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Review Article

Evaluation of green urban areas: some study cases in Florence

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Abstract

According to a multifunctionality perspective, green urban areas increasingly play an important role in the improvement of human quality life. The correct management of such areas needs an in-depth analysis of the resource's economic aspects. Therefore the economic value assessment of commodities and non-commodities related to green urban areas is one of the strategic information which is able to influence planning choices according to a sustainable and multifunctional process. The present article focuses on eight different types of urban parks located in Florence in order to define their Total Economic Value (VET) and, in the same time, to underline some guidelines for assessment of these areas. As a matter of fact, through the linkage of the Contingent Valuation Method and the Visual Preference Method, questionnaires have been prepared and suggested to park's users. Total Economic Value has been achieved by the elaboration of elicited data. Besides, another significant goal had been obtained by the attendances' count in the different examined areas: the individuation of the yearly average user's number, which provides how the necessity of spending time in green urban spaces is noticed by people.

Keywords: *Urban green area, total economic value, multifunctionality of green areas.*

INTRODUCTION

Transformation of Italian landscape was studied as early as the last century to achieve a right territorial planning.

After the great development of the cities that inevitably introduces environmental diseases without control, safeguard of green urban areas become a relevant questions. Technological comfort and industrial progress bring the standard of a new life where pollution has a direct linkage with urban areas where air is not breathable for citizen. Presently life's quality is worse than it was some thirty years ago. People need a right environmental assessment link to sustainable development: it is important for great areas like national parks and for small areas like urban areas.

There are some official documents about environmental management in Italy that may be divided into three levels: Piano di Sviluppo Rural [PSR] is a regional document [general level], Piano Territorial di Coordinamento Provinciale [PTCP] is a provincial document, and Piano Regulator Generale [PRG] is a municipal document [specific level].

The landscape concept is not equal in these documents. It is an environmental valorization in the regional meaning; whilst it is a linkage between cities and rural areas in the provincial meaning, it is also an important area for life's quality in its urban meaning.

Green urban areas have been divided in uniform sub-areas called F1 and G1 in PRG document: the F1 are public urban parks and the latter are gardens and natural parks where infrastructural works are permitted only if sustainable development rules are respected.

We can underline a general deficiency of operative specific rules for urban areas because public stockholders have not enough data for analtsing them. In fact it is important to give economics and statistic data to stakeholders for a right planning of urban parks, because it is impossible to do it with the present planning documents only. Stockholders know the real cost of infrastructural actions inside a park, but unfortunately it is difficult to estimate the right value of citizen's welfare concerning urban areas.

A bottom up analysis based on the characteristic of park's users is an additional tool for right urban green planning. First step has been individuated a typical park user's profile with a questionnaire based on functional and aesthetic aspects of urban parks.

Second step has created a market for non-market goods through the Contingent Valuation where their Willingness To Pay [WTP] has been estimated. The paper focuses on six typical urban parks in Florence: they include different types of areas, like public square's areas, historical gardens, or small local gardens.

This is only a part of a general analysis that will finish next November: the present work shows a general analysis without specific WTP of each urban parks. The next step will analyze WTP and the number of users of Single Park. Thus the Total Economics Value [VET] will be calculated through Contingent valuation method [CVM].It is important to underline the importance of CVM applied to urban areas planning: this is a valid support to stakeholders for right management of these areas.

MATERIAL & METHODS

The contingent evaluation method

The problem of the definition and of the evaluation of the economic value of collective goods as the public parks and gardens has been solved in this study thanks to the implementation of the contingent evaluation method. The theoretical basis of the methodology allows the definition of the total economic value of collective goods by making explicit the willingness to pay [WTP] [or to accept, WTA] the consumer of that specific good. This is being done by handing over a questionnaire.

The questionnaire is also aiming to collect a set of information and of data, to be used in order to define the characteristics of each consumer.

Finally, by the aggregation of the data collected, elaborated with the proper statistical devices, the determination and individuation of different groups of visitors becomes possible. Each group is characterized by a certain number of different aspects such as sex, age, visiting motivations, level of appreciation for the public parks and gardens, willingness to pay, etc.

