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A hedonic analysis of the complex hunting experience

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ABSTRACT

In Denmark, the right to hunt is vested with the land owner but can be transferred to others and is traded on a well-established market. The dominant form of hunting leases is time limited contract transferring the hunting rights on a piece of land to one or more persons. We analyze this market for hunting leases using the hedonic method on a rich set of data obtained from Danish hunters. We hypothesize and show that the price of a hunting lease reflects that hunting is a composite experience; and also reflects aspects relating to the landowners cost of leasing out hunting. Thus, the value of a lease is determined by the location and size of the hunting area, the game harvest and hunting activity itself, several landscape qualities affecting the recreational nature experience, several social aspects of hunting and the relation between the landowner, the hunters and their activities. The results can be used to make informed management and policy decisions that affect wildlife, hunters, landowners and land uses.

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Introduction

Ecosystem services and goods underpin in many ways the economy and our well-being and one of many ecosystem services delivered by nature is the hunting experiences. In many areas income from hunting activities supplements the landowners' income significantly, and outdoor recreation research in the Nordic countries shows that hunters spend a significant amount of income on their hunting hobby, a non-trivial part of this related to hunting leases and fees (Fredman et al., 2010; Jacobsen et al., 2014). While the value of many non-marketed recreational ecosystem services have been extensively researched over the last decades, the value of hunting remains quite understudied, in particular in Europe. Thus, even though the market for various hunting leases is well-established and of considerable size in many countries, little is known as to what determines the price of a hunting lease and hence the value of hunting as a recreational experience (Mozumder et al., 2007). This is unfortunate, as such information will clearly be of value to landowners wanting to improve their property's value as a hunting area, or trying to evaluate the trade-off between having large deer populations to enhance hunting values and suffering the costs of crop damages caused by those same deer. Also, policy makers responsible for regulating hunting as one of many land uses may find useful information in knowing what actually motivates this significant group of stakeholders.

The aim of this study is to investigate what factors determine the price of area based hunting leases in Denmark. To do so, we ask hunters, that are lease holders, how much they pay for hunting rights along with numerous questions about details of the hunting area, their hunting partners, the surrounding landscape and different aspects of the lease contract. On this basis, we estimate a hedonic model, in which the characteristics of the hunting lease are used to estimate the price. While related studies, in particular in the US, have investigated how the price of hunting leases for big game and also area-based leases depends on the natural habitat and the hunting effort, no studies have, to the best of our knowledge, addressed area based hunting leases as quite as multi-faceted a recreational good as we are able to do. We hypothesize and show that the price of a hunting lease reflects that hunting is a composite experience; and also reflects aspects relating to the landowners cost of leasing out hunting.

Previous studies

Hunting contains elements that are clearly consumptive (rival) and elements that are clearly non-consumptive, and thereby it differs from many other nature-based recreational services which, even if excludable, tend to be non-consumptive at least in a physical sense (cf. Vedel et al., 2009). Moreover, it resembles in many ways a service rather than a good, in the sense that the quality of a hunting lease cannot really be inferred before it is experienced through consumption. Furthermore, in a hunting lease the land owner is influenced by the lease holder's activities during the actual consumption. Thus, the factors determining the price of hunting leases are likely to include preferences of the hunters and the costs drivers of land owners.

The economic value of hunting has been subject to a number of studies using different non-market valuation techniques. Many studies operate within a stated preference framework using either contingent valuation (Mattsson, 1989; Goodwin et al., 1993; Hussain et al., 2004; Fix et al., 2005; Mattsson et al., 2008) or some kind of choice modelling (e.g. Boxall and Macnab, 2000; Hunt et al., 2005). Stated preference valuation techniques are especially useful when valuing policies or attributes of goods that might not exist yet but they are also often criticized for their hypothetical nature. One alternative in the category of revealed preferences is the travel cost method that assumes weak complementary between travel cost and the visited (hunting) area. The method has been used by e.g. Knoche and Lupi (2007) and Nguyen et al. (2007) in relation to hunting. However, several – but almost exclusively North American – studies utilize the fact that hunting licences or leases in fact are marketed goods, and applies hedonic type analyses to investigate what determines the price of a hunting lease or big game license (Livengood, 1983; Pope and Stoll, 1985; Messonnier and Luzar, 1990; Le Goffe, 2000; Meilby et al., 2006; Zhang et al., 2006; Hussain et al., 2010; Munn and Hussain, 2010).

Largely, these studies can be divided into studies investigating the pricing of hunting licences specifically for big game or similar, the data often being obtained from auctions or sellers (see e.g.

Buschena et al., 2001; Little and Berrens, 2008) and into studies that, like the current, are analysing the pricing of hunting leases that relate to partial or full hunting rights to a specific area (see e.g. Shrestha and Alavalapati, 2004; Meilby et al., 2006; Hussain et al., 2007; Rhyne et al., 2009; Hussain et al., 2010). These latter exclusively use data obtained from landowners that sell the hunting leases. In our study, we collect the data among hunters, as our investigations suggested that asking land owners could result in low responses or underreporting due to tax concerns. Across these different studies different variables are included as determinants of the price of a hunting licence or lease. Usually the amount or type of game shot is included, as is variables reflecting hunters' effort or travel costs related to the lease. In particular the hunting area focused studies also include different variables describing the attractiveness of the land for hunting, e.g. land cover, and some include variables describing aspects of the contract. A few studies also include possible services by the land owner, like airport pick up. In the present study, we draw on this literature to select a number of variables, but we allow for a much wider set of factors to affect the price and in particular introduce more variables describing social aspects of hunting and the relation between the landowner and the hunters.

With only a few exceptions all the hunting studies cited above are from North America. Among the few exceptions are Mattsson (1989) and Mattsson et al. (2008) who use CVM in Sweden (see also Boman et al., 2011). Another exception is Meilby et al. (2006) who like the present study concerns the Danish hunting lease market. However, Meilby et al. (2006) based their analyses on a fairly limited data set covering income from hunting leases in a small set of larger Danish forest estates. The present study improve this work by targeting hunters instead of landowners, and by eliciting a much more detailed set of data about the hunters and the individual hunting leases, enabling a model which is richer in terms of explanatory variables than any models of the above studies.

The case: hunting leases in Denmark

Hunting is a relatively large recreational activity in many of the Nordic countries. In Denmark a total of 163,600 individuals held a hunting licence in 2006/7, prior to the time our data were collected (Danish Ministry of Environment, 2008), out of approximately 4.4 million Danes above the age of 16 year.

