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ABSTRACT

In recent decades, there has been increased emphasis on the protection of the aquatic environment. One of the measures to improve the surface water quality is to dedicate buffer zones at rivers, streams and lakes, where farmers are not allowed to plant, grow or fertilize. In 2012, riparian buffer zones of ten meters were introduced in Denmark. This study analyses whether: (1) the buffer zones add significant value in terms of open space for recreational use. This value is recognized by stakeholders; and (2) the buffer zones are enhancing aesthetic values of nature/landscape for those who live nearby. Methodologically, this study consists of qualitative and quantitative parts. The qualitative interviews demonstrate that most of the interviewees consider buffer zones to be a benefit to them, their organizations and institutions. Though the interviewees are aware of the political debate and implementation of the buffer zone areas, not many have made use of them due to the short time span between implementation and interview. In the quantitative part of the study, a hedonic house price study is applied in order to be able to generalize the findings and examine in more detail whether these stated opinions of the interviewed stakeholders are backed up by the revealed preferences. In the quantitative study, we found a low and hypothetical impact of the introduction of the riparian buffer zones on house prices. However, it is interesting to see that the new regulation has shifted the attitudes of the citizens from a mainly negative one according to the media discourse to a more positive appreciation regarding our empirical findings.

1. Introduction

To reduce the deterioration of water quality, Denmark has since the 1980s addressed the negative impacts of agriculture on water quality through the Action Plans for the Aquatic Environment (APAE's). In the latest APAE III (2005–2015), which was already replaced by the Agreement on Green Growth in 2009 and the Agreement on Green Growth 2.0 in 2010, these goals are harmonized with the European Water Framework Directive (WFD) as well as with the requirements for Natura2000 sites as stated in the Birds and Habitat Directives. Hence, the Danish government has bound itself legally in the "Miljømålsloven" (Environmental law) to reach a goal of approx. 90 percent of the water bodies showing "good ecological status" by 2015 (Liefferink et al., 2011). Current government regulations were referring to a 'Green transition'. To achieve this good ecological status, in 1992, it was decided to implement two meters buffer zone for all natural streams (§69 vandløbsloven). Farmers were forbidden to cultivate within this zone. Water streams in city areas or summer house areas were excluded from this regulation. As this measure did not reduce significantly eutrophication in water bodies, it was agreed within the APAE III that before 2009 30,000 ha buffer zones of ten meters width around rivers and lakes were to be created voluntarily by farmers who should be compensated from the government accordingly. However, in 2006, it became obvious that the voluntary target would not be met. At this time, the discussion of a legal enforcement of the agreement emerged, among others, in the national press (e.g., Andersen, 2006). After the first evaluation of the APAE III and the detection of its lack of success in 2008, nature conservationist, member of the opposition parties as well as the environmental minister began to discuss in more depth in the media the option to regulate farmers to establish ten meters buffer zones around lakes and water streams (e.g., Hüttemeier, 2008; Sønderborg, 2008). As the European Union (EU) abolished mandatory set-aside of agricultural fields, potentially

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affecting Danish nature negatively, this discussion was intensified. Hence, the nature conservation association 'Naturfredningsforening' put pressure on the government for the establishment of green corridors, i.e., a network of natural habitats for the protection of plants and animals (comparable to Natura2000) mainly around water bodies or former set-aside areas. Their proposal emphasized the social benefits to Danish citizens and tourists as well as outlines the gains for nature conservation—also valid today (Bisschop-Larsen, 2009).

On September 1, 2012, the former voluntary agreement became mandatory with the implementation of the "lov om randzoner" (regulation on buffer zones). According to the regulation ten meters uniform buffer zones are to be established for all water streams and lakes of more than 100 m^2. Accordingly, all water steams, regardless of e.g., water quality, receptive capacity or integration within a stream network, are now included in the buffer zone regulation. The goal of the regulation is to reduce eutrophication of the water streams efficiently with a relatively minimal administrative burden compared to complex regulations adapted to local characteristics. Based on fairness considerations, farmers could also apply for the reduction of the ten meters buffer zone if the assigned area exceeds five percent of the farm's total arable land. Although farmers are not obliged to mow the buffer zones according to the regulation directly, in order to get subsidies from the EU for this area, however, they should mow at least every second year for maintenance. The same holds for non-farming areas according to the existing Danish law. Although agricultural usage is generally forbidden in the area, farmers are allowed to use the area as permanent grassland ('vedvarende græs') for up to seven years or as storage of materials (e.g., straw bales, building materials and machinery) for up to eight or twenty-eight days depending on the season and provided no fertilizers or pesticides have been applied. Moreover, if there is a direct access to the buffer zones and it does not interfere with the Nature Protection Act, the buffer zone area can also be used for social and cultural events, riding, hunting, and other sports or scouts activities.

The uniform and comprehensively implemented first two meters, and in the later regulation, ten meters zones have been extensively debated in the media and in a variety of organizations. As ca. 43 percent of the introduced buffer zone were used as farming area before the regulation became effective, these discussions mainly focus on practical farming issues and on the economic costs and impacts for farmers and landowners of the regulation, in other words whether production loss for farmers/landowners outweighs the benefits for nature conservation and water protection (Frandsen, 2013; Jacobsen, 2006; Navntoft et al., 2009). In the "Virkemiddelsudvalg's reports" (Report on Instrument Selection), the cost-effectiveness (Schou, 2007; Jensen et al., 2009) and cost-benefits (Hasler et al., 2007) of different measures to be applied in the Danish River Basin Management Plans were evaluated. These reports base their calculation of the direct economic costs and benefits of the discussed instruments on either past spending on this measure or stated preference methods conducted in some locations in Denmark (e.g., Dubgaard, 1996 on "Recreation in Mols Bjerge"). It was estimated that the primary effect of riparian buffer zones is the storage of phosphorus. This primary effect leads to a benefit in social welfare of 3.600–6.800 DKK/ha while at the same time the costs are expected to be 120–6.800 DKK per kilogram captured phosphorus. It is assumed that up to three kilogram phosphorus per hectare can be captured with the help of riparian buffer zone (Schou, 2007).

From a social welfare perspective, it was pointed out that benefits of the new extended buffer zones may lie not only in the aesthetic value of the environment, but also in the potential contribution to new, continuous nature walking paths and recreational areas (Jensen and Caspersen, 2011; Kronvang et al., 2010). Therefore, besides the environmental effects (providing habitat and niches for biodiversity and serving as buffer for phosphor and nitrogen input into the water bodies), individual benefits may also be achieved through aesthetic values and recreational use of the zones. In addition the areas will possibly experience an increase in landscape quality, which contributes to social welfare and nature conservation efforts (Brandt et al., 2013; Primdahl et al., 2010), and supports a development towards economically, socially and environmentally sustainable multifunctional rural landscapes (OECD, 2006; Maier and Shobayashi, 2001; Marsden and Sonnino, 2008).

This study seeks to broaden the discussion on direct economic cost and benefits of the uniform buffer zones by calculating the aesthetic and recreational benefits for the surrounding neighborhood. Therefore, firstly guided interviews with potential stakeholders were conducted to identify potential benefits and barriers towards the buffer zones. The insights of the guided interviews are taken up specifically in the second step of our analysis which is a hedonic price approach (based on house prices) carried out for two rural Danish regions in Western Jutland. We combine these two approaches to examine in more detail whether the formulated opinions of the interviewed stakeholders are backed up by a quantitative approach. Hence, the two study questions were: (1) Do buffer zones add significantly value in terms of open space for recreational use, and is this value recognized by stakeholders?, and (2) do the buffer zones enhance aesthetic values of nature/landscape for those who live nearby?

The following section gives a brief overview on the results of the guided interviews. An in-depth description of the interview method and results can be found in Münch et al. (2013). In section 3, the hedonic house price approach regarding water measures is reviewed and social benefits are calculated quantitatively. The paper ends with the conclusion and discussion of the results.

