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THE ROLE OF SPACE IN ENVIRONMENTAL VALUATION

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ABSTRACT
The paper illustrates a methodology based on the combined use GIS instruments and Contingent Valuation Surveys to manage, in an integrated way, geographic information on the distribution in space of natural assets and respondents. The objective is to develop a procedure that, avoiding assumptions on the market scope for environmental assets and on the contents of respondents' choice sets, has the potential to provide more reliable estimates of benefits, to be used in support of environmental and resource management decision.

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INTRODUCTION.

Whether or not revealed through behaviour, people assign values to environmental assets. In general, a zero value is *stated* or *revealed* by consumption choices, if the asset does not belong to the choice set or if it is not the preferred alternative in the choice set. A non-zero value is *stated* or *revealed* if the asset is the preferred alternative in the choice set or, even if it doesn't belong to the choice set or it is not the preferred alternative – and hence its value cannot be observed – it possesses a so called "existence", or non-use values. Values estimation from observations of consumers' behaviour and inference on non-use values are then conditional on the specification of the boundaries and contents of the choice set. As shown by, among others, Caulkins *et al.* (1985), Mckean *et al*. (1990), Swait and Ben-Akiva, (1987a,b), mispecified choice sets produce biased inferences on preference parameters.

In empirical works, researchers often assume that the choice set contains all alternatives or use some deterministic criteria to eliminate alternatives. In the analysis of the demand for environmental assets, for instance, it is usually assumed that the relevant choice set depends on the geographical location of each consumer (Caulkins *et al*., 1986). Either when values are revealed by the choice of locations at which the desired bundles of goods and services is obtained, or stated in a survey, the distributions in space of consumers, human activities and natural assets are at work. Understanding the individual and aggregate responses to private and government actions that modify the existing spatial structures and processes, such in the case of the creation of a national park, is fundamental to the evaluation of the resulting benefits and costs.

This paper introduces a methodological approach that combines techniques for the estimation of benefits of environmental assets (such as the Contingent Valuation method) with Geographic Information System (GIS) and spatial econometrics to manage, in an integrated way, spatial and economic information on values. The procedure it proposes aims to improve the reliability of estimation of benefits to help the decision making process over the conservation or development of unique ecosystems, fragile natural environments, coastal zones, forests. The paper analyses in the first part which spatial factors affects values and distinguishes between the "pure effect of distance" and the effects of distance of substitutes and complements on use and non-use values. The effects of the spatial structure of socio-economic phenomena are also analysed, showing the consequences on statistical estimation of values of spatial heterogeneity and spatial autocorrelation. The second part explains the methodology to deal with the spatial structure of the valuation process. It is based on the building of a geo-referenced database, the data processing and mapping, and the statistical analysis of spatial behavior of values. Then some conclusions are sketched.

Part I

1. The Role of Space 1: The Pure EFFECT OF Distance.

Consider the properties of environmental assets that provide recreational services: they may have a zero price, may be valued not only for the goods and services they provide, but also for their "existence" value[1], and they are available only at a given location[2].

Consumer's decision problem a can be framed as *the choice of the location at which the desired set of environmental goods and services can be obtained, so as to maximize an objective function whose list of arguments contains also a term specifying the non-use value*. The resources required to get to the desired location determine the nature of the constraints of the maximization problem. Movement in space requires expenditure of money and time, and information on the asset and goods and services available at destination. *Travel time* and *on-site time* are uses of a scarce resource, and must appear

[1] Following the nowadays traditional classification, the values related to the consumption or use of environmental goods and services are defined "use values" in contrast with "non-use values" that are related to mere existence of the asset. The "total economic value" of an asset is given by the sum of use values and non-use values.

[2] The interest here is on the demand analysis for stationary environmental assets. It is out of the scope of the paper the analysis of non-stationary assets, such as a migratory species or environmental commons such as pure air.

in a time constraint in the behavioral model. Even if the price of the natural asset is zero, the choice of a recreational site is made taking into account the out-of-pocket expenditure required to move in space, and the opportunity cost of time, deriving from the fact that anything which uses time as an input consumes a resource for which there are utility-generating alternatives. Therefore, an environmental asset belongs to the valuator's choice set if it is *affordable* and the travel time plus the on-site time is less than the time constraint or endowment. The time endowment is defined as the time allocated to recreational activities. Time and budget constraints define the boundaries of the choice set – that becomes a *spatial choice set*.

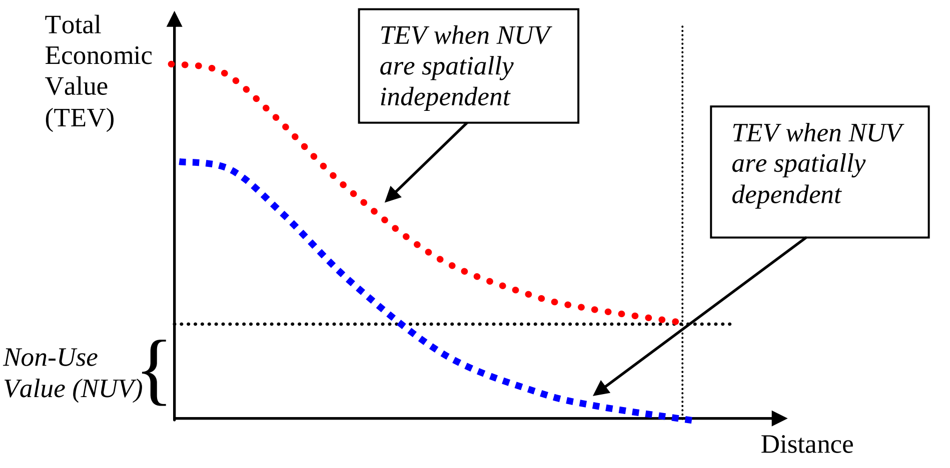
Travel time and money expenditure, as well as the stock of available information, are directly related to the *distance* of the valuator from the asset. This is the first spatial factor affecting environmental asset demand. The effects of distance on spatial behavior may differ with regards to use and non-use values, while the estimations of these effects can be influenced by the way distance is measured.