Hunting leases and licences are sold in different ways in Denmark. The by far dominant way is the one studied here, but a market also exists for what is termed 'day hunts'. These are typically organized as a weekend hunting party, often focusing on fowl hunting (ducks, pheasants) at an estate applying raise and release of fowl, but may also include small game hunting, and even limited deer hunting. More rarely, actual trophy licences for roe and red deer are traded (Hansen, 2000). The right to hunt on any particular area belongs to the landowner entirely. This includes the right to hunt any game for which the law has set a hunting season. Hunters pay an annual licence to the government, which is a lump sum independent of activity. The game itself, being a core attribute of any hunting lease, has special characteristics. It moves, quite a lot in fact, e.g. the typical home ranges of Roe deer (*Capreolus capreolus*) and Red deer (*Cervus elaphus*) are 200–400 ha and 500–1200 ha respectively: much larger than the size of a typical property and average hunting lease (Kanstrup et al., 2009). Provided a property is larger than 5 ha, the landowner is allowed to transfer the hunting right for a specific area to a lease holder, typically against a payment, and thus the landowner can benefit financially from the wildlife resource and the hunting rights. The lease holder can either be an individual hunter or a group of hunters organized in a consortium. In most cases landowners transfer their full hunting right. Thus the lease holder can hunt any game species within the legal hunting season and often without any specified upper limit on quantities. A survey about hunters' preferences, behaviour and engagement (Hansen, 2000) reveals that approximately half of this sample of hunters prefers the hunt on small game, one third prefer deer hunting and the remainder prefer bird hunting.

Hunting leases are very widespread in Denmark and a recent study among landowners indicated that 18% of all land owners lease out all or part of their property (Lund, 2014); in particular larger land owners. Thus a significant and well-functioning market exist. While bilateral informal agreements

clearly exist, a fair proportion of the hunting leases are advertised in e.g. hunting magazines and at different homepages; ensuring transparency and information.[1]

The total value of hunting in Denmark is not trivial. For forests alone, Thorsen and Strange (2001) assess the total market value of hunting leases in Danish forests to presumably exceed 13 million €per year based on a limited set of forest enterprise account data. A recent study on outdoor recreational activities' footprint on the Danish economy revealed that hunters overall spend around 230–240 million €/year on their hunting – all included (Jacobsen et al., 2014), and hunting lease cost constitutes parts of this. A Swedish study reports the gross value of hunting in Sweden to be around 335 million Euro per year (Mattsson et al., 2008).

Theory and methods

In economics, the hedonic demand theory (Rosen, 1974) is used to decompose values of composite goods into its attributes, much in line with Lancaster (1966) who noted that a consumer derives utility from the attributes that goods possess. Based on the housing market, Rosen (1974) demonstrated that buyers and sellers on a perfectly competitive market will reach a market equilibrium guided by the implicit prices of house characteristics. He argues that buyers seek to maximize utility by bidding as little as possibly for every characteristic where as sellers seek to maximize capital rent by offering their house at the highest price possible. The equilibrium price for house characteristics forms where the bid function and offer function converges. Hence, the equilibrium price of any given house can be modelled as a function of its characteristics (Taylor, 2003). The theory is often used to derive values of environmental goods or services that are not directly traded in the market by analysing prices of goods in related markets, as in the example with houses where prices may reflect proximity to e.g. a forest, a beautiful view or a nearby highway.

Hunting leases are likewise traded on a market and we are able to apply directly the hedonic framework on hunting leases to identify attributes that significantly contribute to the price. However, unlike in the housing market, the seller and the buyer in the hunting lease market engage in a longer and somewhat different relationship, which is more comparable perhaps to a landlord and a tenant. The hunters determine the price they are willing pay by evaluating alternatives and choosing among available hunting areas on the market and thus act as price takers on a perfectly competitive market (Taylor, 2003). Landowners set their price so as to maximize their profit taking into account cost of providing possible services and possible spill-overs to other activities. These could include both positive effects (e.g. reduced crop damages from deer's grazing) and negative effects (e.g. ongoing costs of administration, conflict resolution with neighbours etc.).

Following Rosen (1974) and earlier applications on hunting leases (e.g. Little and Berrens, 2008; Meilby et al., 2006; Rhyne et al., 2009; Shrestha and Alavalapati, 2004), we specify the price per hectare P for a hunting lease, i, as a general function of different sets of attributes:

$$P_i = f(L_i, A_i, H_i; S_i, C_i, \varepsilon_i) \tag{1}$$

Here, L, A, H, S and C are vectors of different attributes affecting the price, and ε is an error term capturing the effect of unobserved variables assumed uncorrelated with the reminding variables. The partial derivative of the hedonic price function with respect to an attribute, e.g. $\partial P/\partial s$, gives the marginal implicit price for a marginal change in that attribute. In the present paper, we analyze the data assuming they belong to one and the same market for hunting leases. We also do not aim to identify demand functions for the different attributes, i.e. we do not move to the so-called second stage of the hedonic market models (see Rosen, 1974; Freeman, 1993). We base our choices of variables partly on the literature and partly on the insight we have obtained ourselves, e.g. through focus group interviews with hunters. Note that because attributes may imply different things to the hunter and the landowner, the role of some attributes is not straightforward to foresee.

[1] See e.g. the Danish Hunters' homepage at http://www.jaegerforbundet.dk and an example of a hunting trader homepage is http://www.jagtformidling.dk/.

L is a vector of variables describing the size and the location of the area; characteristics that the landowners mostly cannot change. They include the size of the area, where previous studies have found price per hectare to decrease in area leased and distance to larger cities or regional fixed effects to capture the cost of travelling the distance from home to the hunting area, the opportunity cost of time and other inconveniences (e.g. Little and Berrens, 2008; Rhyne et al., 2009).

The second vector, A, denote amenity and area quality variables, which the owner in some cases will be able to change such as the share of forest and agricultural land, but also whether the lease is on estate land (typically including more scenic, historic buildings, alleys, small lakes etc.) and other variables capturing landscape characteristics. Such variables may reflect both the general recreational quality of going hunting in the area but also underpin e.g. game populations and is commonly included in the literature (e.g. Rhyne et al., 2009; Shrestha and Alavalapati, 2004).

The third vector, H, includes the core hunting outcome and activity measures. The game harvested, captured in e.g. the bag rate[2] of different species provide utility to the hunter of the actual hunting and shooting of game and potentially also the value of the meat. The amount of wildlife on any land can of course be influenced somewhat by, e.g. making fodder available during winter and by careful management of access and disturbances. Hunting activity, e.g. in terms of days hunting annually, is both a costly effort for the hunter, though hunters being very active are likely to derive a higher utility from the activity itself. Hunting activity days is sometimes specified in the hunting leases, because they represent also a potential cost to the landowner if hunting causes conflict with other uses, potentially with neighbours etc.