2. Stakeholders' attitudes towards awareness and use of buffer zones

Geoghegan (2002) concludes that individuals highly value open spaces around their homes. This inspired the qualitative approach of this study as it may be assumed that the implementation of buffer zones, and with this access to more open space, is regarded as beneficial by the individuals. The qualitative study entails phone interviews, carried out with actors representing various organizations between February and April 2013. Regarding the selection of stakeholders, eleven interviewees were chosen representing the following organizations: Danish Hiking Association[1], Danish Orienteering Association[2], The Danish Scout Association[3], Danish Ornithological Association[4], Denmark's Association for Nature Preservation[5], Denmark's Sports Fishing Association[6] and one kindergarten: Børnehuset Borris. The organizations were picked based on their profile of being active outdoor organizations, with the exception of the kindergarten. However, as kindergartens organize regularly outdoor trips and activities, these are represented in this study as well. The assumption is that the organizations' current usage of nature may be positively affected by the implementation of buffer zones as these constitute new areas for potential use. Interviewees were not selected very specifically to represent the areas in this project (which will be introduced below), but rather to identify which barriers exist in general for social acceptance and use. The

[1] Dansk Vandrelaug.
[2] Dansk Orienterings-Forbund.
[3] Det Danske Spejderkorps.
[4] Dansk Ornitologisk Forening.
[5] Danmarks Naturfredningsforening.
[6] Danmarks Sportsfiskerforening.

interview guide is semi structured around the following aspects: (1) Current use of nature, (2) Awareness of buffer zones (and regulation), (3) Attitudes towards buffer zones (and regulation), and (4) Actual use – or potential use – of buffer zones.

Regarding the current use, all our interviewees are using nature either on a daily or a least regularly base. All of the interviewees have also heard about the implementation of riparian buffer zones, mostly through the media, their voluntary work in the organization or discussion with farmers. One even searched for information on the subject on the website of Naturstyrelsen. Hence, all interviewees are aware of the buffer zone and its regulation. In general, most of the interviewees consider buffer zones to be a benefit to them, their organization and institutions. It is argued that easy access to the buffer zones is essential if the public is to use these areas. So, e.g., the Danish Ornithological Union coordinates once per month a counting of different bird species including in the riparian buffer zones. It is noticed by them, that e.g., a rare bird spotting in an area is followed by visits of up to 500 ornithologists in just a few days. Access or non-access is in this case crucial.

A theme of special interest in regards to this study is the interviewees' awareness of the buffer zones combined with their usage of the areas. Though the interviewees are aware of the political debate and implementation of the buffer zone areas, not many have made actual use of them. This might be due to the short-time period passed between the interviews and the implementation of the buffer zone; a time span mainly determined by winter weather which restricts outdoor activities. Existing knowledge on established hiking paths and fields spurs the interviewees to maintain the usage of current paths, fields and areas. It is, however, mentioned that if more information is provided on where the buffer zones are located and how they can be accessed and used actual usage may increase.

3. The hedonic price approach

3.1. The hedonic house price approach applied

In an international context, the hedonic price approach has been widely applied and methodologically improved over the years in order to accommodate the spatial distribution and the non-linear function of house prices. In order to derive the WTP for the recreational and aesthetic value of water bodies, different approaches have been taken. For example, incorporating spatial information, Cho et al. (2011) calculated that residential housing prices in Knox County, Tennessee (USA) increase on average by about US$ 491 when located one mile closer to a water body. However, this effect only holds true in their study for large water bodies that may offer beautiful scenic views (in particular in connection with parks), while small creeks or even lakes are calculated to create no or negative effects on house prices. Thus, distances as such only matter if recreational and aesthetic value is generated by the water body at the same time. An attempt to disentangle the aesthetic from the recreational value is provided by Lansford and Jones (1995). Based on a Box-Cox transformation of the house prices as well as differentiating between the distance to the waterfront (i.e., direct access to lakes) and bluff (i.e., no direct access due to cliffs, but best panoramic views), they estimate that in the Highland Lake area, Texas (USA), house buyers are willing to pay a premium of US$ 59,826 for waterfront properties with direct access. This premium is reduced by about 10 percent if no direct access exists (i.e., Bluff location); thus the view cannot totally offset the lack of access. Moreover, the premium for direct waterfront properties falls rapidly with distance until a distance of approx. 2000 ft., where the price drop slows down (i.e., hyperbolic price function). By comparing an actively managed lake reservoir in Indiana (USA) and a passively managed lake in Connecticut (USA), Muller (2009) reckoned that waterfront access provides a higher value than waterfront views or adjacency to a river area. Yet these values also differ between both regions such that one may assume that water management practice drives the results in his case. An opposite effect is detected for water streams by Netusil (2005), who estimated for the City of Portland, Oregon (USA) that a private stream within 200 ft. of the property decreases sales prices by 2.8 percent, while being located within ¼ to ½ mile from a private stream raises sales prices by 1.84 percent. However, this result does not hold true for publicly accessible water streams. On the contrary, a public trail within 200 ft of the property reduces sales price by 5.54 percent. A taste for privacy and private use of natural amenity seems to be driving these results.

So far, most studies only consider the proximity or quality of water bodies and in particular lake or beach regions, but do not consider the value riparian buffer zones may create. One of the few studies which addresses the value created by riparian buffer zones is Mooney and Eisgruber (2001). Using market-assessed valuation data for single family residences and the proximity to riparian protection measures within the Mohawk watershed, western Oregon (USA), they estimated that although houses closer to water streams are on average seven percent more highly valued, riparian buffer zones (on average ca. nine meters wide) decrease the market value of the property by about 0.06 percent/ft. In other words, a buffer zone on the river which is 50 ft. wide would reduce the market value of an average house by US$ 4650. They explain this result by the fact that these buffer zones are normally treed and therefore the visibility of the water stream is reduced. A second study which evaluates riparian buffer zones is Netusil (2006), who used sales prices for single-family residential properties close to the Fanno Creek Watershed in Portland, Oregon (USA). Differentiating between the kinds of wildlife habitat provided by the buffer zone and their riparian class, this study estimated a positive (decreasing) valuation for large forest patches, wetland areas, and large contiguous patches in uplands. The proximity to forest patches with low structure connector patches along streams and rivers, as well as semi-developed rivers accompanied by low structure vegetation and a forest canopy is, in contrast, estimated to decrease the sales price of the property. Hence, the coverage of the riparian buffer zone in this study seems to determine the valuation of the buffer zone. Bin et al. (2009) compared the effect of the introduction of a mandatory riparian buffer zone with data for the Neuse River Basin in North Carolina (USA). By disentangling the valuation for the pre- and post-buffer zone riparian area, this study concluded that although riparian properties achieve a premium on the housing market, the mandatory buffer zone implemented in 1997 had no significant impact on the value of the property in the researched time period (1992–2002).

In addition to studies of natural amenities and quality, Geoghegan et al. (1997) detect that individuals value the diversity and fragmentation of land use around their homes; open space in particular are valued highly (Acharya and Bennett, 2001; Geoghegan, 2002). Kuminoff (2009) emphasizes the decreasing effect farming areas could have on house prices. However, this effect depends on the kind of houses and type of agricultural usage. Thus, open space as such, as well as environmental amenities do not necessarily raise house prices in all cases.

Regarding the economic benefits of water mitigation measures, Danish studies encompass, for example, project evaluations like the Skjern-River restoration (Dubgaard et al., 2001; Pedersen et al., 2007), the Randers Fjord (Atkins and Burdon, 2006) and the Odense River restoration (Jørgensen et al., 2013). These studies seek to assess the value the Danish population sets on water quality improvement. It is found that the WTP for river restoration declines with spatial distance to the river in question (Jørgensen et al., 2013). Moreover, trust in the given information on the water

quality may drive the response in the former choice experiment (Kataria et al., 2012). All of these studies use stated preference methods. A revealed preference approach like the hedonic price approach has to our knowledge not been applied towards water mitigation measures in a Danish context.