a) *The Pure Effect of Distance*. Distance determines the cost of getting to the environmental asset, and hence if it belongs or not to the choice set. Its effects can be termed as "*the pure effects of distance*". It is comparable to the effect of the own price on the demand for a commodity since, as Beckmann (1999) puts it, *interaction decreases with distance*'. In theory, while use values are expected to be a decreasing function of distance, non-use values are not dependent on monetary or time expenditure, and hence are distance-independent. Therefore, one would expect the total economic value (TEV) of a natural resource (use values plus non-use values) for a given consumer to decay as her distance from the asset increases, until TEV reaches a positive limit (fig. 1). *This suggests a way to compute the non-use value as the limit, as distance increase, of the total economic value.* Adopting a measure of values based on the trade-offs people are willing to make, the Willingness to Pay (WTP) or Willingness to Accept compensation (WTA) functions are then assumed to be distance-dependent up to a limit given by the non-use values of the natural resources.

It may be argued that non-use values are related to the availability of information, and that information is, on a certain degree, distance-dependent. That is, the TEV approaches a zero limit. The best way to solve the question would through empirical analysis. However, economic literature has paid little attention to the issue. It is worth mentioning the Contingent Valuation studies carried out by Sutherland and Walsh

(1985) and Pate and Loomis (1997) with the aim to empirically establish the relationship between distance and Non-use Values. Their contradictory findings do not allow settling the problem.

Fig. 1. Total economics values in relation to distance



The issue is worth exploring also because if analysts were able to identify the distance at which the total economic value reaches its limit, this would give the market area of the environmental asset under valuation, that is, one would be able to identify the population that benefits from the use and non-use of the natural asset. It is customary in empirical studies to assume the scope of the market for and environmental asset coincides with some political or administrative boundaries. It means that values are positive inside these boundaries and null outside, and the parameters of the valuation function are constant inside these boundaries. No distance-effect is taken into account, but only a space-related regime switching from a political jurisdiction to another. There is no reason for the actual and assumed market areas to be the same, i.e., for the regime to switch in correspondence with the administrative limits; in fact, Pate and Loomis (1997) have shown that restricting estimation of benefits of an environmental program to the political jurisdiction in which the natural asset is located would considerably understate the aggregate benefits. Unfortunately there is not a simple way to predict the direction and magnitude of the biases introduced by the assumption on the size of the market area for an environmental asset. Suppose, for instance that the real (A) and assumed (B) market areas simply overlap (fig. 2.a). In this case parameter estimates may considerably understate benefits, since most of the population in B, from which the

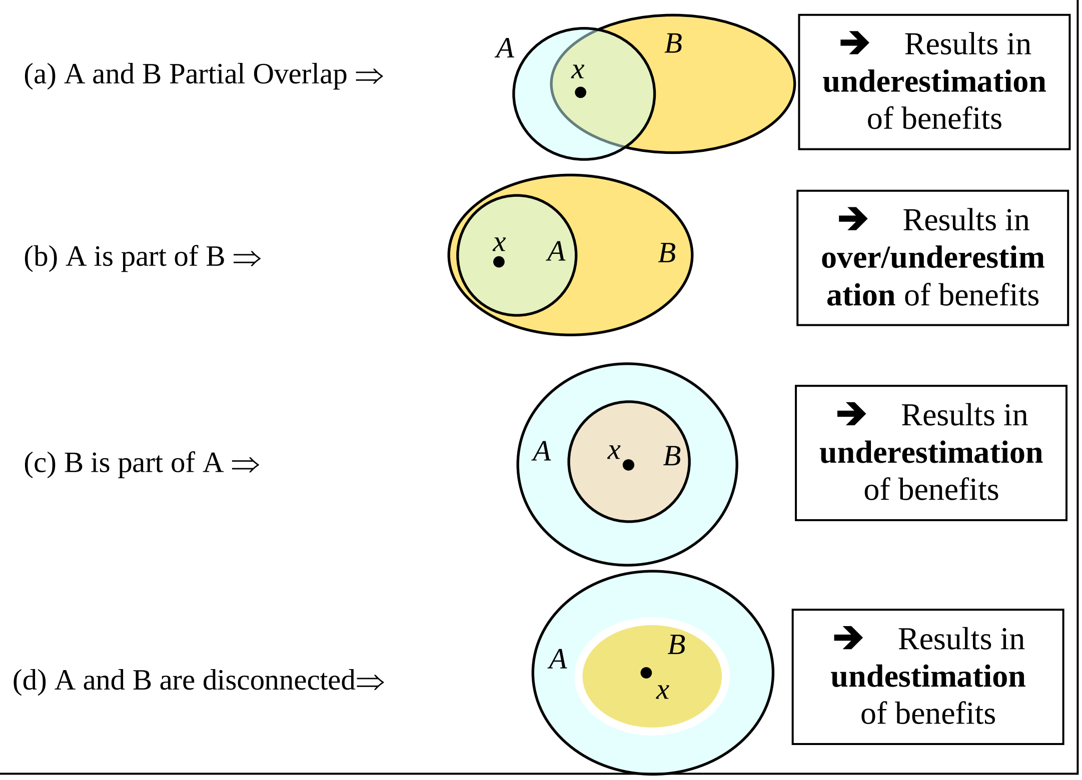


Fig. 2. Market area *A* for environmental asset *x* and political boundaries *B*.

sample is drawn, does not benefit from the natural asset. The magnitude of the underestimation is clearly related to the size of populations in the two areas.

