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Wind farms, farmland occupation and compensation: evidences from landowners' preferences through a stated choice survey in Italy

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Highlights

- The construction of wind farms on farmland involves easement compensation
- Conflicts between system operators and landowners arise for unfair compensation
- The acceptance of wind farms by landowners is investigated by a latent class model
- Farm, landscape and experience aspects influence landowners' acceptance
- Stakeholders should take in account several facets for fair compensation criteria

Wind farms, farmland occupation and compensation: evidences from landowners' preferences through a stated choice survey in Italy

Abstract

The willingness to accept the construction of wind farms on private properties is investigated using a latent class model approach. This type of research is required in view of the frequent conflicts between landowners and system operators, who often pay little in easement compensation.

This study highlights the fact that the acceptance of wind farms is a multifaceted issue comprising aspects relating to socioeconomics, farm type, territory, and past experience. In particular, the compensation claimed by landowners depends on the property's size, the number of turbines, the crop, the presence of surrounding wind farms, natural impacts, the landscape configuration, land fragmentation, land agreements, the presence of other wind towers on the property, and past experience with system operators concerning transparency and participation in the siting and planning phases.

Stakeholders should take these factors into account to develop energy policies based on clear, and well-structured processes concerning the siting, planning, construction, and management of wind farms, in order to prevent conflict and to benefit the community and environment.

Keywords: wind farm; farmland occupation; easement compensation; choice experiment.

1. Introduction

In recent years, the spread of renewable energy sources has become a strategic objective in dealing with global climate change and in reducing carbon emissions. Investments in this field have increased and policy makers have deregulated the related market with incentives aimed at ensuring a reliable power supply (Lim et al., 2015; Aravena et al., 2014). Over the last two decades, investment in wind power has grown considerably worldwide; the installed capacity has risen steadily from about 92.5 gigawatts (GW) in 2007 to more than 466.5 GW in 2016, of which about 452.5 GW is produced onshore (IRENA, 2017). Commercial wind power installations are managed by around 75 countries worldwide, and China, the USA, Germany, Spain, India, and the UK are the world's largest producers of wind energy. It is estimated that the average annual growth rate for the relating market could be as much as 18% over the next few years, which would mainly be driven by developing countries and emerging economies such as China and India. Wind energy can, therefore, be considered the world's fastest-growing energy source (Bond et al., 2013).

Wind power is perceived as an environmentally friendly energy source (Ek, 2005; Krohn and Damborg, 1999) due to its reducing greenhouse gases; in addition, it is also viewed favourably for the additional job opportunities it provides (Bergmann et al., 2006; Longo et al., 2008). However, its infrastructure also generates negative externalities (Zerrahn, 2017; Rygg, 2012) for communities and for properties where turbines are installed. In particular, towers are often constructed on farmland outside urban areas, and their impacts can be categorized according to three potential effects (Hoen et al., 2011):

- occupation stigma, concerning the subtraction of land used to construct the foundations, control rooms, roads, etc., and the need for operators to enter properties for ordinary and extraordinary maintenance, with the consequent disturbance of agricultural practices and possible damage to crops;
- scenic stigma, i.e. the visual impact of wind towers on the landscape;
- nuisance stigma, relating to factors in proximity to wind turbines, such as noise and the shadow cast by blades.

These impacts could negatively affect the landowners' welfare in terms of i) the hindrance of new land uses due to the scenic and nuisance stigmas (e.g. from farmland to farm holidays); ii) the decrease of farm profitability and farmland value due to the occupation stigma; iii) the worsening of farmers' wellbeing in cultivation practice due to the nuisance stigma. The payment of suitable compensation by transmission system operators to landowners is, therefore, essential when new wind towers are to be installed. Compensation should take several elements into consideration, including land occupation by wind farm components (towers, control rooms, and roads); negative impacts on the management of the remaining property area; and negative environmental externalities (noise of turbines, landscape impacts, hydrogeological hazard in sloped territories, shadow cast by blades, etc.). In particular, with reference to land occupation, the capitalisation of a limited future flow of missed revenues from the occupied area should be assured. Besides, the negative impacts on the management of the remaining property area, which derive from changes in the layout of cultivations, roads, irrigation systems, etc., increase the farm management costs, with consequent depreciation. This last element may concern the entire residual farming area, or a part of it, so that it is crucial to investigate the share of the property that is really depreciated. Finally, the construction of wind farm components could generate negative environmental externalities which should be individually identified and monetarized.

However, there is no clear and shared evaluation criteria for wind farm easement in Italy, thus compensation only applies to the occupied area. Further returns are then paid in the case of direct agricultural management of farmland by landowners and when the estimated compensation is accepted. In contrast, the negative impacts on the management of the remaining property area and the negative environmental externalities are neglected. Due to this shortcoming in the assessment practice, landowners often appeal to the law courts for fairer payments, forcing transmission system operators to pay sizeable compensation. This type of conflict causes difficulties in the siting of wind farms (Vajjhala and Fischbeck, 2007) and delays to their planning and construction, in addition to increasing the cost of the energy they generate (Cotton and Devine-Wright, 2013; Devine-Wright, 2013; Jay, 2004).

Researchers could use the real estate market to identify the characteristics of wind farms that should be considered in defining the criteria for fair compensation. However, the Italian land market is rather static and not transparent (Sardaro et al., 2018a; Sardaro et al., 2018b), especially for properties with wind turbines, thus stated preference studies could be performed for stakeholders (Scarpa and Willis, 2010; Carlsson et al., 2011; Ek, 2005; Groothuis et al., 2008; Koundouri et al., 2009; Longo et al., 2008; Meyerhoff et al., 2011). In this regard, compensation involves many characteristics (attributes) of wind farms simultaneously; therefore, choice experiment (CE) is a suitable valuation tool (Aravena et al., 2014). CE provides the marginal rates of substitution between non-monetary and monetary attributes as marginal willingness to pay or accept (WTP or WTA), which are then usable in cost–benefit analyses.

The present research uses a CE based on a latent class model (LCM) to investigate landowners' willingness to accept the construction of wind farms on their properties. In this way, the monetized impact of each wind farm characteristic is evaluated and then used to assess the request compensation. CE studies on the opinion of communities regarding wind farms have been carried out in the last few years, with a focus on technological and environmental issues, i.e. dimension, density and location of towers, environmental and economic impacts, etc. (Strazzera et al., 2012). However, to the authors' knowledge, this is the first study that a) assigns a value to the specific characteristics of onshore wind farms in rural contexts, and b) provides system operators and policy makers with the appropriate means to indemnify the impacts of this infrastructure on farmland.

The study involved landowners of the Apulia Region in southern Italy, where the demand for energy has increased by 18% in the last twenty years (Regione Puglia, 2015). The regional power grid is currently being modernised and improved by wind power, with the installation of 1,496 turbines (32% of the national total). In particular, the CE study focused on the Province of Foggia in northern Apulia, which hosts 67% of the region's turbines and is the territory with Italy's highest density of this infrastructure.

2 Materials and methods

2.1 The questionnaire

The questionnaire had three sections. The first gathered the landowners' opinions of renewable energy in general, and wind farms in particular, focusing on both compensation issues consequent to land occupation and attitudinal factors able to influence preferences. At the end of the first section, respondents were informed about the benefits and costs of wind power and the respective infrastructure. In the second section, landowners were asked to make choices about some structural characteristics and regulatory aspects of wind farms. To verify the consistency between hypothetical and real choices (Hensher et al., 2012), which are assumed to be identical in theory, a supplementary question was inserted at the end of each choice task, responses to which were based on a scale from 0 (very unsure) to 5 (very sure) (Brouwer et al., 2010). In this way, it was possible to account for the risk that respondents attached to each choice, thereby improving the predictive power of the survey (Hensher et al., 2012; Romy et al., 2014). In addition, such a question could help to highlight, in the choice task, alternatives that could provide utilities similar enough that respondents consider them very close substitutes.