The fourth vector, S, captures variables we term social aspects of the hunting activity. These include whether or not the hunting lease is held by a single person or a consortium of persons, if there is a hunting cabin included and whether there are informal relationships between hunters and landowners. Much hunting is as much a social as a solo recreational activity; enjoying the good company of old hunting buddies and friends along with the hunting experience itself. Such values could be part of the benefit associated with being a hunting consortium and may be enhanced by different attributes of the lease. On the others side, handling larger hunting parties alongside other land uses may induce additional costs for the landowner. This set of variables represents aspects studied much less if at all in the literature.

Finally a vector, C, collects other variables related to the contractual design, including e.g. the lease length in years and whether or not a written contract exists. The specific attributes contained in the mentioned vectors can be seen in the first and last column of Table 1 in the data section below.

The definition of the hedonic price function in Eq. (1) does not imply any restrictions to the functional form, except for the linearity implied by the assumption of weak separability inherent in the theory. Hence, the choice of functional form is free, but also important and often discussed in the literature (Halvorsen and Pollakowski, 1981; Cropper et al., 1988; Palmquist, 1991). In this paper we estimate a log-normal equation where the dependent variable price is represented by its natural logarithm, although the models are fairly stable across different model specifications. The independence and normality assumptions have been investigated and we have searched for a parsimonious model excluding insignificant variables to secure the efficiency of the estimates on the parameters that were hypothesized could have an impact on the lease price. The model is in general not sensitive to the removal of insignificant variables, cf. discussion below. The model to be estimated is:

$$\ln(P_i) = \alpha_0 + \sum_{l=1}^{L} \lambda_l L_{il} + \sum_{a=1}^{A} \alpha_a A_{ia} + \sum_{h=1}^{H} \phi_h H_{ih} + \sum_{s=1}^{S} \rho_s S_{is} + \sum_{c=1}^{C} \kappa_c C_{ic} + \varepsilon_i \quad (2)$$

Here P is the price of the ith hunting lease, and the remaining variables L, A, H, S, and C are the included attributes of the hunting lease. Residuals represented by ε are assumed n.i.i.d. $(0, \sigma^2)$.

Note that hedonic models will often hold a number of dummy variables, e.g. whether or not a written contract exist, and in order to be able to make inference from these in a model where the

[2] Bag rate is the amount of animals shot per year and hectare ("carried in the bag").

Table 1
Variable description. The prefix 'd_' indicates dummy variables. Descriptive statistics based on 751 respondents.

Name	Min	Max	Median	Mean	Std. error	Description
Cost						
Price_hectare	13.33	2000	239.69	298.75	236.81	Price in DKK per hectare
ln(price/hectare)	2.59	7.60	5.48	5.39	0.84	Natural Log of price in DKK/hectare
Location variables						
Areasize	5	2000	97	159.67	200.83	Hectare per lease
ln(area size)	1.61	7.60	4.57	4.57	1.01	Natural Log of area in hectares
d_fyn	0	1	0	0.10	0.30	Region dummy (see Fig. 1)
d_sjaelland	0	1	0	0.16	0.36	Region dummy (see Fig. 1)
d_nearcity	0	1	0	0.13	0.34	1 indicates that the hunting area is close to a city
Amenity and area variables						
d_estatehunt	0	1	0	0.29	0.45	1 if the lease is at an estate or similar
forest_share	1	21	3	6.01	6.51	Share of forest on the area in intervals of 5%
farmland_share	1	21	13	11.21	6.73	Share of farmland on the are in intervals of 5%
d_oldforest	0	1	0	0.26	0.44	1 if there is old forest present
Hunting outcome variables						
bag_roe_ratio	0	0.5	0.04	0.062	0.067	The bag rate of roe deer per hectare
bag_red_ratio	0	0.095	0	0.001	0.007	The bag rate of red deer per hectare
bag_other_ratio	0	63.4	0.5	1.009	2.619	The bag rate of other game and birds per hectare
Activity	0	300	30	34.13	26.34	Number of hunting days for the lease holder
Social aspect variables						
d_cabin	0	1	0	0.45	0.50	1 indicates the presence of a hunting cabin
d_careful	0	1	0	0.01	0.12	Indicating self reported carefulness
d_relative	0	1	0	0.15	0.36	1 if the landowner and the lease holder are relatives, friends or similar
d_consortium	0	1	1	0.82	0.38	1 if lease holder is a consortium
Contract variables						
Contractlength	1	99	1	3.30	4.54	Length in years of the lease
d_contract	0	1	0	0.31	0.46	1 indicates a formal contract compared to a verbal agreement

dependent variable is in logarithmic form, the dummy variable has to be corrected with a semi-elasticity calculation (see Halvorsen and Palmquist, 1980):

$$100 \times [\exp(\beta_{\text{dummy}}) - 1] \tag{3}$$

The interpretation is a percentage interpretation as is the case with the other (non-dummy) variables.[3]

Data

The population of hunting leases is unknown and so is even the total area being leased out in Denmark. However, under the reasonable assumption that the market is relatively well-functioning, cf. the description earlier, the individual hunters and land owners act as price takers. Thus, as long as no systematic bias is encountered in the types of hunting areas we obtain data from a sufficiently large number of contracts will provide an unbiased estimate of the market price. Note that as we are

[3] Some authors argue that the variable's variance should be included in the computation of the effect (see Kennedy, 1981; van Garderen and Shah, 2002) but we chose to use the simple version here.

addressing a marketed good, self-selection problems in the population of hunter should not cause a bias in the assessment of the hunting lease price. To avoid systematic bias, we sampled as many hunting leases as possible within the study period across all hunting methods, area types and species hunted and many more variations. To prevent strategic answering by respondents we decided to ask the lease holders rather than the land owners as we suspected some of the income from hunting leases may not be reported. Thus the incentive to give truthful answers was thought to be higher from the former.[4] The population of hunters can be reached through the hunting licence registry, but a representative sample of hunters would likely have to be very large to provide a representative sample of hunting leases as only a small minority of people with a hunting licence hold hunting leases alone or in a consortium. Thus it was decided to make an open survey, where members of the major Danish hunting organizations were invited to answer a questionnaire either at a specific homepage or by requesting a postal questionnaire. The invitation was written twice in the monthly journal of the hunters organization and also posted on numerous web pages, including most local hunting organizations. Out of 163,600 active hunters in 2006/7 (Danish Hunting Association, 2008; Danish Ministry of Environment, 2008) a total of 93,736 were organized in the Danish Hunting Organization by the end of 2007 (Danish Hunting Association, 2008). The identity of every respondent was ensured by comparing to the hunting organisation's member register in order to ensure answers from hunters only and to avoid doublets. Furthermore, we checked whether leases with exact same price, area size and location would appear more than once in the dataset. This was not the case.

