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Externalities, NIMBY syndrome and marble quarrying activity

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Marble quarries like any other mining project are faced with NIMBY ('not-in-my-backyard') reactions, since some negative externalities are inevitable. The paper presents a contingent valuation survey aimed at investigating a local community's willingness to accept (WTA) compensation for allowing the establishment and operation of a marble quarry in its surroundings and exploring the determinants influencing NIMBY reactions against marble quarrying activity. The valuation scenario used involves an annual monetary payment to a community fund in order to be more realistic and to lessen the so-called 'bribe effect', which is common in compensation schemes.

Keywords: marble quarrying; NIMBY; contingent valuation; willingness to accept

1. Introduction

Marble quarries are likely to have lesser impacts on natural and man-made environments compared to metal and coal mines or even aggregate quarries. Yet, they do present a typical range of adverse effects. Mineral workings cause the removal of top soil, damage natural fauna and flora, pollute ground water and soil and lead to soil erosion (Milgrom 2008). Excavations, stockpiles and waste heaps result in serious landscape degradation, forming geometrical features (i.e. benches, heaps, etc.) that replace natural topographic relief (Menegaki and Kaliampakos 2006). Drilling and cutting operations for the extraction of marble blocks, as well as the movement of trucks over quarry and public roads, generate noise and dust nuisance. Hence, even though marble is probably the most popular ornamental stone in the world, marble quarries are usually faced with NIMBY ('not-in-my-backyard') challenges.

The NIMBY acronym is widely used to describe negative reactions against the siting of a variety of locally unwanted land uses (known as LULUs), such as hazardous waste facilities, landfills, airports, windmills, etc. Those facilities are perceived to be related to harmful effects to the environment and public health, a decline in quality of life and the so-called 'stigma' effect in the image of an area, generating negative externalities which are passed on to host communities (Gayer *et al*. 2002, Alberini *et al*. 2007, Schively 2007). Many researchers argue that NIMBY conflicts arise because the external costs affect only the communities surrounding the

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noxious facility, while the benefits are distributed globally throughout the economy (e.g. Kunreuther *et al.* 1987, Groothuis *et al.* 2008). Although other factors, such as bad decision-making processes, mistrust of government or private actors, etc., may also affect NIMBY behaviour, externalities play a dominant role. The latter is clear in cases where local communities even oppose projects with small effects, since people are concerned about the perceived economic cost of the facility to be sited.

A number of methods, the applicability and the effectiveness of which vary, have been proposed to address NIMBY concerns and to encourage the placement of a LULU (Local Unacceptable Land Use) facility, such as: compensation (either monetary or in-kind payments), risk communication, consensus building, empowerment of impact bearers and institutional mechanisms (Schively 2007). This paper, however, focuses solely on the monetary compensation mechanism as a means for resolving the conflict, from an economic point of view, between the potential losers (i.e. the host community) and those who benefit from the operation of the facility in question.

More specifically, the paper presents the results of a contingent valuation (CV) survey, the aim of which is twofold. First, it explores the determinants influencing NIMBY reactions against marble quarrying activity. Second, it investigates a local community's willingness to accept (WTA) compensation for allowing the establishment and operation of a marble quarry in its surroundings.

2. Literature review

CV studies have been conducted in the past to estimate externalities of mining activities. For example, Resource Assessment Commission (Imber *et al.* 1991) used the CV method to assess the environmental value of the Kakadu Conservation Zone in order to determine whether to complete Kakadu National Park by adding the Kakadu Conservation Zone to it or whether to permit the exploitation of mining deposits found in the area in the context of a cost-benefit analysis. Two different risk scenarios were presented to the respondents based on the environmental groups' view of the risk of mining activity to the Kakadu Conservation Zone and the National Park. The study estimated that the willingness to pay (WTP) for preventing possible environmental damage from mining in the Kakadu Conservation Zone ranged from AU$123 to AU$144 per person for the major impact scenario and from AU$52 to AU$81 per person for the minor impact scenario.

