Investigating the Difficulties in Aesthetic Pollution Assessment by Means of Experimental Economics

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Abstract: - This work deals with investigation of certain difficulties met in aesthetic pollution assessment. Experimental Economics techniques, like answering to a questionnaire (including quantifiers under the form of ‘willingness to pay/accept’, WTP/A) have been incorporated into a Fault Synthesis/Analysis (FTS/A) methodology. An implementation is presented concerning the archaeological site of Elefsina, where atmospheric/visual pollution is evident, due to industrial activities taking place in the vicinity. It is proved that there is no significant linear correlation between WTP and WTA, in spite of what is suggested in certain theoretical aspects; thus, not only the WTA-WTP disparity, reported also by some authors (in cases other than aesthetic pollution), is confirmed but, furthermore, the lack of correlation is proved (valid in other two industrial sites near Athens, too). Last, we have indicated that extended aesthetic pleasure (EAP), used as an index of visual externalities, can contribute to the conceptual determination of the optimal value of effort intensification and the resources spent ($I_{opt}$) to achieve a certain aesthetic result. According to this analysis, $I_{opt}$ is decreased in the short run (due to lack of information diffusion, mainly in the public) and increased in the long run, due to knowledge accumulation/transfer/diffusion. The methodology presented herein has been successfully implemented in the case of the archaeological site of Elefsina, where the corresponding EAP is decreased by the industrial activities taking place in the vicinity.

Key-Words: - aesthetic pollution, visual pollution, experimental economics, contingent valuation method, fault tree synthesis, fault tree analysis, benefit maximization, fuzzy sets.

1 Introduction
The difficulties in aesthetic pollution assessment arise from the fact that this kind of pollution cannot be defined in an ambiguous way. Moreover, the same object may be considered by some as contributing to the beauty while others may feel uncomfortable when looking at it. Economic interests play, also, a role in this dispute. For example, some may find advertisements in the streets to have certain aesthetic value, especially when combining successful photographic material or graffiti with social messages; on the other hand, several cities have banned outdoor advertising, responding to both, the public demand and the experts’ opinion.

Although there is no consensus on aesthetics, there are practices of world-wide acceptance. One of these is to set rules in the category of allowed artistic work and the space permitted to be covered by the corresponding artists, who might be selected after some kind of competition. Three examples are given in Fig 1. The top photo presents illegal graffiti painted on the ancient Cononian Walls (constructed by Themistocles about the mid-5th century BC and reinforced later by Admiral Conon) that surround the peninsula of Piraeus, the main port of Athens, Greece. The photo in the middle shows a graffiti painted on the wall of a private house in the old quarters of Athens, although not permitted by city’s regulations. The last photo in Fig. 1 presents graffiti painted on the wall of the old Gas Factory (nowadays serving as a cultural centre) by artists selected and paid by the Athens Municipal Office.

For investigating the difficulties in aesthetic pollution assessment, we have adopted the contingent valuation method (CVM), which is a basic technique of the newly established domain of Experimental Economics. This technique is subjective on its grounds, trying to obtain objectivity by extracting opinion/attitude and information/knowledge from a representative sample of interviewees, who are asked to assign a value on a non-marketable (e.g., environmental or cultural) good or an externality (known, also, as
monuments or works of art which exhibit an extended value, holding a historic/symbolic connotation or referring to environmental/natural context. For example, all ancient temples in Greece were built on sites of extreme natural beauty while the oracles were located in sites carrying, till today, a mystic impression.

2 Methodology

Conventional CVMs concerning monuments of history and sites of environmental interest have been extensively reported [1,2], although not from the EAP point of view, as measures of economic value from the gravity centre in the respective questionnaires: willingness to pay (WTP), which reflects the maximum monetary amount an individual would pay to obtain the non-marketable good/service under consideration, and willingness to accept (WTA), which reflects the minimum monetary amount required as compensation by the individual to order to relinquish this good/service.

The fault tree we have synthesized in order to enhance this methodology, uses as ‘top event’ the main/source weakness under investigation: ‘indetermination of aesthetic pollution assessment’. Part of this tree is described below and shown in Fig. 2.

1.1 Lack of widely recognized product quality standards.
1.2 Lack of broadly recommended practices.
1.3 Weakness in matching observation (including experimental evidence) with the corresponding theoretical aspect, leaving the observed output without a solid definition.

1.1.1 Weakness in applying a reliable verification process to evaluate whether assessment is according to specifications set \textit{a priori}.