A total of 1246 individuals answered the questionnaire. Control for membership removed 195 answers from the sample. A further 12 respondents had left blank answers at essential questions e.g. hunting price or area size and were thus also removed. Of the remaining 1039 respondents a total of 288 individuals were not holding a hunting lease and are therefore irrelevant for the following analysis and the data thus consist of the remaining 751 hunting leases. These leases cover a total area of more than 120,000 ha which is quite a significant share of the total area potential available for hunting leasing, in particular as much land is most likely not under any hunting lease, because properties are too small, of no interest for hunting, under public ownership, too close to residential areas or owned by people not leasing away the hunting rights.[5] The number of hunting leases, the mean lease price and area size and the spatial distribution is shown in Fig. 1.

The questionnaire was designed on the basis of discussions and interviews with hunters and subsequently tested in a focus group. The questionnaire elicited information regarding number of leases, attributes of the hunting area, price, terms of lease, etc. Respondents were also asked to state approximated game populations and bag rates.

Furthermore, questions about hunting preferences and socioeconomic characteristics of the hunter were included. Our data shows that the typical lease holder in the sample is a 49 year old man, who has been hunting for 25 years. He goes hunting 34 days a year and he owns a dog. Besides the amount spent on leasing an area for hunting, he spends on average 17,500 DKK a year on other hunting related issues, mainly shorter hunting trips, e.g. abroad, weapon and ammunition, and costs related to his hunting dog.

The attributes included in the hedonic model are shown in Table 1 along with its descriptive statistics. We see that the average area size for the 751 leases was 160 ha and the average annual lease price per hectare was almost 300 DKK.[6] The variables presented relate to the hunting price Eq. (2) and are summarized under the main categories corresponding to the vector definitions in Eq. (1).

[4] In Denmark, it is the income earner who has the obligation to report income to the tax authorities, and only a few consumptive activities are tax deductible – and the cost of hunting is not one of them.

[5] The total hunting area in Denmark is unknown. An upper estimate would be to take the total area of Denmark (4,300,000 ha) and exclude approximately 10% covered by cities and infrastructure. In this case a very conservative estimate is that our sample covers more than 3% of all hunting areas. According to a recent survey less than 18% of owners lease their land out for hunting (Lund, 2014) and taking this into account our sample might cover as much as 17% of the land leased out for hunting in Denmark.

[6] 1 Euro is approx. 7.5 DKK. In the following DKK will be used.

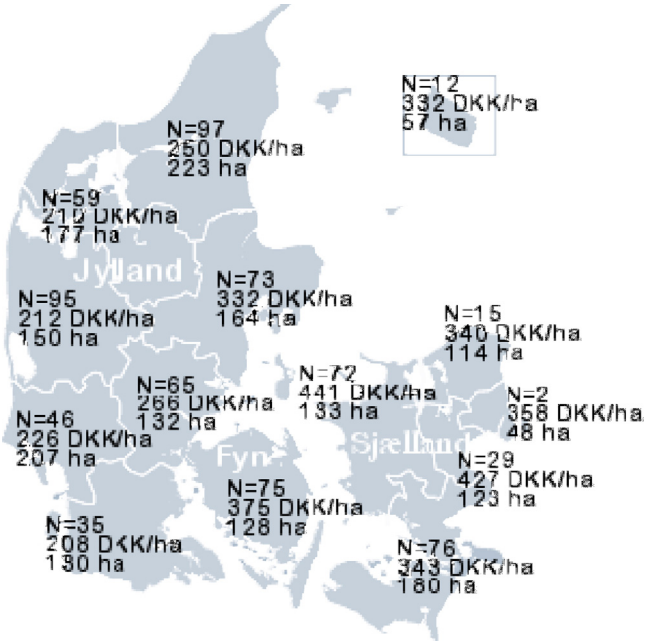

Fig. 1. Distribution of lease responses showing average price and area size.

Fig. 2. Motivations for hunting.

Results

Before we present the results of the hedonic model estimation, we first describe the results of some qualitative questions respondents answered in the survey. This serves the purpose of qualifying our interpretation of the hedonic model results. Next we describe the results of the hedonic model.

To investigate whether the utility of a hunting lease rests on more than the bag rate, we asked questions to elicit hunter's self-stated importance of different motivations for hunting. They were asked to rank a number of statements on a four point scale ranging from 'not important' to 'very important'. Fig. 2 shows the percentage of hunters who stated either 'very important' or 'important' to the motivation questions.[7]

[7] Note, that these motivations are based on the individual respondents' opinion, also in the cases where the hunting lease is held by a consortium.

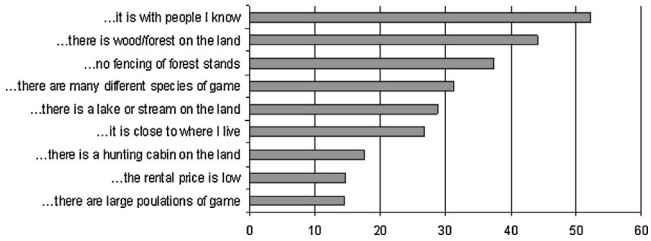

Fig. 3. Important aspects when considering a hunting lease.

The results in Fig. 2 reveal that the core hunting activities (shooting and getting meat) do not top the list of motivations. The hunting of game and the benefit associated with a trophy or meat only rank 7th, 9th and 10th, respectively, among the reasons and motivations for hunting. The general nature experience associated with the hunting activities, on the other hand, ranks in the absolute top, but also the social aspects, e.g. the option to spend meaningful time with friends rank quite high and is assessed as 'important' or 'very important' by some 58% of the sample.

We also asked the hunters to rate the importance of different specific aspects relevant when considering the possible lease of a hunting area. The result is presented in Fig. 3 and shows again that the social aspects of the hunting experience are found quite important by many hunters, in this specific case by more than 50%. The impression from Fig. 2 is also replicated when it comes to the core hunting variable, the game population, which is ranked fairly low. Again, variation in landscape and wildlife is reported to be important – reflecting the general nature experience.