If one of the two areas is contained in the other (fig. 2.b-c), overestimation and underestimation of benefits are both likely. Underestimation occurs if the market area A is larger than the area used for aggregation B, while when the market area is smaller and contained in the political/administrative boundaries, either overestimation and underestimation may occur, according to the relative size of population in A and B. One may also encounter the case in which the two areas are disconnected (fig. 2.d). The population in the area B containing the natural asset may assign a greater value to the development other than to conservation of the environmental commodities.

In case (a) and (b) the estimation problem is made more difficult by the fact that there is a clear lack of uniformity of behaviour in space of the population in B. The model used in parameter estimation does not take into account a phenomenon of spatial heterogeneity (see next section) of the valuation process. In B, indeed, there are two populations that, even if they subsist in the same spatial container, behave differently.

The reverse situation happens in case (c). Here the underlying assumption is that the behavioral model is constant in B, but a structural change occurs as the boundaries of B are crossed, even if this may be not true.

The assumption on the scope of the market is then crucial in estimating the magnitude of benefits. Analysing the spatial pattern of values is then a way to avoid an a-priori assumption, with the results that we may obtain more reliable estimations.

b) *The measurement of distance and its cost*. For prediction and planning one should be able to quantify how much interaction is affected by distance. It is straightforward to quantify the price variable in econometric estimation of demand elasticity. But for distance, the problem is a bit more complex. There are two sources of complexity.

First, there is usually a discrepancy between the actual spatial and temporal distance and the perceived distance of objects. This distinction is particularly important in stated preference methods, in which the value stated could be affected by respondent's estimation of distance. It has been shown, in fact, that people tend to overestimate relatively short distances or durations and underestimate relative long distances or durations. Distance judgments are a power function of actual distance (Block, 1998). Further, prospective judgment tends to differ from retrospective judgments. The result is that analysts and valuators may be judging the effect of distance using different variables. The solution in stated preference surveys should be to provide the respondent with the actual distance of their location from the asset. It would work as an anchor point in distance estimation by respondent, so that the discrepancies between actual and perceived distance are minimized.

Second, the correct time opportunity cost to be specified in the estimation model depends on the time endowment and the choice of valuator in the labor market (Bockstael *et al.*, 1987). The opportunity cost of time varies between valuators, and for the same valuator according to the time allocated to the enjoyment of an environmental asset. It is important to stress that the time allocated to recreation is, to a certain extent, dependent on the distance (spatial and temporal) and the characteristics of the asset. That is, for close assets the time frame or endowment may be given by the weekend, while for distant assets the time endowment could be identified as summer or Christmas holidays. Distance between valuator and the asset gives an reference point to specify the time constraint, that in turns is necessary to identify the spatial choice set and the time opportunity cost. In empirical studies, time opportunity cost is approximated by the wage rate (or fraction). The choice is clearly questionable, but the data requirement to introduce a better measure of the opportunity cost in the estimation model appears to be unmanageable.

The problem of distance measurement has other fascinating implications when the notion of space is extended beyond the strict Euclidean sense to include political, inter-personal or economic distances. For instance, income differentials could be employed to test the hypothesis of spatial autocorrelation and spatial heterogeneity, to be analysed in section 3. The next section, instead, is concerned with the other factor affecting spatial pattern of values.

2. The Role of Space 2: Spatial Distribution of Substitutes and Complements.

The attraction of a location is not merely a function of its distance but also depend the number of *intervening opportunities* (Stouffer, 1940). In economic jargon, one can say that the effect of space depends on the "price" of the opportunities at a given location and the "prices" of substitute or complementary opportunities at other locations. The price of substitutes and complements is the monetary and time expenditure necessary to enjoy them and, as for the natural asset under valuation, it is an increasing function of the distance between assets and valuators. Temporal distance and monetary costs determines if a substitute or complement asset belongs to the spatial choice set. The location of the valuator determines, via the distance effects on time and money expenditure, the set of environmental substitutes and complements. The substitution and complementary opportunities change over space. Spatial information provides then a tool to specify the content of the choice set, and avoid a-priori assumptions on the set of alternatives to be taken into consideration in the estimation process.

Values, therefore, follow a spatial pattern that depends on the distribution in space of intervening opportunities. The effect of the spatial distribution of substitutes and complements may be different on the two classes of values as well. While substitution (complementarity) effects are expected to affect negatively (positively) use values, the effect on non-use values is less clear-cut; in theory, non-use values are unrelated to the existence of other natural assets. The answer should come from the analysis of the spatial pattern of values. Further, substitutes may not affect the non-use value of a given resource but the ability of the economic agents to actually pay for preservation. If this is true, spatial distribution of income and spatial distribution of preserved environmental assets may be related.