The Department of the Environment, Transport and the Regions (DETR) conducted two separate studies, which were both based on the CV method, aiming at calculating a tax on the output of aggregates based on the externalities generated by quarrying activity. The first study (London Economics 1998) implemented a willingness to accept (WTA) open-ended format to explore local residents' WTA compensation for externalities from quarries. The average local environmental costs per tonne ranged from £2.62 for hard rock quarries up to £9.00 for sand and gravel quarries, with an average for all aggregates of £4.63 per tonne. The second study (London Economics 1999) investigated whether residents in Great Britain would be willing to pay more tax to secure the environmental benefits that would flow from the early closure of aggregate quarries. According to the findings of the study, people living near hard rock quarries expressed a willingness to pay (WTP) of about £10.23 per year (£0.34 per tonne) and those living near sand and gravel operations expressed a WTP of about £15.57 per year (£1.96 per tonne). Residents living in the vicinity of

hard rock quarries located in national parks were willing to pay £18.11 per household per year (£0.07 per tonne) to stop the environmental effects of mining activities, while non-residents throughout Great Britain stated that their WTP was about £5.09 per household per year, which corresponds to £10.52 per tonne.

Externalities produced by aggregate quarries have also been monetised by Willis and Garrod (1999) using an alternative stated preference valuation method, namely Choice Experiment. The study adopted a willingness to accept (WTA) framework to elicit compensation for the impacts of a hard rock quarry located at Aycliffe near Darlington (UK), as a means to set the level of an appropriate environmental tax. The survey found that the value of one less day of noise, dust and mud is £3.54, resulting in an annual value of £1,111.46 per household (a lower range estimate was £433.32 per household per year). Bearing in mind the quarry's annual output, the external cost was £0.41 to £1.05 per tonne.

Mendonca and Tilton (2000) measured the use and non-use value of the natural resources threatened by large-scale mining in the Brazilian Amazon as a whole and in a specific area. CV results indicated that the average WTP of the population of Brasilia was R$5.90. Pemberton *et al.* (2010) examined whether the Dominican population and tourist visitors would agree and be willing to make a one-time payment for the preservation of the natural environment for eco-tourism and agricultural activities instead of copper-gold mining activity. On average, the WTP of the respondents was EC$ 320.78 (Caribs: 67.99, rural group: 426.16, urban group: 421.79, visitors: 447.75).

The CV analysis has also been utilised to measure the compensation necessary to overcome the NIMBY syndrome for the siting of unwanted land uses, such as hazardous waste facilities or electrical generation windmills (e.g. Groothuis and Miller 1994, Groothuis *et al.* 2008).

3. Survey design and data collection

3.1. Theoretical context and methodological approach

CV analysis employs two possible questions in order to assess respondents' valuation of environmental goods or services, i.e. willingness to pay (WTP) and willingness to accept (WTA), which derive from the Hicksian welfare measures of the compensating variation (CoV) and the equivalent variation (EV). More specifically, WTP is the maximum amount an individual would pay to gain an environmental improvement (CoV) or to avoid an environmental deterioration (EV). WTA is the minimum amount an individual would take as a compensation to accept an environmental deterioration (CoV) or to forgo an environmental improvement (EV).

In principle, WTP or WTA formats could be used interchangeably to elicit individuals' preferences for change in the level of environmental goods and services (Venkatachalam 2004). However, as indicated by many empirical findings, stated WTA is commonly greater than stated WTP. The disparity between WTP and WTA estimates may be large. For example, Horowitz and McConnell (2002), using a collection of 45 WTA/WTP studies, found that the mean WTA/WTP ratio was approximately 7. For this and other reasons, NOAA Blue Ribbon Panel (1993) recommends using always the WTP format for practical studies, which provides more conservative estimates.

Both theoretical and experimental research efforts have examined the factors influencing the variation in the WTP and WTA measures. For example, Kahneman

and Tversky (1979) explained the WTA/WTP disparity by means of the 'prospect theory', according to which individuals base their preferences on the net change relative to status quo and not on their well being before and after a change (Haab and McConnell, 2002). Hanemann (1991) showed that WTA/WTP difference can be explained not only by the income elasticity but also by the elasticity of substitution between environmental and market goods. Alheim and Bucholz (2000), following Hanemann, argued that the size of the WTA/WTP disparity is mainly affected by substitution effects and, therefore, seemingly anomalous phenomena, particularly for environmental goods, could be explained by the framework of standard utility theory. Other explanations have attributed the WTA/WTP difference to 'property rights' issues, 'familiarity' issues, etc. (see Venkatachalam 2004).