We note that some of the statements in Figs. 2 and 3 may indeed be endogenous to price of the hunting rental. That is, aspects known to typically imply a higher lease price may receive less weight in statements like this, indicating that one should be careful with interpretations about causality across attitude statements and the hedonic results.

Results of the hedonic price estimations were based on an ordinary least square regression and are presented in Table 2. We show the results of a log-normal equation where the dependent variable 'price per hectare' and the explanatory variable 'area size' are the only ones represented by their natural logarithm. The dummies and the variables already represented as ratios, e.g. the share of forest, are not transformed.

Among several variables that were hypothesized to contribute to lease value we included only those that had a significance level of 10% or better in the final model here. Other physical attributes such as shooting stalls (hochsitzs), if young forest stands were fenced or if artificial fox holes where present did not come out significant in the models estimated. When interpreting the role of each variable, the size of the parameter estimates should be interpreted taking into account the range of the underlying variable cf. Table 1.

Looking across the variables, they all have sensible signs. The negative coefficient of the variable *ln_areasize*, suggests that there is a quantity discount as price per hectare decreases with area size. Location attributes here are chosen so as to reflect locations relatively close to cities, in central regions or close to population centres. Therefore the region dummies for the islands of Zealand (*d_sjaelland*) and Funen (*d_fyn*) have a positive effect as has the 'Near city'-dummy. The recreational qualities of the area are seen to depend positively on the sort of property (estate or not), and the amount of forest vs. agricultural land and whether there is old forest on the area.

The core hunting variables all have a significant positive effect on lease price. They include the bag rate of roe and red deer and small game (hare, fox, pheasants etc.) and the activity in terms of annual number of hunting days is also positive. The absolute effect depending much on the actual level of these variables, which are defined as, e.g. deer or smaller game harvested per hectare, cf. Table 1 for means and medians of these.

Among the set of social aspect variables, we see that access to a hunting cabin contributes positively to the price. Hunting areas leased to a consortium (*d_consortium*) seem to be priced some 48% higher

Table 2
Log-normal model.

Dep. variable: ln (price) in DKK/ha and year Variable	Estimate	Std. error	*t*-Value	Effect on hunting price in per cent per unit of change
Intercept	5.033***	0.165	30.5	
Location variables				
ln(area size)	−0.106***	0.032	−3.32	−10.60
d_fyn	0.429***	0.074	5.83	53.63
d_sjaelland	0.387***	0.062	6.26	47.32
d_nearcity	0.116	0.063	1.84	12.29
Amenity and area variables				
d_estatehunt	0.148**	0.055	2.69	16.00
forest_share	0.012*	0.005	2.3	1.20
d_oldforest	0.145**	0.049	2.98	15.60
farmland_share	−0.021***	0.005	−4.37	−2.12
Hunting outcome variables				
bag_roe_ratio	2.379***	0.398	5.97	237.93
bag_red_ratio	12.556***	2.915	4.31	1255.60
bag_other_ratio	0.042***	0.009	4.82	4.17
Activity	0.002*	0.001	2.16	0.18
Social aspects variables				
d_cabin	0.330***	0.052	6.38	39.11
d_consortioum	0.388***	0.060	6.47	47.45
d_relative	−0.294***	0.061	−4.78	−25.45
d_careful	−0.388*	0.177	−2.19	−32.14
Contract variables				
d_contract	0.268***	0.051	5.26	30.68
Contractlength	0.011*	0.005	2.48	1.14
Obs	751			
Adj *R*-square	0.536			

* The significance level is 95%.
** The significance level is 99%.
*** The significance level is 99.9%.

than areas typically leased to individual hunters. If the landowner and the lease holder are related there is a significant reduction in price, almost 30%. In the questionnaire we asked the respondents whether they believed that the lease price was affected by something not covered in the questionnaire. A small number of hunters (1.5%) replied that they considered themselves and/or their consortium as 'careful' hunters with high standards in practice and ethics, and they believed that for that reason they enjoyed a sort of discount on the price. This discount is indeed confirmed by our results and is estimated to as much as 32% reduction, but note the small sub-sample this represents.

Finally, hunting leases based on a written contract compared to a verbal agreement seem to have almost 20% higher price per hectare, whereas the price increases with slightly more than 1% for each year a contract covers.

Discussion

The results reveal first and foremost, as hypothesized, that the price of hunting leases is determined by many factors, which in turn reflects that the hunting experience is a composite good from which the hunters derive a complex utility. Furthermore, some of the patterns we see, such as contract details and the hunter's relation to the landowner, can perhaps be understood better, if we take into account the supply side of the market as the landowners offering the hunting leases will be affected by the construction and use of the lease. Overall, our results confirm many of the results found in the

literature covered in Section II, but as we have more detailed data we are able to extend the literature in the field and contribute with new insights.

The location and size of the hunting lease

Once the right to hunt on a given area has been secured by the hunting lease, the hunter's effort on the area depends on the marginal cost of effort weighted against the marginal benefit. The distance of travelling to the hunting grounds is potentially an important cost component. Thus, the lower this distance, the lower the marginal cost of effort and the higher the benefit that the hunter derives from the lease. This is confirmed by the positive impact of being near cities, where also most hunters live, and by the regional dummies for Funen and Zealand, which are the regions that can be reached by most of the population within reasonable time, i.e. a few hours or less. The results conform to earlier findings (e.g. Little and Berrens, 2008; Rhyne et al., 2009).

We observe a discount on quantity, as price decreases with the size of the area leased. This in all likelihood reflects that hunters expect a decreasing marginal utility of hunting grounds as making full use of more land will require a higher effort at potentially higher marginal costs. Even with uniform quality of hunting grounds, this will cause a decrease in the per hectare price, and the result is common in analyses of area leases, see e.g. Shrestha and Alavalapati (2004).

Amenities and area characteristics

From the stated reasons for going hunting (Figs. 2 and 3) the non-consumptive benefits associated with the nature experience is given higher stated importance than the core hunting activities such as the shooting, meat and trophy acquisition. As the core hunting activities, that is hunting, shooting and carrying home the game, is what differentiates hunting from other recreational activities, this result could be seen as somewhat surprising. It would be easy for the hunters to substitute their hunting activities with several other nature based recreational activities, which would even be much cheaper if not free. This begs the question to which degree the lease holders are just choosing the political correct categories in Fig. 2; perhaps thinking that sending the message 'I love nature' makes them look better than 'I like shooting game' does.