Finally, the third section collected socioeconomic characteristics of the landowners (gender, age, education level, employment, etc.), besides structural aspects of their properties (farm area, crop, presence of wind towers, etc.). The study area included the municipalities of Accadia, Bovino, Faeto, Foggia, Lucera, Orsara di Puglia, San Severo, Sant'Agata di Puglia, and Troia (Province of Foggia, northern Apulia). Face-to-face interviews lasting approximately 45 minutes were conducted from October 2017 to March 2018 at sixteen out of nineteen (84%) of the study area's agricultural assistance centres. These are the sole offices appointed for aiding agricultural operators in the management of their relationships with local, national, and European institutions through the production of administrative and economic documents. Due to the essential nature of their services, the agricultural assistance centres are frequented by all the agricultural operators in the study area (reference population), thus ensuring that the sample is highly representative. Interviews were conducted by one co-author of the Department of Agricultural and Environmental Science at University of Bari. He was trained by an experienced interviewer, a Professor in the same Department.

2.2 The CE design

The CE is a stated preference method, which allows respondents to express preferences among several alternatives concerning goods, services, or projects. These alternatives are defined by different combinations of attributes and respective levels. However, only a few alternatives are selected through an experimental design, and these are then used to create choice tasks. Finally, for each choice task, respondents are asked to choose the preferred alternative, i.e. the one giving the greatest relative utility (Hensher et al., 2015).

Some attributes were selected through the literature, i.e. the number and the height of turbines (Strazzera et al., 2012; Brennan and Van Rensburg, 2016; García et al., 2016; Liebe et al., 2017; Langer et al., 2017). The remaining attributes and the levels were identified by a focus group, i.e. a qualitative pre-testing able to ensure the survey design's quality and content validity (Johnston et al., 2017). Several studies highlight the importance of focus groups in stated preferences studies (Desvousges and Smith 1988; Chilton and Hutchinson 1999; Coast et al., 2004), since they provide a method for discussing concepts and language, for explaining scenarios, and for assessing the information that respondents require to answer the valuation questions. Due to the absence of sensitive topics and issues requiring one-on-one discussions, the focus group was selected instead of the cognitive interview for this study. In addition, one discussion meeting was necessary for the study area participants' high level of familiarity and knowledge of the goods at hand (Johnston et al., 2017).

The focus group meeting was held at University of Foggia in July 2017 and involved landowners (3), system operator delegates (2), and compensation assessment experts (2). These individuals comprised a convenience (non-random) sample for their involvement in the easement compensation issues for wind farms' construction or for their key position in target electric companies. In this way, the participation of a wide variety of stakeholders from different backgrounds was ensured, since focus groups are a means of public engagement aimed at involving a representative sample of stakeholder perspectives (Quick and Zhao, 2011). Moreover, the target size of the focus group was between 6 and 10 individuals, as suggested in the literature (Krueger, 2000).

The participants were invited one month before the meeting through standard practices, including the contacting of each participant via email to provide a general description of the research, the topics of discussion, and the importance of the participants' opinion (Stewart and Shamdasani, 2014). A recruitment letter containing more information on the discussion topics was then distributed to each individual two weeks later, thus allowing the participants to begin considering the topics to be discussed (Pyrialakou et al., 2019).

The focus group meeting was designed to last approximately 60 min and was led by a moderator who facilitated and prompted conversation based on the following discussion topics: i) types of impacts caused by wind turbines on farmland; ii) easement problems deriving from the installation of wind turbines on farmland. In particular, a semi-structured interview was used for which four questions were formulated: 1) Are there advantages from energy produced by wind farms? 2) Are there disadvantages from energy produced by wind farms? 3) Could the construction of wind farms on farmland cause environmental and management problems to landowners? 4) Could the construction of wind farms on farmland generate legal problems for landowners? Finally, as suggested by the literature and practice, the focus group closed with an opportunity for the participants to debrief (Bloor, 2001). Audio from the discussion was recorded and it was transcribed verbatim. The focus group meeting was conducted by a moderator (one of the co-authors of this study) and two assistants (two students in Environmental economics at University of Bari)[1]. All transcripts were returned to participants for comment. Inductive and deductive analyses were adopted for data analysis. The main themes were extracted separately and results were discussed and agreed upon during a meeting among the co-authors (Song and Guo, 2019).

The participants of the focus group meeting recognized a certain benefit in producing energy by wind and concentrated on two types of turbines: 1) small wind turbines able to produce up to 50 kW and installed on 30 or 50 m-high towers; 2) turbines able to generate up to 3 MW and installed on 50 or 100 m-high towers. The first type of turbine is rather rare in the study area but was preferred by the landowners. They were willing to implement this energy solution both to meet their farms' power demand and to sell the energy produced. In contrast, system operators exclusively preferred the 3-MW turbines, i.e. the most frequent wind energy converters in the study area. However, this second solution generated animated considerations in terms of land occupation, landscape impact, and easement duration. Consequently, the landowners tentatively accepted 3-MW turbines in exchange for fairer compensation. However, the system operator delegates did not question the present

[1] The moderator and the two assistants were trained by an experienced moderator, a Professor in the Department of Agricultural and Environmental Science at the University of Bari.

compensation criteria, even though the estimators pointed out some criticisms of the fairness and transparency of these criteria.

With reference to the attribute's levels, it emerged that landowners, beginning with their top preference, i.e. the autonomous installation of small wind turbines, could have accepted up to 3 turbines of 3 MW on their properties, depending on their farm area and crop. Moreover, they pointed out the excessive burden deriving from a 20-year easement, while a 10-year or even shorter easement was preferred. Finally, the absence of any system operator for the management of wind farms was highlighted, in contrast to public energy companies and, to a lesser extent, to private energy groups. Considerations regarding the presence of other wind farms on neighbouring properties were also discussed, and the willingness to accept new turbines was confirmed only if a certain distance between the properties and the nearby towers was ensured.

These findings permitted the identification of a set of attributes concerning the intrinsic characteristics of wind farms, i.e. a combination between the number and the power of wind turbines to install on the property, as well as the height of towers; the impacts of nearby wind farms in terms of distance between the surrounding wind towers and the boundary of the property; and normative issues, i.e. the easement duration and the type of wind farm manager (Table 1). The discussion's semi-structured approach allowed the moderator to add further questions during the meeting in order to investigate possible trade-offs, so as to quantify the attributes' levels.

Table 1 – Attributes and their respective levels used in the CE study (reference levels in italics).

The monetary attribute was based on the actual compensation paid by system operators for new wind farms. In particular, a survey data referred to the period June 2013 - May 2017 was carried out in the study area, so that data from 84 easement agreements between system operators and landowners were collected. Hence, the monetary attribute was expressed as unit benefit that landowners are willing to accept (€ m^{-2}). In this regard, the welfare measures used for the CE are based on the concept of compensating variation and equivalent variation (Hicks, 1943). The former measures the amount of additional money required, after the change, to restore the initial respondent's level of utility, while the latter measures the amount of additional money required, before the change, to maintain the final level of utility. These concepts lead to WTA, when compensation is required, and WTP, when a payment is required. As WTA usually exceeds WTP (Horowitz and McConnell, 2002), several reasons have been suggested. Theoretical explanations are based on (Tunçel and Hammitt, 2014): income effects and transaction costs (Randall and Stoll, 1980); the absence of substitutes (Hanemann, 1991); commitment costs, related to delaying the decision until more information is available (Zhao and Kling, 2004); limited incentives to learn about preferences for a hypothetical transaction (Guzman and Kolstad, 2007); psychological aspects such as framing and endowment effects (Thaler, 1980; Kahneman et al., 1990). Further explanations concern the difference between buyers and sellers (Brown and Gregory, 1999), i.e. between persons who would gain (potential gainers) or who would lose (losers) utility from implementing the intervention, as well as experimental-design features and elicitation techniques (Plott and Zeiler, 2005, 2007). In this study, the WTA format was used since it allowed an exact simulation of the actual scenario involving system operators and landowners. Several CE studies have been successfully used for the assessment of wind farm externalities by WTA (Brennan and Van Rensburg, 2016; Strazzera et al., 2012; Groothuis et al., 2008; Dimitropoulos and Kontoleon, 2009). This welfare measure can be less liable to strategic bias in the CE studies (Burton, 2010; Schläpfer and Fischhoff, 2012), especially if respondents have a high degree of familiarity with the good at hand (Romy et al., 2014; Giannoccaro et al., 2017). Moreover, in the stated preference methods, potential losers (in this case landowners) are asked their minimum WTA for the implementation of a plan or project (Tunçel and Hammitt, 2014; Horowitz and McConnell, 2002).