Substitution and complementarity are also dependent on the direction along which natural assets are spatially distributed, as well as on the distance between them. Two assets at the same distance from the location of the valuator may be substitutes if they are located in opposite directions from agent's location (for instance, north-south), while may be regarded as complements even if they differ in distance but are located on the same route, so that the agent visits both of them on the same trip. This consideration suggests two other variables that can convey useful information on substitution and complementarity (distance between assets and direction in relation to valuator's location). When different valuators regard an asset differently because of its direction, the statistical model should abandon the hypothesis that space is *isotropic*. The mean value of the estimated distance parameter varies according to direction, suggesting the necessity to adopt estimation techniques to accommodate non-constant parameters. This is clearly a source of spatial heterogeneity. In general, one can say that estimation of distance parameters is dependent on the assumption regarding the stability of the behavioral relationship under study. Is space *homogeneous*, so that the spatial behavior of the valuation function is stationary and *isotropic*, or is it *heterogeneous* and the valuation process is non-stationary over space? The next section analyses this issues.

3. The Role of Space 3: Spatial Heterogeneity and Spatial Autocorrelation.

Fig. 1 depicts the effect of distance for a generic valuator. For the same relationship to be valid in the aggregate the valuation process has to be *stationary* – its statistical properties are independent of absolute location or are constant in the region from which the sample is drawn - and *isotropic* –it depends only on distance between valuators and the object, and not on the direction in which they are separated. Assumptions of stability and isotropic space are common in parameter and functional form estimation. Locational specificities are sometimes discarded because data availability constrains the modelling strategies that could be implemented. In fact, the spatial formulation of the statistical model could not be estimated when there are more parameters than observations. Small sample size often forces to make the simplifying assumption of homogeneous space[3].

There are several reasons to assume heterogeneity in space:

- Variability of choice sets according to location;
- externalities in space;
- income distribution
- Other spatial phenomena (cultural clustering).

The variability in space of the choice set has been analysed in the previous section. The same classes of directional and distance indexes can be used to describe other objects in the human or natural environments, whose spatial relationships with the natural asset are relevant in the valuation process. To exemplify this case, one can think of a valuing agent living next to a highly polluting factory. Suppose that humans require a minimum level of "pure air", below which the risks of illness (or even death) are unbearably high. The agent living next to the factory needs to move in space to enjoy higher quality air and restore her risk level to a satisfactory point. The closer his/her average level to the critical one, the greater the need to move in space in search for "pure air". That is, the greater her willingness to trade off time and money for reductions in risk. Living next to a negative or positive externality emitter influences values people place on natural assets. A structural change in the valuation function or non-constant parameters are then likely in the sample, according to the location of valuators relatively to the externality emitters.

Spatial heterogeneity is also likely to occur in econometric estimations carried out on data sets of dissimilar spatial units, such as rich neighborhoods in the north and poor neighborhoods in the south. When distribution of income displays a spatial pattern such clustering according to different income classes, so do the values estimated using income as an explanatory variable. This is valid even for other spatial phenomena that are assumed to affect the valuation process, and whose eventual spatial distribution is reflected in the spatial pattern of values.

The spatial structure of phenomena assumed to affect values, may cause spatial autocorrelation between units in the same neighborhood. Spatial dependence or autocorrelation depicts the lack of independence among observations. It can be the result of the inherent spatial organization of variables affecting values, other than a consequence of dependence of units' behavior. Imposing a structure to the spatial

[3] A solution to the problem of small sample size, and hence to the hypothesis of homogeneous space,

functional relationship of observations, a model could be specified, estimated and tested, and prediction obtained when observations are not available.

The next part suggests a methodology to treat the effects of the spatial distribution of environmental assets, the spatial structure of socio-economic phenomena and the relating spatial heterogeneity and autocorrelation.

Part II

1. A METHODOLOGY FOR THE ANALYSIS OF SPATIAL PATTERNS OF VALUES.

This section suggests a methodological approach to analyse the spatial pattern of values for environmental assets. Our approach aims to use spatial information at the level of individuals, exploiting the potential of GIS instruments in storing, managing, organizing, displaying and analyzing information in a geo-referenced database. The objective is to use GIS instruments in combination with a Contingent Valuation (CV) survey to develop a procedure that, while reducing the number of assumptions, makes possible it to:

- *identify in space the objects affecting the valuation process*, and hence use information on these objects in the specification of the behavioral model adopted for estimation purposes;
- *study how values change in space*, exploring the possibility of spatially distinguish between use values and non-use values;
- *identify the relevant population of a given valuation problem*;
- a*nalyse the relationship between spatial distribution of values and other spatial phenomena such as income distribution*
- *study the possibility of predicting values where observations are unavailable or information incomplete.*

2. STAGES IN THE RESEARCH

The research is organized in ***three stages***: the building of a geo-referenced database, the processing of data and the display of results via maps, and the spatial analysis of

is the use of maximum entropy methods (see Golan, Judge & Miller, 1996) geo-referenced data.

STAGE 1: ***Building a geo-referenced database*** requires:

A) **DESIGN AND IMPLEMENTATION OF A CONTINGENT VALUATION SURVEY**.