The results from the hedonic model reveal that this is not the case. The variables representing recreational quality of the area and landscape are significant and have signs in accordance with other studies of recreational preferences for different habitats in Denmark (Jacobsen et al., 2012). The more forest land, the higher the lease price and conversely, the more agricultural land, the lower the lease price. Forests may be better hunting areas as they provide cover and shorter shooting distances for the hunters, and the border between field and forest may be important for some hunters, providing both cover and good vision over the shooting area and finally old forests may be better for some game species. However, most of these roles of land cover should already be captured in the bag rate, and therefore the area characteristic parameters seem more likely to reflect the recreational and nature experience value of forest land. Likewise, the presence of old forest is likely to reflect a pure amenity value in this model. Old forest predominantly favours birds and birds of prey not on the list of wildlife that can be hunted.

The dummy variable 'estate hunt' also has a positive impact of some magnitude, and this may again reflect cultural and amenity values related to the estate landscape, which often involves larger areas being carefully groomed and nurtured according to a larger plan for the estate, e.g. well-kept avenues and peasants houses. Hunters may have access to parking at the manor, enjoy the historical buildings and other aspects that make estate type landscapes stand out compared to other areas in the Danish landscape. The results from this group of variables are slightly richer than most existing studies, but related to e.g. Shrestha and Alavalapati (2004), Hussain et al. (2007) and Rhyne et al. (2009).

The numerical size of these variables with a positive effect on lease price is not inferior. Taking into account their possible range, they may each add another 15–30% to price. For example, a hunting lease entirely made up of forest land will command a price, which is on average almost 30% higher than a lease made up entirely of agricultural land. If it is old forest to a significant degree, another 15% can be

added. Thus, the hunters' stated importance of the general nature experience does find considerable support in the hedonic price function for hunting leases.

The hunting variables

The core hunting variables involves the bag rate of red deer, roe deer and other game including birds, which are all calculated as harvested game per hectare. They were indeed found to influence the lease price positively as expected. The impacts of these variables seem at first glance to be quite high, with an estimated parameter of 1248%, 248% and 4%, respectively. However, the influence is relatively small compared to e.g. the recreational and nature experience variables, if we take into account the mean and median bag-rate per hectare from Table 1. Setting all variables equal to their mean level according to Table 1, they contribute collectively with around 23% to the price per hectare. This, however, increases quickly with the level of the variables, so that setting all the variables equal to the maximum value observed they contribute collectively with more than 44% to the price per hectare. The hedonic model assumes full information about the good being traded and it could be argued that an asymmetry exists with respect to the population of game. It is our impression that many areas are rented out on a continuous basis and thus the lease holder might have information about previous harvest, note e.g. that the average contract length is around three years. Also in consortiums we often see a constant in/outflux of new members and thus the consortium has good knowledge about previous years' harvest.

In previous studies addressing the price of areas based hunting leases, data have been obtained from landowners (e.g. Shrestha and Alavalapati, 2004; Hussain et al., 2007) and therefore our results here are the first to present implicit prices for the game itself. The literature on e.g. pricing of elk licences and the like of course have similar measures, but from a very different market type (Buschena et al., 2001).

We also find that the number of hunting days has a positive impact on the price (around 6% evaluated at their mean value). Clearly, the number of hunting days increases the utility derived by the hunter, as long as the marginal benefit of another hunting days exceeds the cost of the effort. Thus, hunters with a lower cost of effort will typically be able to bid a higher price for a lease area, and also have a larger utility surplus and hence willingness to pay for the hunting rights. However, given hunters and landowners are price takers, hunters of this type should be able to keep this additional consumer surplus for themselves. This suggests that the effect we see here is a supply side effect: The more active the hunter or the consortium is, the larger an inconvenience he will also be for the landowner as well as e.g. hunting consortiums on neighbouring areas. Thus, the estimated parameter here may reflect a cost effect on the supply side. We note, though, that the number of hunting days is represented by the hunter who filled in the questionnaire may not necessarily represent the activity of rest of the consortium. In any case, we see that the range of effects from these core variables are all in all in the range from some 30 to 50% as we go from mean to maximums of variable ranges. The previous literature on area based hunting have not been able to measure variables like this, as they have addressed land owners, but e.g. Little and Berrens (2008) document an increasing price of trophy hunt licences the longer the hunting trip.

The social aspects

Recalling the impressions from Figs. 2 and 3, the social aspects of the hunting experience were reported as being important or very important for a large proportion of the lease holders themselves. Again, one may wonder if this reflects actual preferences which will be reflected in the way hunters organize themselves and value different hunting lease arrangements, or if they just represent general statements, which are in general not actually retrievable from market transactions. The social aspects are hard to capture in easily measured variables, but we have collected a few variables that reflect different social aspects. Hunters state that it is important for them to go hunting with someone they know. This may imply two things: that they consider it important and of value to go hunting as a group, and secondly that in such a group, it is important to know each other, e.g. to feel secure and share standards and ethics. The presence of a hunting cabin has a clear and positive effect on price. While a

cabin can of course be shelter for rain and bad weather and have value as such, it seems more likely that its value is related to the option to have a place for enjoying meals and the post hunting social activities when hunting as a group. Furthermore, a cabin may imply costs also for the landowner.

Secondly, we find a large effect on price of the dummy for consortium. Thus, hunters are willing to pay more per hectare for being part of a consortium holding a lease than for buying the same lease on their own. It seems that this variable could reflect an increased quality of the hunting experience from the social relations enjoyed in the consortium, e.g. hunters may also derive utility from experiencing the hunting luck of their colleagues. It may also reflect that a consortium can plan and undertake a wider variety of hunting techniques, game tending and habitat nursing than a single hunter usually can – thus some positive economies of scale may be enjoyed in the consortium. The price premium may also reflect diseconomies of scale for the landowner: a consortium implies that for every hunting day several hunters and not only one will be active and hence any inconveniency, including conflicts with other recreational user groups, is likely to increase at the cost of the landowner.

One could argue that a potential reason for higher lease prices where consortiums are involved may simply be that the consortium members can pool their financial resources and thus afford the more expensive (i.e., more desirable) leases. We argue, however, that as long as the price of a hunting lease is formed on a competitive market where both landowner and leaser are price takers this cannot be the case as consortiums should be able to harvest the consumer surplus themselves. Nevertheless, this large group (82% of all leases) must derive additional utility from being in a consortium like the ones mentioned above to be willing to compensate the owner the higher price. There are related results in the literature, as e.g. Shrestha and Alavalapati (2004) also included the number of hunters in a lease. While they found a positive parameter, it was not significant.