An important phase of a CE study concerns the experimental design, which allows selection of a suitable number of alternatives. For the type of attributes in describing the compensation criteria, we imposed that all attributes were statistically independent of one another; thus, by an orthogonal design 28 profiles were generated, starting from 1,728 alternatives (3^3x4^3), besides the “no choice” option. Then 14 choice tasks were assembled and split into two blocks of seven, so that each landowner completed one randomly assigned block (Table 2). Constraints concerning the combination of the wind turbines’ power and height were exploited, since wind turbines able to produce up to 50 kW are installed on 30 or 50 m-height towers, while 3-MW turbines are installed on 50 or 100 m-height towers.

The “no option” was inserted in the choice set since it simulates the mechanism of choice in real estate market situations, thus ensuring conceptual validity of the design for the voluntary nature of participation. Furthermore, the “pick-one” responses format (Flynn et al., 2007) was used for its simulation of real-life decision-making in capturing the first preference. In addition, the number of alternatives is the second most influential design dimension in terms of error variances (Caussade et al., 2005), thus a 3-alternative design (including the “no option”) was adopted since it seems to generate more participation than a 2-alternative design (Rolfe and Bennett, 2009). The creation of the blocks was necessary in order to reduce the cognitive effort of the respondents (Weller et al., 2014). The alternatives were unlabelled (Louviere et al., 2000) in order to investigate the role of attributes for the respondents, and to increase their attention (de Bekker-Grob, 2009). Based on this CE design, 1,000 interviews were planned, 500 for each block. Overall, the study concerned real goods (farmland) on the real estate market; therefore, it can be assumed, with reasonably certainty, that the risk of biases related to the CE is rather low (Louviere et al., 2000).

Table 2 – Example of a choice set used during the interviews.

A quantitative pretesting was carried out due to the high-stakes nature of the study and the conflictual effects of estimates among stakeholders (Bateman et al. 2002; Champ et al. 2017). This permitted the assessment of the potential survey response rate and the item nonresponse rates, as well as the verification of the experimental design's suitability (Vermeulen et al. 2011). The quantitative pre-testing, based on the full version of the questionnaire, was carried out one month before the full survey and involved 93 respondents, who were drawn from the target population at the same agricultural assistance centres where the full survey was conducted. The outcomes included a high rate of completed interviews (97.4%), the full comprehension of the questions and proposed scenarios, the absence of any fatigue phenomenon on the part of the respondents, and a successful administration of the questionnaire to individuals with different backgrounds, interests, experiences, and knowledge levels. These findings confirmed that the respondents found the questionnaire and the related decision scenarios comprehensible and credible, thus ensuring a balanced and effective presentation of information (Johnston et al., 2017).

2.3 The latent class model

The CE approach is based on Lancaster's theory of value (Lancaster, 1966) and the Random Utility Model framework (McFadden, 1974), and assumes that the landowner i chooses the alternative j among n alternatives if $U_{ij} > U_{in}$, i.e. the alternative with the greatest utility U. However, only a portion of the determinants of the individual utility is observable, or deterministic (V_{ij}), while the second component is stochastic, or random (ε_{ij}), including other factors not observable by the researcher. Hence, the utility formula can be written as:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \qquad [1]$$

In particular, the deterministic component is:

$$V_{ij} = \beta_{ijk} \times X_{ijk} \qquad [2]$$

where X_{ijk} is the vector of the k utility determinants, and β_{ijk} is the vector of coefficients indicating the marginal utility. Assuming that the error terms are independently and identically distributed (IID) with a Gumbel distribution, and relaxing the independence of the irrelevant alternatives (IIA) assumption by a discrete distribution of parameters (Louviere et al., 2000; Train, 2009), a latent class model (LCM) can be obtained (Lazarsfeld and Henry, 1968; Goodman, 1974). In particular, this model clusters parameters in classes to catch the heterogeneity from unobservable preferences, thus allowing a sample segmentation and a segment-specific estimation of parameters. The segments highlight differences to the proposed good, plan, or project among individual preferences, which are also based on socio-demographic and attitudinal characteristics, with crucial policy implications (Wedel and Kamakura, 2000). In this way, the model captures preference heterogeneity across classes, but assumes homogeneous parameter estimates within each class (Greene and Hensher, 2003).

The LCM assumes that individuals are implicitly sorted into Q classes, and, based on the logit form, the conditional choice probability of finding the landowner i in the class q for the observed alternative j is:

$$\pi_{ij|q} = \frac{\exp\left(\beta_q' x_{ij}\right)}{\sum_{q=1}^{Q} \exp\left(\beta_q' x_{ij}\right)} \qquad [3]$$

where x_i denotes a set of characteristics that are associated with class membership and β_q are the specific class-related coefficients to estimate (Boxall and Adamowicz, 2002). The conditional probability that the landowner *i* chooses the alternative *j* is:

$$\pi_{ij} = \sum_{q=1}^{Q} \pi_{iq} \; \pi_{ij|q} \qquad [4]$$

Finally, in order to best explain landowners' choices, the estimation of the parameter values is carried out through the maximization of the log likelihood function:

$$\ln L = \sum_{i=1}^{N} \ln \left[\sum_{q=1}^{Q} \pi_{iq} \left(\prod_{t=1}^{T_i} \pi_{it|q} \right)^{y_{ij}} \right] \qquad [5]$$

where y_{ij} is one or zero if the respondent *i* chooses the alternative *j* or not, respectively. Having obtained the coefficient estimates, the marginal rates of substitution between the attributes for each class can be calculated. If the utility is a linear function of all the attributes and a monetary attribute is included, the WTA for a change of the level of another attribute for the individuals in the latent class *q* is calculated as follows:

$$WTA_{(A|q)} = \frac{\hat{\beta}_{(A|q)}}{\hat{\beta}_{(P|q)}} \quad [6]$$

where $\hat{\beta}_{(A|q)}$ and $\hat{\beta}_{(P|q)}$ are the estimated coefficients, for the class q, of the non-monetary and monetary attributes, respectively. In order to relax the assumption that WTA is symmetrically distributed (Hole, 2007), 95% confidence intervals for the WTA estimates were created by the parametric bootstrapping technique proposed by Krinsky and Robb (1986). It is based on the simulation of a distribution of 1,000 observations for each WTA estimate. Results are analogous to those of the delta method. The number of classes was selected by the Akaike Information Criterion (AIC), the Bayesian Information Criterion (BIC), and the Bozdogan AIC (AIC3). The analysis was carried out using NLOGIT 5.

3 Results

3.1 Sample characteristics

There were 856 complete and coherent questionnaires, while 144 were discarded either because the respondents (86) completed only between one and four choice tasks out of seven (with an average of three), or because they always selected the "no option" alternative (58). In both these cases, the respondents' motivation was investigated by asking them to select a statement among a set of 5 assertions at the end of section two. The two statements these respondents selected to explain their behaviour or preferences were 1) I do not trust renewable energy from wind farms to create a cleaner environment (42.4% of 144), and 2) High voltage transmission lines should be boosted (57.6% of 144). Due to the evasive and contradictory meaning of the assertions selected, these respondents were excluded from the final analysis. Moreover, some answers in section one of the questionnaire revealed that 43% of these landowners had an ongoing legal action against system operators in order to obtain fairer compensation for the installation of wind turbines on their properties. Therefore, the topic of the study probably irritated these respondents, so that they left the interview.

An average score of 4.8 (min 4.0; max 5.0; std. dev. 0.8) was obtained from the complete questionnaires in response to the supplementary question inserted at the end of each choice task. This was in line with the pre-testing results (average score 4.9; min 4.0; max 5.0; std. dev. 0.6), thus excluding possible problems related to the uncertainty of the responses or to the similar utility of the alternatives. Consequently, no further use of this information was made in the final analysis. In contrast, a low average score already obtained in the pre-testing phase would have highlighted the need to revise the experimental design.

The sample (Table 3) mainly consisted of male landowners aged 31 to 50, with a secondary-school education and Bachelor’s degree, and non-farmers comprised 46.8% of the respondents. The most representative net income was between 15,100 and 30,000 Euros, and most of the properties were smaller than 10 hectares. Most of the properties (72.5%) were not rented out, were used to grow cereals and vegetables (both over 60%), but also olives and grapes, and were located in the hilly areas of the province (57.5%). A third of the sampled properties contained wind turbines, 36% were more than 1,000 metres distant from neighbouring wind infrastructure, while 43% of the respondents recognized that the wind farms depreciate up to 25% of the property area. Finally, 20% of the respondents believed that wind turbines produced irritating noise, and 13% dangerous electromagnetic fields affecting agricultural activities. However, a reasonable wind farms’ social function in supplying renewable energy to the community was recognized (52% of the respondents). The sample characteristics were similar to the reference population (landowners in the studied area), thus minimising risks of sample section bias.