It allows us to collect information on a number of socio-economic, spatial variables and monetary values people assign to a specified environmental asset. Following the established results in the literature, we would employ a ***dichotomous choice format with follow up***. In this type of format, the questionnaire contains a ***referendum-type question*** (that requires a yes/no answer) on the Willingness to Pay a given monetary amount for the natural asset. It is followed by a second question in which the monetary amount is increase or decreased according to the answer given in the previous question. This type of questionnaire has been shown to produce estimates comparable to those derived from other elicitation methods (Jakobsson & Dragun, 1996). It is easily understood by respondents but poses problems of identifying a plausible range of monetary amounts and payment vehicles. Our sample of respondents would be divided in sub-samples on the basis of different monetary amounts asked in the first WTP question. Furthermore, the data we collect will make possible to group respondents in the sample according to different spatial descriptors ***and separately analyse their behavior in space.***

B) JOINING THE CV SURVEY DATABASE TO OTHER GEOGRAPHICAL DATABASE. There are two alternatives:

- Merging the CV database with an existing geographical database containing information on ***land use, transport system, land cover*** and so on. This choice has the advantage to contain information on the natural asset to be evaluated and its ***potential*** substitutes or complements, but it requires a great amount of geographical data. In this extended database, valuators and assets are geo-referenced via ***absolute locations***, i.e. via coordinates. It could accommodate spatial and temporal distances as attributes of the objects in space.
- Build a database on the base of Relative Locations. This corresponds to building a lattice or an artificial (regular or irregular) grid that contains only valuators and natural assets, identified by ***relative distances***. It does not require a great amount of geographical information. In theory, the information collected with the CV could suffice.

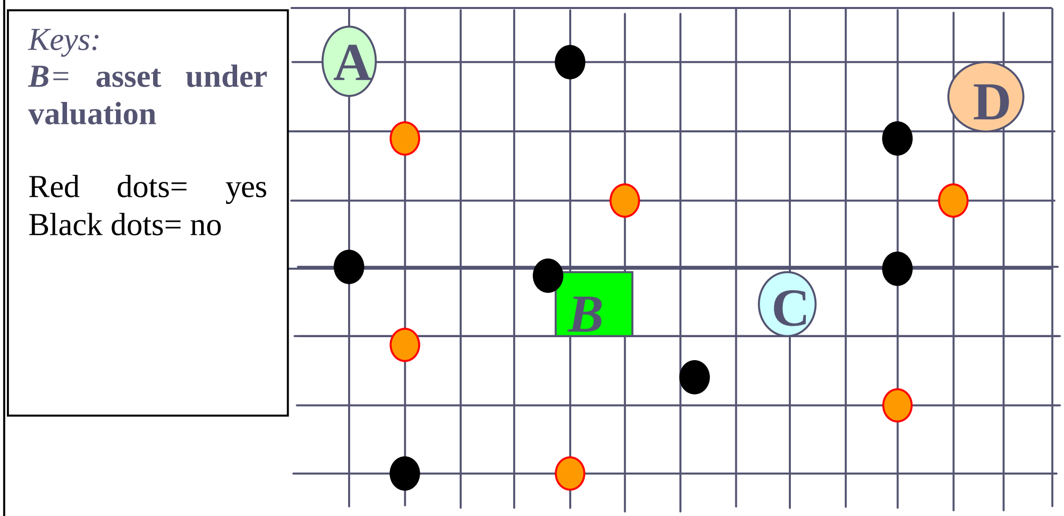
STAGE 2: ***Data processing and Mapping***. Once we have collected data on the sample through the CV survey, ***we proceed using mapping techniques with the aim to discover spatial patterns***, according to the following steps:

STEP 1: mapping the yes/no answers. We assign as attribute a 0/1 dummy variable to each respondent and identify him on a map, on the basis of the response to the WTP question. On the map, the yes response (the variable has value of 1) would be identified by a given color and the no response (0) by another. Displaying on a map the yes/no answer for each sub-sample allows us to identify by ***visual examination*** if there is ***any visible spatial pattern in the scattering of yes/no answer***, such as clustering around the given asset, or its substitutes or for given neighborhoods. We show it in fig. 3a-b, in which we have build an artificial lattice based on given relative distances and directions.

In the ***worst scenario*** we would find these points in space are ***scattered randomly***. No spatial pattern would seem to exist. This result may be due to:

a) spatial-independent socio-economic characteristics and preferences of respondents dominate over the others;
b) the dummy variable is too raw to discern a spatial pattern, and hence we need to further analyse the sample, that is to introduce a behavioral model. We have to proceed to a second stage.

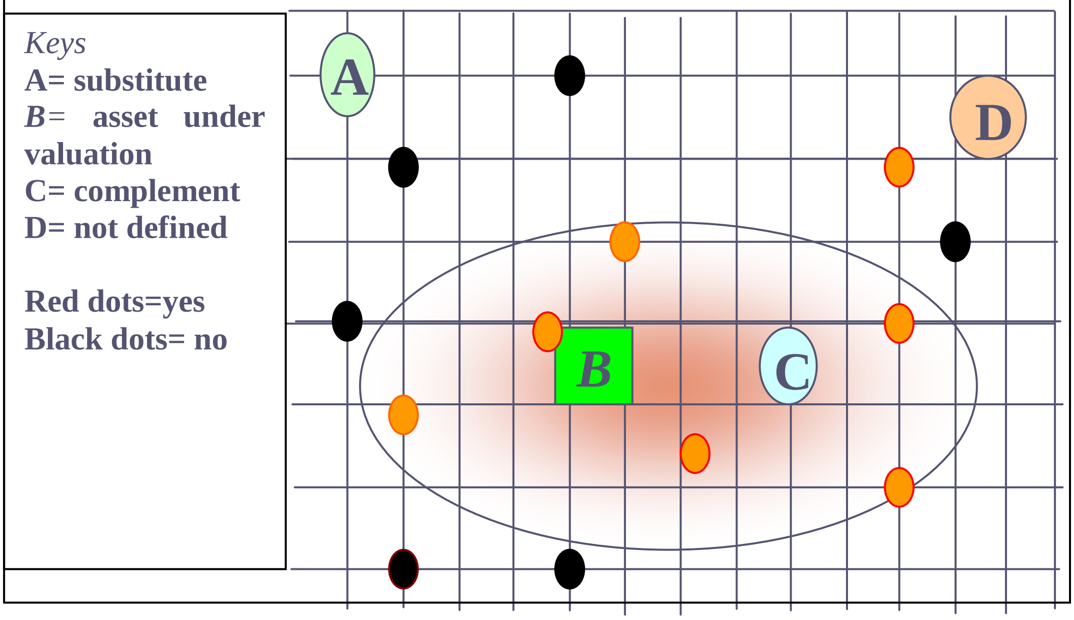
Fig. 3.a. Mapping the Yes/No answers: **No spatial pattern**