It is evident how the validity of the research is a direct consequence of the appropriateness and efficaciousness of the questionnaire.

Thanks to the contingent evaluation method, it is possible to simulate the existence of a real market for the good to be esteemed. The consumer is induced to act as if he was dealing with a whatever market good, allowing the researcher to evaluate and measure the willingness to pay of the consumer, calculated as a function of the utility produced by the same good esteemed.

Among the different possible choices of making explicit the WTP, in the paper the double band dichotomy approach has been used. In this method the consumer of an environmental good deals with a relatively realistic situation. In fact, the interviewer proposes the consumer to pay or to accept a certain amount of money, drawn by chance, and the interviewed has just to answer positively or not. This particular type of WTP is also likely to reduce at the minimum the risk of strategic answers from the interviewed, because it is reasonable to imagine that the consumer has concern in giving a right answer.

Moreover, in this particular case, the interviewed is put in a nearly real market situation, where the prices are exogenous factors, thus allowing him to adopt his usual consumer's behavior, accepting or not to purchase a good at that specific price.

In order to analyze the answers this methodology needs the use of particular statistical devices given in a dichotomous form. Thus, the aggregation and the reading of the data, is less immediate. The use of a double band approach allows, increasing the levels of choices of the interviewed, a more precise definition of the willingness to pay of the consumer himself.

The higher complexity of the elaboration of the data collected needs to be analyzed more in detail. The starting point is represented by the hypothesis that each consumer has its own utility function U [J-Y], where j is a binary variable that assumes values equal to 1 when the access to the park is allowed and 0 when it is not allowed and Y represents the yearly income. Obviously, it is verified that U [1,Y] is greater than U[0,Y].

The value that each consumer gives to the fruition of the site, expressed in willingness to pay [WTP], is the one that satisfies the following indifference equation:

$$U(1, Y - WTP) = U(0, Y) \quad [1]$$

Going further with this elaboration, it is introduced to the dichotomous method [both single and double band]. Thus the [1] changes into the following inequalities:

$$U(1, Y - x_i) < U(1, Y - WTP) \quad [2a]$$

$$U(1, Y - x_i) > U(1, Y - WTP) \quad [2b]$$

If, respectively, x_i is higher or lower than WTP. The interviewed will accept to pay x_i if and just if $x_i \leq DAP$.

Thus, specifying with Prob[SI/x_i] the probability that the consumer accepts to pay the amount of money x_i, drawn by chance, it is possible to obtain the following:

$$\Pr ob(SI / x_i) = \Pr ob(WTP \geq x_i) \equiv 1 - G_{WTP}(x_i)$$
[3]

where GWTP is the function of the cumulative distribution, f.c.d., of the casual variable WTP, whose mean is given by the following:

$$E(WTP) = \int_0^\infty \left[1 - G_{WTP}(x)\right] dx \quad [4]$$

Con $WTP \in R^+$.

The knowledge of the f.c.d. GWTP[x_i] is also indispensable in order to measure other values of the distribution, among which the WTP* median value, that represents the specific amount of money x_i to which corresponds:

$$1 - G_{WTP}^{-1}(x_i) = 0{,}5 \quad [5]$$

The equations [4] and [5] shows the significant role carried out by f.c.d. in the evaluation process.

In order to get to the definition of the f..c.d. it is possible to follow two options: the first one is linked to a parametric approach, the second one to a non-parametric.

The parametric approach has been formalized by Hanemann [1984] and it follows the theoretical scheme of the maximization of the difference of casual utility.

The essential theorem of this formulation is that it becomes impossible to precisely know all the variables that take part in the definition of the individual utility function, thus the WTP too, which operates as a random variable. This condition is formally expressed by adding to the previously described utility functions [1] a stochastic component , independent and identically distributed in the different utility levels.