Table 3 – Socio-economic and property characteristics of landowners.

3.2 CE results

Concerning the selection of the number of classes, the AIC, BIC, and AIC3 criteria were minimised at four segments, thus a four-class LCM was examined (Table 4).

Table 4 – Fitting measures for the selection of the LCM's number of classes.

The analysis highlights four groups of landowners (Table 5). The first (LCM1) accounts for 20% of the sample and includes respondents who accept the installation of a maximum number of two turbines on their properties, but based on a ten-year easement. Other aspects related to the height of towers, influence of nearby wind farms, and type of system operator do not affect these subjects' preferences. The negative alternative-specific constant (ASC) indicates a willingness toward the installation of this infrastructure.

With reference to its socio-economic characteristics (Table 6), the group includes young and middle-aged farmers with an upper middle net income and large farm size. They directly manage agricultural activity relating to cereals and vegetables and mainly in the flat and fertile areas of the province. These landowners have not experienced turbine installation on their property so far, work in a territory characterized by a low density of turbines, and believe that these infrastructures may depreciate the value of the property by up to 25%. They do not believe that turbines have negative impacts on human health due to noise and electromagnetic fields. On the contrary, they recognize their social function in increasing the supply of energy from renewable sources to the community. In general, these respondents are high-income farmers interested in exercising full rights over their properties; however, they are in favour of the installation of turbines for supplying social benefits to the community, provided that the easement lasts up to ten years. The average WTAs for the significant attributes and levels are reported in Table 7, where the negative values indicate aversion toward the specific attribute and/or level. These values are used to calculate the total WTA for two extreme scenarios based on the specific characteristics both of the turbines' installation and of the easement conditions. Indeed, the attributes and levels considered in the study generate different degrees of acceptance toward wind farms due to the different impacts on farm management and property rights. All these possible combinations range between two extreme scenarios: i) the installation of one 50-metre-high turbine within a territory with pre-existing wind towers at 1,000 metres from the boundary of the property and based on a 10-year easement with a private system operator; ii) the installation of three 100-metre-high turbines within a territory with pre-existing wind towers at 100 metres from the boundary of the property and based on a 20-year easement with a public system operator. Thus, the total WTA for these two extreme scenarios is calculated via the algebraic sum of the WTAs related to the significant attributes and levels, per class (Table 8). This approach is very useful for system operators and policy makers to decide on the suitability of specific energy policies in the study area, facilitating the assessment of their global impact in terms of community acceptance. Thus, the minimum compensation accepted for the least impacting scenario is 5.95 € m^{-2}, i.e. 1.02 times the amount paid out by system operators in the LCM1 respondents' area (5.84 € m^{-2}) (Table 6). On the contrary, the WTA for the worst scenario is negative; therefore, landowners are not willing to accept those specific installation characteristics and easement conditions.

The LCM2 group (27% of respondents), like the first group, is reasonably willing to install up to two turbines (also confirmed by the negative ASC) based on a ten-year easement and with private rather than public system operators, probably because of the greater flexibility in negotiating. The height of towers and the presence of other nearby wind farms are irrelevant to this group.

This class includes high-income and middle-aged respondents who do not operate in the primary sector but own medium-sized cereal farms, mostly inherited, and currently rented. They consider a minimum depreciation effect (up to 25% of the area), do not believe that turbines cause serious impacts on human health but do believe in their moderate social function in supplying renewable energy. In general, they are well-read landowners operating in the secondary and tertiary sectors whose primary objective is to obtain an income from farmland by renting it out, including to private system operators for the production of renewable energy. The minimum compensation claimed for the best scenario is 9.21 € m^{-2}, i.e. 1.03 times the amount paid out by transmission system operators in the LCM2 respondents' area (8.90 € m^{-2}). In comparison, the WTA for the worst scenario is negative in this case too, indicating aversion by the landowners.

Table 5 - Latent Class Model (LCM) estimates for the installation of wind turbines.

The third group (LCM3) accounts for 14% of the respondents, who accept the installation of up to one turbine with an easement of ten years. The height of towers and the type of system operator are irrelevant to them, while the presence of other wind farms up to 500 metres from their property boundaries reduces their willingness to accept this infrastructure, probably due to landscape issues and the sensation of spatial oppression generated by wind towers. The ASC is positive and significant at 10%, indicating partial aversion to wind farm installation.

This group consists of at least middle-aged farmers with at most an average income mainly from the cultivation of cereals and vegetables. There are wind turbines on their properties, which are located in hilly territories with a discrete density of surrounding wind farms. They believe that this infrastructure depreciates the value of their property by at least a quarter, consider the noise of turbines to be more dangerous to human health than electromagnetic fields, and recognise an important social function in supplying renewable energy to the community. In general, they are landowners across the whole study area who have experienced wind farms, easement, and bargaining with system operators already, and the minimum compensation they request for the best scenario is 10.56 € m^{-2}, i.e. 1.59 times more than the compensation paid out by system operators in the LCM3 respondents' area (6.64 € m^{-2}). However, the WTA for the worst scenario is negative in this case too.

Finally, reference class (LCM4) accounts for 39% of landowners. They are willing to accept one 50-metre turbine, but only if nearby wind farms are more than 1,000 metres from the boundaries of their properties, with an easement duration of ten years and a private system operator. In general, this is another group that approves the installation of wind farms (negative and significant ASC), but under restricted conditions.

Analysis of the socio-economic characteristics shows that these respondents are mainly middle-aged and elderly farmers with at most an average income from small farms in the hill areas of the province, which are characterized by a discrete density of wind farm in the surrounding territory. They consider wind turbines to have a depreciation effect of at least 50% of the property's value. With regard to negative effects on human health, they are only slightly concerned by noise and electromagnetic fields, while they recognize a moderate social function in supplying renewable energy to the community. The minimum compensation for the best scenario is 15.05 € m^{-2}, i.e. 1.67 times more than the compensation paid out in the LCM4 respondents' (9.01 € m^{-2}), while aversion is expressed for the worst set of installation and easement conditions.

Table 6 – Socio-economic and property characteristics of landowners, per latent class.

Table 7 - Average WTAs (€ m^{-2}) for the significant attributes and levels, with 95% confidence interval in parenthesis.

Table 8 – WTAs (€ m^{-2}) of the two extreme scenarios, per class.

The final analysis was characterized by two shortcomings. The first one concerns the potential informative loss due to the exclusion of 144 respondents who did not complete the choice tasks or always selected the “no option” alternative. In particular, 43% of these subjects have wind farms on their properties and ongoing appeals to obtain fairer compensation from system operators. Thus, a future investigation on the preferences of this type of respondents could allow a more in-depth setting of proper strategies aimed at the mitigation of the social tensions that the installation of wind farms generates in the considered territory. The second shortcoming concerns the use of attitudinal questions, i.e. those related to noise and electromagnetic fields generated by wind turbines, as explanatory variables in the LCM (Hess and Beharry-Borg, 2012). Indeed, these answers are a function of underlying attitudes, rather than a direct measure of attitudes, and their use as explanatory variables could be affected by measurement error. Moreover, the responses to attitudinal questions could be correlated with other unobserved factors that enter the model’s error term, thus leading to potential problems with endogeneity bias (Ben-Akiva et al., 1999; Ashok et al., 2002; Ben-Akiva et al., 2002). However, the use of a latent class approach could have mitigated this issue.

4 Discussion of results

The results prove that system operators must consider several aspects in order to satisfy landowners’ requests and ensure the community benefits from the supply of renewable energy at a reasonable cost. In particular, contrasting opinions emerge among landowners about the installation of wind farms on their properties, as confirmed by the ASCs, thus generating conflicts due to the low level of compensation that is offered. Hence, the following findings could be used to lessen or even avoid this kind of stalemate.