In the ***best scenario*** we would find a clear clustering and dispersion of yes/no answer according to the spatial features and/or the spatial-dependent socio-economic variables. ***This would suggest the explanatory variables to be included in the behavioral model in the next stage***. In fig. 3.b, this corresponds to identify which of the environmental assets in the same space is working as a complement or as a substitute of the asset under valuation.

STEP 2: mapping the estimated probabilities of a yes/no answer. In this stage we process data from the CV survey via a probabilistic model. Probabilities are estimated using a basic model in which utility is function only of socio-economic characteristics of respondents and attributes of the natural asset. Mapping the

Fig. 3.b Mapping the Yes/No answers: **Clustering**



probabilities as attributes of the respondent and then grouping them in classes (via color differentiation) should show us if there is any spatial phenomenon (fig. 4a-b). If the worst scenario were the correct one, we wouldn't expect any spatial pattern to emerge again (fig. 4.a.). Space has to be considered neutral.

In the best scenario, (fig. 4.b), map would display a clear clustering of probabilities around the asset B and its complement C.

Fig. 4.a. Mapping the Prob. of Yes/No answers: **No spatial pattern**

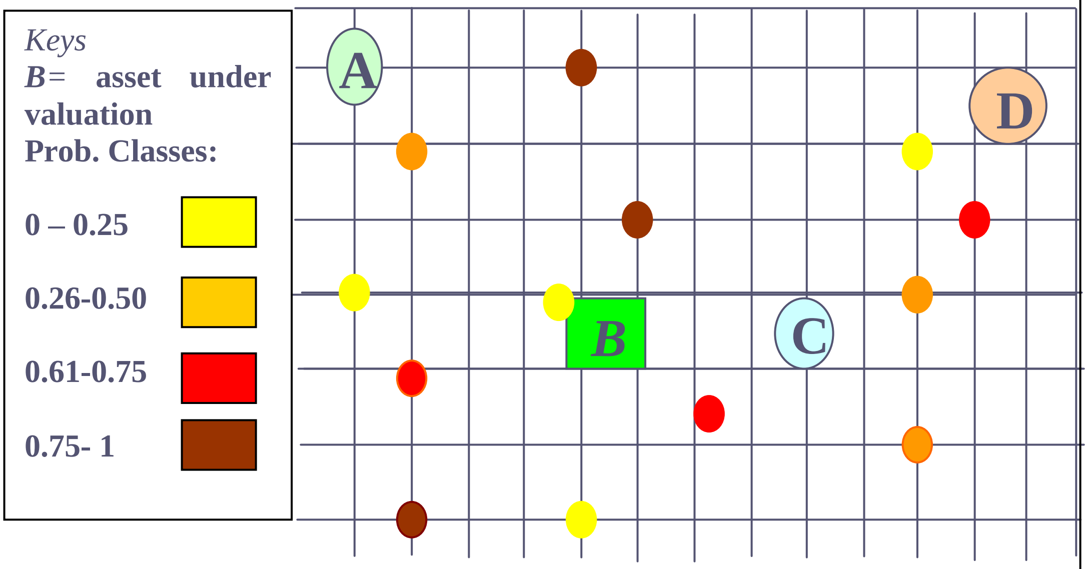
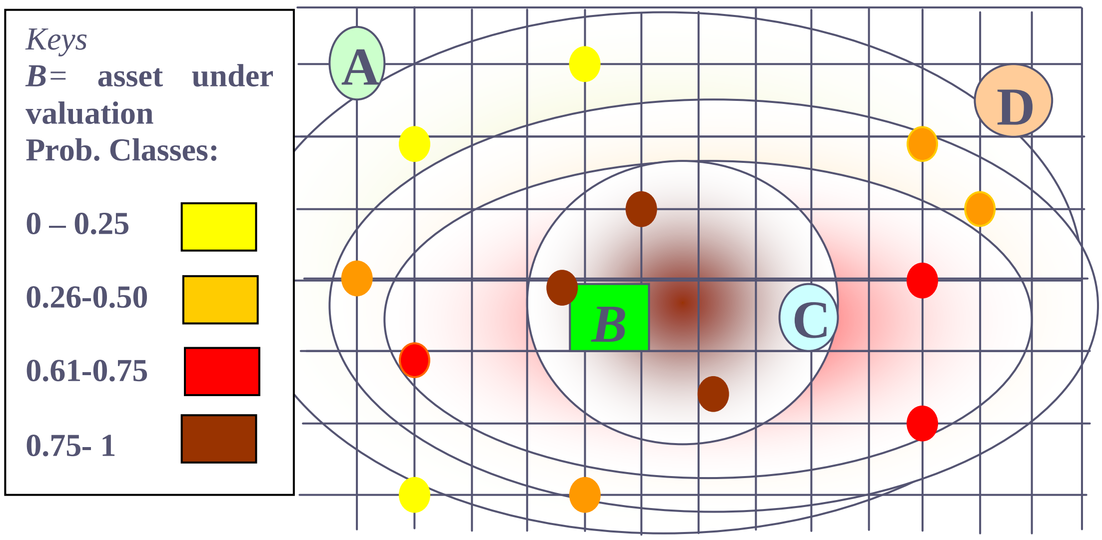