1.1.2 High spatiotemporal dependence of the aesthetic result.

1.1.1.1 High degree of subjectivity in assessing an aesthetic result.

1.1.1.2 Weakness of stating exact specifications \textit{a priori}.

1.2.1 High disagreement between experts as regard the rules to be adopted \textit{a priori} concerning the procedure of assessment.

1.2.2 Inadequate availability of experts of the required specialty, also combining the experience in art with the knowledge of the public opinion response.

1.3 Economic mismatching.

1.3.1.1 High disparity between WTP and WTA.

1.3.1.2 Theoretical aspect in significant dispute.
1.3.1.1 Low income.
1.3.1.2 High availability of satisfactory substitutes.
1.3.1.3 Great difference between \textit{a priori} aesthetic value and the corresponding \textit{a posteriori} (i.e., after initiating an experimental procedure for estimating the aesthetic value in order to connect this value with a kind of cost) assessment.
1.3.1.4 Significant endowment effect.
1.3.1.5 High ambiguity concerning the ‘real value’ in economic terms.
1.3.2 Ethical mismatching.
1.3.2.1 Strong social norm against giving up cultural objects/monuments (usually symbolizing either
glorious pages of history or/and civilization milestones) in return for money.
1.3.2.2 High tendency to avoid responsibility by participating in an activity that might be proved (later on) damaging.

3 Implementation

The methodology described above (i.e., a CVM-based questionnaire, enhanced with the corresponding FTA) has been implemented in the case of Elefsina, a small industrial city between Athens and Corinth, in Greece, best known for as the site of the ‘Eleusinian Mysteries’, one of the most famous events of the ancient Greek religion, and the birth place of Aeschylus, one of the three great tragedians of antiquity. Nowadays, Elefsina is a major industrial centre with establishments that contribute to aesthetic degradation/damage of the archaeological site, as shown in Fig. 3.

An input-output extract is presented in Fig. 4. Since Rule Based Reasoning (RBR) has been adopted for the FTA, we present a sample of the fuzzy rules used (in order to count for uncertainty), depicting a chain leading from the four-digit set 1.1.1.1, 1.1.1.2, to the one-digit top event: IF 1.1.1.1 is \( H \) and 1.1.1.2 is \( L \) THEN 1.1.1 is \( M \); IF 1.1.1 is \( M \) and 1.1.2 is \( L \) THEN 1.1 is \( L \); If 1.1 is \( L \) and 1.2 is \( H \) and 1.3 is \( L \) THEN 1 is \( L \). The symbols \( L, M, H \) stand for the linguistic terms \textit{low}, \textit{medium}, \textit{high}, obtained by the partitioning of the space of variables.

The input triangular fuzzy numbers assigned to each event of the path used to present a

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure2.png}
\caption{Representative sample of the tree designed/developed for investigating the causes of the assessment of indetermination of aesthetic pollution.}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure3.png}
\caption{The industrial establishments near the archaeological site of Elefsina (three chimneys are shown in the back) contribute to the aesthetic degradation of the site.}
\end{figure}
Figure 4. Fuzzy intermediate and final output (shown in the diagrams of events/causes under the codes 1.1.1 & 1.1. and 1, respectively) and input (in the rest diagrams) representing FTA for the branch 1.1 in Fig. 2. The results are given in fuzzy form by the shadowed trapezoids that can be defuzzified to give the crisp numbers/indices quoted in the text, indicating low/mild influence of the input.
quantification example from the numerical analysis point of view are given subsequently.

1.1.1.1: 30, 39, 51  
1.1.1.2: 28, 36, 45  
1.2: 41, 49, 60  
1.3: 23, 37, 48

The results are given in fuzzy form by the shadowed trapezoids depicted in the diagrams of Fig. 4 corresponding to the intermediate events (1.1.1, 1.1) and the top event (1), that can be defuzzified to give the crisp numbers/indices 55.61%, 18.27%, and 15.72% respectively, indicating low/mild influence of the input quoted above.

As regards the intermediate cause 1.3.1.1, we found very great disparity between WTP and WTA (for industrial plants removal or remaining, respectively), and no correlation between them as proved by the very low Pearson product-moment (or ‘simple’) correlation coefficient \( r = -0.111 \). It is worthwhile noting that similar low values have been estimated for two other industrial sites, as well, Agioi Theothoroi (51 km south of Athens, where an oil refinery is in operation) and Khalkida (55 km north of Athens, where a cement production plant is in operation), with r-values 0.133 and -0.091, respectively. An additional cause (to the ones quoted in the fault tree of Fig. 2) of this lack of correlation and great disparity is that the reviewees in these sites are not familiar in dealing with hypothesized transactions, while they all show a passive attitude avoiding to undertake responsibility to participate, even by expressing opinion, in an activity that might be proved (later on) damaging, as described in the final cause 1.3.2.2 and confirmed by a post-questionnaire.