This study seeks to disentangle the WTP for the proximity to a water body and the area surrounding the water (riparian buffers as well as buffer zones around lakes). Therefore, the study is in the realm of research on riparian buffer zones and draws on the hedonic price approaches on the valuation of aesthetic and recreational values of water bodies. Moreover, this study is not restricted to a specific water basin but uses all property sales in the chosen Postal code area in the respective time period. Hence, the variation in environmental amenities surrounding the houses is increased while at the same time a potential selection bias is reduced. Additionally, studies for riparian buffers mostly neglect the clustering of natural coverage. Thus, if the spatial autoregressive factor is considered at all, it is restricted on the dependent variable, sales prices, but not extended to the independent variables, drivers of house prices. This might lead to biased standard errors if spatial autocorrelation occurs also among the independent variables and are not accounted for in the estimation model. Spatial autocorrelation on both sides of the estimations will be considered in more depth in this study.

3.2. The hedonic house price theory and method

The hedonic house price approach draws on the theory of revealed preferences—revealed in the activity of buying a house. A house is in this sense a good with a bundle of characteristics (e.g., size, material quality, age, design). Besides these 'individual' characteristics of the house (S), additional surrounding factors may also support the decision of the individual to buy this specific house for this price. These additional surrounding factors may be (1) economic/social (L): e.g., positive: distance to place of employment, public transport facilities, and/or negative: closeness to street noise/emission, crime; (2) natural (N): e.g., positive: distance to beach and recreational areas, negative: closeness to waste site, windmills (e.g., notion of 'not in my backyard'); and (3) aesthetic value (F) which is created by the natural fragmentation of the surrounding area as well as view on the natural element.

$$P = P(S, L, N, F) \tag{1}$$

As a house is a bundle of characteristics, the buyer always faces a trade-off between these different characteristics. The actual buying decision should reflect the preference ordering of the different characteristics within the price (i.e., WTP). The hedonic price method seeks to disentangle sales prices for houses on the market into WTPs for different characteristics of the houses as well as neighborhood characteristics and if possible, controls for the individual characteristics of the buyer (e.g., income, age, family status). As we conduct a first-stage analysis, the latter is not further considered. Based on Gibbons et al., (2011) our basic linear regression model takes on the form:

$$P_{it} = \alpha + \beta_1 S_{it} + \beta_2 L_i + \beta_3 N_i + \beta_4 F_i + \beta_5 T + \epsilon \tag{2}$$

where the dependent variable (P_{it}) is the sales price of house i at the t time of sale, while S_{it} is the vector of the structural characteristics of house i at the time of sale (e.g., building size, number of rooms, number of bathrooms, age); L_i indicates the locational characteristics of house i, such as distance to economic variables—e.g., transport infrastructure (public transport, motorway etc.), distance to service provisions—e.g., hospitals and schools, and distance to a labor market, etc.; N_i denotes the vector of the neighborhood characteristics, in our case: the natural amenities (e.g., proximity to recreational facilities and buffer zones); while F_i captures the aesthetic value derived from the natural fragmentation around the house and the view on the natural element under consideration. T is a time dummy which captures exogenous unobserved developments in the housing markets in the respective year of sale and β_1, β_2, β_3 and β_4 are the coefficients for the structural, locational, natural and aesthetic attributes. Finally, the unobserved components are included in the error term ϵ.

Based on the assumption that the supply of houses meets the demand of houses in the given area, and at the same time the house purchaser maximizes his utility in this purchase given the available budget and the range of choice available, the partial derivative of the estimated$\beta_b = \frac{\partial \ln(P)}{\partial \ln(b)}$ price function (2) will yield the marginal implicit price of the attribute in the estimation. Hence,, which is the marginal willingness to pay (MWTP), i.e., in our case the benefit of a one-unit change in the distance towards the buffer zone (b), ceteris paribus (Mooney and Eisgruber, 2001).

To derive the average WTP for the implementation of the buffer zones, the marginal implicit price is derived from the following under the assumption of a linear WTP function:

$$WTP = \frac{\partial \ln(P)}{\partial \ln(b)} \bar{p} \tag{3}$$

where $\bar{p}$ is the average price.

One critical point in this approach is the underlying form of the price function assumed in the regression model. In the literature, a longstanding discussion is whether a Box–Cox transformation is the appropriate estimation form for calculating the WTP (Cassel and Mendelsohn, 1985). Despite criticism, some authors claim that a Box–Cox transformation lead to an appropriate estimation (e.g., Lansford and Jones, 1995; Mooney and Eisgruber, 2001), while the majority of studies use the natural logarithm as the functional form to be estimated as it is simpler to interpret, mostly reflects the price function as well as the Box–Cox transformation, and disturbances due to spatial autocorrelation can be corrected (Muller, 2009; Cho et al., 2011).

Regarding spatial autocorrelation, Acharya and Bennett (2001) found in their dataset no significant spatial autocorrelation which might bias the estimation of the standard errors if not corrected for (Anselin, 2001). Kadish and Netusil (2012) detected within their dataset some spatial autocorrelation which, according to tests, are captured best by a spatial error model. Bin et al., (2009) do not report any test results for spatial autocorrelation but rather apply the spatial error correction in their estimation. Kuminoff et al. (2010) provide evidence that models including at least spatial fixed effects perform better than standard linear estimation models. In our dataset spatial autocorrelation is detected in the dependent variable of sales prices for houses (i.e.,: Moran's I and Geary's C are significant). Hence, the sales price of house i is not independent of the sales price of the neighboring house j. Given these high z-scores of Moran's I, the likelihood that this clustered pattern could be the result of random chance is less than one percent. Thus, the above mentioned simplistic hedonic price approach needs to be extended towards a spatial regression model based on the natural logarithm of the price function.

Following Elhorst (2010), further tests were undertaken to specify which spatial regression model reflects best the detected spatial correlation in our sample data. Applying the robust LM-tests (see Anselin et al., 1996), the simple linear model as described in equation two was rejected in favor of a spatial lag or spatial error model. After estimating the spatial Durbin model as well as calculating the likelihood ratio (LR) test the spatial lag and spatial error model were rejected in favor of the spatial Durbin model. This model is computed as follows:

$$Y = \rho WY + \alpha \tau_N + X\beta + WX\theta + \epsilon \tag{4}$$

where Y denotes the dependent variable (i.e., natural log of sales price), WY is the spatial lag of the dependent variable, ρ is the spatial autoregressive coefficient, τ_N refers to the constant term, α,β are the associated estimated coefficient vectors, and X denotes the exogenous independent variable. For simplicity in display, X is the combined vector of the above mentioned independent vectors S_{it}, L_i, N_i, F_i and T. WX are the spatially lagged independent variables, θ the fixed but unknown parameters, and ϵ the error term.

The use of a model which includes spatial lags of the dependent and independent variable needs also to be theoretically justified. One can argue that house prices in one region are not independent from each other due to unobserved characteristics, e.g., design, time of building or selection effects of people with similar income (i.e., budget restriction) into the same area. Additionally, if house i is not far away from a natural amenity, its neighbor j is also close to this amenity. Hence, observed characteristics as well as unobserved characteristics of the houses are not independent from each other; a fact which violates the basic assumption of linear regression models.

The spatial weight matrix (W) is calculated using an inverse distance matrix (i.e., $W = 1/d_{ij}$ with d as distance between house i and house j), which is row standardized (i.e., takes the interval (w_{min}, 1)). Thus, it is assumed that the price of house i has an impact on the price of house j, and the other way around. This impact is declining linearly with increasing distance between houses i and j. All independent variables, except the dummy variables, enter into the regression as a natural logarithm. Therefore, coefficients need to be interpreted as change in percent. Variables were regressed separately in different regression models if it was to be expected that multicollinearity would bias the estimation (i.e., following Hill and Adkins (2007) the Variance Inflation Factor in each models scores lower than six). Moreover, heteroskedasticity is controlled for by estimating the robust standard errors.

