 p

Johannesson M, Johansson PO, O'Conor R (1992) The value of private safety versus the value of public safety. J Risk Uncertain 13:263–275

Kolstad CD (1999) Environmental economics. Oxford University 400 p

Kriström B, Riera P (1997) El método de la valoración contingente: Aplicaciones al medio rural español. Economía Agraria 179:133–166

Larruga E (1795) Memorias políticas y económicas. Sobre los frutos, comercio, fábricas y minas de España: con la inclusión de los reales decretos, órdenes, cédulas, aranceles y ordenanzas expedidas para su

gobierno y comercia. Minas y producciones de la provincia de Extremadura. Imp. Benito Cano. Madrid

Lin B, Tan R (2017) Estimation of the environmental values of electric vehicles in Chinese cities. Energy Policy 104:221–229

Llanderas A (1998) Historia de la minería de Extremadura desde los orígenes del ser humano. Museo de Geología 5:45–53

Marchán C, Sánchez A (2013) Consideraciones sobre el patrimonio minero desde la perspectiva de un servicio geológico nacional. Boletín paranaense de geociencias 70:77–86

Marella G, Raga R (2014) Use of the contingent valuation method in the assessment of a landfill mining project. Waste Manag 34:1199–1205

Mitchel RC, Carson RT (1998) Using surveys to value public goods: the contingent valuation method. Resource for the future, Washington DC

Munasinghe M (1992) Environmental economics and valuation in development decision making. Working paper. World Bank, Environment Department, Washington, D.C., USA

Pagiola S (1996) Economic analysis of investments in cultural heritage: insights from environmental economics. Report of the World Bank

Puche O, Hervás AM, Mazadiego LF (2011) El Patrimonio Histórico Minero-Metalúrgico en España: Su impacto en el turismo cultural. De Re Metallica 17:27–46

Randall A, Ives BC, Eastman C (1974) Bidding games for valuation for aesthetic environmental improvements. J Environ Econ Manag 1: 132–149

Riera P (1993) Rentabilidad social de las infraestructuras: Las Rondas de Barcelona, un análisis coste-beneficio. Ed. Civitas. 171 p

Riera P (1994) El Método de Valoración Contingente. Instituto de Estudios Fiscales. Madrid (Spain), 112 p

Rodríguez Díaz A et al (2014) La minería protohistórica en Extremadura: El caso del estaño en el cerro de San Cristóbal de Logrosán (Cáceres). CPAG 24:167–201

Sánchez Gómez J (1989) De minería, metalurgia y comercio de metales. Ed IGME-Universidad de Salamanca, Salamanca

Sánchez A (2010) Estudio del Patrimonio Minero de Extremadura. In: Florido P, Rábano I (eds) Una visión multidisplinar del patrimonio geológico y minero. Cuadernos del Museo Geominero, no. 12. Instituto Geológico y Minero (IGME)

Shogren JF, Shin SY, Hayes DJ, Kliebenstein JB (1994) Resolving differences in willingness to pay and willingness to accept. Am Econ Rev 84:255–269

Solow RM (1988) Grown theory and after. Am Econ Rev 78(3):307–317

Sueiras JC, Martínez JM (2010) El valor económico de los espacios naturales. In: Esteve MA, Martínez JM, Soro B (eds) Espacios Naturales protegidos en la región de Murcia: Valoración ecológica, económica y jurídica. Editum, Murcia

Sun C, Zhu X (2014) Evaluating the public perceptions of nuclear power in China: evidence from a contingent valuation survey. Energy Policy 69:397–405

Thanh D, Viet Huynh K (2017) Estimating residents' willingness to pay for groundwater protection in the Vietnamese Mekong Delta. Appl Water Sci 7(1):421–431

Thompson MS, Read JL, Lian M (1984) Feasibility of willingness-to pay measurement in chronic asthritis. Med Decis Mak 4:195–215

Thompson E, Berger M, Blomquist G, Allen S (2002) Valuing the arts: a contingent valuation approach. J Cult Econ 26:87–113

Venkatachalam L (2004) The contingent valuation method: a review. Environ Impact Assess Rev 24:89–124

Water Resource Council (1979) Procedures for evaluation of national economic development (NED): benefits and costs in water resources planning (level C). Final rule. Fed Regist 44(242):72892–72977

Water Resource Council (1983) Principles and guidelines for water and related land resources implementation studies

World Bank (1998) Handbook on economic analysis of investment operations. Washington