The CE approach highlights four groups of landowners based on their personal and property characteristics: large-scale farmers, medium-scale farm owners, landowners with wind turbines on their properties, and smallholders. All groups reject the installation of three turbines, apparently because of the excessive load on their property, while large and medium landowners (LCM1 and LCM2) accept up to two towers. Farmers with pre-existing wind farms and smallholders (LCM3 and LCM4), on the other hand, accept just one tower. These findings reveal that the willingness to accept wind turbines involves several aspects including, firstly, the property size. The share of a property affected by the infrastructure (about 5,000 m^2 for each turbine, in addition to the area for roads and control rooms) diminishes as property size increases, so that the easement burden decreases. Therefore, wind turbines are mostly accepted on large properties, while the limitation of property rights is more evident for smallholders, whose occupied area can be a large percentage of their land. Large-scale farmers consider the occupation of a small share of their property as a further income opportunity, due to compensation, which obviously does not decrease the total farm revenues. In comparison, the area occupied by the foundations and other elements of a wind farm can be sizeable for the LCM4 group; as a result, substantial productive land is withdrawn from use, with negative repercussions on farm returns (Figure 1A).

Figure 1 – Relationship (kernel regression) between WTA for one turbine and property size (A) and distance from neighbouring wind farms (B).

These landowners are in the inland and hilly areas of the province, which are characterized by a high degree of farmland fragmentation and landscape issues (Roselli et al., 2009); as a result, they admit one turbine, but with a maximum height of 50 metres for reducing the visual impact. Therefore, system operators should also consider the landscape and aesthetic features of wind farms (Pons et al., 2017; Devine-Wright and Batel, 2013; Maslov et al., 2017; Mirasgedis et al., 2014; Sklenicka and Zouhar, 2018; van Grieken and Dower, 2017) in order to increase their acceptance in the inner territories.

Another important aspect concerns the presence of possible agreements on properties (rent) owned by non-farmers (LCM2), which may favour turbine installation; like the LCM1 group, these respondents tend to consider compensation as a further source of income.

The analysis also highlights that previous installation of turbines on property reduces respondents' acceptance (higher WTA) of further wind towers (LCM3), which might be explained in terms of the growing burden on their property. However, the demand for higher compensation may also be a signal of discontent, the causes of which, though not investigated in this study, could be the focus of future research. In particular, the specialist literature refers to several possible determinants (Nelson et al., 2017): mistrust toward the agencies responsible for siting, construction, and management (Ceglarz et al., 2017; Jenkin-Smith et al., 2009; Schively, 2007); lack of information and a sense of exclusion from the decision-making process (Lienert et al., 2018; Gross, 2007); a negative institutional context (Friedl and Reichl, 2016; Devine-Wright, 2009); and the lack of simplified and standardised regulatory frameworks (Battaglini et al., 2012). Hence, investigation of these further issues could improve findings in favour of conflict reduction, thus ensuring "procedural justice" and "social trust" with better policy outcomes (D'Souza and Yiridoe, 2014; Ritchie et al., 2013; Steinbach, 2013; Mohanty and Tandon, 2006; Roussopoulos, 2005; Casieri et al., 2010).

The study also shows that several strategic behaviours are mitigated, such as the "Not In My Backyard" (NIMBY) reaction, i.e. public opposition to the siting of infrastructure (Cain and Nelson, 2013), and "place attachment", i.e. the sense of affiliation toward the place where people live or work (Joe et al., 2016; Aas et al., 2014; Batel and Devine-Wright, 2015; Cotton and Devine-Wright 2013; Devine-Wright, 2013; Devine-Wright, 2014). Indeed, even the more recalcitrant landowners (LCM3 and LCM4) are willing to accept the installation of one turbine, and this could be explained by their recognition of a social function in owning property that supplies clean energy to the community, especially for the LCM3 group. Therefore, increasing landowners' awareness about the importance of their role and decisions could improve their acceptance of wind farms on private property.

Another important aspect concerns the presence of surrounding wind farms. The impact is absent for large and medium properties of the LCM1 and LCM2 classes, while for the other two groups the negative influence disappears starting from 1,000 metres. On this aspect, Figure 1B shows how the WTA elicited by each group of respondents for the installation of one turbine decreases as the distance from the neighbouring wind farms increases. However, the trend is significantly different among the groups. These results recall the outcomes of another study based on real estate market research (Jensen et al., 2018), for which on-shore wind turbines negatively affect the price of surrounding properties within three kilometres. The negative impact increases with the number of wind towers, but declines with distance. Therefore, this aspect, which combines property size and the density of turbines on the neighbouring territory, is crucial for system operators, including for its landscape implications.

Two contractual characteristics require consideration, i.e. easement duration and the type of system operator. The CE highlights that the 20-year easements are rejected, probably due to the sense that one's full rights over the property are being limited. Hence, institutions, landowners, and system operators should identify a shared contractual strategy and the easement duration to make wind farms both acceptable and profitable to the respective stakeholders. Furthermore, the private or public nature of system operators influences the burden of agreement and administrative aspects; thus, the simplification, acceleration, and transparency of the siting and assessment phases should be a key concern overall for public operators (Lienert et al., 2018).

Interesting aspects also emerge from the respondents' other sociodemographic and attitudinal characteristics. In particular, the opinion that electromagnetic fields generated by turbines affect human health is only somewhat accepted. Noise annoyance, on the other hand, is only widely considered by the LCM3 class, i.e. by the landowners with turbines already sited on their properties, so that previous experience with this infrastructure may generate inconvenience in this field. However, the greater noise impact for the LCM3 group could also be explained by the crops they plant. Like the LCM1 group, these landowners cultivate cereals, but more vegetables, which require longer-duration farming activities than cereals or olives. Thus, these respondents' reaction to noise could be proportional to the annual duration of agricultural practices (Acciani and Sardaro, 2014). The type of crop, therefore, also seems to be related to noise annoyance, and to influence wind turbine acceptance. However, outcomes in this research field (McCunney et al., 2014) confirm no clear association between wind turbine noise and human health. Infrasound and low frequency sound do not present health risks to people living or operating near wind turbines, since their levels are below audibility or threat thresholds. Therefore, *ad hoc* and further studies concerning the relationship between crop and acceptability of turbines would be useful.

Another important outcome concerns the impact of wind farms on the value of the residual property. This is a crucial element in assessing the total compensation to be paid to landowners, but is greatly underestimated by system operators. Results highlight that respondents in the first two classes recognize a minimum depreciation effect, while this can be greater for LCM3 and LCM4 landowners. Obviously, this impact also depends on property size, so that system operators should consider this additional element for compensation, while relating it to property size.

Further considerations emerge from the absolute value of the estimated WTA, which increases from the LCM1 to the LCM4 class. This trend is due to the different importance of its determinants (land occupation, negative impacts on the management of the remaining property area, and environmental externalities) among the territories related to each investigated class. In particular, the increase of the estimated WTA from the flat and fertile areas to the hilly and dry territories can be explained as the outcome of two opposite trends among its determinants: i) the missed revenues for land occupation decrease, as suggested by the respective farmland values (table 6); ii) as the estimated WTA increases, the sum of the negative impacts on the management costs of the remaining property area (depreciation) and the requested compensation for the negative environmental externalities rises. Consequently, from the first to the fourth class, the missed revenues progressively become a minority share of the total compensation required by landowners. Furthermore, the attitude of the respondents in the inner areas could be strengthened by the lack of substitutes (Hanemann, 1991) and the endowment effect (Kahneman and Tversky, 1979). The first aspect occurs when a lack of substitutes (i.e. occupation by wind turbines, which precludes any future land use) makes it impossible to offer proportionate compensation for the lost good, thus generating extreme WTA values. The endowment effect suggests that desirable goods are more valuable when they are part of one's own endowment, so that ownership or experience of a good increases the value recognised. In this research, the lack of substitutes may especially concern the LCM4 respondents, i.e. smallholder farmers, while the endowment effect may concern the LCM3 landowners who have wind farms on their properties but identify problems (noise) and possible conflicts with system operators in the siting, planning, construction, and/or management phases. Hence, these respondents' negative experience could increase their WTA.

The results point out that the actual compensation per class (Table 6) is often underestimated compared to the WTA, even if it follows the same increasing trend from the LCM1 to the LCM4 class. This insight highlights the system operators' recognition of the increasing depreciation of the unoccupied area and environmental impacts deriving from the construction of wind farms. In any case, the difference between the actual compensation and the estimated WTA also significantly increases, highlighting a rising refusal of the recognized benefit.