Although it is clear that there exists a disparity between WTA and WTP, and it is preferable to use the WTP elicitation format, the WTA framework adopted in this study was more appropriate considering the valuation scenario (i.e. deterioration of the environment and the quality of life due to the siting of a marble quarry) and the perceived property rights of individuals residing in the vicinity of the facility. On this basis, WTA is measured by the expenditure function:

$$WTA = e(\boldsymbol{p}, \boldsymbol{q}, U) - e(\boldsymbol{p}, \boldsymbol{q}*, U), \tag{1}$$

where $\boldsymbol{p}$ is a vector of prices for marketed goods, $\boldsymbol{q}$ and $\boldsymbol{q}^*$ represent the initial and the final level (i.e. after the siting of the quarry) of environmental quality, U is the initial utility level given by the indirect utility function $V(p, q, y)$ and y is the income.

3.2. *Questionnaire design and data collection*

The questionnaire used in the survey was finalised after a pre-test and consisted of four parts, as follows:

(1) a set of questions aiming at collecting a respondent's opinion about marble quarries and their impacts on the environment, the quality of life and the economy;
(2) a set of questions investigating NIMBY issues and marble quarrying activities;
(3) a set of questions regarding the acceptance and the amount of compensation;
(4) a set of typical demographic notes, e.g. gender, age, family status, annual income etc.

The first part included five questions grouped in two different categories. The first group of questions aimed at investigating respondents' knowledge about marble quarrying activities and the existence of quarry sites in the broader area. Following this, respondents were asked to identify and rate the most important environmental and socio-economic impacts associated with marble quarries. Then respondents were asked whether they agreed or disagreed with the following sentences:

- 'Marble quarrying activities create environmental externalities, without offering significant benefits for the society'.
- 'Marble quarrying activities create environmental externalities, but contribute to economic growth'.

- 'Marble quarrying activities create environmental externalities, but contribute to the creation of employment'.

The second part involved three questions. In the first question of this set, respondents were asked to vote for or against the termination of marble quarrying activities in the area of interest, justifying their opinion. Then, those who voted for the termination of quarry works were asked if they would change their opinion if it were the case that marble deposits were extracted exclusively by underground mining methods (e.g. 'room-and-pillar'). Finally, those who were against underground quarrying were asked under what particular circumstances they would reconsider their position.

The third part of the questionnaire focused on respondents' willingness to accept compensation for permitting the operation of a marble quarry within the boundaries of their community. First, respondents were asked if they were informed about actions undertaken by marble quarrying operators to compensate local communities for the impacts of marble extraction in their areas and, if so, how satisfied they were with these actions. Next, they were asked to indicate what further actions should be taken by quarrying firms in order to support local communities. Furthermore, they were asked to mention if they (or someone they knew) were professionally involved with marble quarrying activities.

With regard to the valuation question, respondents were asked if they would accept an annual amount of money that would be paid to their community by a quarrying firm as compensation (i.e. 'host fees') in order to consent to the operation of the quarrying works, as follows:

Suppose that a quarrying firm wishes to operate a marble quarry within the boundaries of your community. Would you be tolerant of your community receiving compensation for hosting this activity?

(a) Yes → In that case, what would be, according to your opinion, an acceptable amount of compensation to be offered every year to your community?
(b) No → Why? Please explain your reasons.
(c) Don't know – I am not sure.

This form of compensation, i.e. cash payment to a community fund, was selected for two reasons. First, this valuation scenario is more realistic given that aggregate quarries pay a Special Aggregate Tax of 5% of their gross value of sales to hosting communities as a compensation for the annoyance caused by the mining activity (according to mining legislation this special tax is applied only to aggregate quarrying, so far). Second, this alternate form of compensation could improve WTA responses. Frey *et al.* (1996) argued that compensation schemes frequently fail due to the 'bribe effect'. Respondents believe that accepting money as compensation may be perceived as a form of bribery, i.e. they receive money for private benefit at the expense of the entire community. On this ground, it was presumed that a payment directed to a community fund could be seen as a moral transaction, in line, however, with respondents' interests.

This type of elicitation format (i.e. compensation to community) was also used by Ferreira and Gallagher (2010), who examined attitudes regarding compensation in communities who were directly impacted by final waste disposal infrastructure projects. The results, as far as the valuation question is concerned, were encouraging

given that the authors found that only a very small percentage of respondents (43 out of 2000) criticised the offer of community compensation.

