Spanish Journal of Agricultural Research
20 (4), e0106, 16 pages (2022)
eISSN: 2171-9292
https://doi.org/10.5424/sjar/2022204-18480
INIA-CSIC

RESEARCH ARTICLE

OPEN ACCESS

Spatial discounting in food products from high natural value agroecosystems

Rubén Granado-Díaz[1,2], Anastasio J. Villanueva[1,3] and José A. Gómez-Limón[1]

[1] Universidad de Cordoba. Water, Environmental and Agricultural Resources Economics (WEARE) Research Group. Córdoba, Spain. [2] Agencia de Gestión Agraria y Pesquera de Andalucía (AGAPA), Córdoba, Spain. [3] Instituto de Investigación y Formación Agraria y Pesquera (IFAPA), Granada, Spain

Abstract

Aim of study: To test the hypothesis that consumers' willingness to pay (WTP) for traditional food products expresses their willingness to conserve the bundle of ecosystem services (ES) provided by the territories of origin and that the intensity of these preferences is subject to spatial discounting.

Area of study: We used Iberian dry-cured ham as a case study. This is a traditional and highly appreciated product characteristically produced in the Dehesa agroforestry system (southern Iberian Peninsula), an agricultural system characterized by high levels of ES provision.

Material and methods: The analysis relies on a discrete choice experiment using some recently developed spatial indexes that go beyond traditional "distance-decay" effects. This method was fed with primary data gathered from a face-to-face survey administered in Andalusian food retail establishments to 1,158 Iberian ham (acorn- or fodder-fed) consumers.

Main results: The results provide evidence of the effects of spatial discounting on the purchase of acorn- and fodder-fed Iberian hams associated with the agroecosystem in which they are produced. These effects presumably stem from consumers' cultural identity linked to the agroecosystem of origin and their willingness to support the local economy and communities. In addition, in the case of acorn-fed Iberian ham, spatial discounting is affected by consumers' perception of the ES provided by the agroecosystem, with consumers who significantly perceive these services showing a higher WTP, regardless of their place of residence (no spatial discounting).

Research highlights: Relevant insights can be gained from the results, especially concerning marketing strategies and the adoption of environmental and sociocultural certifications.

Additional key words: Iberian dry-cured ham; consumers' preferences; ecosystem services; choice experiments; dehesa; agroforestry system; commodification.

Abbreviations used: AIC (Akaike information criterion); ASC (Alternative Specific Constant); CP (consumer profile); DCE (discrete choice experiment); DF (degrees of freedom); ES (ecosystem services); LLR (log-likelihood ratio); MXL (mixed logit model); WTP (willingness to pay).

Citation: Granado-Díaz, R; Villanueva, AJ; Gómez-Limón, JA (2022). Spatial discounting in food products from high natural value agroecosystems. Spanish Journal of Agricultural Research, Volume 20, Issue 4, e0106. https://doi.org/10.5424/sjar/2022204-18480

Supplementary material (Tables S1-S2 and Fig S1) accompanies the paper on SJAR's website.

Received: 02 Jun 2021. **Accepted:** 19 Oct 2022.

Funding agencies/institutions	Project / Grant
European Regional Development Fund (ERDF)	INTERREG VA Spain-Portugal Program 2014-2020, Cross-Border Cooperation Project for the Integral Valorization of the Dehesa-Montado 0276 PRODEHESA MONTADO 6 E)

Competing interests: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Correspondence should be addressed to Anastasio J. Villanueva: anastasioj.villanueva@juntadeandalucia.es

Introduction

Food products have a wide array of attributes, both intrinsic (*e.g.,* taste, flavor, texture, or color) and extrinsic (*e.g.,* brand, packaging, quality certification label, denomination of origin, image of traditional product, or health benefit effects), which can provide particular benefits that consumers seek and that will ultimately support their personal values (Espejel *et al.,* 2007). Existing literature on the attributes influencing meat purchase decisions has provided wide-ranging evidence that the extrinsic attributes such as the geographical origin and the production/farming technology (*i.e.,* type of breed, feed use, environmental-friendly labels, animal welfare) are highly relevant. Among others, Hersleth *et al.* (2012), Bernabéu *et al.* (2018), and Aboah & Lees (2020), show that these attributes tied to the agricultural production systems significantly affect consumers' willingness to pay (WTP) for food products.

Different reasons can mainly motivate consumers' preferences for the extrinsic attributes related to the agricultural production system, which to some extent can be separated according to use and non-use values stemming from food consumption. Within the former, extrinsic attributes related to the production system can be understood by consumers as quality cues informing them about the sensory properties of the food product to be consumed, with preferences very much subject to be modulated by cultural factors (Salazar-Ordóñez *et al.,* 2018). Consumers may also consider that these extrinsic attributes provide personal use values emanating from sociocultural and environmental services provided by the agricultural production systems and enjoyed by the familiarized consumer (Borrello *et al.,* 2022), especially when local food is consumed (Gracia *et al.,* 2014). Within the non-use values attached to the agricultural production system, the related-extrinsic attributes may also be useful for consumers to identify those products grown or bred in specific agricultural production systems these individuals are connected with through different geographical ties, especially, but also environmental, social, or cultural ties (Iaccarino *et al.,* 2006; Viegas *et al.,* 2014). This last meaning of the extrinsic attributes is linked to non-use values such as "environmental enhancement" or "fulfilled and responsible feeling" (López-Mosquera & Sánchez, 2011), "social embededness" (Gracia *et al.,* 2012), and the sense of "territorial identity" (Scarpa *et al.,* 2005).

This dichotomy between use and non-use values is similar to that found in the economic valuation of the set of ecosystem services (ES) provided by natural sites and agricultural systems (Madureira *et al.,* 2013). However, contrary to environmental economics (see Schaafsma, 2015 for an overview), only seldom has food economics attempted to incorporate the spatial dimension into value assessments. In fact, just a few studies focused on "local" food are worth highlighting in this sense; specifically, they hint at a distance-decay effect (*i.e.,* consumers who live closer to the agricultural production system express relatively higher values). Menapace & Raffaelli (2016) showed that food purchase decisions are made with reference to both the quality of the product based on the *terroir* (a territory's set of characteristics contributing to product quality) and the distance between the production site and the consumer's place of residence as an environmental attribute affecting carbon emissions resulting from transportation. Aligned with these results, de-Magistris & Gracia (2016) find a significant marginal WTP for locally-grown almonds (produced at the shortest distance) and produced using environmental-friendly production techniques. Lim & Hu (2016) and Farris *et al.* (2019) found that consumers' preferences are consistent with local preferences based on geopolitical boundaries (*e.g.,* the state or province) and not distance. Ay *et al.* (2017) showed that French consumers' WTP increases for organic and local wines, also demonstrating that the organic premium significantly decreases with the distance between the consumer's home and the vineyards. While all these studies point to the spatial heterogeneity of extrinsic values attached to the agricultural production system, there is still a knowledge gap regarding the spatial discounting patterns of individuals' preferences toward the environmental, social, and cultural attributes linked to a given territory, encapsulated within food products (Herrmann & Teuber, 2011).

Within this framework, this paper attempts to bridge the said knowledge gap by systematically testing for the existence of a positive relationship between WTP for a food product and the proximity between the site of supply and the consumers' place of residence (*i.e.,* spatial discounting), especially for the case of identity-based products anchored to the territory from which they originate.

Unlike in non-market environmental valuations, for the case of food product purchase behavior, there is no clear economic rationale for spatial discounting, whether in attributes with use values (as consumption is possible in any location) or non-use values (as bequest, altruistic, and existence values are assigned regardless of the location) (Brinkley, 2017). As commented above, one possible reason is the consumers' preferences toward local food due to pro-environmental values related to their carbon footprint (shorter transportation distances involve lower levels of greenhouse gas emissions) (Menapace & Raffaelli, 2016). Another relates to consumers' recognition of the ES provided by the agricultural production system of origin, especially as regard to activities involving use values such as aesthetics and recreation, hunting, or mushroom and berry picking. As for these environmental ties, spatial discounting in territorial identity-based products can also be explained by social and cultural ties linking agricultural production systems to consumers, alternatively known in the environmental economics literature as "sense of place", "spatial identity", or "sense of ownership" (Hanley *et al.,* 2003). Therefore, extrinsic attributes relating to the agricultural production systems of these traditional food products, in addition to cues relating to product quality, can be seen as characteristics associated with consumers' preferences toward the conservation of specific territories where farming activities involve traditional know-how (Bowen & Mutersbaugh, 2013).