All these aspects show the need to adopt more suitable assessment criteria that take into account the neglected components of compensation, which should also be based on the changeable characteristics of the farmland and environment across the study area, with particular emphasis on farm size, land fragmentation, aesthetical aspects, surrounding wind farms, and environmental externalities. In addition, fair compensation and treatment in favour of all landowners, participative and collaborative planning, more transparent communication, as well as simplification, acceleration, and transparency of the siting and assessment phases, should ensure "procedural justice" and "social trust" and, therefore, a better relationship among stakeholders, with consequent benefits for the community.

5 Conclusion and Policy Implications

This study investigates the acceptance of easement compensation paid to landowners for new wind farms. The results confirm that the actual payment is underestimated and identify the elements to be considered for a fair compensation assessment. Indeed, it emerges that compensation to landowners is a multifaceted and complex issue deriving from personal, social-psychological, and contextual factors, knowledge of which is a key element in understanding the reasons favouring or limiting the acceptance of wind farms on private properties. These results confirm the need to define a new feasible assessment path able to improve the present evaluation method for compensation assessment. Furthermore, these insights could be useful in ensuring the development of suitable energy policies based on well-structured and clear siting, planning, construction, and management processes for wind farms (Devine-Wright, 2007). This study highlights the fact that compensation is based on numerous elements: the property's size, the number of turbines, the crop, the presence of surrounding wind farms, the aesthetics and height of turbines, environmental issues, land fragmentation, land agreements, and the presence of other wind towers on property.

The study also provides some important insights concerning the environmental impact assessment (EIA) for the construction of energy infrastructure in Apulia (Regional Act n. 11 of 12 April 2001) and Italy (Ministerial Decree of 10 September 2010, regarding the authorization for systems powered by renewable sources), with particular reference to citizens' participation. In general, it is aimed at a) informing and involving citizens in the initiatives and proposed actions that affect their territory and their living conditions; b) obtaining the knowledge necessary for the final valuation decision; and c) developing control and mitigation measures. However, the high number of conflicts demonstrates the system operators' failure to involve the community. The pursuit of this objective – the involvement of the community – may instead favour the gathering of information that can improve the decision-making process. Such information includes the accepted number of turbines per property, depending, as well, on its size and crop, the distance between properties and neighbouring turbines, the depreciation effect recognized by landowners, the type of proponent (public or private), the easement duration, and the aesthetic characteristics of towers. Landowners' knowledge of these factors and related characteristics could ensure their greater co-operation with other stakeholders, while fostering recognition of the public function of landowners' property for the production of renewable energy. Furthermore, this strategy could contribute to the definition of mitigation measures, especially for landscape preservation (density, size, and aesthetics of towers).

However, it must be stressed that this participative approach is not compulsory for project authorization, since it adheres more closely to participatory democracy (which involves minorities) than to representative democracy (which is legitimized by the majority of votes), and does not, therefore, result in community empowerment. On the contrary, the environmental, landscape, economic, and legal aspects of a wind farm mainly involve the local communities that are directly advantaged or damaged by the project. Hence, the outcomes of the participative process, even if related to participatory democracy, should in any case be mandatory in the various stages of the infrastructure planning.

In conclusion, this is a first attempt at understanding the multidimensional attitude of landowners towards wind farms in Italy. System operators and institutions can use these outcomes for improving the present evaluation method and resolving the frequent tensions among stakeholders, so as to benefit the community and environment.

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Table 1 – Attributes and their respective levels used in the CE study (reference levels in italics).

Attributes	Description	Levels
Turbines	Number and power of wind turbines to install on the property (n)	*1 turbine < 50 kW* 1 turbine of 3 MW 2 turbines of 3 MW 3 turbines of 3 MW
Height	Distance from the base to the hub of a wind turbine (m)	*30* 50 100
Distance	Distance between pre-existing wind towers on nearby farmland and the boundary of the property (m)	*0* 100 500 1,000
Easement duration	Duration of occupation (Years)	*5* 10 20
System operator	Type of transmission system operator	*None* Private group Public company
Compensation	Payment by the system operator for the construction of wind towers on the property (€ m^{-2})	2, 4, 10, 20

Table 2 – Example of a choice set used during the interviews.

Attribute	Option A	Option B	No option
Turbines	1 turbine of 3 MW	3 turbines of 3 MW	Neither A nor B. I do not want wind turbines on my property.
Height	100 m	50 m	
Distance	500	100	
Easement duration	20 years	10 years	
System operator	Public	Private	
Compensation	4 €	10 €	
Your choice	☐	☐	☐

Table 3 – Socio-economic and property characteristics of landowners.

Variable		Respond. (%)	Mean of reference population [a]
Gender	Male	68.3	69.1
	Female	31.7	30.9
Age (years)	18-30	16.7	17.4
	31-50	49.8	47.2
	51-75	33.5	35.4
Education level	Primary school/Middle school	40.0	42.8
	Secondary school/Bachelor degree	60.0	57.2
Employment	Farmer	53.2	
	Secondary sector	26.7	
	Tertiary sector	20.1	
Net income (.000 €)	0-15	15.6	
	15.1-30	56.3	
	> 30	28.1	
Property size (hectares)	0-10	46.8	53.5 [b]
	10.1-20	32.3	29.8
	> 20	20.9	16.7
Property rented	No	72.5	76.8
	Yes	27.5	23.2
Crop	Cereals	42.5	47.6
	Olives	10.0	8.2
	Grapes	12.0	9.5
	Vegetables	23.6	25.2
	Untilled	11.9	9.5
Hilly territory	No	42.5	46.3
	Yes	57.5	53.7
Pre-existing turbines on the property	No	67.3	
	Yes	32.7	
Distance from surrounding wind farms (metres)	0-100	18.7	
	101-500	28.1	
	501-1,000	17.2	
	> 1,000	36.0	
Opinion about the property's share depreciated by wind towers (%)	0-25	42.6	
	26-50	19.8	
	51-75	14.6	
	76-100	23.0	
Wind turbines generate irritating noise	No	79.6	
	Yes	20.4	
Wind turbines generate dangerous electromagnetic fields	No	86.5	
	Yes	13.5	
Need to supply energy from renewable	No	48.1	

sources by wind farms to the community	Yes	51.9

[a] Data from the Agriculture National Census, 2010.

[b] The letter as superscript indicates a statistically significant difference between respondents and reference population, based on a t-test analysis ($p < 0.05$).

Table 4 – Fitting measures for the selection of the LCM's number of classes.

Model	Log-Likelihood	AIC [a]	BIC [b]	AIC3 [c]
MNL	-4735.73	9539.46	4850.52	9573.46
LCM2	-4565.06	9226.12	4727.11	9274.12
LCM3	-4392.83	8949.66	4669.67	9031.66
LCM4	-4246.48	**8724.96**	**4638.11**	**8840.96**
LCM5	**-4215.02**	8730.04	4721.44	8880.04

[a] Akaike information criterion: -2(LL-P)

[b] Bayesian information criterion: -LL+(P/2) * ln(N)

[c] Modified Akaike information criterion (Bozdogan AIC): -2LL + 3P

Table 5 - Latent Class Model (LCM) estimates for the installation of wind turbines.