With regard to the study area, the population of interest comprised all inhabitants residing in four North-Eastern Attica communities (Greece), namely Dionyssos, Rodopoli, Anixi and Drosia, where important marble quarries were mainly found (at present, only one quarry site is still active). According to the most recently available national census data, the population of the surveyed area comprises approximately 1400 households (ELSTAT 2010). Answers were collected by telephone interviews, which were conducted between May and July 2010. Respondents were selected randomly from the area telephone directory. In total, 270 questionnaires were successfully completed. Given the described probability sampling procedure, the sample is considered to be representative of the population.

4. Survey results

4.1. Main findings

With regard to the demographic characteristics of the respondents, 53.7% were women and 46.3% were men. In total, 37.8% of the respondents were younger than 40 years old, 46.3% were between 40 and 60 years old and the rest were older than 60 years old. Approximately 4.8% had not reached high-school, 36.3% had stopped their education at the end of high-school, 13.2% had basic technical education and the rest had a higher education. Approximately 53% of the respondents were employed and 6% were unemployed. The remainder were pensioners (13.3%), students (8.9%) and housekeepers (19.2%). Approximately 5% of the respondents had a household income of less than €20,000, 43.5% between €20,000 and €40,000, and 51.1% more than €40,000.

The vast majority of the respondents (94%) were aware of active and inactive marble quarries located in the surrounding area. Regarding the environmental and social impacts of marble quarries, approximately 32% of the respondents identified damage to the natural ecosystem in general, and 10% referred to visual impacts in particular. Dust creation (28.3%), high noise levels (13.5%) and trucks travelling on public roads (7.1%) were reported as sources of annoyance. Finally, approximately 8.5% of the respondents stated that marble quarries contribute to the national economy and create employment. As far as the significance of those impacts is concerned, environmental degradation, followed by landscape intrusion and dust dispersion were considered to be the most important negative externalities. Furthermore, the creation of employment was ranked higher than the contribution to economic growth. It was interesting, however, that only 26.3% of the respondents thought that marble quarries offer nothing to the society but environmental externalities. The majority of the respondents agreed that marble quarrying activities, apart from provoking environmental impacts, contribute to economic growth (78%) and the creation of employment (91%).

The above-mentioned beliefs were reflected in respondents' vote for or against the termination of marble quarrying activities in the area of interest, since two-thirds of them (66.2%) voted for the continuation of quarrying works. According to the justifications provided, nuisance caused by dust and noise, irreversible environmental damage, incomplete restoration efforts, loose implementation of environmental laws, and the residential character of the area are the main reasons driving respondents to reject the operation of marble quarries. On the other hand, those

supporting marble quarrying activity referred to, besides employment and economic growth, the importance of marble as a raw material and the relatively low environmental impacts of marble quarries compared to other mining operations.

Approximately 30% of those who voted against the continuation of mining activity said that they would change their point of view if marble deposits were extracted exclusively by underground quarries. Furthermore, an additional percentage (28%) of the 'protesters' would opt for underground mining under particular circumstances (e.g. the restoration of abandoned pits, strict implementation of environmental rules, etc.).

Approximately 63% of the respondents said that they were aware of actions taken by marble quarrying operators to compensate local communities for the impacts caused by marble extraction, such as cash donations (42.1%), forest fire prevention measures (26.1%), and 'in-kind' compensation (31.8%), e.g. construction works, marble products, etc. Nevertheless, 50% stated they were 'a little' or 'not at all' satisfied by these actions.

4.2. *WTA quarrying activity*

4.2.1. *Acceptance of compensation*

The respondents were first required to answer whether or not they would accept compensation paid to their community in order to permit the operation of a marble quarry in their 'neighbourhood'. Approximately 53% of them said that they would be willing to consent to this proposal, while approximately 20% rejected the policy option, claiming that 'money is not enough'. Furthermore, 27% of the respondents concealed their true preferences by replying 'don't know'. It is worth mentioning that almost 80% of the respondents who rejected the compensation had also voted for the termination of quarrying works and approximately 75% of them had stated that they were 'a little' or 'not at all' satisfied by the 'community benefit' packages of marble quarrying firms.

Those respondents who accepted the compensation were then asked what amount of money, according to their opinion, should be paid to a community fund from the quarrying firm on an annual basis. Approximately 15% of them claimed that they were unable to estimate the amount of compensation in absolute terms and instead they proposed a percentage of an operation's gross value of sales. Interestingly, the mean (and median) value was 5%, which is equal to the Special Tax paid by aggregate quarries to local communities for the annoyance caused from their operation. Nevertheless, those answers were excluded from further analysis. Furthermore, three implausibly large bids were identified as outliers, based on a simple statistical analysis, and were also removed from the sample.