The objective of this paper was to test the hypothesis that consumers' WTP for traditional food products expresses their willingness to conserve the bundle of ES (related to biodiversity, climate stability, landscape, and cultural heritage) provided by the territories of origin, and that the intensity of these preferences is subject to spatial discounting. If this hypothesis is accepted, the heterogeneity in consumers' WTP for these food products could be (partly) explained by the effects on spatial discounting exerted by their heterogeneous perceptions (*i.e.,* identity ties) about the provision of ES by the agroecosystem of origin. To this end, we used Iberian dry-cured ham as a case study, which is a traditional Spanish food product for which the features that provide its greatest organoleptic properties are intimately linked to the agroecosystem of origin, the Dehesa, an agricultural system notably characterized by high levels of ES provision (Granado-Díaz *et al.,* 2021; Villanueva *et al.,* 2021).

The analysis relies on a discrete choice experiment (DCE) using some recently developed spatial indexes that go beyond traditional "distance-decay" effects, in an effort to incorporate other spatial factors besides distance into the analysis. To the authors' knowledge, this is the first attempt to systematically analyze spatial discounting in consumers' preferences for food products, with an additional focus on different territorial-based attributes offering use and non-use values.

Material and methods

The Iberian dry-cured ham produced in the Dehesa agroforestry system

Dry-cured ham is one of the most characteristic products of the Spanish gastronomy. Within the dry-cured ham, the Iberian ham (*i.e.,* that coming from the *Sus scrofa mediterraneus* pig breed) is probably the most widely-known, particularly due to its higher organoleptic quality and recognized identity (*i.e.,* traditionally produced in extensive production systems using transgenerational knowledge). The feeding and management system determines the category of the Iberian ham, basically distinguishing between two main categories: acorn-fed (*jamón ibérico de bellota*) and fodder-fed (*jamón ibérico de cebo*). The former involves animals extensively managed, slaughtered after foraging for acorns, grass, herbs, wild legumes, and other natural resources from the *Dehesa* (or *Montado* in Portuguese) agricultural ecosystem without external feed input in the final months of the animals' life. The latter involves animals intensively managed, entirely fed with commercial feed.[1] As shown in the dry-cured ham quality standard (BOE, 2014), sub-categories of Iberian ham result from combining these types of management and feeding systems with different levels of breed purity.

The acorn-fed Iberian ham is the most valued by consumers (Díaz-Caro *et al.,* 2019; Granado-Díaz *et al.,* 2021). This is due to its superior organoleptic properties (especially taste, flavor, texture, and color) compared to the fodder-fed Iberian ham. This higher quality coupled with lower yields compared to the latter give rise to significantly higher price levels of the acorn-fed Iberian ham. In particular, while fodder-fed Iberian ham can often be purchased in the market at €5-10/100-g-package, acorn-fed Iberian ham prices can easily reach over €20/100-g-package, placing the latter within the premium segment (Mesías *et al.,* 2013).

The acorn-fed Iberian ham is closely connected to the Dehesa agricultural ecosystem, a Mediterranean oak savanna, agro-sylvo-pastoral system unique for its high levels of provision of ES (including provisioning, regulating, supporting, and cultural services) (Garrido *et al.,* 2017; Campos *et al.,* 2019). It is the result of a historical interaction between ecological and social systems, encouraging multiple land-uses (especially cropping, livestock −including swine, ovine and bovine cattle− and timber and non-timber products) within the Dehesa system. This agricultural system covers 3.1 million hectares in the southwest of Spain and Portugal (Moreno & Pulido, 2009), with approximately one-third located in the region of Andalusia.

There is a great social demand for the ES provided by the Dehesa system (Ovando *et al.,* 2016), with Andalusian people showing both use and non-use values. Notable examples of the former are recreation and aesthetics, hunting, and mushroom and berry picking, while among the latter, biodiversity-related services and cultural values linked to cultural heritage, traditional knowledge, and animal welfare are worth noting (Garrido *et al.,* 2017; Granado-Díaz *et al.,* 2021). However, it is unclear to what extent consumers of acorn-fed Iberian ham consider these values in their purchasing decisions and whether this may be subject to different spatial discounting patterns. Among the studies to date that have analyzed consumers' preferences toward this type of ham, Mesías *et al.* (2009), Sahelices *et al.* (2017), Díaz-Caro *et al.* (2019), and García-Gudiño *et al.* (2021) provide evidence of preferences for geographical origin of production. The first three studies offer information about consumer preferences toward protected designations of origin (PDO) −arguably related not only to a geographical location but also to quality cues− and the latter focuses on traditional producer regions. However, there has been no

[1] There is another type of Iberian ham, which is a mix of the two types (mixed-fed or *cebo de campo*) but it is much less consumed than the other two.

Table 1. Attributes and levels of the choice experiment.

Attribute	Levels	
Price	Acorn-fed Iberian ham: €13 / 100-g €16 / 100-g €19 / 100-g €22 / 100-g	Fodder-fed Iberian ham: €4 / 100-g €7 / 100-g €10 / 100-g €13 / 100-g
Iberian breed purity	50% Iberian breed 75% Iberian breed 100% Iberian breed	
Slicing type	"Hand-sliced" claim No claim	
Dehesa origin claim	"Produced in the Dehesa" claim No claim	
Pictorial representation of Dehesa	No background (no picture) Background-Agricultural system Background-Dehesa system Background-Dehesa system with Iberian pigs	

explicit focus on the agroforestry production system (Dehesa) in the specialized literature.

Choice experiment: attributes and levels

The DCE method (Hensher *et al.,* 2015) was used to build a hypothetical market to analyze the impact of Iberian dry-cured ham attributes on consumers' preferences. This method relies on the Lancaster Consumer Theory (Lancaster, 1966) and the Random Utility Theory (McFadden, 1974) and has been extensively used in the analysis of consumer preferences regarding food products, including meat products (*e.g.,* Gracia & de-Magistris, 2013; Lusk & Tonsor, 2016).

Table 1 shows the attributes and levels included in the DCE. It includes four non-monetary attributes (*Breed purity, Slicing type, Dehesa origin claim, and Pictorial representation of Dehesa*) and the monetary attribute Price. The selection of the former is based on previous studies (Mesías *et al.,* 2009; Sahelices *et al.,* 2017; Díaz-Caro *et al.,* 2019) and direct observation of retailer meat shelves. Considering the differences in price and quality encountered for acorn-fed and fodder-fed Iberian hams, a labeled DCE design was employed, using the same attributes and levels except for the *Price* attribute. This design was used under the assumption that the Iberian ham type (the "label") already provides the consumer with relevant additional information beyond that included in the attributes and levels (Hensher *et al.,* 2015). Hence, unlike for unlabeled designs, effects specifically related to the Iberian type can be estimated for each attribute. We describe them in more detail below.

The *Price* attribute was set taking into account market prices of Iberian hams, distinguishing between acorn-fed and fodder-fed. Four levels were set for the *Price* attribute. They range from €13 to €22/100-g for the acorn-fed ham alternative and from €4 to €13/100-g for the fodder-fed ham alternative, with price differences of €3 between consecutive levels in both cases. Fig. S1 [suppl] presents an example choice card, where it can be observed that prices were displayed at the bottom of the card, which resembles a supermarket shelf, with the price given in euros per 100-g package (in large font size) and in euros per kilogram (in small font size).

The non-monetary attributes included two directly related to the product quality (*Breed purity* and *Slicing type*) and two related to the agricultural production system (*Dehesa origin claim* and *Pictorial representation of Dehesa*), with the latter being key for the spatial analysis carried out here. The *Breed purity* attribute included three levels, reflecting the dry-cured ham standard regulation (BOE, 2014): 50% (minimum legal level to be labeled Iberian), 75%, and 100% Iberian breed. The *Slicing type* attribute comprised two levels: a mention of the "Hand-sliced" claim in the packaging design and no mention of it (*i.e.,* implicitly indicating that the ham was "Machine-sliced"). These attributes were selected because they were identified as relevant determinants of the product price: Iberian hams from higher breed purity and/or sliced by hand are more expensive.

To test the origin feature related to the Dehesa system, the two attributes included in the DCE were: the *Dehesa origin claim,* with two levels, one where the claim "Produced in the Dehesa" was included on the packaging and the other where it was not; and the *Pictorial representation of Dehesa*, where a pictorial representation of the agricultural system was incorporated at the bottom of the package. The latter attribute included four levels, related to four different images: 1) No background (no picture), 2)

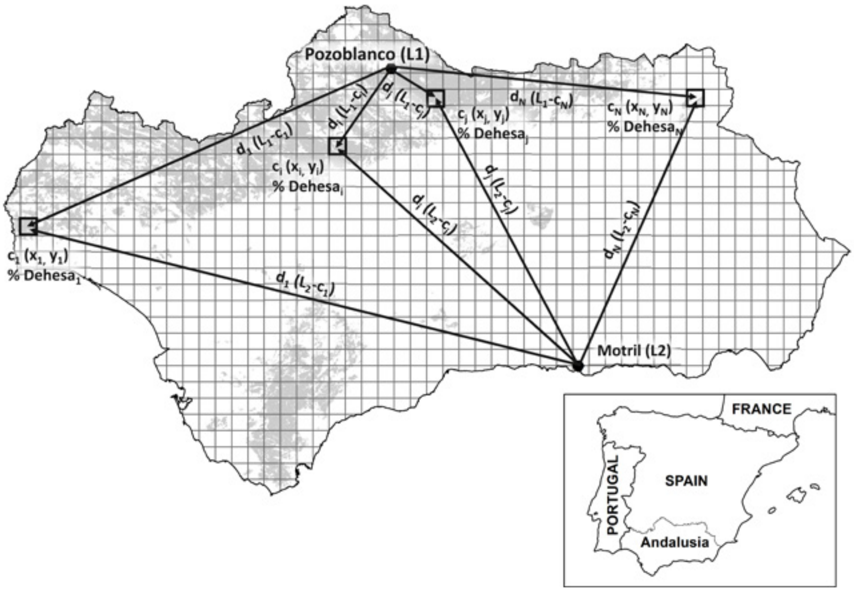

Figure 1. Calculation of spatial indexes in the Dehesa system in Andalusia.