$$V(1, Y - WTP) + \varepsilon_1 = V(0, Y) + \varepsilon_0 \quad [6]$$

where V[0] is the mean of the random variable U[0]. The interviewed will accept to pay the amount x_i if and only if:

$$V(1, Y - x_i) + \varepsilon_1 \geq V(0, Y) + \varepsilon_0 \quad [7]$$

From [7] it becomes evident that the answer of the interviewed owns the characteristics of a casual variable, whose distribution of probability is:

$$\begin{aligned}\Pr ob(SI / x_i) &= \Pr ob\{V(1, Y - x_i) - V(0, Y) \geq \varepsilon_0 - \varepsilon_1\} \\ &= \Pr obF(\Delta V) \geq \eta \\ &= F_\eta(\Delta V) \\ &= 1 - G_{WTP}(x_i) \quad (8)\end{aligned}$$

Where $F_\eta(0)$ represents the cumulative distribution function of $\eta = \varepsilon_0 - \varepsilon_1$, and $\Delta V = V(1, Y - x_i) - V(0, Y)$.

The expression [8] defines the link between two types of probabilities, one in the geometric space and one pointed out in the WTP space.

In order to be able to go further with the parametric approach, it becomes necessary to define:

The distribution of the stochastic component $F_\eta(0)$

The variables and the formulations of the deterministic component $\Delta V(0)$

The final evaluation model is given by the combination of the two above mentioned choices.

As regards the first specification, the existing literature gives numerous solutions, even though it is not always easy to find applicable and accessible algorithms.

In this specific study, the solution will be limited to the case of the distribution family, thus:

$$\Pr ob(SI / x_1) = F_\eta = 1 - \left[1 + \lambda \exp(\Delta V)\right]^{-1/\lambda} \quad [9]$$

It represents a flexible family which allows as many distribution of probability as the number of values given to the parameter .

In particular, it has been considered the logistic distribution that generates the logit model:

$$\Pr ob(SI / x_1) = F_\eta = \left[1 + \exp - (\Delta V)\right]^{-1} \quad [10]$$

With $\lambda = 1$.

As regards the second specification, it has been used as a limit widely adopted in literature, that is a single varied utility function, also linear in the income. This solution shows, in addition to its simplicity, the advantage of allowing a comparison with the non-parametric evaluation by imposing the same conditions. Moreover, from a theoretical point of view, this solution is acceptable, because of the little amount of money involved in respect to the yearly individual income of each interviewed.

The utility function, linear in the income, is:

$$U_j = \alpha_j + \beta Y \quad [11]$$

Where j=0, 1, α_j is a constant and β is the income marginal utility.

If considered as a difference of utility functions, the previous [11] becomes:

$$\Delta V = \alpha - \beta x_i \quad [12] \text{ Con } \alpha = \alpha_i - \alpha_0 .$$

By combining [12] with [10] it is possible to get to the linear-logit model.

$$\Pr ob(SI / x_i) = \left[1 + \exp - (\alpha - \beta x_i)\right]^{-1} \quad [13]$$

The estimation for the parameters α and β are obtained thanks to the use of the method of maximum likelihood ratio.

The punctual estimation of the mean WTP of the linear-logit method is obtained by using the analytic solution given by Hanemann [1989]:

$$E(WTP / WTP \in R^+) = 1/\beta \ln(1 + \exp(\alpha)) \quad [14]$$

It is important to point out that this value corresponds to the average of the willingness to pay of each interviewed and not to the real mean WTP. This occurs because the representatives of the sample, to be satisfied, has to be calculated considering that between the number of yearly visits and the WTP, there usually exists an inverse relation. In fact, in general he who does more than one excursion per year expresses a lesser WTP and, in the cases in which a considerable number of visitors do make an high number of visits, it becomes necessary to calculate the weighted mean WTP [41].

The use of the non-parametric approach allows the overcoming of the difficulty of the definition a priori of the conditions needed for the parametric estimation.

In this case, some limitations have to be made, for example that the utility function needs to be linear in the income, which implies that the probability of the answers depends only on the dimension of the amount x_i.

Thanks to the dichotomy approach, it becomes possible to point out the number of interviewed ri which are willing to pay the same amount x_i. This information enables us to quantify the frequency $\pi_i = r_i / n_i$. Ayer et al. Demonstrate that the observed frequencies π_i represent the estimation of maximum likelihood ratio of the probability Probe [SI/x_i], if the sequence $\pi = (\pi_1, \pi_2, ..., \pi_k)$ is a not increasing monotonic function. This sequence represents the non-parametric estimation of the function $1 - G_{WTP}(x_i)$.