Due to the imposed spatial interaction of the independent variables (WX) within the SDM estimations, the MWTP cannot be derived directly from the estimated coefficients as in a standard linear approach (LeSage and Pace, 2009). The marginal effects of the independent variables of interest on house prices are therefore calculated following Vega and Elhorst (2013):

- Average direct impact: Diagonal elements of $(I - \rho W)^{-1}\left[\beta_k + W\theta_k\right]$.
- Average indirect impact: Off-diagonal elements of $(I - \rho W)^{-1}\left[\beta_k + W\theta_k\right]$.

The average total impacts are the sum of all matrix elements divided by N for each exogenous variable.

3.3. Data

As mentioned above, postal code areas were employed in the quantitative analysis instead of restricting data to a water basin area. Thus, data was collected in the municipality Ringkøbing-Skjern (Postal code 6880 [Skjern] and Postal code 6900 [Tarm]), and in the municipality of Esbjerg for Ribe (Postal code 6760). Using postal areas allowed us to exploit wider variations in house and natural characteristics. Moreover, a potential selection effect of people with distinct preferences for being close to a river and therefore, migrating into a specific river basin can be ruled out, as houses far away from the big rivers were also included. This allows a more general evaluation of buffer zones. This seems to be the most promising strategy as the buffer zone regulation is not focused on specific rivers but rather applied uniformly in Denmark. Moreover, we analyze two rural municipalities in Western Jutland, Denmark, which are dominated by the sectors agriculture and tourism. Albeit, these areas have a different history regarding their approach to surrounding nature, open space is plentiful available compared to urbanized areas which are predominantly studied in previous work on Danish WTP for water amenities. The focus of this study is on rural areas as we seek to determine a conservative measure of WTP for the newly introduced buffer zone which reflects the attitude of a broader population segment which are affected by the new law instead for the rather special case of the (semi-) urban population which are less effected by the new regulation.

Table 1
Number of house in our sample per municipality.

No of detach single-family houses	Ribe	Skjern/Tarm
Sold in 1996–2007	1013	1723
Sold in 2008–2013	516 (33.7%)	750 (30.3%)
Thereof have a buffer zone on the lot	19 (ca. 4%)	18 (ca. 2%)
Total	1529	2473
Thereof have a water stream on the lot	28 (ca 2%)	32 (ca. 1%)

The dependent variable is a vector of sales prices for houses (in DKK). For our study, we limited this variable to detach single-family houses sold on the free market, i.e., auctions, family transfers, etc. are excluded, as well as to houses with different purposes than for private use. Moreover, farm houses and holiday houses were not included as one may argue that these houses belong to a different property market segment, as well as the fact that the effect of buffer zones on farm land (economic effect) has already been discussed by Jensen et al. (2009) and Schou (2007). We obtained sales data from 1996 to 2013 provided by KMD (ESR-sales data) for properties (i.e., land price is not included). To avoid duplicates within the dataset caused by houses which are sold in the time period more than once, only the last sale of the property was included. Sales prices for the houses were deflated by the Consumer price index as provided by Statistics Denmark (2013). An overview of the location of the two study areas can be found in Fig. 1.

Summarizing the dependent variable per area (see Table A1 & Table A2, Appendix 1), the average sales price in Skjern/Tarm is lower than the one in Ribe. A two-sample t-test with unequal variances confirmed that the average sales price in Ribe is significantly higher than the one in Skjern/Tarm (see Table A3, Appendix 1). Based on a distinct difference in house price level, the two municipalities will be calculated separately based further on the assumption that there is no or at least a negligible interdependence between the house prices in Ribe and Skjern/Tarm. In addition, in the estimation for the dataset Skjern/Tarm, a dummy was included which captures potential unobserved systematic differences between the two areas within the municipality.

The ten meters buffer zone regulation has been discussed in the media at least since 2006, but eventually implemented in September 2012. Considering the media attention in connection with the first evaluation of the APAE III, the discussion on forcing farmers to implement the before voluntary promised ten meters buffer zone took up pace in 2008. This study addresses the impact on house prices of the ten meters buffer zone regulation already sold between 2008 and 2013, hence before the actual implementation. The interviews indicated that people are aware of the discussion on the extension of the two meters buffer zone into the ten meters buffer zone. Therefore, one can expect to find an effect on the house prices before the actual implementation of the extended buffer zones as a potential threat/chance which would already affect the decision of buying a new house. However, sales prices for houses, which peaked in 2006, started to decline in 2008 and stabilized up from 2009 (Realkreditforeningen, 2014). Hence, positive impacts of the to-be introduced riparian buffer zone on house prices are rather underestimated than overestimated by considering a time span starting from 2008.

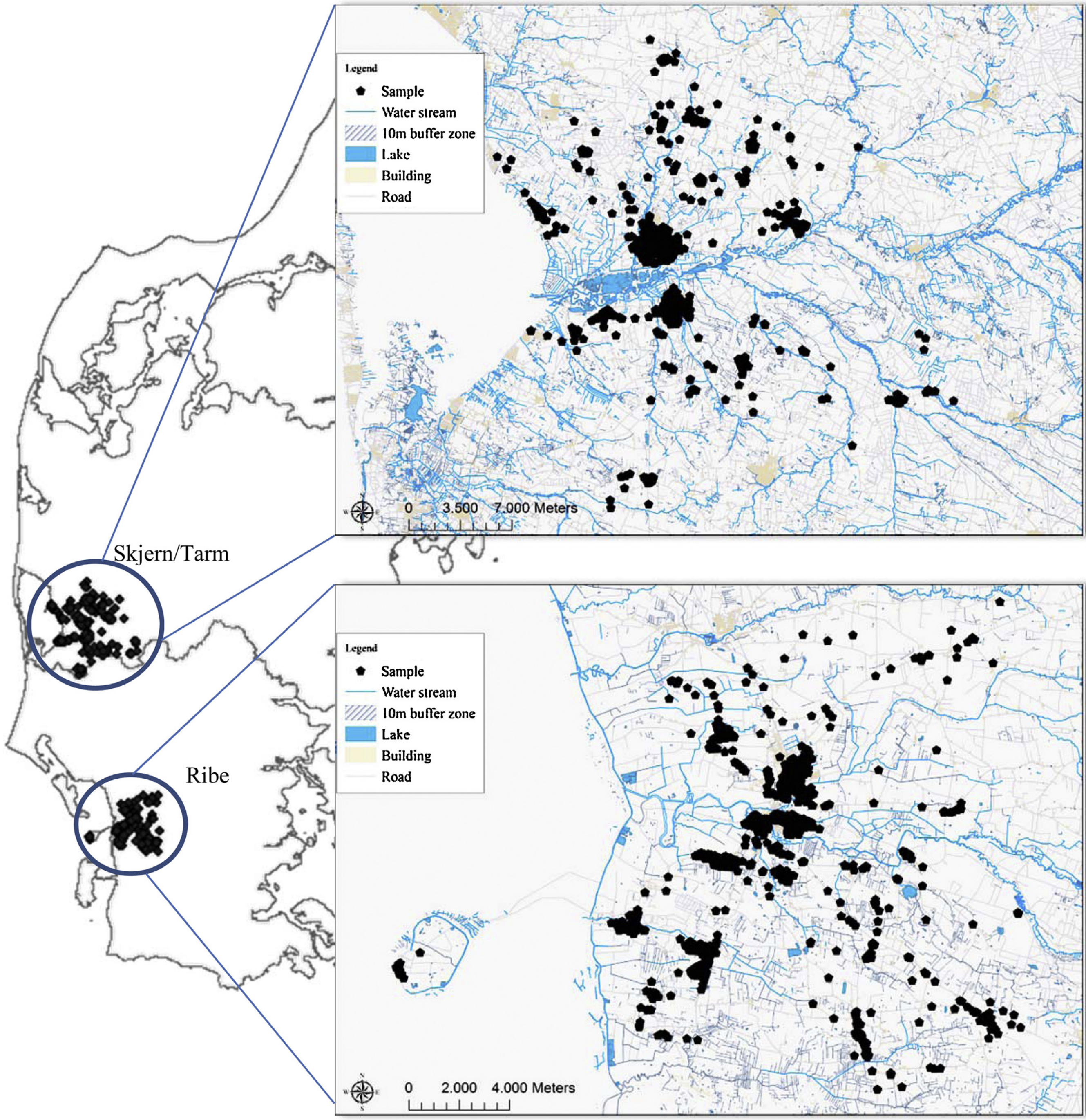

Fig. 1. Map of the two study areas showing the location of houses included in the model and selected area characteristics.