Background-Agricultural system (picture of a common agricultural system −cereal cultivation), 3) Background-Dehesa system (picture of the Dehesa system), and 4) Background-Dehesa system with pigs (picture of the Dehesa system with Iberian pigs eating acorns).[2]

As shown in Fig. S1 [suppl], the choice cards reproduced the front[3] of two 100-g packages (alternatives) of acorn-fed and fodder-fed Iberian ham. This product format was used since this type of package is highly standardized, which also facilitated the graphical design of the alternatives (reflecting the most typical layout encountered on the market). In addition to the two ham alternatives, the no-purchase option was added to make the choices more realistic.

Spatial indexes

The research on spatial heterogeneity of individuals' preferences has long evidenced distance-decay effects, especially using case studies focusing on spatially concentrated sites (*i.e.,* sites located within a spatially-contiguous site) (Hanley *et al.,* 2003; Bateman *et al.,* 2006). To show these effects, the use of the distance to the nearest point (*i.e.,* Euclidian distance) between the site under study and the household has been widely used (Schaafsma, 2015).

However, when dealing with scattered environmental sites (over multiple non-contiguous locations), as is the case of most agricultural systems (like Dehesa here), quantity-within-distance approaches are more suitable compared to the traditional distance-to-the-nearest-point approaches (see Granado-Díaz *et al.,* 2020, for a comprehensive theoretical framework and empirical comparison). In the quantity-within-distance approaches, not only the distance but the area of the site within a certain distance from a respondent's place of residence are assumed to determine respondent's preferences (Glenk *et al.,* 2020). Previous studies show the suitability of using quantity-within-distance approaches for the case of scattered sites such as natural areas (De Valck *et al.,* 2017), forest areas (Yao *et al.,* 2014), river bodies in a certain watershed (Holland & Johnston, 2017), and agricultural systems (Granado-Díaz *et al.,* 2020). To the authors' knowledge, the current paper is the first to provide empirical evidence of the use of both, quantity-within-distance and only distance-based approaches, to analyze spatial heterogeneity of preferences for food product attributes. For it, one distance-based spatial index and three area-based spatial indexes have been used. We turn to describe the spatial indexes used.

Following the theoretical framework of Granado-Díaz *et al.* (2020), the spatial discounting effect for spatially-dispersed sites can be explained by the following expression:

$$U_h = u_{kh} + \ln\left[\int_{Y^-}^{Y^+}\int_{X^-}^{X^+}\left[p(x,y)\ \delta(x,y)\right] dx\, dy\right] \quad (1)$$

where u_{kh} represents the utility provided by the site to the household *h; p(x,y)* is a dummy spatial variable taking the

[2] It is worth mentioning that the dry-cured ham standard regulation (BOE, 2014) only permits an evocation of the Dehesa for acorn-fed Iberian ham. However, for this research, the reference to the Dehesa was also applied to fodder-fed Iberian ham to control whether this claim *per se* influences the purchasing choices of this ham.

[3] Respondents were told that, as usual, the back of the packages included the mandatory information (*i.e.,* manufacturer, place of origin, product description, nutritional information, and so on).

value 1 when the point with coordinates *(x,y)* is included within the limits of the site under analysis and 0 if located elsewhere; $\delta(x_i,y_i)$ is the distance function determined by the difference in the Cartesian coordinates of the site *i* related to household *h*; and X^+, X^-, Y^+, and Y^- are latitudes and longitude defining the region to be analyzed.

This approach is adapted to the case study by using a 1-km grid for the whole Andalusian region (*N*= 88,792 grid units). This grid was intersected with the Andalusian Dehesa cartography to obtain the area of Dehesa contained in each 1-km grid square and the percentage of its area represented by this system.[4] Moreover, we calculated the distance from every household location represented in the sample to the centroid of every 1-km grid square with the Dehesa area as the Euclidean distance.

Equation (1) was then approximated in two ways: first, by substituting *p(x,y)* with the percentage of Dehesa in each grid square, to account for the relative presence of this system throughout the space, and second, by substituting the double integral with the sum of the percentage of Dehesa areas in each grid square, discounted by different functions calculated from the distance between each grid square to each sample location (see below). In Fig. 1 this procedure is depicted graphically.

Using this approach, three different spatial indexes were calculated for each consumer sampled considering his/her place of residence: *Area_Inv*, in which the area is discounted by the inverse of the distance, *Area_In2*, in which the area is discounted by the square of the distance, and *Area_InL*, in which the area is discounted by the natural logarithm of the distance. The expressions used for each index are the following:

$$Area\_Inv = 10 \times \sum_{i=1}^{i=N} \frac{1}{d_i} \times \%Dehesa\_area_i \qquad (2)$$

$$Area\_In2 = 10{,}000 \times \sum_{i=1}^{i=N} \frac{1}{d_i^2} \times \%Dehesa\_area_i \qquad (3)$$

$$Area\_InL = \frac{1}{1{,}000} \times \sum_{i=1}^{i=N} \frac{1}{\log d_i} \times \%Dehesa\_area_i \qquad (4)$$

The indexes are multiplied by a factor of 10, 10,000, and 1/1,000 to scale them up to approximately one unit on average.

To test whether this approach outperforms indexes based only on distance, a simple inverse-of-the-distance index was also included in the analysis, calculated from the distance of each location to the nearest Dehesa plot.

Data gathering and experimental design

The investigation is based on a face-to-face survey administered in Andalusian food retail establishments where packages of acorn-fed and fodder-fed Iberian ham were sold. Interviewees responded to the questionnaire voluntarily and there was no reward for it. The questionnaire was administered to a total of 1,158 respondents aged 18 years old or over who had bought Iberian ham (acorn- or fodder-fed) at least once in the last year.

A quota sampling procedure was used in proportion to residence in acorn-fed Iberian ham producing and non-producing provinces. As the Iberian ham consumer population is unknown, we could only consider the whole adult population in Andalusia. The sampling design ensured that a relevant number of rural and urban municipalities were included in the survey. Interviews were made following random routes across shops and supermarkets selling Iberian ham at different times of the day. The socio-demographic characteristics of the sample, including its spatial distribution (using the *Area_Inv* index), are shown in Table S1 [suppl].

The questionnaire included four blocks, comprising questions relative to: i) the interviewees' habits relating to the consumption of Iberian ham; ii) the DCE; iii) the interviewees' knowledge about the Dehesa system and opinions on the environmental and social values associated with it; and iv) the interviewees' socio-demographic characteristics. In block three, the interviewees were asked to assess their perception about the main ES provided by the Dehesa using a Likert scale, the descriptive parameters of which are shown in Table S2 [suppl].

For the experimental design, valuation results from other surveys were employed to foresee the order of magnitude of the parameters of the consumer utility function. Based on this and following a conservative approach, positive close-to-zero priors for the non-monetary attribute parameters were set, whereas that for the monetary attribute was anticipated to have a negative sign with an order of magnitude two and three times higher for fodder- and acorn-fed alternatives, respectively, compared to the other attributes. An efficient design minimizing the D-error employing Bayesian techniques was used (Rose *et al.,* 2011). The final design included 24 choice sets, containing 4 blocks of 6 sets and presenting a D-error of 0.436. For this purpose, NGene 1.2.1 was used. A pre-test of 40 interviews was implemented to validate the appropriateness of the questionnaire and the experimental design.

[4] For practical reasons, Dehesa outside Andalusia was not included in the spatial analysis given that it is very unlikely that an Andalusian ham consumer lives closer to Dehesa areas outside the region, considering that all of them are located in the same direction where Andalusian Dehesa is prominent (*i.e.,* at the northwest of the region –see Fig. 1) and only a very small proportion of the Andalusian population lives close to Dehesa outside the region. Thus, any potential bias resulting from not considering other Dehesa is negligible.