RESULTS & DISCUSSION

Cluster analysis method

One of the limits of the contingent evaluation is that the value of a not real consumer's willingness to pay is being reproduced. In fact, the result of this evaluation comes from the aggregation of the n values, with n equal to the sample numerousness. The so obtained WTP, representing in any case a very useful value, could give a much more real result if it would be possible to consider and to analyze, through the whole universe of interviewees, some homogeneous samples. In order to answer this question, a cluster analysis was applied to the data obtained with the questionnaires for the determination of eventual similar groups of urban green areas' visitors. The occurrence of significantly distinct categories, brought out by the cluster analysis, underline and define specific types of green areas' visitors allowing the explanation of different behaviors.

As a matter of fact, by the generic knowledge of demand, it is possible to determinate a strict and specific picture of each sample's aspects, segmenting and examining the different groups. In such a way, the public administrator owns strategic information that is very important when decisions about urban planning have to be taken. As a matter of fact, such information are able to direct decisions according to users' requirements. From a multidimensional data, cluster analysis is able to assign the single unit to categories not determinate a priori, and to make groups homogeneous inside and heterogeneous between them.

K. Pearson, in the last X_IX, for first time used the study of classification in a statistic way.

Since then, several algorithms have been made and used. In particular, from the second part of 1950`s, some grouping techniques have been deeply developed thanks to the concordance with the graph theory [Mignani e Montanari, 1994]. Afterwards, algorithmic aspects have been improved with the development of calculation methodologies.

Today, we own several alterative solutions for the group analysis. Approximately all the techniques consider a dissimilarity matrix that shows the information about the level of dissimilarity between the statistic units.

The dissimilarity matrix is obtained both by subjective considerations about the differences between the units and by the calculation of the matrix's data.

In this second case, several criteria exist according to the type of the chosen variables [quantitative, qualitative, binary ecc.] In the case of quantitative variables, for example, the dissimilarity between units match their distance. Anyway, the dissimilarity calculation changes each time according to the type of variable. Once fixed the dissimilarity levels are fixed, hierarchic or not-hierarchic definition of groups represents the next step. In our case, the classification method is hierarchic, due to the impossibility of the knowledge of the number of groups a priori, and agglomerative.

Such a method allows examining the grouping structure related with variable levels of homogeneity inside the different groups.

An essential element for the understanding of the hierarchic methods is the graph representation of the grouping structure by the use of dendrograms [Fig. 2].

Choosing dendrogram at a specific dissimilarity level, it is possible to obtain a partition in separate and homogeneous groups.

Agglomerative algorithmics are methods that work through following aggregations of units that is from the leaves of the dendrogram to the root.

What really differentiates the agglomerative hierarchic clustering method is the way to determinate the groups dissimilarity. The Figure 1.2 shows the peculiar aspects of the main methods.

Study's cases: valuation of recreational supply of urban areas in Florence

Six green urban areas in Florence

The choice of green urban areas for Contingent Valuation analysis focuses on different types of parks in Florence with different size and locations. The size of areas is properly related to number of users: there are small local gardens visited by small number of persons and large areas visited by great number of persons [table 3]. Another choice's element of the areas is their location: the parks have been selected with a casual distribution around the center of the city [see Figure 2 for details].

Data elaboration

The paper focuses on the recreation's function of green urban areas in Florence through the analysis of questionnaires about six urban parks. Total number of interviews use for the analysis is 495, so generic characteristics of six urban parks users in Florence have been analyzed through 495 questionnaires: typical users are 50 years old [average age], 55% of the total numbers are females and 45% are males. Predominant study degree of users is represented by high school degree users [33%] while 29% of the total numbers have a secondary school degree; primary degree and university degree users are respectively 20% and 14%. Many users go to parks to bring children to play with mates [41%], and for spend free time for walking inside parks [26%]. They use urban parks for relaxing [67%] and for urban noise's isolation [13%].

WTP elicitation method has formalized in questionnaires with a double bounded question about an availability to pay n euro per year for better urban areas planning and no limit access to parks.