	LCM1		LCM2		LCM3		LCM4 (reference class)	
Class probability	0.203		0.270		0.138		0.389	
	Coeff.	Std. err.	Coeff.	Std. err.	Coeff.	Std. err.	Coeff.	Std. err.
Utility function								
Turbines: 1	0.313	0.03 ***	0.390	0.17 **	0.742	0.30 **	1.361	0.16 ***
Turbines: 2	0.405	0.14 **	0.717	0.27 **	-0.275	0.21	-1.937	0.25 ***
Turbines: 3	-0.501	0.11 ***	-0.669	0.08 ***	-1.524	0.09 ***	-2.415	0.18 ***
Height: 50 m	0.247	0.19	0.170	0.15	0.210	0.18	0.219	0.08 **
Height: 100 m	0.186	0.13	0.195	0.12	0.345	0.23	-0.615	0.22 **
Distance: 100 m	0.334	0.27	-0.341	0.20	-0.675	0.09 ***	-0.924	0.32 **
Distance: 500 m	0.150	0.11	-0.206	0.16	-0.293	0.12 **	-0.613	0.22 **
Distance: 1,000 m	0.248	0.24	0.173	0.12	0.109	0.04 **	0.112	0.04 **
Easement duration: 10 yrs	0.271	0.11 **	0.294	0.03 ***	0.410	0.15 **	0.168	0.07 **
Easement duration: 20 yrs	-0.292	0.18	-0.253	0.26	-0.608	0.25 **	-0.771	0.13 ***
System operator: Private	0.188	0.16	0.119	0.05 **	-0.355	0.26	0.214	0.09 **
System operator: Public	0.470	0.28	0.185	0.14	0.317	0.22	0.492	0.27
Compensation	0.095	0.01 ***	0.091	0.01 ***	0.115	0.01 ***	0.142	0.02 ***
ASC	-1.338	0.19 ***	-1.503	0.27 ***	2.698	1.32 *	-2.884	1.10 **
Segment probability function								
Constant	0.647	0.11 ***	0.539	0.07 ***	0.703	0.27 **		
Age: 51-75 years	-0.204	0.03 ***	0.035	0.15	0.152	0.17		
Sec. school - Bach. degr.	0.332	0.20	0.882	0.35 **	0.368	0.27		
Farmer	0.715	0.09 ***	-0.404	0.03 ***	0.651	0.12 ***		
Net income: > 30,000 €	0.502	0.13 ***	0.619	0.09 ***	0.102	0.08		
Property size: 0-10 ha	-0.289	0.06 ***	-0.738	0.22 ***	0.274	0.18		
Property size: > 20 ha	1.625	0.15 ***	0.345	0.30	0.149	0.12		
Property rented	-0.292	0.23	1.021	0.43 **	0.031	0.05		
Cereals	0.513	0.09 ***	0.830	0.25 **	0.495	0.21 **		
Grapes	0.172	0.21	-0.299	0.11 **	-0.218	0.29		
Vegetables	0.387	0.19 *	-0.156	0.09	0.630	0.14 ***		
Hilly territory	-0.060	0.02 ***	-0.263	0.11 **	0.027	0.02		
Pre-existing turbines	-0.171	0.03 ***	0.077	0.07	0.859	0.19 ***		
Depreciation 0-25%	0.415	0.10 ***	0.302	0.06 ***	0.100	0.08		
Depreciation 26-50%	0.104	0.07	0.154	0.14	0.337	0.08 ***		
Depreciation 76-100%	-0.156	0.03 ***	-0.188	0.04 ***	0.116	0.11		
Noise	0.232	0.13	-0.026	0.02	0.327	0.06 ***		
Electromagnetic fields	-0.163	0.02 ***	-0.337	0.20	0.199	0.13		
Benefits to the community	0.449	0.07 ***	0.592	0.43	0.350	0.09 ***		
Obs.	5.992							
McFadden pseudo-R^2	0.336							

***: sign. 1%; **: sign. 5%; *: sign. 10%.

Table 6 – Socio-economic and property characteristics of landowners, per latent class.

Variable		LCM1 Mean	LCM1 S. D.	LCM2 Mean	LCM2 S. D.	LCM3 Mean	LCM3 S. D.	LCM4 Mean	LCM4 S. D.
Gender	Male	0.69 [a]	0.68	0.69 [a]	0.77	0.65 [a]	0.66	0.70 [a]	0.85
	Female	0.31 [a]	0.52	0.31 [a]	0.56	0.35 [a]	0.46	0.30 [a]	0.54
Age (years)	18-30	0.38 [a]	0.64	0.12 [c]	0.10	0.13 [b,c]	0.09	0.04 [d]	0.06
	31-50	0.49 [a]	0.36	0.49 [a]	0.44	0.49 [a]	0.81	0.52 [a]	0.74
	51-75	0.14 [d]	0.21	0.39 [b,c]	0.73	0.38 [c]	0.39	0.43 [a]	0.72
Education level	Primary school/Middle school	0.51 [a]	0.64	0.04 [b]	0.07	0.51 [a]	0.68	0.54 [a]	0.82
	Secondary school/Bachelor deg.	0.49 [c,d]	0.72	0.96 [a]	0.66	0.49 [b,c,d]	0.46	0.46 [d]	0.37
Employment	Farmer	0.80 [a]	0.88	0.04 [d]	0.06	0.76 [b]	0.81	0.53 [c]	0.86
	Secondary sector	0.12 [c,d]	0.09	0.45 [a]	0.56	0.11 [d]	0.11	0.39 [b]	0.54
	Tertiary sector	0.07 [d]	0.13	0.51 [a]	0.60	0.13 [b,c]	0.10	0.09 [c,d]	0.16
Net income (.000 €)	0-15	0.05 [c,d]	0.08	0.03 [d]	0.03	0.23 [b]	0.39	0.31 [a]	0.23
	15.1-30	0.55 [c]	0.49	0.38 [d]	0.32	0.70 [a]	0.55	0.63 [b]	0.60
	> 30	0.40 [b]	0.39	0.60 [a]	0.99	0.07 [c,d]	0.07	0.06 [d]	0.06
Property size (hectares)	0-10	0.12 [d]	0.11	0.21 [c]	0.34	0.63 [b]	0.52	0.91 [a]	0.84
	10.1-20	0.20 [c]	0.20	0.78 [a]	0.91	0.25 [b]	0.43	0.06 [d]	0.11
	> 20	0.68 [a]	0.64	0.01 [d]	0.02	0.12 [b]	0.17	0.03 [c,d]	0.02
Property rented	No	0.88 [a]	0.73	0.32 [b]	0.35	0.84 [a]	0.76	0.86 [a]	0.60
	Yes	0.12 [d]	0.18	0.68 [a]	0.49	0.16 [b,c,d]	0.20	0.14 [c,d]	0.23
Crop	Cereals	0.60 [a]	0.61	0.46 [b]	0.36	0.41 [c]	0.76	0.24 [d]	0.41
	Olives	0.01 [c]	0.02	0.17 [a]	0.31	0.03 [b,c]	0.05	0.19 [a]	0.34
	Grapes	0.13 [a]	0.10	0.05 [b]	0.08	0.13 [a]	0.24	0.17 [a]	0.20
	Vegetables	0.25 [b]	0.23	0.15 [c,d]	0.18	0.43 [a]	0.43	0.12 [d]	0.14
	Untilled	0.01 [d]	0.01	0.18 [b]	0.18	0.01 [c,d]	0.01	0.29 [a]	0.43
Hilly territory	No	0.79 [a]	0.66	0.41 [b]	0.67	0.28 [c]	0.34	0.22 [d]	0.33

	Yes	0.21 [d]	0.36	0.59 [c]	0.45	0.72 [b]	0.91	0.78 [a]	0.56
Pre-existing turbines on the property	No	0.97 [a]	0.80	0.76 [c]	0.99	0.17 [d]	0.24	0.80 [b,c]	0.60
	Yes	0.04 [d]	0.05	0.24 [b,c]	0.30	0.83 [a]	0.90	0.20 [c]	0.32
Distance from surrounding wind farms (metres)	0-100	0.05 [d]	0.04	0.07 [c,d]	0.06	0.24 [b]	0.19	0.38 [a]	0.59
	101-500	0.09 [c]	0.11	0.25 [b]	0.28	0.39 [a]	0.42	0.40 [a]	0.48
	501-1,000	0.08 [d]	0.13	0.22 [b]	0.22	0.27 [a]	0.44	0.11 [c,d]	0.13
	> 1,000	0.78 [a]	0.63	0.46 [b]	0.61	0.10 [d]	0.14	0.11 [c,d]	0.15
Opinion about the property's share depreciated by wind towers (%)	0-25	0.86 [a]	0.64	0.79 [b]	0.58	0.02 [c,d]	0.02	0.02 [d]	0.02
	26-50	0.06 [d]	0.09	0.11 [c]	0.11	0.51 [a]	0.73	0.11 [b,c]	0.13
	51-75	0.06 [c]	0.07	0.07 [b,c]	0.06	0.01 [d]	0.01	0.45 [a]	0.34
	76-100	0.02 [c]	0.03	0.03 [b,c]	0.05	0.46 [a]	0.59	0.42 [a]	0.58
Wind turbines generate irritating noise	No	0.97 [a]	0.56	0.97 [a]	0.74	0.31 [b]	0.34	0.93 [a]	0.90
	Yes	0.03 [d]	0.06	0.03 [c,d]	0.03	0.69 [a]	0.57	0.07 [b,c,d]	0.12
Wind turbines generate dangerous electromagnetic fields	No	0.98 [a]	0.80	0.86 [b,c]	0.74	0.80 [d]	0.67	0.83 [c,d]	0.85
	Yes	0.03 [c]	0.04	0.15 [b]	0.19	0.20 [a]	0.30	0.17 [a,b]	0.15
Need to supply energy from wind farms to the community	No	0.24 [c]	0.28	0.70 [a]	0.89	0.28 [b,c]	0.51	0.71 [a]	0.83
	Yes	0.76 [a]	0.65	0.30 [c,d]	0.40	0.72 [b]	0.73	0.29 [d]	0.33
Compensation (€ m^{-2}) *		5.84 [b]	3.18	8.90 [a]	2.17	6.64 [b]	2.90	9.01 [a]	4.89
Farmland value (€ m^{-2}) **		3.73 [a]	1.61	3.50 [b]	2.08	2.72 [c]	1.47	2.41 [d]	1.33

[a,b,c]: values with the same letter as superscript indicate not statistically significant differences between the latent classes; the differences were estimated through the two sample Wilcoxon rank sum (Mann-Whitney) test, $p < 0.05$.