Econometric approach

We used the mixed logit model (MXL) in preference-space,[5] which improves the standard conditional logit models by accommodating panel data and allowing for flexible substitution patterns to better model preference heterogeneity across individuals (Hensher *et al.,* 2015). MXL has been extensively used to analyze individuals' preferences toward food consumption (Kallas *et al.,* 2019), as well as environmental services (Yao *et al.,* 2014). Model formulation accounts for the utility that individual *i* derives from choosing alternative *j* on purchase occasion (or in choice scenario) *s* (U_{isj}) as follows:

$$U_{isj} = U_{njt} = \beta_i \chi_{isj} + C_{ij} + \varepsilon_{isj} \;, i = 1, \ldots, I;\; s = 1, \ldots, S;\; j = 1, \ldots, J \quad (5)$$

where χ_{isj} is the vector of the attributes and levels, β_i is the vector of coefficients, C_{ij} is a specific component of the alternative and ε is the random error term (assumed to follow a Gumbel distribution). The joint probability of individual *i* choosing alternative *j* in each of the choices *s* is:

$$Pr[y_i \mid \theta, \chi_i] = \int_{\beta} \prod_{s=1}^{S} \frac{\exp(\beta_i \chi_{isj} + C_{ji})}{\sum_{j=1}^{J} \exp(\beta_i \chi_{isJ} + C_{ji})} f(\beta|\theta)\, d\beta \quad (6)$$

where y_i is the sequence of choices of individual *i*. This integral requires an iterative process as it has no closed-form solution (Train, 2009). Estimation results described below were produced using 1000 Halton draws to simulate the likelihood functions to be maximized (Train, 2009). All attribute parameters were assumed to be normally distributed.

The modeling procedure was carried out as follows. First, an MXL model considering only the DCE attributes (*i.e., Base Model* without any interaction) was run. Second, MXL models exploring heterogeneity in the mean were run, including interactions of all the non-monetary attribute parameters related to the agroecosystem (the "Produced in the Dehesa" claim, the three levels of the Pictorial representation of Dehesa attribute, and the alternative specific constants, ASCs) with the different spatial indexes considered. To test for differences in goodness-of-fit of models with different spatial indexes, the Vuong's (1989) test for non-nested specifications was used. The spatial index with the best performance, as indicated by this test, was then selected for the subsequent analysis, and for the sake of parsimony only statistically significant interactions were kept in the model. This was done following a sequential procedure, each time eliminating the interaction with the lowest level of significance. The resulting model was termed the *Spatial Model*. With this model, spatial discounting effects can be evidenced, though we cannot separate to what extent they relate to the consumers' preferences toward conserving the bundle of the ES provided in the agroecosystem of origin. Thus, to test for this hypothesis and check whether spatial discounting is determined by the intensity of these preferences, consumers' perceptions about the provision of ES in the agroecosystem of origin were incorporated into the Spatial Model.[6] This was done by using the variable *PerceivedES*, which incorporates the consumers' average perception about the ES provided by the Dehesa system (those related to biodiversity, forest fires prevention, animal welfare, soil conservation, landscape aesthetics, cultural heritage, as well as provisioning services linked to rural vitality).[7] The descriptive statistics of the variable *PerceivedES* are shown in Table S2 [suppl], along with those of the variables related to the individual ES comprising the former variable. The resulting model was termed the *ES-Spatial Model*, and included the interactions between attributes and the spatial index or the variable *PerceivedES*, and double interactions between attributes and the latter two variables. In any case, the final model reported here only includes the significant interactions. This parsimonious model was built following the same sequential procedure proposed for the Spatial Model.

Finally, to compare the goodness-of-fit of the three models built (Base Model, Spatial Model, and ES-Spatial Model), likelihood-ratio tests were used.

Results

The performance of spatial indexes

To check that spatial discounting significantly influences the consumers' WTP for the Iberian ham, the performance of the traditional distance-decay approach (*Dist_Inv*) and the other spatial indexes proposed (*Area_Inv*,

[5] Other econometric specifications were explored (including MXL in WTP-space and generalized MXL), but they either did not converge or did not provide good solutions in terms of goodness-of-fit and interpretation. These results are available on request.

[6] As noted by an anonymous reviewer, consumers' preferences for the attributes related to the Dehesa agroecosystem could also be related to quality cues such as organoleptic characteristics of the products, as the Iberian ham product with the highest organoleptic quality comes from this agroecosystem. However, no theoretical motivation supports the existence of spatial discount related to these cues, as the consumer can enjoy the underlying sensory properties regardless of her/his location with respect to the production place. As a result, the presence of spatial discount in these attributes must be related to other extrinsic attributes related to the production system, including those mentioned above (*i.e.,* territorial identity, local preference, sociocultural and environmental services related to the agroecosystem of origin, among others). By incorporating into the model consumers' perceptions about the provision of ES in the agroecosystem of origin, we claim to control the extent to which the extrinsic attributes related to such ES determine spatial discounting patterns.

[7] The correlation between the spatial index and the *PerceivedES* variable has been tested using the Pearson correlation coefficient, showing a very weak correlation value of 0.167.

Table 2. Goodness-of-fit statistics and likelihood ratio tests for nested models.

	Pseudo-R^2	AIC/N	Spatial Models *vs.* Base Model	
			LLR statistic	Critical χ2 (DF)
Base Model	0.323	1.498		
Spatial Model-Dist_Inv	0.324	1.498	21.07 *	18.31 (10)
Spatial Model-Area_Inv	0.325	1.497	30.07 ***	18.31 (10)
Spatial Model-Area_In2	0.324	1.498	22.80 *	18.31 (10)
Spatial Model-Area_InL	0.325	1.496	38.24 ***	18.31 (10)

AIC/N: Akaike information criterion divided by the number of observations. LLR: log-likelihood ratio. DF: degrees of freedom. *, **, and *** denote significance at 5%, 1%, and 0.1% levels, respectively.

Area_In2, and *Area_InL*) were assessed. For this purpose, model fit results of the Base Model *(i.e.,* not including any distance or spatial index) were compared with those from the different Spatial Models (*i.e.,* including interactions of Dehesa-related attributes and ASC for both acorn- and fodder fed alternatives with the spatial index considered).[8] Table 2 shows the results of these comparisons, in particular including log-likelihood ratio (LLR) tests. The results suggest that model fit can be significantly improved (at least at the 5% level) by incorporating spatial indexes, whether the one solely based on distance or those based on area.

Vuong's tests for non-nested specifications were carried out to test for significant differences in model fit between Spatial Models. The results are shown in Table 3, indicating that those that include interactions with the *Area_Inv* and *Area_InL* indexes significantly outperform those using *Dist_Inv and Area_In2*, with no significant differences between the latter two models.

Results from the Vuong's tests justified focusing on Spatial Model-*Area_Inv* and Spatial Model-*Area_InL*. However, the model using the *Area_InL* yielded results that are more difficult to interpret, which led us to conduct the subsequent analysis of the effects of spatial discounting on WTP estimates using only on the model based on the *Area_Inv* index. Moreover, it is worth pointing out that, to facilitate the explanation of the modeling results, a parsimonious version (including only the statistically significant interactions with the spatial index) of this model is shown. We refer to it hereafter as the Spatial Model.

Spatial discounting effects on consumers' preferences for Iberian ham

Table 4 shows the results of both the Base and the Spatial Models. Both of them are highly significant, with the latter yielding similar results in terms of significant attribute-level parameters but clearly outperforming the former (LLR test significant at a 0.1% level) due to the inclusion of significant interactions with the spatial index. Focusing on the Spatial Model*,* all parameters were highly significant, shown by either the significant main or interaction terms, except those related to Background-Dehesa system with pigs for both types of Iberian ham, Background-Dehesa system for acorn-fed ham, and Background-Agricultural system for fodder-fed. *ASC-a* and *ASC-f* (*i.e.,* the ASCs for the acorn- and fodder-fed alternatives) were significant and positive, indicating a systematic preference for the Iberian ham options over the no-purchase option due to unobserved characteristics. All the significant attributes had the expected sign, that is, positive for the non-monetary attributes and negative

Table 3. Results of the Vuong's test for non-nested models.

	Dist_Inv	Area_Inv	Area_In2	Area_InL
Dist_Inv	---			
Area_Inv	-2.310*	---		
Area_In2	-0.594	3.805 ***	---	
Area_InL	-2.618 **	-0.790	-2.382 **	---

*, **, and *** denote significance at 5%, 1%, and 0.1% levels, respectively. A positive (negative) sign means that the model in the column (row) outperforms the model in the row (column).

[8] The results from all these Spatial Models considering distance-decay and the various spatial indexes proposed are available from the authors on request.

Table 4. Results of the Base and Spatial Models.