Table 3 shows WTP general analysis: we used a spreadsheet model to solve it [Brun, 2002].

A contingent valuation limit is to analyze heterogeneous data of complex users characteristics and so next step is to create uniform user's groups. Thus the analysis is based on a hierarchic cluster method of values. It operates for subsequent aggregations of units from n groups of only one individual group.

Seven variables have been used in cluster analysis: five socioeconomic variables [age, sex, type of study degree, professional conditions and civil status] and two park's fruition variables [purposes and frequency of use]. The result of process are 3 uniform groups with low deviance. Each group is respectively compose by 161, 186 and 123 persons.

The outliers number [all interviewees that give wrong answers with an influent weight on statistics analysis] is 25, and it is not considered into the analysis.

Cluster analysis has been operated through Ward method that bases on group's aggregation with minimum deviance. The distance between two groups is the difference between total deviance and the sum of internal group's deviance [figure 4].

It is possible to divided each group about the age of persons: the first group [group 1] is 71 years old [average age], the second [group 2] is 45 years old, and the last one [group3] is 27 years old.

The previous group has been composed by 42% of female and 58% of male. Same percentage is represented by primary degree users while the person with secondary school degree is 26%. 80% of all are retired men and 63% are married people [63%].

34% of users bring children to play with mates, 28% of them meet friends or other people inside the parks and 36% of them spend time for walking. The frequency of park's fruition is 2 hours, 1-4 day per week [87% of interviewees]. 135 people prefer the functional aspects of these areas rather than their aesthetic aspects.

88% of interviewees has a positive opinion about infrastructural aspect such as sport and play areas. People think that the grass maintenance aspect, the organization of functional areas, the kind of plants and the walking areas are well preserved, while animal areas and illumination service are not enough well preserved: there is no enough illumination for 70 interviewees [43% of all]. 53% of users spend free time in green urban areas because it is relaxing to stay inside a place far away from urban pollution and traffic noise and they are very important for cities decongestion.

The biological indicators of environmental conditions are rare kind of plants [important for biodiversity] and vertebrate animals and invertebrate animals such as "ducks and peafowl" for first category and "hornets and spiders" for latter. Typical kind of plants is more important than animals [77% of users]: the bird's presence is better than insect's presence [41% of users prefer birds, only 2% prefer insects], because interviewees identified insects like mosquito's noise.

Table 4 shows statistical index. Willingness To Pay of this group is about 4.398 euro per year, maximum value is 5.758 euro and minimum value is 3.037. Standard deviation [quantification of distance from average value] is 0.067 while variance is 0.00449.

Kurtosis analysis shows a positive value [0.05], it is a leptocurtic data distribution with no changeable values close to average value. Figure 4 shows frequencies distribution of WTP data.

Asymmetry analysis [asymmetry around average value] has a negative value [-0.26]: this indicates a left tag longer than the right one from average value.

The second cluster analysis group is 45 years old [average age] and it has been composed by 66% of female [122 on 186 persons] and 34% of male.

A great part of interviewees has secondary school degree [38%] and high school degree [44%]; there are some university degree users [32 on 186 person], while the primary degree users are only 17% of all.

Married people are 25% of all while dependent of public or private enterprises are 22%: a great part of this [72%] is married [134 on 186 persons] and while only 15% of all are student. A great part of interviewees [like the precedent group] use green areas for bring children to play in the park [62%] and for spend time for walking [18%]. The frequency days use is one and half hour, 1-4 days per week. 80% of people prefer the functional aspects of these areas rather than their aesthetic aspects.

This group is more dissatisfied than precedent about this functional aspect: in fact 35%

of interviewees are not satisfied for play areas, and 39% are not satisfied for organization of animal areas [many people want closed areas for dogs, because they are dangerous for children and they leave dirty excrements inside the parks]. Illumination services are important [37% of total interviewees] for a night use of areas.

The aesthetic function is less important than functional aspect: only10% of person appreciate parks for flowers, fountains or pond, while the other [90%] appreciate parks because they are a natural barrier against urban noise.

The safe biological indicators for environmental protection [special kind of plants] have been chosen by 76% of interviewees, while vertebrate and invertebrate animals have been selected by a few part of users.