The issue of trust in social relations also plays a role in the hunting market. Trust may be an explanation why hunters will also enjoy a significant discount in the lease price, if they are a relative of the landowner. Another – less charming – explanation could that hunting leases among relatives are more likely to be made and paid without the involvement of the tax authorities, though the variable for a written contract should account for some of this.

The issue of trust may also be underlying the parameter for the variable 'careful'. This variable is based on answers to an open question where respondents were asked to state other determinants affecting the lease price not covered by the main questions in the questionnaire. Although only about 1.5% of the hunters mentioned carefulness as a cause for discounts, we find the parameter is positive and significant in size. This reflects, that hunters that identify themselves as having a high standard in careful hunting practice and ethics, do in fact seem to enjoy the trust of the landowners and enjoy a significant discount probably reflecting a similar decrease in the costs perceived by the landowner. We stress that the result should not be extrapolated too far as the group is rather small and thus also the only variable that is not significant across all different functional forms.

The contract

We see that two variables related to the lease have a significant effect on the equilibrium price of the hunting lease market. First of all, having a written contract increases the price of a hunting lease with almost 30%. One may speculate if this reflects that some undiscovered quality aspect is captured by the variable, but this seems unlikely. A written contract is usually associated with a higher cost of administration, but 30% does seem out of scope with that explanation too. Rather, the unfortunate explanation again is in all likelihood that there is a higher frequency of 'black' money in the part of the market, where agreements are not put on paper. In short, the hunting lease income is not always reported to the tax authorities in these cases, whereas for all contracts on paper, income will for sure be reported. The result is new to the literature.

The longer a lease runs on a hunting lease, the higher the average per hectare price of the lease: not much, but enough to be significant. This suggests that hunters find it attractive to rent for longer periods and suggests that they then expect to benefit from medium to long-term planning of hunting and habitat restoration efforts, e.g. they may benefit from providing fodder during winter, from selective harvesting of game, for restoring lakes for duck hunting etc. Conversely, the pattern may reflect increased

costs on the supply side, where the longer contracts may be associated with a loss of managerial flexibility. This result confirms results of e.g. Rhyne et al. (2009) and Shrestha and Alavalapati (2004).

Caveats and omissions

In the present study, we have estimated a hedonic price function for the Danish market for hunting leases on private land. It is a general drawback that the population of leases is not known, but we have compensated for this by collecting a sample of hunting lease contracts covering a non-trivial part of the potential land on the market.

Using the hedonic pricing function we are able to discuss the implicit price of a number of hunting lease attributes. We have, however, worked under the assumption that the data gathered can be considered one market, but there may possibly be different markets, e.g. between west and east Denmark, or between the larger estate hunts and other smaller hunting lands. However, income effects are not the focus this paper but equity issues could be studied in further analysis.

The paper utilizes survey data and is thus liable to self-selection bias as is the case with any study which relies on people to respond to a questionnaire. However, this should have no influence on the estimates related to the price of the hunting contract and the relation to the physical attributes of the leased land as this price is determined by the market, where the individual hunter is a price taker. We do, however, not know the population of hunting leases and in spite of our sample being quite large compared to the likely true population in terms of hectares, we cannot know if our sample is 'thin' in some types of hunting leases, where the patterns found are potentially different.

Concluding remarks

In this study we analyze the complexity of the hedonic price function for hunting leases in Denmark. As we ask hunters a number of detailed questions about their hunting practices, their hunting lease and the property on which it is, we are able to provide a much richer analysis of the determinants of the price of hunting lease than previous studies. We show that the hunting experience is a much more varied good than the literatures' focus on game so far have uncovered. We find that the main characteristics of hunting as opposed to other recreational activities – the shooting and getting the meat – influence the price relatively less than expected. The general recreational experience associated with the landscape is equally important, and also several social aspects and e.g. the issue of trust between landowner and hunters seem to be reflected in the hedonic price function. Finally we find that interaction between the landowner and the lease holder are important for the price. Landowners will be affected by the hunters' consumption of the good they have purchased. Therefore, the equilibrium price also seems to reflect the disutilities experienced by the landowner. The results can be used to make informed management and policy decisions that affect wildlife, hunters, landowners and land uses and hence in turn the market for hunting leases. The results will also be important input when mapping and valuing ecosystem services, ongoing work in at least most EU-countries. This is indeed useful for gaining a better understanding of the cultural values and benefits of ecosystem services in order to improve nature conservation and ecosystem management.

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References

Boman, M., Mattsson, L., Ericsson, G., Kristrom, B., 2011. Moose hunting values in Sweden now and two decades ago: the Swedish hunters revisited. Environ. Resour. Econ. 50, 515–530.

Boxall, P.C., Macnab, B., 2000. Exploring the preferences of wildlife recreationists for features of boreal forest management: a choice experiment approach. Can. J. For. Res.-Rev. Can. Rech. For. 30, 1931–1941.