	Base Model				Spatial Model			
	Mean		SD		Mean		SD	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Acorn-fed Iberian ham								
ASC-a	5.719 ***	0.423	4.437***	0.292	5.947***	0.441	4.700***	0.300
Breed purity-75% Iberian	0.449 **	0.167	0.281***	0.623	0.379*	0.178	1.436***	0.334
Breed purity-100% Iberian	0.471 **	0.165	0.700***	0.532	0.552**	0.175	1.207**	0.387
Hand-sliced claim	0.921 ***	0.161	2.940	0.232	0.947***	0.172	2.776***	0.234
"Produced in the Dehesa" claim	0.275 *	0.137	0.308	0.327	-0.386	0.298	0.924**	0.331
Background-Agricultural system	0.514 *	0.205	1.979	0.304	0.526*	0.205	1.334***	0.354
Background-Dehesa system	0.212	0.249	0.600	0.391	0.174	0.264	1.370***	0.329
Background-Dehesa system with pigs	0.144	0.199	0.649	0.521	0.173	0.199	0.325	0.485
Price	-0.287***	0.023	0.168***	0.017	-0.297***	0.025	0.173***	0.017
Fodder-fed Iberian ham								
ASC-f	1.247***	0.243	3.469***	0.228	1.308***	0.249	3.377***	0.236
Breed purity-75% Iberian	0.269	0.152	0.141	0.565	0.333*	0.160	0.160	0.356
Breed purity-100% Iberian	0.541***	0.153	1.335***	0.233	0.630***	0.157	1.127***	0.269
Hand-sliced claim	0.648***	0.136	1.565***	0.257	0.637***	0.140	1.724***	0.234
"Produced in the Dehesa" claim	-0.070	0.109	0.054	0.292	-0.742**	0.242	0.452	0.274
Background-Agricultural system	0.177	0.198	1.131**	0.375	0.089	0.201	0.823*	0.387
Background-Dehesa system	0.188	0.174	0.461	0.338	0.807*	0.344	0.784*	0.363
Background-Dehesa system with pigs	0.123	0.164	0.287	0.292	0.065	0.167	0.012	0.338
Price	-0.105***	0.021	0.259***	0.023	-0.109***	0.022	0.284***	0.027
Heterogeneity in the mean								
"Produced in the Dehesa" (acorn-fed) × Area_Inv					0.451*	0.178		
"Produced in the Dehesa" (fodder-fed) × Area_Inv					0.468**	0.147		
Background-Dehesa system (fodder-fed) × Area_Inv					-0.399*	0.199		
Model fit statistics								
Log-likelihood (LL)	-5169.17				-5153.79			
Pseudo R^2	0.323				0.325			
AIC/N	1.498				1.495			
Observations (individuals)	6948 (1158)				6948 (1158)			
LL Ratio Test (DF) Spatial Model vs. Base Model	30.76*** (3)							

SD: standard deviation. Coef: coefficient. SE: standard error. ASC-a: alternative specific constant for acorn-fed ham. ASC-f: alternative specific constant for fodder-fed ham. AIC/N: Akaike information criterion divided by the number of observations. DF: degrees of freedom. *, **, and *** denote significance at 5%, 1%, and 0.1% levels, respectively.

for the price, except the attribute "Produced in the Dehesa" claim for fodder-fed Iberian ham, which showed a negative sign. The latter finding suggests that the claim that fodder-fed Iberian hams (which usually come from intensive livestock management) are produced in the Dehesa system (which is related to extensive and high nature value farming) generally results in disutility for the consumers. In any case, this disutility was affected by spatial discounting effects, as explained below. Additionally, out of the 18 model parameters (incl. ASCs), 14 showed significant standard deviations, indicating a high level of preference heterogeneity.

The interactions of the attribute "Produced in the Dehesa" claim with the spatial index were statistically significant and positive for both the fodder-fed and acorn-fed Iberian ham. These interactions genuinely reflect spatial discounting effects, showing that the greater the area of the Dehesa system in the surroundings of the individual's place of residence, the higher the utility attached to the interacting parameter. It is worth noting that, whereas the mean attribute

Table 5. Results of the ES-Spatial Model.

	Mean		SD	
	Coefficient	**SE**	**Coefficient**	**SE**
Acorn-fed Iberian ham				
ASC-a	4.158***	0.614	4.352***	0.288
Breed purity-75% Iberian	0.423*	0.177	1.500***	0.366
Breed purity-100% Iberian	0.533**	0.170	0.726	0.411
Hand-sliced claim	1.031***	0.169	2.904***	0.234
"Produced in the Dehesa" claim	-0.393	0.303	0.902**	0.298
Background-Agricultural system	0.581**	0.204	1.357***	0.321
Background-Dehesa system	0.114	0.256	0.604	0.443
Background-Dehesa system with pigs	0.139	0.197	0.570	0.450
Price	-0.299***	0.023	0.165***	0.015
Fodder-fed Iberian ham				
ASC-f	1.515***	0.274	3.518***	0.239
Breed purity-75% Iberian	0.290	0.159	0.340	0.376
Breed purity-100% Iberian	0.619***	0.159	1.285***	0.238
Hand-sliced claim	0.662***	0.140	1.729***	0.258
"Produced in the Dehesa" claim	-0.802**	0.245	0.253	0.314
Background-Agricultural system	0.102	0.205	1.121***	0.330
Background-Dehesa system	0.191	0.185	0.911**	0.300
Background-Dehesa system with pigs	0.119	0.165	0.188	0.308
Price	-0.109***	0.022	0.274***	0.024
Heterogeneity in the mean				
ASC-a × Area_Inv	1.418***	0.338		
ASC-a × *PerceivedES*	2.592***	0.728		
ASC-a × *PerceivedES* × Area_Inv	-2.015***	0.461		
ASC-f × *PerceivedES* × Area_Inv	-0.364*	0.157		
"Produced in the Dehesa" (acorn-fed) × Area_Inv	0.474**	0.183		
"Produced in the Dehesa" (fodder-fed) × Area_Inv	0.526***	0.150		
Model fit statistics				
Log-likelihood (LL)	-5139.99			
Pseudo R^2	0.327			
AIC/N	1.492			
Observations (individuals)	6948 (1158)			
LL Ratio Test (DF) ES-Spatial Model vs. Spatial Model	27.60*** (3)			

ASC-a: alternative specific constant for acorn-fed ham. ASC-f: alternative specific constant for fodder-fed ham. AIC/N: Akaike information criterion divided by the number of observations. DF: degrees of freedom. SD: standard deviation. SE: standard error *, **, and *** denote significance at 5%, 1%, and 0.1% level, respectively.

was significant and negative for fodder-fed ham, the utility attached to this attribute was generally positive as a result of the positive interaction with the spatial index, especially for those individuals who live surrounded by the Dehesa areas. Conversely, those who live far away from the Dehesa showed disutility for this attribute. The standard deviation of this attribute's mean parameter was not significant for the fodder-fed ham, which indicates that the interaction with the spatial index largely captures the preference heterogeneity associated with this attribute. Conversely, it was significant for the acorn-fed ham, thus suggesting that there was still heterogeneity not captured by this interaction.

The Background-Dehesa system interaction for the fodder-fed ham was significant and negative, while the mean parameter was positive. As a result, the opposite effect to that found for the "Produced in the Dehesa" claim arises, whereby those who live in locations closer to Dehesa areas presented disutility for the inclusion of such pictures on the package. The value of this interaction was of the same order of magnitude as that of the "Produced in the Dehesa" claim but of the opposite sign, and the sum of both interactions was tested (using Wald test) to be not significantly different from zero. Therefore, there was no overall spatial effect in the fodder-fed ham when both attributes related to the Dehesa system were present in the package.

The role of the consumers' perceptions about the ES provided by the Dehesa system

To examine whether the spatial discounting effect evidenced above is related to consumers' perception about the provision of ES in the agroecosystem of origin, the heterogeneity was further explored by incorporating this information into the Spatial Model. Table 5 shows the results of the resulting ES-Spatial Model, which includes single interactions with the *Area_Inv* index and *PerceivedES* and double interactions with both variables.

As can be seen, the ES-Spatial Model outperforms the Spatial Model (LLR test significant at 0.01%), presenting higher values for the model fit statistics. The model shows similar results to the Spatial Model with regard to the mean parameters and standard deviations, along with the single interactions between the *Area_Inv* index and the "Produced in the Dehesa". The fact that no significant interaction with *PerceivedES* or *PerceivedES* × *Area_Inv* was found indicates that this effect applies to all consumers regardless of their perception about the ES provided by the Dehesa system. Additionally, unlike with the Spatial Model, the interaction between *Area_Inv* index and the Background-Dehesa system attribute did not turn out to be significant, most likely due to the new interactions incorporated into the model.[9]

The main differences compared to the Spatial Model were found with regard to the interaction with both the *ASC-a* and the *ASC-f*. The *ASC-a* significantly interacts with the three co-variables included in the model, which are the *Area_Inv* index, the *PerceivedES*, and the interaction between the two (*PerceivedES* × *Area_Inv*). Concerning the interactions with *Area_Inv* and *PerceivedES* × *Area_Inv*, they showed opposite values: positive for the former and negative for the latter, with the net effect being not significantly different from zero (*i.e.,* the interactions offset one another, as shown by the Wald test). These results indicate the presence of a spatial discounting effect for the acorn-fed Iberian ham that only affects consumers who do not perceive the ES provided by the Dehesa (who are only affected by the *ASC-a* × *Area_Inv* interaction). This means that consumers who do not perceive the ES provided by the Dehesa and who live surrounded by Dehesa areas reported a higher utility from purchasing this product in comparison with those who live far away from the system. In contrast, for consumers perceiving these ES, who are affected by both interactions, no discounting effect was found. However, the interaction *ASC-a* × *PerceivedES* yielded a positive value, indicating that those consumers that perceived the Dehesa as an agroecosystem with high levels of ES provision showed a higher preference for purchasing acorn-fed Iberian ham (*i.e.,* the ham type produced in such an agroecosystem), regardless of their place of residence.