Fig. 4.b. Mapping the Prob. of Yes/No answers: **Clustering**



At this stage, however, the model itself could be a source of biases. To test this hypothesis, we can map not just the probabilities, but group the respondents on the basis of the correct/incorrect estimation. That is, if the model predicts high probability of a yes answer when the actual response was negative, we can assign to the respondent a color and identify he/she on the map. ***Are these errors randomly***

distributed? If not, and a spatial pattern emerges, the model should be try to improve taking into account the spatial variables. ***Otherwise we could not reject the hypothesis that space is neutral.*** In case we could identify some process of clustering or grouping of class of probabilities according to location of natural assets or valuators, we proceed to improve the model, introducing the spatial variables.

STEP 3: <u>mapping the probabilities computed by the extended model</u>. Which spatial variables are to be included in the model? We start including any spatial variables suggested by the outcomes of the previous steps. Then we compute the new probabilities and map them. This procedure requires a great amount of variables to be introduced in the model. But we need a method to identify with greater precision the spatial variables at work. We can proceed *mapping the statistically significant difference in probabilities estimated with the basic and the extended model*. ***In this way we are clearing out the effect of the socio-economic characteristics***. Where the spatial features have a strong effect on probabilities, we would expect significant differences, and hence a clustering pattern according to space. For those respondents with a statistically significant difference, we can identify the spatial variable(s) that affects their responses and get rid of those spatial variables that are not working.

STEP 4. <u>Computing the mean/median WTP</u>. For a discrete change in a spatial variable (distance or number of substitutes), we can compute the effect on the mean or median WTP, ***estimate a WTP decay function and visualize the results as a series of isotropic lines around a natural asset,*** as in fig. 5.a. The figure has been drawn taking into consideration absolute spatial distance. The natural asset B is the only element of the choice set. Its value spread across the space as function of distance between asset and valuators. The *contour levels* correspond to different values; these decrease as distance from B increase (from higher values – dark colors – to low values – light colors). Drawing the contour levels as perfect circles implies that space is homogeneous.

We want analyse if there is any parameter or structural change in the WTP decay function. The statistical analysis of its properties is undertaken in the next stage.