With the introduction of the buffer zone, 134 private properties in our sample are affected by the regulation by having a buffer zone on the lot. Out of these 134 properties, 37 have been sold since 2008 (see Table 1). In order to measure the effect of the regulation following Bin et al. (2009), a dummy variable ($D^{buffer}_{sold2008}$) was integrated into the regression which measures the effect of the introduction of the buffer zone for the properties which have at least one buffer zone on the lot and was sold in 2008 and later. An interaction term between the dummy variable $D_{sold2008}$, which denotes all houses which have been sold up from 2008 with a one, and the variable 'distance to the nearest buffer zone' measures the aesthetic value of the buffer zone on the house sales price since 2008. A second option to capture the aesthetic value would be to use the fragmentation of open space around the house. However, this landscape fragmentation cannot directly be related to the buffer zone regulation and will be in the following considered only as control variable. The interaction term between the dummy variable $D_{sold2008}$ and the variable 'distance to the nearest buffer zone access point' captures the recreational value of the buffer zone on the house sales price since 2008. In addition, the dummy variable D^r captures the time-invariant effect of having a water stream on the property.

The independent variables to be integrated into the regression model are divided into house characteristics (S_{it}), locational economic (dis-) amenities (L_i), natural (dis-) amenities (N_i), and surrounding landscape fragmentation (F_i) (see Table A1 & Table A2, Appendix 1). For the categories (S_{it}) and (L_i), we followed Osland

(2010) as far as suitable for our case. The house (S_{it}) is described by the variables: *age* of the building, *squared age* of the building, an interaction term between the incident of a crucial *renovation* (rebuild)-dummy and the age of the building, the *size* of the building, the size of the lot and the number of water flushed *toilets* in the building. This housing data includes data that is extracted by KMD (2013) from the databases SoegEjendom (main characteristics of the building), and BBR (use of the houses and specific characteristics, e.g., heating and building material). For ease of interpretation, the variables age and age^2 (time between year of construction until June 30, 2013 and its square) are demeaned. Both were integrated into the estimation simultaneously to account for the nonlinear impacts of house age on price.

To capture economic (dis-) amenities (L_i), the Euclidean distance from the respective house to the *city center* as well as to the next *street* (wider than three meters) were calculated based on maps provided by Geodatastyrelsen (2013). Alternative to distance to city center, a dummy variable (D^{urban}) is created which denotes if the house is *urban* planning zone according to maps provide by AIS (2000). Additionally, the Euclidean distance towards *parking* lots was integrated. Parking lots are partly within in industrial areas (i.e., work and shopping facilities) as well as in city centers (i.e., employment, shopping, and cultural/social facilities). Hence, this variable shall capture the distance to the next employment and shopping options. Moreover, distance to the next *waste* site was included as economic disamenity. Data for the latter is provided by AIS (2000).

The core of the analysis is to measure the WTP for natural amenities (N_i), in particular for the creation of buffer zones along lakes and rivers. Therefore, the Euclidean distance was measured between house *i* and the closest visible *river, lake* and the *ten meters buffer zone*. In principle, nearly all surface water bodies in our sample were subject of the two meters buffer zone regulation (99 percent). But while in the region of Skjern/Tarm only 43 percent of the surface water bodies were regulated by the ten meters buffer zone regulation, in the region of Ribe 88 percent of the surface water bodies fell under the same regulation. Moreover, small water streams may not have the same effect as larger rivers (Cho et al., 2011). To control for this potential effect, the Euclidean distance to the next *river above 2.5 meters* was measured as well. These variables of linear distance are meant to proxy the aesthetic values of the stream, assuming that in this short time period no trees will influence the view and therefore decrease the value of the property (Mooney and Eisengruber, 2012). The data for the location of river and lakes are based on maps provided by Geodatastyrelsen (2013). The locations of buffer zones were taken from compensation maps as published by NaturErhvervstyrelsen (2012).

As we learned from the guided interviews, the proximity to the buffer zone as such is not the decisive factor for the use and valuation of the buffer zone but rather the access to them. In order to capture this argument, the closest *access* to the buffer zone was calculated, i.e., the distance from house *i* via roads and pathways towards the nearest buffer zone as mapped by NaturErhvervstyrelsen (2012). An access point into the buffer zone is defined as the intersection point of a pathway/road and the ten meters buffer zone. It is assumed that the existence of an access point to the buffer zone allows the access and use of the buffer zone which in turn creates a recreational value for the respective user.

We further controlled for the Euclidean distance to the closest *beach* and *forest* to capture additional recreational value based on data provided by Geodatastyrelsen (2013). To capture potential natural disamenities created by the proximity to the agricultural-urban edge or to windmills, the Euclidean distance to the closest *farmland* and *windmill* was integrated into the regression. In the region of Ribe-Esbjerg ca. 62 percent of the buffer zones were classified as farmland. In the area of Ringkøbing-Skjern ca. 52 percent of the buffer zones are former farmland. In order to rule out that distance to farmland is actually capturing the distance to the next ten meters buffer zone, the distance was calculated to farmland which is not part of the buffer zone regulation. However, in the case of ca. 17 percent of our observations in Ringkøbing-Skjern and ca. 32 percent of our observations in Ribe the nearest buffer zone is adjacent to farmland. Data on the location of these natural (dis-) amenities were taken from NaturErhvervstyrelsen (2012) and Miljoportalen (2012).

To determine the value created by open land, a fragmentation index, the mean patch fractal dimension (*MPFD*), was calculated (Raines, 2002). As the average lot is 140 meters long, it was decided to calculate the fragmentation of an area of 150 meters around the house. Landscape elements like water streams, lakes and fields served as open space elements. This index measures the shape complexity, which equals one for shapes with simple perimeters and approaches the value two when shapes are more complex; thus, more space is taken up by the natural open space elements. Regarding our sample, it becomes obvious that some houses are closer to the city center and with this surrounded by buildings while others are in rural areas with hardly any neighbors but plenty of open space, or somewhere in between both extremes. The fragmentation index shall capture this difference in the direct surrounding area.

3.4. Results

Estimations were based on a Spatial Durbin model (SDM, see description above) and were conducted separately for the areas Ribe and Skjern/Tarm for the time period 1996–2013. Model 1 includes into the estimation S_{it}, L_i, F_i and the basic N_i (i.e., no buffer zone variable or dummy variables regarding the buffer zone effect). This model serves as baseline model. Hence, Model 2-4 are extensions of Model 1. In Model 2, the distance to the ten meters buffer zone from house *i* as well as $D^{buffer}_{sold2008}$, and the interaction terms of $D_{sold2008}$ with distance to the ten meters buffer zone are implemented into the SDM estimation. The variable of special interest is the interaction term as it captures the part of the sales price which is conceived by the aesthetic value of the riparian buffer zone generated since 2008. In Model 3, the interaction term is altered towards of $D_{sold2008}$ with distance to the next ten meters buffer zone access. The access issue was pointed out in the guided interviews and is in the quantitative analysis to measure the part of the sales price which originates from the recreational value of the riparian buffer zone initiated since 2008.