In addition, the *ASC-f* showed a significant and negative interaction with *PerceivedES* × *Area_Inv*, indicating the existence of a negative discounting effect among consumers who perceived the ES provided by the Dehesa. Thus, consumers who lived surrounded by this agroecosystem showed a lower preference for purchasing fodder-fed Iberian ham than those who lived far from it. These results are consistent with the fact that the fodder-fed Iberian ham is only loosely related to the Dehesa system.

Impact of spatial discounting and ES perception on willingness to pay estimates

Using the results of the ES-Spatial Model, we could estimate the WTP for different Iberian ham products and different consumer profiles (CPs) defined according to their proximity to the Dehesa system and perception of the ES provided by this agroecosystem. Table 6 shows the estimates for four selected profiles, resulting from the combination of perception or not of the ES of the Dehesa system and two different locations: Pozoblanco (Cordoba province), a town surrounded by Dehesa areas, and Motril (Granada province), located far away from Dehesa areas (see locations L1 and L2, respectively, in Fig. 1). Moreover, four different Iberian ham products were considered, including different attributes significantly influenced by spatial discounting and ES-perception effects. They were fodder-fed 50% Iberian breed ham; fodder-fed 50% Iberian breed ham with "Produced in the Dehesa" claim; acorn-fed 100% Iberian ham; and acorn-fed 100% Iberian ham with "Produced in the Dehesa" claim. All products considered were not hand-sliced and included no background picture.

All the estimated WTP values were significantly different from zero, except for the fodder-fed 50% Iberian breed

[9] Concretely, the appearance of a significant interaction between the *ASC-f* with *PerceivedES* × *Area_Inv* in this model would explain that the Background-Dehesa system, which was significant in the Spatial Model, ceases to be significant in the ES-Spatial Model.

Table 6. Total willingness to pay (WTP) for different Iberian ham products (in € / 100-g-package of Iberian ham).

Consumer profile		Acorn-fed 100% Iberian Ham	Acorn-fed 100% Iberian Ham "Produced in the Dehesa" claim	Fodder-fed 50% Iberian breed Ham	Fodder-fed 50% Iberian breed Ham "Produced in the Dehesa" claim
		Mean (Conf. Int. 95%)	Mean (Conf. Int. 95%)	Mean (Conf. Int. 95%)	Mean (Conf. Int. 95%)
Perceiving the ES	Close to dehesa	24.39***	28.59***	5.00	10.46**
		(21.06-27.84)	(23.92-33.37)	(-0.91-10.70)	(4.62-17.03)
	Far from dehesa	24.39***	25.62***	11.52***	7.68**
		(21.06-27.84)	(22.06-29.23)	(8.10-15.70)	(4.11-11.45)
Non-perceiving the ES	Close to dehesa	28.15***	32.34***	14.20***	19.66***
		(24.94-31.49)	(28.36-36.61)	(10.09-19.41)	(13.93-27.24)
	Far from dehesa	19.32***	19.21***	14.20***	10.36***
		(17.37-21.28)	(17.19-21.28)	(10.09-19.41)	(6.49-14.84)
Differences in WTP					
Close to dehesa *vs.* Far Perceiving ES		0.00	2.97**	-6.52	2.78
Close to dehesa *vs.* Far Non-perceiving ES		8.83***	13.13***	0.00	9.30***
Perceiving *vs.* Non-perceiving ES Close to dehesa		-3.76	-3.75	-9.20	-9.20
Perceiving *vs.* Non-perceiving ES Far from dehesa		5.07**	6.41**	-2.68	-2.68

Conf. Int. 95%: 95% confidence interval. ***, **, * denote significance at 0.1%, 1%, and 5% levels, respectively. All product profiles include non-hand-sliced ham. Estimations were obtained using the Krinsky & Robb's method (1986) (5000 random draws). The Poe *et al.*'s (2005) test based on full convolution was used to check for differences between WTP distributions.

ham for consumers who perceived the ES of the Dehesa and live close to the system, indicating that those consumers might not be willing to purchase this product.

For acorn-fed 100% Iberian ham, the results showed diverse effects of spatial discounting on WTP estimates depending on whether or not the consumers perceived the ES of the Dehesa. Specifically, consumers who perceived the ES provided by this agroecosystem showed no significant difference in WTP values, regardless of their location (comparison between CP1 and CP2). In addition, the inclusion of the "Produced in the Dehesa" claim only increased the WTP for those who live close to it. On the contrary, spatial discounting was evident in the WTP values of consumers who did not perceive the ES of the Dehesa (*i.e.,* CP3 and CP4), showing significant differences among consumers living close and far away from it (*i.e.,* CP2 and CP4). As a result, consumers who live close to the Dehesa were willing to pay €8.83/100-g more for a package of acorn-fed 100% Iberian ham than those living far from it, and this difference increased to €11.80/100-g when the "Produced in the Dehesa" claim was included on the package.

No significant difference in the WTP values for acorn-fed Iberian ham was found among consumers who live close to this agroecosystem, regardless of their perception of the ES provided by the Dehesa (CP1 vs. CP3), while consumers living far from it showed significantly higher WTP when they perceive such ES (CP2 vs. CP4). Consequently, it can be inferred that consumers who perceive the Dehesa system as a provider of ES show similar WTP for acorn-fed Iberian ham, regardless of where they live. Likewise, consumers living close to the Dehesa show similar WTP, regardless of their perception of such ES.

Finally, for the fodder-fed 50% Iberian breed ham, no spatial discounting was found among the different consumer profiles, or among different profiles regarding ES perception. The only exception was the introduction of the "Produced in the Dehesa" claim, which significantly increased the WTP of consumers living close to the Dehesa when they did not perceive the ES it provides.

Discussion

The results obtained in this paper point to the existence of spatial discounting in the purchase of food products linked to the agroecosystem in which they are produced. In previous literature, limited evidence of such effects was found, by showing the influence of political boundaries (Lim & Hu, 2016; Farris *et al.,* 2019), local labels (Ay *et al.,* 2017), or, as best, discrete distance intervals between production and consumption (de-Magistris & Gracia, 2016) on consumers' WTP for food products. Our study goes beyond these studies by including direct estimations of spatial discounting associated with the combination of distance to and area of scattered producing systems in consumers' WTP. Said effect has previously been demonstrated in environmental valuation (see Schaafsma, 2015, for a literature review), although there is a paucity of studies providing evidence for scattered ecosystems (Czajkowski *et al.,* 2017; Holland & Johnston, 2017). Of those that do, only one is focused on agroecosystems (Granado-Díaz *et al.,* 2020). Therefore, to the authors' knowledge, this is the first study to prove this effect in a valuation context focusing on marketed food products. In this regard, it is worth noting that our results mirror those of Granado-Díaz *et al.* (2020) in that area-based indexes are found to outperform simple distance-based indexes, better accounting for spatial discounting in scattered agroecosystems.

In particular, spatial discounting is evidenced by significant interaction terms of the spatial index with attributes related to the agroecosystem of origin, specifically written prompts referring to the Dehesa (*i.e.,* the "Produced in the Dehesa" claim). This claim is associated with significant effects of spatial discounting for both acorn- and fodder-fed Iberian ham. Taking into account that the latter product was only loosely related to the Dehesa, we interpret this finding as reflecting consumers' cultural identity linked to the agroecosystem and their willingness to support the local economy and communities, in keeping with previous literature on local food products (see Feldmann & Hamm, 2015, for a review). Consequently, consumers living surrounded by Dehesa areas would be willing to pay more for food products that claim to be produced there.