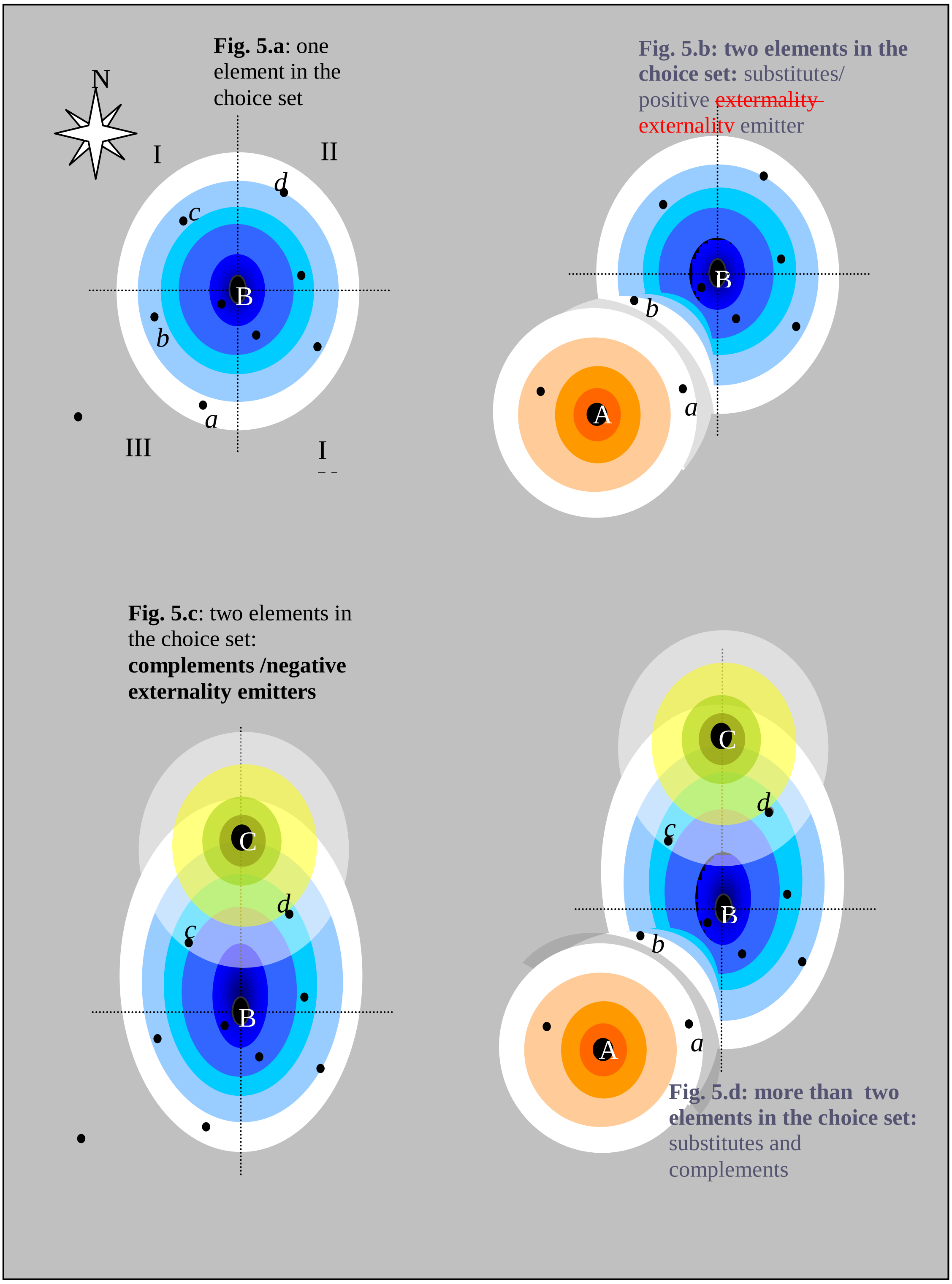


Fig. 5.a: one element in the choice set

Fig. 5.b: two elements in the choice set: substitutes/ positive ~~extermality~~ externality emitter

Fig. 5.c: two elements in the choice set: **complements /negative externality emitters**

Fig. 5.d: more than two elements in the choice set: substitutes and complements

STAGE 3: ***Statistical Analysis of probabilities.***

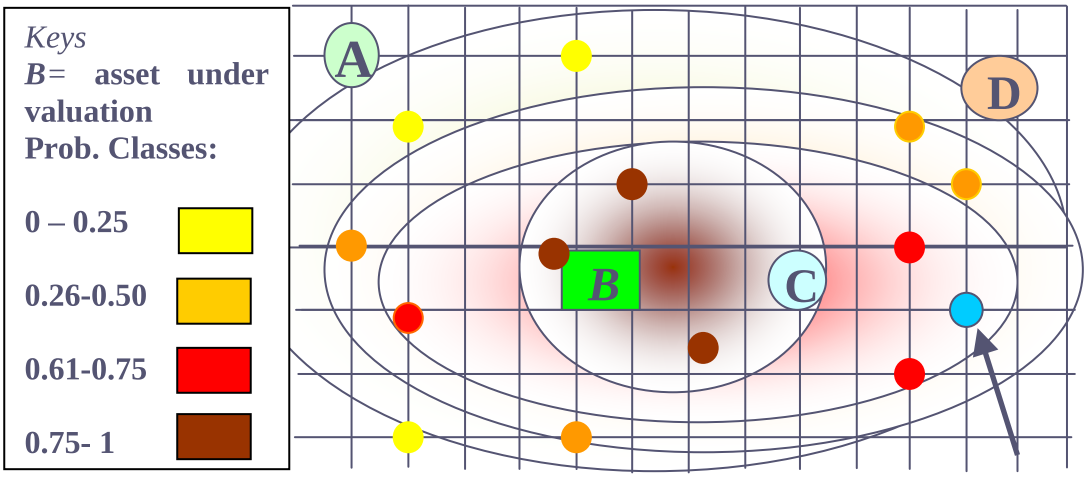
1. Spatial Heterogeneity: Do the parameters of the decay function change with

space? In fig. 5.a values spread across the space as function of distance between asset and valuators. Fig. 5.b illustrates a situation in which the asset B is introduced in a choice set that already contains the substitute A. Compared to 5.a, the diffusion in space of values is now altered by A. The contour levels are distorted by asset A. Individual *a* shifts from a positive contour level to zero value for B, because it is located farther that its substitute A. Individual *b* shifts to a lower contour level. ***The structural form of the decay function changes because of A.*** Fig. 5.c shows how the contour levels change when B is perceived as complement of existing natural asset C. Individuals *c* and *d* assign values higher than in case a). In this case, ***parameters of the decay function change, as one gets closer to the complement asset C***.

The last case merges substitution and complementary assets, ***giving a set of contour lines that are not longer perfect circles around the asset B.***

2. <u>Spatial correlations</u> We analyse the spatial correlation between yes/no answers or probabilities with the objective to predict values. Suppose, for instance, that yes/no answers are spatially autocorrelated. Also assume that we have information on socio-economic characteristics on some individuals and their neighborhood (such as the average income, level of education, religion and so on) and their responses to the WTP questions. Can we exploit spatial autocorrelation and information on neighborhoods to predict the kind of answer

Fig. 6. Predicting the Prob. for the Agent indicated by the arrow.



(or the probabilities of a yes/no answer) for individuals for which information are not available?

In term of fig. 6, can we predict the probabilities of the individual identified by the arrow, exploiting the spatial correlation of his neighbors' probabilities and socio-economic information on neighborhood?

5. CONCLUSION.

The combined use of spatial and socio-economic information for value estimation appears, on theoretical grounds, to provide a better way to understand the process of environmental valuation. Manipulation of spatial data via econometric techniques in the contest of environmental valuation offers an alternative to analyst to assume:

- The scope of the market for a given environmental asset;
- The substitution and complementarity opportunities for the asset under valuation.

This would result in more reliable (and possible unbiased) estimation of benefits. Further, it allows

- Predicting values for environmental assets where observation are not available;
- Obtaining insights on the relation between values and other spatial phenomena (as income distribution or cultural structure of regions).

This information is essential in environmental policy. Comparing the cost and benefits of a given policy requires an informational base build around the spatial structure of economic, demographic and natural phenomena. The methodology proposed in the paper for the demand analysis of environmental assets is potentially able to provide more reliable estimates of the values people assign to the environment.

The costs of this choice are given by the increased data requirement and the resources to manage them. However, it seems that, thanks to the rapid development of software and hardware for spatial data storage, editing and analysis, spatial analysis of environmental valuation has become a feasible, competitive alternative to current practices.

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