The presence of birds and insects for environmental quality are more important than other group [41% versus 24%], where 34% of users consider presence of only birds more important than presence of only insects [they was 41% in the previous group].

Table 5 shows statistical index. Willingness To Pay of this group is about 4.935 euro per year [maximum value is 6.285 euro and minimum value is 3.586 euro]. Standard deviation is 0.064 while variance is 0.004410.

Kurtosis analysis shows a negative value [-0.28].It indicates a platicurtic data distribution with changeable values close to average value. Figure 4.1 shows frequencies distribution of wtp data.

Asymmetry analysis [asymmetry around average value] has a positive value [0.15]: this indicates a right tag longer than the left one from average value.

The third group of cluster analysis is called the younger group: it is 27 years old [average age] where 57% users are female and 63% are male. The group's numerousness is consisting of 123 persons.

The reduction of average age is not proportional to the type of study degree, in fact there is an increment of university degree users [24% versus 3% of first group and 17% of second group], and high school degree users [52%, it is the highest percentage of interviewees].

It has a typical profile of young people: a great number of interviewees are students [46%], they have a dependent job in private and public enterprises [14%], they are not married [75%].

Relaxing activities are main park's uses, in fact 24% of interviewees go to green areas for spend time for walking [one and half hour per day]. Frequency of use is a variable number between 18% of week end users and 33% of 3-4 days per week users. 107 people prefer the functional aspects of these areas rather than their aesthetic aspects.

Organization of these areas is not enough well preserved [30% of interviewees]: there is a relationship between age and sport activity: younger people is more interested to sport than oldest people.

The other functional aspects are well preserved except for illumination services [27% of users] and animal areas [24% of interviewees]. The green urban areas are important for relaxing and for isolation from urban noise like the other groups.

The same opinion about environmental indicators: rare kind of plants is more important [76%of users] than vertebrate and invertebrate animals and the 47% of interviewees consider the presence of both species [birds and insects] an important choice.

Table 6 shows statistical index. Willingness To Pay of this group is about 4.220 euro per year [maximum value is 2.919 euro and minimum value is 5.520 euro]. Standard deviation is 0.071 while variance is 0.005030.

Kurtosis analysis has the same distribution of previous group. It shows a negative value [-0.06].It indicates a platicurtic data distribution with changeable values close to average value. Figure 4.2 shows frequencies distribution of wtp data.

Asymmetry analysis [asymmetry around average value] has a negative value [-0.25]: this indicates a left tag longer than the right one from average value.

CONCLUSION

The paper focuses on CVM applied to urban parks management where stakeholders are supported by economics and statistical analysis: it is a planning process of green urban areas based on bottom up analysis.

It is possible to underline a low efficiency of environmental planning documents in Tuscany, that they do not consider green urban areas safeguard. There are three different levels of planning documents: regional PSR, provincial PTCP and local PRG which include some theoretic rules but they do not consider practical rules.

The analysis of the characteristic and behaviour of parks users gives complex results because of this stakeholders need specific rules and instrument for making the right choice.

Through 495 questionnaires the typical characteristic of Florentine parks users have been defined: the average age of them is 50 years old, most of them are female [55%], 33% of users have a high school degree, 29% have a secondary school degree while primary degree users and university degree users are respectively 20% and 14% of all. Many users go to parks for bringing children outside [41%] and for walking [26%], they use urban parks for relaxing [67%] and for protecting themselves from urban noise [13%].

4.564 euro per year is their average willingness to pay for a better urban areas planning and no limit access to parks. A contingent valuation limit is to analyze heterogeneous data of complex users' characteristics and thus cluster analysis has been operated to solve it. Through this statistical method three uniform groups of users have been obtained. Each group has a different average age of users [71, 45, 27 years old].

The groups analysis underlines how the first group has a lower number of female than the others, in general school degree is linked to the age of interviewees, in fact group 3 [average age 27 years old] has an average higher school degree than group 1 [average age 71 years old]. The principal reason of park use is bring children to play inside it [34% of users of group 1 and 62% of group 2], while for group 3 [24% of users] is spending free time for walking.