* Means were calculated through a sample of 84 compensations recognized by transmission system operators in the study area, and referred to the period June 2013-May 2017.

** Means were calculated through a real estate survey sample concerning 264 farmland values. Data originated from transfer acts (74%) and estate agencies (26%), and referred to transactions between February 2015 and March 2018, corresponding to a relatively stable period in the farmland market of the study area.

Table 7 - Average WTAs (€ m^{-2}) for the significant attributes and levels, with 95% confidence interval in parenthesis.

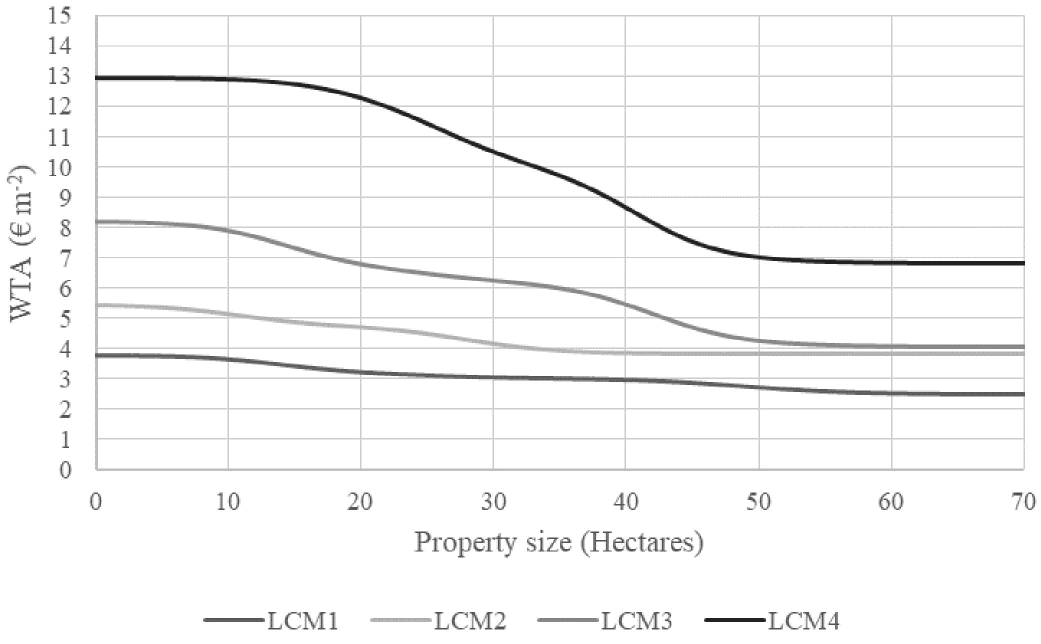
	LCM1	LCM2	LCM3	LCM4
Turbines: 1	3.13 (2.47 3.79)	4.65 (3.81 5.49)	6.13 (4.04 8.21)	9.87 (6.81 12.93)
Turbines: 2	4.10 (3.08 5.13)	8.12 (5.68 10.56)		-12.90 (-15.35 -10.45)
Turbines: 3	-5.22 (-6.26 -4.18)	-7.63 (-9.61 -5.65)	-13.18 (-18.06 -8.30)	-17.44 (-21.80 -13.08)
Height: 50 m				1.62 (1.13 2.21)
Height: 100 m				-3.85 (-5.12 -2.58)
Distance: 100 m			-5.69 (-7.11 -4.27)	-6.47 (-9.12 -3.82)
Distance: 500 m			-2.24 (-2.91 -1.57)	-4.51 (-5.32 -3.70)
Distance: 1,000 m			0.94 (0.69 1.19)	0.77 (0.63 0.91)
Easement: 10 years	2.82 (2.20 3.44)	3.26 (2.35 4.17)	3.49 (2.55 4.43)	1.24 (1.02 1.46)
Easement: 20 years			-5.20 (-7.23 -3.17)	-5.46 (-6.93 -3.99)
System operator: Private		1.30 (1.11 1.50)		1.55 (0.99 2.11)
System operator: Public				

Table 8 – WTAs (€ m^{-2}) of the two extreme scenarios, per class.

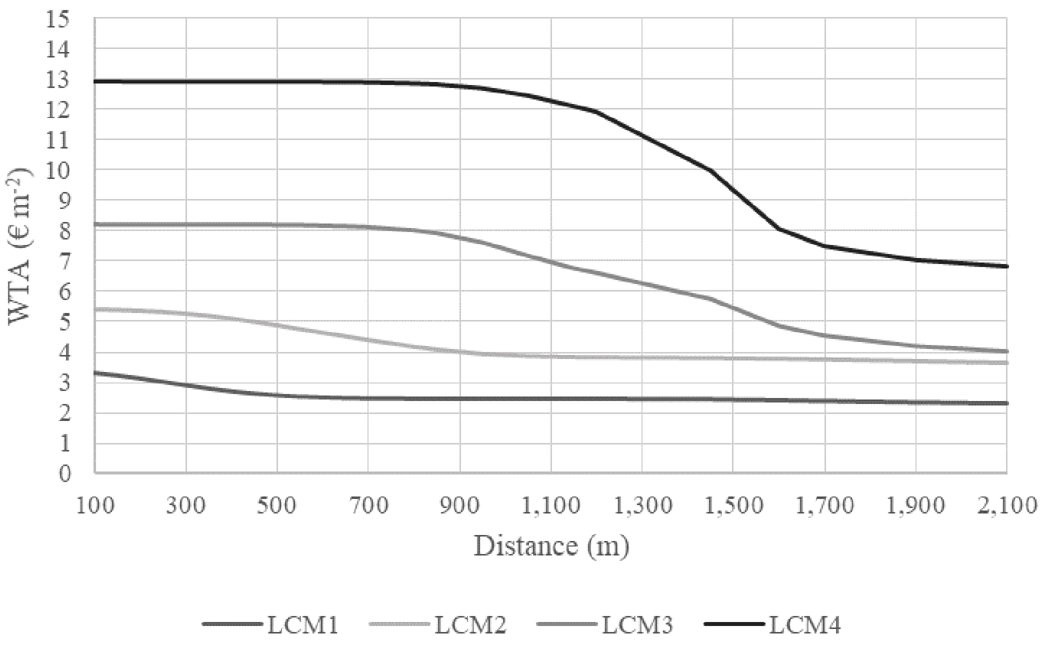
Least impacting scenario				
	LCM1	LCM2	LCM3	LCM4
Turbines: 1	3.13	4.65	6.13	9.87
Height: 50	0.00	0.00	0.00	1.62
Distance: 1000	0.00	0.00	0.94	0.77
Easement: 10	2.82	3.26	3.49	1.24
System operator: Private	0.00	1.30	0.00	1.55
Total WTA	5.95	9.21	10.56	15.05
Most impacting scenario				
	LCM1	LCM2	LCM3	LCM4
Turbines: 3	-5.22	-7.63	-13.18	-17.44
Height: 100	0.00	0.00	0.00	-3.85
Distance: 100	0.00	0.00	-5.69	-6.47
Easement: 20	0.00	0.00	-5.20	-5.46
System operator: Public				
Total WTA	-5.22	-7.63	-24.07	-33.22

Figure(s)

Figure 1 – Relationship (kernel regression) between WTA for one turbine and property size (A) and distance from neighbouring wind farms (B).



A



B