The result of Model 1–3 indicates that in our sample of Ribe the distance to water streams counterintuitively raised house sales price, Model 4 is implemented as a weak robustness check of Model 3. Instead of the distance to all surface water streams, the distance to only the larger rivers (above 2.5 meters width) in the area is included into the regression. Results of the estimations are displayed in Table 2 (sample of Ribe) and Table 3 (sample of Skjern/Tarm).

In general, our variables describing the house qualities and characteristics showed expected signs. In the case of Skjern/Tarm, houses older than the average were more expensive. The effect of age, however, was decreasing considering the negative significant sign of age squared. With increasing building areal and/or lot size, houses increased in price. Accordingly, it can be concluded that the quality and size of a property is quite significant in determining house prices. This is consistent with findings for summer houses in Hjalager et al. (2009).

Regarding economic amenities, in the estimations for the area of Ribe a significant premium within in the house sales prices is reflected for the proximity to parking areas (i.e., shopping facili-

Table 2
Spatial Durbin Model Estimation (Sample Ribe) Robust standard errors in parentheses.

Sample: Ribe				
Dependent Variable: Ln(Sales price)				
	Model 1	Model 2	Model 3	Model 4
Age (demeaned)	0.000331	0.000200	0.000194	0.000131
	(0.000722)	(0.000704)	−0.000703	(0.000700)
Age^2 (demeaned)	−1.19e−07	−9.12e−08	−9.45e−08	−7.93e−08
	(3.63e−07)	(3.55e−07)	(3.54e−07)	(3.51e−07)
Rebuild x Age (dem.)	$9.98e\text{-}07^{**}$	$9.52e\text{-}07^{*}$	$9.52e\text{-}07^{*}$	$9.64e\text{-}07^{*}$
	(4.91e−07)	(4.94e−07)	(4.95e−07)	(4.94e−07)
Ln(toilet)	0.000765	0.000681	0.000695	0.000691
	(0.000549)	(0.000539)	(0.000542)	(0.000536)
Ln(building size)	0.273^{***}	0.256^{***}	0.264^{***}	0.255^{***}
	(0.0540)	(0.0540)	(0.0539)	(0.0538)
Ln(lot size)	0.234^{***}	0.236^{***}	0.238^{***}	0.237^{***}
	(0.0545)	(0.0524)	(0.0524)	(0.0526)
Ln(city)	−0.000121			
	(0.000230)			
D^{urban}		0.0808	0.0759	0.0617
		(0.0867)	(0.0871)	(0.0905)
Ln(street)	−0.0155	−0.00981	−0.0127	−0.0143
	(0.0252)	(0.0252)	(0.0252)	(0.0250)
Ln(parking)	-0.113^{***}	-0.122^{***}	-0.119^{***}	-0.149^{***}
	(0.0369)	(0.0377)	(0.0371)	(0.0388)
Ln(waste)	0.107	0.125^{*}	0.141^{**}	0.116
	(0.0668)	(0.0703)	(0.0702)	(0.0728)
Ln(river)	0.0747^{*}	0.0850^{**}	0.0841^{**}	
	(0.0386)	(0.0415)	(0.0414)	
Ln(river>2.5 m)				−9.61e−05
				(0.0403)
Ln(10 m buffer)		-0.000291^{*}	-0.000376^{**}	-0.000271^{*}
		(0.000166)	(0.000149)	(0.000165)
Ln(access 10 m buffer)		-0.000393^{**}	−0.000278	−0.000257
		(0.000177)	(0.000175)	(0.000175)
Ln(lake)	−0.0670	−0.0696	−0.0652	−0.0579
	(0.0468)	(0.0465)	(0.0466)	(0.0481)
Ln(beach)	−0.0913	−0.0961	−0.121	−0.122
	(0.138)	(0.138)	(0.139)	(0.130)
Ln(forest)	−0.00456	−0.00839	−0.00616	−0.0202
	(0.0278)	(0.0280)	(0.0280)	(0.0288)
Ln(farmland)	0.0229	0.0149	0.0122	0.0269
	(0.0374)	(0.0382)	(0.0382)	(0.0365)
Ln(windmill)	0.113	0.0885	0.0871	0.0539
	(0.110)	(0.110)	(0.110)	(0.109)
MPFD	0.840^{**}	0.803^{*}	0.849^{**}	0.619
	(0.410)	(0.410)	(0.414)	(0.404)
D^{r}	0.147	0.120	0.0845	0.0210
	(0.115)	(0.108)	(0.105)	(0.111)
$D^{buffer}_{solid2008}$		0.114	0.102	0.0312
		(0.103)	(0.0982)	(0.0973)
Ln(10m buffer) x $D_{solid>2008}$		−0.000153		
		(0.000214)		
Ln(access 10 m buffer) x $D_{solid>2008}$			-0.000872^{***}	-0.000914^{***}
			(0.000251)	(0.000254)
Year-Dummies	YES	YES	YES	YES
Constant	6.667	3.311	4.921	1.449
	(8.155)	(7.820)	(7.853)	(8.046)
Rho	0.882^{***}	0.886^{***}	0.879^{***}	0.863^{***}
	(0.102)	(0.0994)	(0.104)	(0.113)
Sigma	0.584^{***}	0.582^{***}	0.583^{***}	0.582^{***}
	(0.0152)	(0.0151)	(0.0152)	(0.0153)
Observations	1,529	1,529	1,529	1,529
sqCorr	0.487	0.492	0.491	0.493
varRatio	0.486	0.488	0.488	0.489
Wald test Rho = 0	74.65^{***}	79.37^{***}	71.98^{***}	58.25^{***}
Wald test WX = 0	124.5^{***}	121.1^{***}	121.3^{***}	122.1^{***}

The same models as reported in Table 2 were calculated including the squared distance to river, ten meters buffer zone and access to the ten meters buffer zone. However, none of the models showed a significant effect. Calculations are therefore not further reported.

ties, employment opportunities) as well as distance to waste sites. In both areas, proximity to city center or the location within an urban planning zone was not significant. Thus, city centers with all their amenities (i.e., culture, shopping, employment opportunities or access for commuting [i.e., train station] to the place of employment) were not valued highly in our sample of the two study areas.

The valuation for natural amenities, however, is apparently more complex. The estimation for Ribe pointed towards a positive evaluation of distance to rivers. Hence, people in this area were

Table 3
Spatial Durbin Model Estimation (Sample Skjern/Tarm) Robust standard errors in parentheses.