The results also suggest that spatial discounting is affected by consumers' perception of the ES provided by the producer agroecosystem. We found that consumers who actually perceive that the Dehesa provides such ES are willing to pay more for food products directly coming from it (in our case acorn-fed Iberian ham from the Dehesa) independently of their location with respect to the agroecosystem; as such, they do not exhibit spatial discounting. Previous literature regarding environmental valuation suggests that the lack of spatial discounting could be related to the existence of non-use values attached to these environmental sites (*e.g.,* Bateman *et al.,* 2006; Granado-Díaz *et al.,* 2020). Our results suggest that a similar pattern may arise with food products linked to agroecosystems with high levels of ES provision, as is the case of the Dehesa system. Therefore, consumers who perceive these ES might be taking into account non-use values—which are enjoyed regardless of their place of residence with respect to the Dehesa—incorporating them into the product value. On the contrary, a different spatial discounting pattern was found for consumers who did not perceive these ES, as our results indicated that their preferences revealed the effects of spatial discounting. As little or no relation with the provision of ES could be identified for these consumers, the existence of this effect could simply be related to "sense of place" or "spatial identity", as suggested by Hanley *et al.* (2003). In addition, consumers perceiving the ES of the Dehesa presented a negative spatial discount for fodder-fed ham, which could be linked to greater knowledge of the different Iberian ham products and their actual relationship with this agroecosystem. This result shows a more accurate spatial discounting effect as compared to that in Villanueva *et al.* (2021), who, using the same survey data, found a significant negative relationship between WTP for using pictures of Dehesa as background of fodder-fed Iberian ham packages and living in a Dehesa municipality and/or province where Dehesa landscape is prominent. In any case, we consider that further research is needed to shed light on how consumers' perception of the ES provided by the producing system shapes spatial discounting, especially by identifying use and non-use values attached to these services. Moreover, the role of the consumer's identity on this effect should clearly be acknowledged.

All the above-mentioned findings support most of the assumptions of the theoretical model developed by Yamaguchi & Shah (2020) to explain the spatial discounting of ES. In particular, our results evidence that spatial discount rate for ES is heterogeneous among individuals, showing it depends on key parameters identified in such a theoretical model, such as pure rate of spatial preference (*i.e., the Area_Inv* index), consumption change (*i.e.,* quality cues variables: Iberian breed purity, Slicing type, Dehesa origin claim, and Pictorial representation of Dehesa), and perceived ES (*i.e., PerceivedES* variable).

Relevant insights can be gained from the results, especially concerning marketing strategies. For instance, the results suggest that information campaigns aimed at increasing consumers' awareness of the ES provided by the agroecosystem in question would result in higher WTP for the food products coming from it (Pirard & Lapeyre, 2014). In turn, this would help to incentivize farmers' ES provision as consumers would become more sensitive to differentiation strategies relying on commodification (as highlighted by Salazar-Ordóñez *et al.,* 2021). For the specific case of Iberian ham coming from the Dehesa system, this would imply that marketing and information campaigns should focus on informing consumers of the different services provided by the Dehesa system, its intimate relationship with acorn-fed Iberian ham production and, therefore, the role of this production in sustaining a high natural value system. In addition, the positive results encountered for written prompts referring to the Dehesa system hint at the potential benefits of developing a specific label related to this agroecosystem. In this sense, the Iberian ham sector (especially the acorn-fed producers) would greatly benefit from combining such informational cues with forthcoming quality certifications informing of environmental performance (*e.g.,* eco-score), once these certifications are fully implemented. Given the importance of the sociocultural services provided by this agroecosystem, as for many other traditional food production systems, the inclusion of the sociocultural performance into the calculation of such a score would be recommended.

Authors' contributions

Conceptualization: R. Granado-Díaz, A.J. Villanueva, J.A. Gómez-Limón
Data curation: R. Granado-Díaz
Formal analysis: R. Granado-Díaz
Funding acquisition: R. Granado-Díaz
Investigation: R. Granado-Díaz, A.J. Villanueva, J.A. Gómez-Limón
Methodology: R. Granado-Díaz, A.J. Villanueva, J.A. Gómez-Limón
Project administration: R. Granado-Díaz, A.J. Villanueva
Supervision: J.A. Gómez-Limón
Writing – original draft: R. Granado-Díaz, A.J. Villanueva, J.A. Gómez-Limón
Writing – review & editing: R. Granado-Díaz, A.J. Villanueva, J.A. Gómez-Limón

References

Aboah J, Lees N, 2020. Consumers use of quality cues for meat purchase: Research trends and future pathways. Meat Sci 166: 108142. https://doi.org/10.1016/j.meatsci.2020.108142

Ay JS, Chakir R, Marette S, 2017. Distance decay in the willingness to pay for wine: disentangling local and organic attributes. Environ Resour Econ 68: 997-1019. https://doi.org/10.1007/s10640-016-0057-8

Bateman IJ, Day BH, Georgiou S, Lake I, 2006. The aggregation of environmental benefit values: welfare measures, distance decay and total WTP. Ecol Econ 60: 450-460. https://doi.org/10.1016/j.ecolecon.2006.04.003

Bernabéu R, Rabadán A, El Orche NE, Díaz M, 2018. Influence of quality labels on the formation of preferences of lamb meat consumers. A Spanish case study. Meat Sci 135: 129-133. https://doi.org/10.1016/j.meatsci.2017.09.008

BOE, 2014. Real Decreto 4/2014, de 10 de enero, por el que se aprueba la norma de calidad para la carne, el jamón, la paleta y la caña de lomo ibérico. Boletín Oficial del Estado, Madrid.

Borrello M, Cecchini L, Vecchio R, Caracciolo F, Cembalo L, Torquati B, 2022. Agricultural landscape certification as a market-driven tool to reward the provisioning of cultural ecosystem services. Ecol Econ 193: 107286. https://doi.org/10.1016/j.ecolecon.2021.107286

Bowen S, Mutersbaugh T, 2013. Local or localized? Exploring the contributions of Franco-Mediterranean agrifood theory to alternative food research. Agric Human Values 31: 201-213. https://doi.org/10.1007/s10460-013-9461-7

Brinkley C, 2017. Visualizing the social and geographical embeddedness of local food systems. J Rural Stud 54: 314-325. https://doi.org/10.1016/j.jrurstud.2017.06.023

Campos P, Oviedo JL, Álvarez A, Mesa B, Caparrós A, 2019. The role of non-commercial intermediate services in the valuations of ecosystem services: Application to cork oak farms in Andalusia, Spain. Ecosyst Serv 39: 100996. https://doi.org/10.1016/j.ecoser.2019.100996

Czajkowski M, Budziński W, Campbell D, Giergiczny M, Hanley N, 2017. Spatial heterogeneity of willingness to pay for forest management. Environ Resour Econ 68: 705-727. https://doi.org/10.1007/s10640-016-0044-0

de-Magistris T, Gracia A, 2016. Consumers' willingness-to-pay for sustainable food products: The case of organically and locally grown almonds in Spain. J Clean Prod 118: 97-104. https://doi.org/10.1016/j.jclepro.2016.01.050

De Valck J, Broekx S, Liekens I, Aertsens J, Vranken L, 2017. Testing the influence of substitute sites in nature valuation by using spatial discounting factors. Environ Resour Econ 66: 17-43. https://doi.org/10.1007/s10640-015-9930-0

Díaz-Caro C, García-Torres S, Elghannam A, Tejerina D, Mesias FJ, Ortiz A, 2019. Is production system a relevant attribute in consumers' food preferences? The case of Iberian dry-cured ham in Spain. Meat Sci 158: 107908. https://doi.org/10.1016/j.meatsci.2019.107908

Espejel J, Fandos C, Flavián C, 2007. The role of intrinsic and extrinsic quality attributes on consumer behaviour for traditional food products. Manag Serv Qual 17: 681-701. https://doi.org/10.1108/09604520710835000

Farris J, Malone T, Robison LJ, Rothwell NL, 2019. Is "localness" about distance or relationships? Evidence from hard cider. J Wine Econ 14: 252-273. https://doi.org/10.1017/jwe.2019.42

Feldmann C, Hamm U, 2015. Consumers' perceptions and preferences for local food: A review. Food Qual Prefer 40: 152-164. https://doi.org/10.1016/j.foodqual.2014.09.014

García-Gudiño J, Blanco-Penedo I, Gispert M, Brun A, Perea J, Font-i-Furnols M, 2021. Understanding consumers' perceptions towards Iberian pig production and animal welfare. Meat Sci 172: 108317. https://doi.org/10.1016/j.meatsci.2020.108317

Garrido P, Elbakidze M, Angelstam P, Plieninger T, Pulido F, Moreno G, 2017. Stakeholder perspectives of wood-pasture ecosystem services: A case study from Iberian dehesas. Land Use Policy 60: 324-333. https://doi.org/10.1016/j.landusepol.2016.10.022