4 Discussion

The spatiotemporal dependence of the aesthetic result (intermediate cause 1.1.2), as this is assessed by both, the experts and the public, is also connected with the effort and the resources spent for achieving this result. For assessing the contribution of EAP to the determination of the optimal value of effort intensification (in a certain spatiotemporal domain), \( I_{\text{opt}} \), we may consider the total benefit \( B \) as consisting of two conflict variables \( B_1(I) \) and \( B_2(I) \). The first, depended on EAP and generally on externalities, is an increasing function of \( I \) with a decreasing rate (i.e., \( \frac{dB_1}{dI} < 0, \frac{d^2B_1}{dI^2} < 0 \)) due to the validity of the Law of diminishing returns. The second, depended on the economic assessment of \( I \), is a decreasing function of \( I \) with a decreasing algebraic or an increasing absolute rate (i.e.,

\[
\text{Figure 5. Dependence of partial benefits } B_1 \text{ and } B_2 \text{ on intensification of effort } I, \text{ and shifting of } B_1 \text{ (a) in the short and (b) in the long run.}
\]

dB_2/dl<0, d^2B_2/dl^2<0 or d(dB_2/dl dl)>0, since the opportunity cost (as defined in terms of the value of the alternatives or other opportunities that have to be foregone for sake of achieving the pre-set goal) becomes disproportionately higher when \( I \) increases. Evidently, \( I_{\text{opt}} \) is the abscissa of \( B_1 \) or \( B_2 \) (or \( B_1+B_2 \)) with \( MB_1=MB_2 \), where \( MB_1=dB_1/dl \) and \( MB_2=|dB_2/dl| \)
are the marginal values of the partial benefits \( B_1 \) and \( B_2 \), respectively.

In the short run, the \( B_1 \)-curve is expected to be at the lower position \( B_1' \), because of lack of information to both, the public and the personnel working in relevant services; the slope of the new curve is smaller for identical \( I \)-values, deriving a more flat configuration, since the deviation from the original curve is greater in the region of higher \( I \)-values, where the impact of lack of information is higher (may be critical in certain cases); as a result, \( I_{\text{opt}} \) is shifting to \( I_{\text{opt}}' \), where \( I_{\text{opt}}' < I_{\text{opt}} \), as shown in Fig. 5a. In the long run, the \( B_1 \)-curve is expected to move upwards to \( B_1'' \), due to knowledge accumulation/transfer/diffusion; the slope of the new curve is greater for identical \( I \)-values, deriving a steeper configuration, since the deviation from the original curve is greater in the region of higher \( I \)-values, where the impact of knowledge accumulation is higher; as a result, \( I_{\text{opt}}'^{''} \) is shifting to \( I_{\text{opt}}'' \), where \( I_{\text{opt}}'' > I_{\text{opt}}' \), as shown in Fig. 5b.

It is worthwhile noting that instead of waiting for such an achievement we can facilitate/subsidize the participation of public to the corresponding events in order to (i) accelerate information diffusion and (ii) cultivate the respective aesthetic criteria. In such a case, the \( B_2 \)-curve will move downwards (as shown in Fig. 6) because of cost increase, becoming also steeper, since the difference form the initial \( B_2 \)-curve will be greater in the region of higher \( I \)-values; as a result, the lopt will move to \( I_{\text{opt}}^* \), where \( I_{\text{opt}}^* < I_{\text{opt}} \), i.e., to the opposite direction of the \( I_{\text{opt}}''-shifting, while the synthesis of these two vectors will give the final result that should be evaluated against subsidizing.

5 Conclusion

We have proved that Experimental Economics may provide the techniques, which, incorporated within a Fault Tree Synthesis/Analysis (FTS/A) methodology, are suitable for investigating the difficulties in aesthetic pollution assessment. We have also indicated that extended aesthetic pleasure (EAP), used as an index of visual externalities, can contribute to the conceptual determination of the optimal value of effort intensification and the resources spent (\( I_{\text{opt}} \)) to achieve a certain aesthetic result. According to this analysis, \( I_{\text{opt}} \) is decreased in the short run (due to lack of information diffusion, mainly in the public) and increased in the long run, due to knowledge accumulation/transfer/diffusion. The methodology presented herein has been successfully implemented in the case of the archaeological site of Elefsina, where the corresponding EAP is decreased by the industrial activities taking place in the vicinity, producing atmospheric/visual pollution and changing the original beautiful blue color of the homonymous gulf.

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