A common element of these groups is the opinion about functional aspect of the parks: it is more important than aesthetic aspect. All the groups appreciate parks for relax and because they are a natural barrier against urban noise. A the same time all the groups seem to prefer typical plants rather than animals like life's quality indicators.

Highest willingness to pay is 4.935 euro per year [group 2] while lowest wtp is 4.220 euro per year [group 3]. This result shows how income represents the constraining factor in the wtp for a general good.

This elaboration is the first step of VET urban parks definition. Present target is to join economics methods [CVM] and statistical methods [Cluster analysis] in a bottom up analysis where citizen are involved. This method can also represent a valid instrument for stakeholders decision planning and it can be a valid support to integrate legislative documents with practical topics.

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Table1. Main hierarchic agglomerative methods

Single linkage

Distance between two different groups is the minimum distance of the unitsThe main limit ot the method is to link units belonging to different groups..

Complete linkage
Distance between two different groups is the maximum distance of the units.

Average linkage
Distance between two groups is the averange of the distances of the units.

Centroid Linkage
The centroid of each group is defined as the point which has as co-ordinate the average of co-ordinate of the units.Distance of two groups is the euclidean distance between the centroids.

Ward's method
Deviances related with all the possible groups are calculated and the aggregation with the minimum deviance is maden. Distance beteween groups is the difference between the whole deviance and the sum of the deviance of the units of each group.

Source. Stata operation manual

Table 2. Urban areas in Florence [size]

ID	*Urban Area*	*Sup (mq)*
1	Villa Vogel	49.783
2	Villa Strozzi	87.000
3	Piazza Tasso	6.165
4	Giardino di Borgo Allegri	1.870
5	Campo di Marte	25.957
6	Viale Tatini - Galluzzo	12.150

Table3. Total WTP

max wtp	**3.223**
min wtp	**5.904**
average wtp	**4.564**
median wtp	**4.5**
10th percentile	**1**
90th percentile	**7.5**
E (wtp) random number	**4.564**
standard deviation wtp	**0.042**

Table 4. Statistic index

minimum wtp	3.037
maximum wtp	5.758
average wtp	4.398
median wtp	4.500
stand. Dev. Wtp	0.067

Table 5. Statistic index

minimum wtp	3.586
maximum wtp	6.285
average wtp	4.935
median wtp	5.000
stand. Dev. Wtp	0.064

Table 6. Statistic index

minimum wtp	2.919
maximum wtp	5.520
average wtp	4.220
median wtp	4.500
stand. Dev. Wtp	0.071

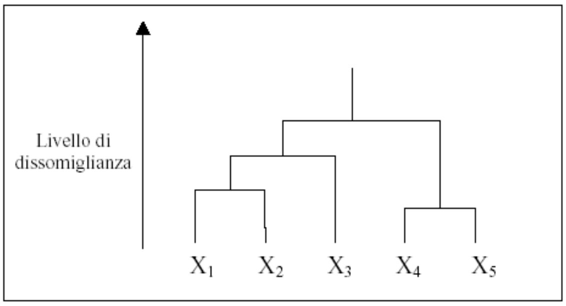

Fig 1. Example of dendrogram

Fig 2. Urban areas in Florence [location)
Source. our elaboration on Google Earth Figure

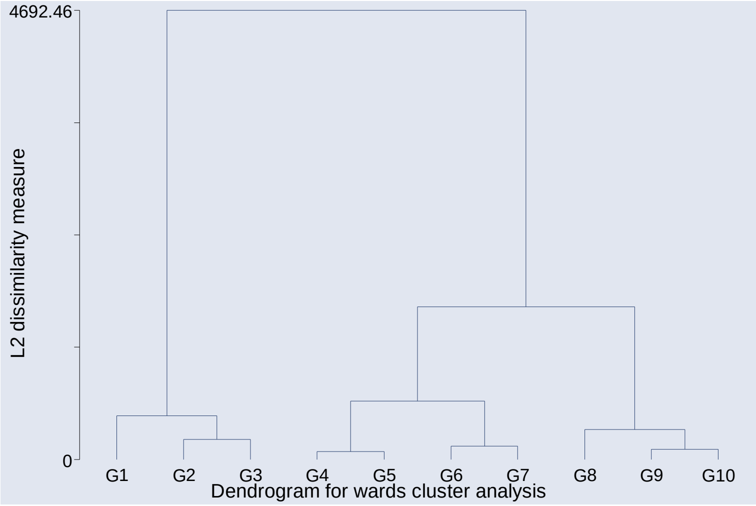

Fig 3. Dendrogram for wards cluster analysis [cut line in red)