Glenk K, Johnston RJ, Meyerhoff J, Sagebiel J, 2020. Spatial dimensions of stated preference valuation in en-

vironmental and resource economics: methods, trends and challenges. Environ Resour Econ 75: 215-242. https://doi.org/10.1007/s10640-018-00311-w
Gracia A, de-Magistris T, 2013. Preferences for lamb meat: A choice experiment for Spanish consumers. Meat Sci 95: 396-402. https://doi.org/10.1016/j.meatsci.2013.05.006
Gracia A, de Magistris T, Nayga Jr. RM, 2012. Importance of social influence in consumers' willingness to pay for local food: Are there gender differences? Agribusiness 28: 361-371. https://doi.org/10.1002/agr.21297
Gracia A, Barreiro-Hurlé J, López-Galán B, 2014. Are local and organic claims complements or substitutes? A consumer preferences study for eggs. J Agric Econ 65: 49-67. https://doi.org/10.1111/1477-9552.12036
Granado-Díaz R, Gómez-Limón JA, Rodríguez-Entrena M, Villanueva AJ, 2020. Spatial analysis of demand for sparsely located ecosystem services using alternative index approaches. Eur Rev Agric Econ 47: 752-784. https://doi.org/10.1093/erae/jbz036
Granado-Díaz R, Villanueva AJ, Rodríguez-Entrena M, Salazar-Ordoñez M, Estévez M, Sanz A, Manrique T, 2021. ¿Existe un patrón de preferencias del consumidor diferente según el tipo de jamón ibérico? Inf Tec Econ Agrar 117: 557-579. https://doi.org/10.12706/itea.2021.002
Hanley N, Schläpfer F, Spurgeon J, 2003. Aggregating the benefits of environmental improvements: distance-decay functions for use and non-use values. J Environ Manage 68: 297-304. https://doi.org/10.1016/S0301-4797(03)00084-7
Hensher D, Hanley A, Rose JM, Greene WH, 2015. Applied Choice Analysis, 2nd ed. Cambridge Univ Press, UK. https://doi.org/10.1017/CBO9781316136232
Herrmann R, Teuber R, 2011. Geographically differentiated products. In: The Oxford Handbook of the Economics of Food Consumption and Policy; Lusk JL, Roosen J, Shogren JF (eds.). pp: 1-37. Oxford Univ Press, UK. https://doi.org/10.1093/oxfordhb/9780199569441.013.0034
Hersleth M, Næs T, Rødbotten M, Lind V, Monteleone E, 2012. Lamb meat - Importance of origin and grazing system for Italian and Norwegian consumers. Meat Sci 90: 899-907. https://doi.org/10.1016/j.meatsci.2011.11.030
Holland BM, Johnston RJ, 2017. Optimized quantity-within-distance models of spatial welfare heterogeneity. J Environ Econ Manage 85: 110-129. https://doi.org/10.1016/j.jeem.2017.04.006
Iaccarino T, Di Monaco R, Mincione A, Cavella S, Masi P, 2006. Influence of information on origin and technology on the consumer response: The case of soppressata salami. Food Qual Prefer 17: 76-84. https://doi.org/10.1016/j.foodqual.2005.08.005
Kallas Z, Varela E, Čandek-Potokar M, Pugliese C, Cerjak M, Tomažin U *et al.*, 2019. Can innovations in traditional pork products help thriving EU untapped pig breeds? A non-hypothetical discrete choice experiment with hedonic evaluation. Meat Sci 154: 75-85. https://doi.org/10.1016/j.meatsci.2019.04.011
Krinsky I, Robb AL, 1986. On approximating the statistical properties of elasticities. Rev Econ Statist 68: 715-719. https://doi.org/10.2307/1924536
Lancaster KJ, 1966. A new approach to consumer theory. J Polit Econ 74: 132-157. https://doi.org/10.1086/259131
Lim KH, Hu W, 2016. How local is local? A reflection on Canadian local food labeling policy from consumer preference. Can J Agric Econ 64: 71-88. https://doi.org/10.1111/cjag.12062
López-Mosquera N, Sánchez M, 2011. The influence of personal values in the economic-use valuation of peri-urban green spaces: An application of the means-end chain theory. Tour Manag 32: 875-889. https://doi.org/10.1016/j.tourman.2010.08.003
Lusk JL, Tonsor GT, 2016. How meat demand elasticities vary with price, income, and product category. Appl Econ Perspect Policy 38: 673-711. https://doi.org/10.1093/aepp/ppv050
Madureira L, Santos JL, Ferreira A, Guimarães H, 2013. Feasibility study on the valuation of public goods and externalities in EU Agriculture. Publications Office of the European Union, Luxembourg.
McFadden DL, 1974. Conditional logit analysis of qualitative choice behaviour. In: Frontiers in Econometrics; Zarembka P (ed.). pp: 105-142. Acad Press, NY.
Menapace L, Raffaelli R, 2016. Preferences for locally grown products: evidence from a natural field experiment. Eur Rev Agric Econ 44: 255-284. https://doi.org/10.1093/erae/jbw017
Mesías FJ, Gaspar P, Pulido ÁF, Escribano M, Pulido F, 2009. Consumers' preferences for Iberian dry-cured ham and the influence of mast feeding: An application of conjoint analysis in Spain. Meat Sci 83: 684-690. https://doi.org/10.1016/j.meatsci.2009.08.004
Mesías FJ, Pulido F, Escribano M, Gaspar P, Pulido ÁF, Escribano A, Rodríguez-Ledesma A, 2013. Evaluation of new packaging formats for dry-cured meat products using conjoint analysis: an application to dry-cured Iberian ham. J Sens Stud 28: 238-247. https://doi.org/10.1111/joss.12040
Moreno G, Pulido FJ, 2009. The functioning, management and persistence of Dehesas. In: Agroforestry in Europe: Current status and future prospects; Rigueiro-Rodríguez A, McAdam J, Mosquera-Losada MR (eds.). pp: 127-160. Springer, Dordrecht, The Netherlands.
Ovando P, Campos P, Oviedo JL, Caparrós A, 2016. Ecosystem accounting for measuring total income in private and public agroforestry farms. Forest Policy Econ 71: 43-51. https://doi.org/10.1016/j.forpol.2016.06.031
Pirard R, Lapeyre R, 2014. Classifying market-based instruments for ecosystem services: A guide to the lit-

erature jungle. Ecosyst Serv 9: 106-114. https://doi.org/10.1016/j.ecoser.2014.06.005

Poe GL, Giraud KL, Loomis JB, 2005. Computational methods for measuring the difference of empirical distributions. Am J Agric Econ 87: 353-365. https://doi.org/10.1111/j.1467-8276.2005.00727.x

Rose J, Bain S, Bliemer MC, 2011. Experimental design strategies for stated preference studies dealing with non-market goods. In: The International Handbook on Non-Market Environmental Valuation; Bennet J (ed.). pp: 273-299. Edward Elgar Publ, Cheltenham, UK.

Sahelices A, Mesías FJ, Escribano M, Gaspar P, Elghannam A, 2017. Are quality regulations displacing PDOs? A choice experiment study on Iberian meat products in Spain. Ital J Anim Sci 16: 9-13. https://doi.org/10.1080/1828051X.2016.1266704

Salazar-Ordóñez M, Schuberth F, Cabrera ER, Arriaza M, Rodríguez-Entrena M, 2018. The effects of person-related and environmental factors on consumers' decision-making in agri-food markets: the case of olive oils. Food Res Int 112: 412-424. https://doi.org/10.1016/j.foodres.2018.06.031

Salazar-Ordóñez M, Rodríguez-Entrena M, Villanueva AJ, 2021. Exploring the commodification of biodiversity using olive oil producers' willingness to accept. Land Use Policy 107: 104348. https://doi.org/10.1016/j.landusepol.2019.104348

Scarpa R, Philippidis G, Spalatro F, 2005. Product-country images and preference heterogeneity for Mediterranean food products: A discrete choice framework. Agribusiness 21: 329-349. https://doi.org/10.1002/agr.20051

Schaafsma M, 2015. Spatial and geographical aspects of benefit transfer. In: benefit transfer of environmental and resource values; Johnston RJ *et al.* (eds.). pp: 421-439. Springer, Dordrecht, The Netherlands. https://doi.org/10.1007/978-94-017-9930-0_18

Train K, 2009. Discrete choice methods with simulation, 2nd ed. Cambridge Univ Press, UK.

Viegas I, Nunes LC, Madureira L, Fontes MA, Santos JL, 2014. Beef credence attributes: implications of substitution effects on consumers' WTP. J Agric Econ 65: 600-615. https://doi.org/10.1111/1477-9552.12067

Villanueva AJ, Salazar-Ordoñez M, Granado-Díaz R, Rodríguez-Entrena M, 2021. Consumers' preferences for traditional meat products: production system and objective quality cues in Iberian ham. Ital J Anim Sci 20: 1987-2001. https://doi.org/10.1080/1828051X.2021.1982419

Vuong QH, 1989. Likelihood ratio tests for model selection and non-nested hypotheses. Econometrica 57: 307-333. https://doi.org/10.2307/1912557

Yamaguchi R, Shah P, 2020. Spatial discounting of ecosystem services. Resour Energy Econ 62: 101186. https://doi.org/10.1016/j.reseneeco.2020.101186

Yao RT, Scarpa R, Turner JA, Barnard TD, Rose JM, Palma JHN, Harrison DR, 2014. Valuing biodiversity enhancement in New Zealand's planted forests: socioeconomic and spatial determinants of willingness-to-pay. Ecol Econ 98: 90-101. https://doi.org/10.1016/j.ecolecon.2013.12.009