Table 1 presents the distribution of compensation amounts (zeros and outliers excluded).

4.2.2. *Treatment of zeros and 'don't knows'*

Those who answered 'do not know' to the WTA question were treated as if they had responded 'no', following Carson *et al.* (1998), Haener and Adamowicz (1998), Hackl and Pruckner (1999), Carson and Hanemann (2005). This is the most popular treatment assuming that 'do not know' answers tend to be 'no' responses (e.g. it is

Table 1. Bid frequency distribution.

Bid	Percentage
10,000–30,000	26.4%
30,000–50,000	29.9%
50,000–100,000	32.5%
100,000–150,000	6.0%
150,000–200,000	4.3%
200,000–250,000	0.9%

argued that individuals avoid saying 'no' because they feel guilty for not supporting the plan, or because they tend to behave politely and do not want to displease the interviewer). In any case, this approach is conservative and leads to estimates that err on the safe side, which is acceptable from a policy perspective.

The treatment of zero bids, classified into 'true zeros' and 'protest zeros', is an open issue in the economic literature. While the stand approach consists of including only true valuation responses in the analysis, some researchers argue that protesters would more probably vote against the proposed policy and they are better treated as 'no' responses, since a selective data removal may affect the validity of the estimates (e.g. Halstead *et al*. 1992, Jorgensen and Syme 2000, Carson and Hanemann 2005). Removal of protest responses could be valid if protesters were not significantly different from the remainder of the sample. If this is not the case, it would be better to adopt sample selection models (e.g. Alvarez-Farizo *et al*. 1999, Kontoleon and Swanson 2002, Strazzera *et al*. 2003).

In WTA surveys, 'protest zeros' are usually related to the hypothetical market, a lack of information concerning the compensation offer, belief that the money would not be paid and 'infinite compensation', while 'true zeros' are those claiming that the amount of compensation is insufficient or that the compensation is unnecessary because they are in favour of the development (Ferreira and Gallagher 2010). Nevertheless, Halstead *et al*. (1992), argued that protest bids can be considered as legitimate zero valuations when the CV survey is aimed at measuring the values of policy options rather than a specific good.

Following Halstead *et al*. (1992), and given that in the case presented what is being valued is actually a potential policy option, it was assumed that the stated objections can be deemed as legitimate zeros, representing preferences that are not favourable to the proposed policy.

4.2.3. *Non-parametric and parametric estimation of WTA*

The non-parametric estimation of WTA responses was based on the Kaplan-Meier product limit estimator (Bateman *et al*. 2002). The mean aggregated WTA value, which was found equal to €32,500 (median: €20,000), was calculated by the following equation:

$$\bar{C} = \sum_{j=0}^{J} \widehat{S}(C_j) \cdot [C_{j+1} - C_j], \tag{2}$$

where $\overline{C}$ is the mean WTA value, C_j is the ordered WTA values from lowest to highest (C_0 is equal to zero and C_J is the largest WTA value in the sample) and $\widehat{S}(C_j)$ is the empirical estimate of the survivor function at each of the C_j.

The parametric estimation of WTA values followed the method proposed by Reiser and Shechter (1999), which is an extended spike model approach introduced by Kriström (1997), i.e. a mixture model implying that the population of interest can be considered to be composed of two sub-populations. In this case, one sub-population is not at all willing to accept compensation for permitting the operation of the marble quarry, while the other sub-population is willing to accept compensation and has a continuous WTA distribution.

For an observed random sample of n individuals, $\delta_i = 1$, if the i-th individual's observed WTA is zero (i.e. she/he rejects compensation) and 0 otherwise. Thus, likelihood function can be written as proportional to:

$$\prod_{i=1}^{n} p^{\delta_i}[(1-p)f(w_i)]^{1-\delta_i} = \prod_{i=1}^{n} p^{\delta_i}(1-p)^{1-\delta_i} \prod_{w_i>0} f(w_i), \tag{3}$$

where f is obtained as the derivative of $F(x)$ with $x > 0$, i.e. the continuous cumulative distribution function (cdf) for the sub-population willing to accept compensation and $\Pi_{wi>0}$ represents the product taken over all individuals with observed WTA > 0.

Reiser and Shechter (1999) suggested breaking up the likelihood function into two separate parts, which can be maximised separately to provide maximum likelihood estimates of the unknown parameters.