Sample: Skjern/Tarm				
Dependent variable: Ln(Sales price)				
	Model 1	Model 2	Model 3	Model 4
Age (demeaned)	0.00781***	0.00789***	0.00775***	0.00772***
	(0.00143)	(0.00144)	(0.00144)	(0.00145)
Age^2 (demeaned)	−0.000136***	−0.000134***	−0.000133***	−0.000133***
	(2.55e−05)	(2.53e−05)	(2.51e−05)	(2.55e−05)
Rebuild x Age (dem.)	1.29e−06**	1.27e−06**	1.32e−06**	1.30e−06**
	(6.05e−07)	(6.02e−07)	(6.02e−07)	(6.07e−07)
Ln(toilet)	0.000671	0.000667	0.000705	0.000671
	(0.000624)	(0.000577)	(0.000591)	(0.000593)
Ln(building size)	0.547***	0.552***	0.547***	0.548***
	(0.0418)	(0.0418)	(0.0417)	(0.0419)
Ln(lot size)	0.00216	0.00218	0.00217	0.00217
	(0.00134)	(0.00134)	(0.00134)	(0.00134)
Ln(city)	9.31e−05			
	(0.000311)			
D^{urban}		−0.0178	−0.0149	−0.00985
		(0.0488)	(0.0487)	(0.0488)
Ln(street)	0.0315	0.0376	0.0337	0.0374
	(0.0258)	(0.0263)	(0.0264)	(0.0264)
Ln(parking)	−0.00995	0.000136	0.000383	0.00175
	(0.0243)	(0.0243)	(0.0242)	(0.0243)
Ln(waste)	−0.0756	−0.0740	−0.0799	−0.0708
	(0.0550)	(0.0572)	(0.0585)	(0.0586)
Ln(river)	−0.0299	−0.0225	−0.0267	
	(0.0374)	(0.0378)	(0.0371)	
Ln(river > 2.5 m)				−0.0522
				(0.0384)
Ln(10 m buffer)		−0.000688***	−0.000688***	−0.000650***
		(0.000118)	(0.000115)	(0.000119)
Ln(access 10 m buffer)		0.000221	0.000536**	0.000507**
		(0.000206)	(0.000229)	(0.000230)
Ln(lake)	0.0169	0.0289	0.0244	0.0216
	(0.0399)	(0.0408)	(0.0406)	(0.0413)
Ln(beach)	−0.00454	−0.0136	−0.0323	−0.0314
	(0.0745)	(0.0752)	(0.0790)	(0.0794)
Ln(forest)	−0.000939***	−0.000952***	−0.000961***	−0.00103***
	(7.65e−05)	(7.82e−05)	(7.83e−05)	(7.18e−05)
Ln(farmland)	0.00801	0.0172	0.0143	0.0233
	(0.0296)	(0.0309)	(0.0312)	(0.0304)
Ln(windmill)	0.0888	0.103*	0.0820	0.0801
	(0.0600)	(0.0602)	(0.0606)	(0.0604)
MPFD	0.298	0.311	0.326*	0.325*
	(0.195)	(0.193)	(0.194)	(0.194)
D^r	−0.0721	0.0691	0.0756	0.0546
	(0.114)	(0.118)	(0.118)	(0.122)
$D^{buffer}_{solid2008}$		−0.325**	−0.343***	−0.336**
		(0.133)	(0.132)	(0.132)
Ln(10m buffer) x $D_{solid>2008}$		0.00998		
		(0.0353)		
Ln(access 10 m buffer) x $D_{solid>2008}$			−0.000794***	−0.000740***
			(0.000274)	−0.00028
$D^{Zip6900}$	−0.0509	−0.0371	−0.0327	−0.0191
	(0.174)	(0.174)	(0.176)	(0.174)
Year-Dummies	YES	YES	YES	YES
Constant	−6.284	−6.700	−6.250	−6.949
	(4.853)	(5.392)	(5.530)	(5.533)
Rho	0.506***	0.459**	0.459**	0.525***
	(0.178)	(0.182)	(0.183)	(0.177)
Sigma	0.550***	0.546***	0.548***	0.549***
	(0.0120)	(0.0119)	(0.0119)	(0.0120)
Observations	2,473	2,473	2,473	2,473
sqCorr	0.488	0.494	0.491	0.489
varRatio	0.489	0.496	0.494	0.491
Wald test Rho = 0	8.103***	6.353***	6.277***	8.786***
Wald test WX = 0	125.1***	135.7***	132.5***	132.4***

The same models as reported in Table 3 were calculated including the squared distance to river, ten meters buffer zone and access to the ten meters buffer zone. However, none of the models showed a significant effect. Calculations are therefore not further reported.

significantly willing to pay a premium for a house which is further away from all kinds of surface water streams. However, this effect vanished if only the distances to the main rivers (more than 2.5 meters wide) are considered. These results seem to be in line with the findings of Cho et al. (2011) that the proximity to small water streams may create a negative economic value. Cho et al. (2011) explained this effect with the lack of aesthetic values of a small water stream, in particular if this stream is not managed prop-

erly. Thus, aesthetic values are created by natural topography also by a proper land management regime and access. Another argument to explain this result might be that the WTP to avoid risks (due to e.g., kids drowning in the stream, diseases transmitted by mosquitos breeding in the small water streams etc.) overrules the recreational and aesthetic benefits of such small water streams. In particular, in our sample region of Ribe, some home owners with basements have also had problems with incoming water and moisture due to rising ground water levels in the region. This may also create a preference for having some distance from a water stream in order to avoid basement damages. As mentioned above 88 percent of rivers are subject to the buffer zone regulation. It can therefore not be rule out for this area that a kind of threshold effect of optimal distance to surface water is driving our results of a significant positive evaluation of the 10 meter buffer zone. In contrast, house prices in Skjern/Tarm reflected no significant preference (positive or negative) for the distance to water streams, irrespective of size, but an appreciation of the closeness to the ten meters buffer zone. As mentioned above, in the region of Skjern/Tarm only 43 percent of the surface water streams are affected by the buffer zone regulation. Hence, it is not likely that the positive valuation of the buffer zone in this region is a threshold effect of the optimal distance to the river.

Most of the other natural variables integrated in the estimation surprisingly turn out not to be significant in the Ribe area. Open space, measured here as the fragmentation of natural elements in 150 meters around the house, was valued significantly positive in the area of Ribe in Model 1–3 (Table 2) and in Skjern/Tarm in Model 3–4 (Table 3). Thus, the combination of landscape elements like rivers, lakes and fields raised sales prices for houses in this region while the direct distance to the natural element seems to be not valued as important enough to significantly increase house sales prices. In estimations for Skjern/Tarm additionally the proximity to the forest increased house prices while the proximity to windmills slightly decreased the sales price of the property. Neither the distance to beach or agricultural land showed a significant effect on house prices.

In contrast to Bin et al. (2009), riparian properties in our sample areas did not yield a premium in sales price, either in Ribe or in Skjern/Tarm. Moreover, the 18 private properties in Skjern/Tarm which are directly affected by the buffer zone regulation were sold for a more than 30 percent lower sales price (see $D^{buffer}_{sold2008}$, Table 2 & Table 3). Hence, the ten meters buffer zone is in this area positively evaluated as long as it is not on one's property. The buffer zone regulation might here interfere with the private property rights of the owner. Allowing access to the buffer zone may in fact be perceived as an intrusion of privacy for the owner. Direct access to the buffer zone on one's own property allows other people to walk on one's property. Hence, public access to the private property on the riverside could have a negative impact on the prices of these houses/properties and a positive impact on the prices of houses in the rows behind them, an effect hardly to be controlled for. People may be willing to walk a few extra meters to access such a recreational area of the buffer zone rather than to have it directly in their backyard in order to avoid unknown people on their property, a result in line with Netusil (2005).

Taking up the argument that only proper management creates aesthetic and recreational values for water bodies (Cho et al., 2011), one may assume that this argument can be equally true for riparian buffer zones. Farmers are obliged to mow the buffer zones at least every second year for maintenance in order to receive further subsidies from the EU for this area. But it is up to the farmer to take care of the buffer zone area. Dependent on the effort of the farmer (or in some cases the municipality), a buffer zone as shown in Fig. 2 might be generated which assumingly creates a higher aesthetic and recreational value than the one shown in Fig. 3. Thus,

Fig. 2. Picture of buffer zone with recreational infrastructure added, Lolland. (May 2013, Photo: Søren Rosenberg and Philip Rasmussen)

Fig. 3. Picture of buffer zone in Himmerland (Immediately in the outskirts of a village, September 2012, Photo: Anne-Mette Hjalager.

Fig. 4. Picture of buffer zone close to Ribe under different land management regimes (August 2013, Photo: Annette Aagaard Thuesen).

the observed economic value could be locally dependent on the management of the buffer zone.