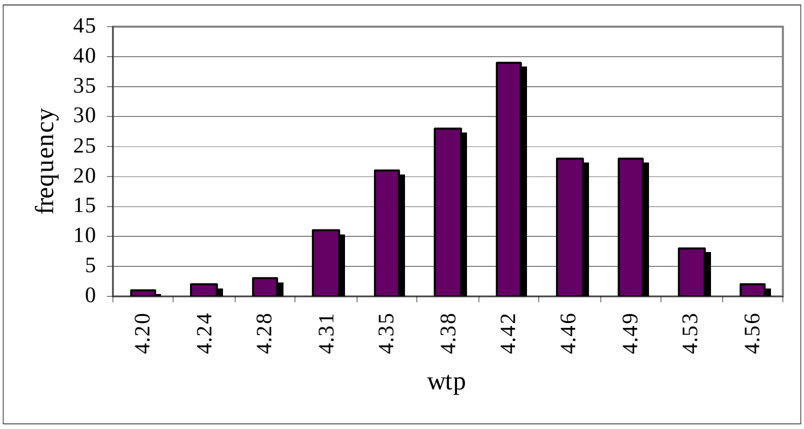

Fig 4. Frequencies distribution

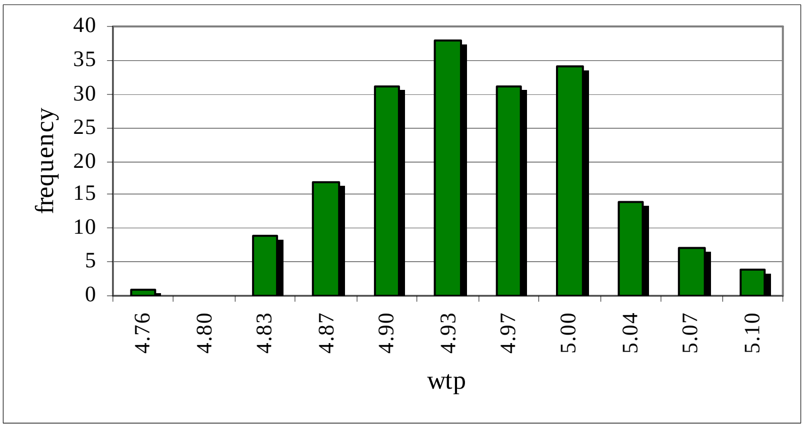

Fig 5. Frequencies distribution

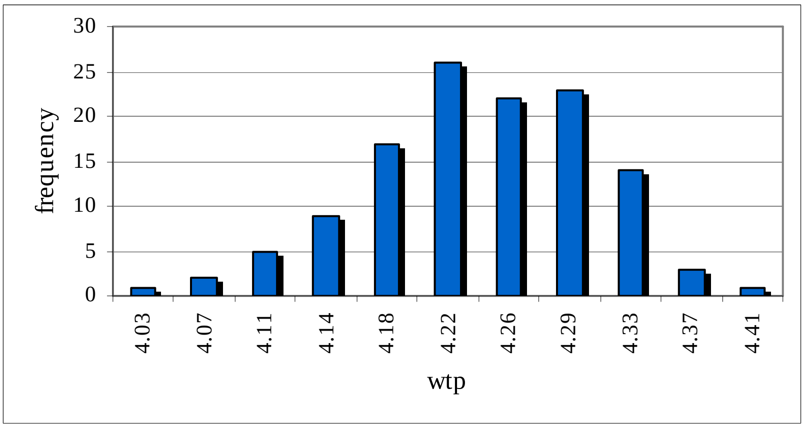

Fig 6. Frequencies distribution