Maximising the first part it comes out that $\hat{p} = \frac{\sum \delta_i}{n}$, which is the percentage of the observed denial answers provided by the respondents. To maximise the second part, an appropriate distribution for F should be selected, which in the case studied was the lognormal distribution, with:

$$F(z) = \Phi\left(\frac{\log z - \mu}{\sigma}\right) \quad \text{and} \quad \Phi(t) = \int_{-\infty}^{t} \frac{1}{\sqrt{2\pi}} e^{-u^2/2} du. \tag{4}$$

The mean and median WTA values can be estimated as follows (Bateman *et al.* 2002):

$$\text{Mean} = (1-p)e^{\mu+\sigma^2/2}$$

$$\text{Median} = \left\{ \begin{array}{cc} (1-p)e^{\mu}, & p < \frac{1}{2} \\ 0, & p \geq \frac{1}{2} \end{array} \right\}. \tag{5}$$

Values of μ and σ were calculated by MLE and were found equal to 2.3866 and 0.06016, respectively. By substituting the estimated μ, σ and p (which was found equal to 47% including also the 'don't knows'), the mean and median WTA values were estimated to €29,000 and €28,000, correspondingly.

4.2.4. Factors influencing WTA

In order to explore the factors influencing the acceptance or rejection of compensation and the amount suggested to be paid by the quarrying firm to the community, both logistic and linear regression models were utilised. More specifically, the responses of the total population to the binary WTA question (i.e. whether compensation is accepted or not) were analysed using a logit model, while

the WTA bids of the sub-population that is willing to accept compensation were connected with variables that are supposed to have an influence on the stated amounts using a linear regression model.

4.2.4.1. The binary model. Attitudinal and demographic (continuous and discrete) variables were used as independent predictors to model the binary WTA question. Table 2 presents the outcomes of the logistic regression equation according to which probability of compensation acceptance increases for respondents who know active or inactive marble quarries in the broader area, vote against the termination of quarrying works, are informed about 'community benefit' packages offered by marble quarrying firms, and believe that marble quarrying activity contributes to the creation of employment.

It seems somewhat unexpected that people who are concerned about the environmental impacts of marble quarries are more likely to accept compensation in order to consent to the operation of a quarry within the boundaries of their community. Nevertheless, this finding is explained by the fact that those who accept compensation are primarily respondents who voted for the continuation of quarrying activities on the basis, among others, that marble quarries have relatively low environmental impacts compared to other mining operations. Furthermore, it could be argued that the rejection of compensation is mainly affected by nuisance factors (e.g. dust and truck haulage). This assumption is also supported by the negative sign in the DISTANCE variable, which indicates that respondents who live close to the only active quarry site in the area are less likely to accept compensation. A deeper analysis of those two groups, i.e. respondents residing close to the quarry

Table 2. Logit model results.

Variable	b	Description of variables
QUARRYINF	1.685*	Respondents' knowledge about marble quarrying activities in the broader area [1:YES/0:NO]
QUARRYCONT	2.862***	Continuation of marble quarrying activity [1:YES/0:NO]
COMMBENEFIT	0.816*	Respondents' knowledge about 'community benefit' packages offered by marble quarrying firms [1:YES/0: NO]
DUST	−0.203*	Annoyance caused by dust [1: not important 5: very important]
TRUCK	−0.260*	Annoyance caused by trucks [1: not important 5: very important]
ENVDEGRAD	0.506**	Impacts on the environment [1: not important 5: very important]
EMPLOYMENT	0.336**	Impacts on employment creation [1: not important 5: very important]
DISTANCE	−0.918*	Relative distance of respondent's community from the active marble quarry site in the area [1: Close/0: Far]
Constant	−3.915**	
Observations	270	
−2LL	153.513	
Pseudo R^2	46.5%	

Notes: *Significant at 90% level; **Significant at 95% level; ***Significant at 99% level.

site and those who live in neighbouring communities, reveals that the former are more sensitive to nuisance parameters that the latter.

4.2.4.2. The linear model. A lognormal regression model was used, based on a bid function, as follows:

$$\ln \mathrm{WTA} = f(x_i, \beta, \sigma, \varepsilon_i), \tag{6}$$

where x_i is a vector of the selected explanatory variables of respondent i, β is the estimated coefficient of corresponding explanatory variables, σ is a variance parameter, and ε_i is a random error component with mean zero.