Buschena, D.E., Anderson, T.L., Leonard, J.L., 2001. Valuing non-marketed goods: the case of elk permit lotteries. J. Environ. Econ. Manage. 41, 33–43.
Cropper, M.L., Deck, L.B., McConnell, K.E., 1988. On the choice of functional form for hedonic price functions. Rev. Econ. Stat. 70, 668–675.
Danish Hunting Association, 2008. Annual Report 2007., pp. 21.
Danish Ministry of Environment, 2008. Wildlife Information 08., pp. 16.
Fix, P.J., Manfredo, M.J., Loomis, J.B., 2005. Assessing validity of elk and deer license sales estimated by contingent valuation. Wildl. Soc. Bull. 33, 633–642.
Fredman, P., Svensson, B., Lindberg, K., Holmstedt, A., 2010. Ekonomiska värden i svenskt friluftsliv – en enkätundersökning (The economic value of Swedish outdoor recreation – a questionnaire survey). Forskningsprogrammet Friluftsliv i förändring[[nl]]The Research Programme Outdoor Recreation under Change (in Swedish), Report no. 14, Sweden, 54 pp.
Freeman, A.M., 1993. The Measurement of Environmental and Resource Values: Theory and Methods. Resources for the Future, Washington.
Goodwin, B.K., Offenbach, L.A., Cable, T.T., Cook, P.S., 1993. Discrete-continuous contingent valuation of private hunting access in Kansas. J. Environ. Manage. 39, 1–12.
Halvorsen, R., Pollakowski, H.O., 1981. Choice of functional form for hedonic price equations. J. Urban Econ. 10, 37–49.
Halvorsen, R., Palmquist, R., 1980. The interpretation of dummy variables in semi-logarithmic equations. Am. Econ. Rev. 70, 474–475.
Hansen, H.P., 2000. Jagt i Danmark år 2000 (Hunting in Denmark Year 2000). (Master thesis), University of Roskilde (in Danish).
Hunt, L.M., Haider, W., Bottan, B., 2005. Accounting for varying setting preferences among moose hunters. Leis. Sci. 27, 297–314.
Hussain, A., Munn, I.A., Grado, S.C., West, B.C., Jones, W.D., Jones, J.C., 2007. Hedonic analysis of hunting lease revenue and landowner willingness to provide fee-access hunting. For. Sci. 53, 493–513.
Hussain, A., Zhang, D.W., Armstrong, A.B., 2004. Willingness to pay for hunting leases in Alabama. South. J. Appl. For. 28, 21–27.
Hussain, A., Munn, I.A., Hudson, D., West, B., 2010. Attribute-based analysis of hunters' lease preferences. J. Environ. Manage. 91, 2565–2571.
Jacobsen, J.B., Lundhede, T.H., Thorsen, B.J., 2012. Valuation of wildlife populations above survival. Biodivers. Conserv. 21, 543–563.
Jacobsen, L.B., Jensen, F.S., Bakhtiari, F., Thorsen, B.J., 2014. Friluftslivets nationaløkonomiske fodaftryk (The National Account Footprint of Outdoor Recreation. IFRO Report 229). Department of Food and Resource Economics, University of Copenhagen, Denmark (in Danish), 129 pp.
Kanstrup, N., Asferg, T., Jensen, T.S., Flinterup, M., Thorsen, B.J. (Eds.), 2009. Vildt & Landskab. Resultater af 6 års integreret forskning i Danmark 2003–2008 (Wildlife and Landscape – Results of an Integrated Research Programme). Hornslet Print, Denmark, http://www.e-pages.dk/hobo/files/vildt_og_landskab_final_ipaper.pdf (in Danish only), 108 pp.
Kennedy, P.E., 1981. Estimation with correctly interpreted dummy variables in semi-logarithmic equations. Am. Econ. Rev. 71, 801.
Knoche, S., Lupi, F., 2007. Valuing deer hunting ecosystem services from farm landscapes. Ecol. Econ. 64, 313–320.
Lancaster, K.J., 1966. New approach to consumer theory. J. Polit. Econ. 74, 132–157.
Le Goffe, P., 2000. Hedonic pricing of agriculture and forestry externalities. Environ. Resour. Econ. 15, 397–401.
Little, J.M., Berrens, R., 2008. The southwestern market for big-game hunting permits and services: a hedonic pricing analysis. Hum. Dimens. Wildl.: Int. J. 13 (3), 143–157.
Livengood, K.R., 1983. Value of big game from markets for hunting leases – the hedonic approach. Land Econ. 59, 287–291.
Lund, J.F., 2014. Hvilken rolle spiller jagt i forvaltningen af det åbne land? In: Paper presented at the Conference Hunting, Wildlife and Society, 29th September 2014, Copenhagen, Denmark.
Mattsson, L., Boman, M., Ericsson, G., 2008. Jakten i Sverige – Ekonomiska värden och attityder jaktåret 2005/06 (Hunting in Sweden – Economic Value and Attitudes in the Hunting Year 2005/06. Adaptiv Förvaltning av Vilt och Fisk, forskningsrapport nr 1. Sveriges Lantbruksuniversitet). https://sverigesradio.se/diverse/appdata/isidor/files/4061/10200.pdf (in Swedish only).
Mattsson, L., 1989. The economic value of wildlife for hunting. Multiple Use of Forests Economics and Policy. Scand. For. Econ. 30, 42–51.
Meilby, H., Strange, N., Thorsen, B.J., Helles, F., 2006. Determinants of hunting rental prices: a hedonic analysis. Scand. J. For. Res. 21, 63–72.
Messonnier, M.L., Luzar, E.J., 1990. Hedonic estimation of implicit price and demand for a Louisiana deer hunting lease attribute. Am. J. Agric. Econ. 72, 1360.
Mozumder, P., Starbuck, C.M., Berrens, R., Alexander, S., 2007. Lease and fee hunting on private lands in the U.S.: a review of the economic and legal issues. Hum. Dimens. Wildl. 12, 1–14.
Munn, I.A., Hussain, A., 2010. Factors determining differences in local hunting lease rates: insights from blinder-oaxaca decomposition. Land Econ. 86, 66–78.
Nguyen, T.N., Shaw, W.D., Woodward, R.T., Paterson, R., Boyle, K., 2007. An empirical study of option prices for hunting permits. Ecol. Econ. 63, 476–484.
Palmquist, R., 1991. Hedonic methods. In: Braden, J.E., Kolstad, C.D. (Eds.), Measuring the Demand for Environmental Quality. Elsevier Science Publishers, North Holland, Amsterdam, pp. 43–77.
Pope, C.A., Stoll, J.R., 1985. The market value of ingress rights for white-tailed deer hunting in Texas. South. J. Agric. Econ. 17, 177–182.
Rhyne, J.D., Munn, I., Hussain, A., 2009. Hedonic analysis of auctioned hunting leases: a case study of Mississippi sixteenth section lands. Hum. Dimens. Wildl.: Int. J. 14, 227–239.
Rosen, S., 1974. Hedonic prices and implicit markets – product differentiation in pure competition. J. Polit. Econ. 82, 34–55.
Shrestha, R.K., Alavalapati, J.R.R., 2004. Effect of Ranchland attributes on recreational hunting in Florida: a hedonic price analysis. J. Agric. Appl. Econ. 36, 763–772.
Taylor, L., 2003. The hedonic method. In: Champ, P., Brown, T., Boyle, K. (Eds.), A Primer on the Economic Evaluation of the Environment. Kluwer, Dordrecht, pp. 331–393.

Thorsen, B.J., Strange, N., 2001. Økonomisk vurdering af en konvertering til naturnær skovdrift (An economic evaluation of the conversion to near-natural forestry. Rapport ved Energi- og Miljøministeriet) (in Danish only), 88 pp.
van Garderen, K., Shah, C., 2002. Exact interpretation of dummy variables in semilogarithmic equations. Econ. J. 5, 149–159.
Vedel, S.E., Thorsen, B.J., Jacobsen, J.B., 2009. First-movers, non-movers, and social gains from subsidising entry in markets for nature-based recreational goods. Ecol. Econ. 68, 2363–2371.
Zhang, D., Hussain, A., Armstrong, J.B., 2006. Supply of hunting leases from non-industrial private forest lands in Alabama. Hum. Dimens. Wildl. 11, 1–14.