Statistically significant variables, as well as respective coefficients, are presented in Table 3. According to the results, the amount of compensation requested is generally greater for individuals with higher income and for those who stated that quarrying activity contributes to the creation of employment. On the other hand, the bid is lower for respondents who:

- vote for the continuation of quarrying activities;
- are informed about the impacts of quarrying activities on the environment; and
- believe that visual impacts caused by marble quarries are significant.

The negative sign of QUARRYCONT, ENVIMPACTS and VISIMPACTS variables is attributed to the characteristics of the sub-population that participates in the compensation 'market'. For example, those who support the continuation of quarrying activity also believe that marble quarries have adverse environmental impacts that are less significant than those of other mining projects. In addition, those living in neighbouring communities are more likely to accept compensation than those residing in the 'hosting' community. Thus, even though they state that visual pollution constitutes an important issue, the actual impact to them is lower due to the greater distance from the quarry site.

Based on the findings of Table 3, the average amount of annual compensation paid to the community equals to €27,800, given that the compensation acceptance ratio is 0.53 for the population of interest.

Table 3. Linear model results.

Variable	b	Description of variables
QUARRYCONT	−0.436***	Continuation of marble quarrying activity [1:YES/0:NO]
VISIMPACTS	−0.142**	Landscape impacts [1: not important 5: very important]
ENVIMPACTS	−0.237*	Respondent is informed about the environmental impacts of marble quarries [1:YES/0:NO]
EMPLOYMENT	0.696**	Respondent believes that quarrying activity contributes to employment [1:YES/0:NO]
INCOME	0.136**	Total income of all household members
Constant	11.319	
Observations	101	
Adj. R^2	21.9%	

Notes: *Significant at 90% level; **Significant at 95% level; ***Significant at 99% level.

5. Discussion

Marble is a famous raw material and it is common that marble extraction has relatively less adverse effects upon the natural and man-made environment compared to other mining activities (e.g. coal or metal mines). Yet, marble quarries, like any other mining project, are faced with NIMBY challenges. Local communities are concerned about the perceived economic cost of marble facilities operating in their vicinity since some negative externalities are unavoidable. It is argued that compensation paid directly to host communities, in order to ensure that the losers are actually compensated, could play a role to help eliminate public opposition, at least from a theoretical point of view. In practice, however, as Frey *et al*. (1996) noted, this is not usually the case.

This study aimed at revealing the external costs of marble quarries to people residing in their surroundings. Towards this direction, a CV study was conducted that adopted the WTA elicitation format. The valuation scenario proposed annual compensation paid by a quarrying firm to host communities in order to be more realistic, as well as to lessen the so-called 'bribe effect' (Frey *et al*. 1996). According to the empirical findings, only 20% of the respondents denied that they wanted compensation, stating clearly that 'money is not enough'. Yet, those who said that they would be willing to consent to this proposal constituted 53% of the population, since 27% of the respondents replied that they were not sure whether or not they would accept compensation for approving the operation of a quarry in the boundaries of their community.

The probability of compensation acceptance increases for respondents who know marble quarries in the broader area, vote against the termination of quarrying works, are informed about the 'community benefit' packages offered by marble quarrying firms, and believe that marble quarrying activity contributes to the creation of employment. Furthermore, nuisance factors seem to dominate the impacts of quarrying works upon the environment, since respondents who are more sensitive to nuisance parameters are less likely to accept compensation. With regard to the compensation amount, those who are more tolerant of marble quarrying activity and its environmental impacts require less compensation than other individuals.

The annual compensation amount offered to the community is approximately €30,000 (non-parametric median: €20,000), which corresponds to approximately €21 per household. This amount is very close to the estimates of Groothuis *et al*. (2008), who found that the compensation required to site wind turbines was US$23 per household per annum, and the findings of the study commissioned by London Economics (1999), i.e. £10.23–£18.11 per household per year. However, it is a fraction of the amount reported by Willis and Garrod (1999) of £433.32–£1,111.46 per household per year. This vast disparity in the estimates, given that the latter study also adopted a WTA framework, may be attributed to: (a) the valuation method used, i.e. choice experiment, (b) the intensity of environmental disamenities caused by hard rock aggregate quarries in comparison to marble extraction activities, and (c) the elicitation question format, i.e. direct household benefit from tax reduction instead of payment to community. The outcomes of this study indicate that the WTA framework used resulted in more conservative estimates. However, to obtain a more clear explanation of the disparities in the estimates, as well as the effect of community payment to the 'bribe effect', further research is required.

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