In addition to management, access to the buffer zone was shown above as a major determinant for the economic value of the riparian buffer zone. Access here is only measured as the opportunity to enter the buffer zone (connected by a path). However, due to management of the buffer zone, access might be restricted. Although a path to the buffer zone may exist, walking within the buffer zone and enjoying this recreational area is dependent on the management of the buffer zone. So, for example, if the area is mowed regularly (see Fig. 4), a higher economic value might be expected than if no entrance into the area is available due to high vegetation (see Fig. 5). These interdependences between management and access, however, are difficult to disentangle in a quantitative approach. For ease of interpretation, it is assumed here that access to the buffer zone contributes to the recreational value, while distance to the buffer zone is part of the aesthetic value. Hence, results

Table 4
Direct, indirect and total effects of the buffer zone related variables for Ribe and Skjern/Tarm Standard errors in parentheses

	Ribe			Skjern/Tarm		
	Average direct impact	Average indirect impact	Average total impact	Average Direct Impact	Average indirect impact	Average total impact
Model 2						
$d^{buffer}_{solid2008}$	0.1361	21.015	21.151	−0.342***	−8.462	−8.804
	(0.1140)	(38.024)	(38.083)	(0.129)	(9.748)	(9.755)
Ln(10m buffer) x $D_{solid>2008}$	0.00033	0.3799	0.3802	0.00910	−1.012	−1.003
	(0.0006)	(0.5051)	(0.5056)	(0.0359)	(1.412)	(1.416)
Model 3						
$d^{buffer}_{solid2008}$	0.1080	9.089	9.1974	−0.361***	−8.406	−8.766
	(0.1083)	(35.478)	(35.529)	(0.127)	(8.935)	(8.942)
Ln(access 10m buffer) x $D_{solid>2008}$	−0.00115***	−0.1965	−0.1976	−0.00085**	−0.033	−0.034
	(0.00030)	(0.1691)	(0.1692)	(0.00036)	(0.109)	(0.110)

*** $p < 0.01$
** $p < 0.05$
* $p < 0.1$

Fig. 5. Picture of buffer zone close to Ribe without access (August 2013, Photo: Annette Aagaard Thuesen).

of the quantitative analysis pinpoint to additional recreational values for local residents by introducing riparian buffer zones.

With respect to the difference in estimation results between the two areas, it is shown that although fewer observations are included in the estimation for Ribe than for the estimation of the Skjern/Tarm-model, the necessary variation is still given to ensure robust estimations (see Table A1 & Table A2, Appendix 1). Moreover, the distribution of sales prices in both sample data reflects the distribution of sales prices of houses in Denmark in general if compared to 'Boligsidens popularitetsindeks' (The popularity index of a popular Danish house sales website; Realkreditforeningen, 2014). Thus, a potential bias with regard to the dependent variable seems unlikely.

A two-sample *t*-test was employed to test for significant difference in the independent variables between the two sample communities (Table A3, Appendix 1). According to this test, the sold houses in Ribe in our sample are significantly older and larger in building size compared to Tarm/Skjern. Our two sample communities are also distinctively different in most of the natural attributes integrated in the estimation. But, as a rather wide region (Postal code) is examined, a distinctive selection effect for people with a preference for living close to a specific natural amenity which might drive our results should be very low. In other words, using postal areas as study area allows including various groups which have sorted themselves due their preference and therefore allow a general assessment of the WTP for this measure uniformly implemented in all areas of Denmark. This lack of a specific focus in our analysis on a self-selected group into an area of interest, in turn, may also explain the fact that in the estimation nearly no natural (dis-) amenities showed a significant effect, although in previous studies, distinctive effects could be pointed out (e.g., Danish studies including: Ladenburg and Lutzeyer, 2012 for windmills, Præstholm et al., 2002 for forest proximity).

As econometric misspecifications appear to be unlikely, the difference in result for the two sample regions might be based on the history of fierce debate over the restoration of the Skjern Aadal. One may assume that experiencing such a top-down approach of the central government with a wide social, natural and economic impact on the citizen in the region can lead to a more careful evaluation of the new buffer zone regulation in this area. A decreased house price about 30 percent if a ten meters buffer zone is to be expected on the property (see variable $D^{buffer}_{sold2008}$, in Table 3 and Table 4), however, seems to be a drastic reaction on the regulation as such, but might be explained by the Danish culture of preferring bottom-up approaches instead of top-down approaches regarding surface water management (Liefferink et al., 2011).

The main focus of the study was to evaluate whether an aesthetic or recreational value of the newly introduced ten meters buffer zone can be determined and the size of this value. For this reason, an interaction effect between the dummy variable $D_{sold2008}$ and the variable Ln(10m buffer) (i.e., 'distance to the nearest buffer zone') and the variable 'Ln(access 10m buffer)' (i.e., 'distance to the nearest buffer zone access point'), respectively, was introduced into the SDM estimation models 2–4. This interaction term was used to calculate the MWTP for the ten meters buffer zone. Estimation model specification encompasses the integration of the spatial lag of the dependent variable *WY* as well as the spatial lag of the independent variables (*WX*). Hence, the coefficients in Table 2 and Table 3 report besides the direct effect of distance to the buffer zone on house price the effects of feedback loops between the observations and their neighboring observations (i.e., *WX*). Following LeSage and Pace (2009), to obtain the marginal effects the coefficient of the SDM model are corrected for the spatial dependence within the independent variables. The average direct, indirect and total impacts over the sample region are calculated as described in the method section. Results are displayed in Table 4. Standard errors and p-values were calculated with the help of a Monte Carlo simulation from a set of 1000 simulated parameter values (i.e., a rather conservative measure).

Results show that the proximity to an access point of a ten meters buffer zone significantly directly increased house sales prices in the region sold after 2008, i.e., since the buffer zone regulation is discussed. The same effect could not be shown for the distance as such to the riparian buffer zone. Hence, as mentioned in the interviews, access to the buffer zone is the crucial aspect for stakeholders and local residents. A house which is one meter further away from the ten meters buffer zone access point would on average be sold for about 0.115 percent less in the area of Ribe than

Table 5
Average WTP for being one meter closer to the ten meters buffer zone access point.

	Ribe		Skjern/Tarm	
Average sales price	DKK 2177,132		DKK 1664,133	
	Direct Effect	WTP	Direct Effect	WTP
Ln(access 10 m buffer) x D_{2008}	−0.00115	DKK −2,503.70	−0.00085	DKK −1,414.51

a comparable similar house. This effect would be 0.085 percent in the commune of Skjern/Tarm. In monetary terms, if the average sales price is taken into consideration, the average direct effect for the first meter closer to the ten meters buffer zone access point leads to a price premium of approx. DKK 2500 in Ribe and approx. DKK 1400 in Skjern/Tarm considering the estimation coefficients of Model 3 (see Table 5).

These numbers are denoting by definition the recreational benefit of the newly introduced buffer zones in our sample regions. However, an aesthetic value can so far not be determined significantly.

4. Discussion

4.1. Lack of practical use of the buffer zones

The study shows that the amenity values of buffer zones are acknowledged by users, but not to such an extent that it affects behaviors of citizens and recreational users extensively. Negative consequences may overrule the positive effects of the regulation. Moreover, using the agricultural areas as a scene for a rural multifunctionality is still modest. There are a number of plausible reasons for the lack of practical use of the buffer zones and the low valuation of their qualities:

4.1.1. Access issues

Maintenance of the buffer zones is mainly the responsibility of the farmers. The extension of the zones from two to ten meters has happened only recently, and their practices in terms of management of the wider areas is not grounded to any extent yet, and it is likely that many farmers are still considering how to ensure the required maintenance. Farmers' economic motivation to establish and maintain trails other facilities may be limited; as such, facilities require a continuous attention. A motivation to establish an infrastructure might occur if the farmers can gain additional income, for example related to farm holidays, angling, canoeing etc. Diversification of farm holdings into tourism and leisure is increasing, although still at a moderate rate (Nielsen et al., 2011).

Often, citizens and recreationalists experience an absence of proper access due to a lack of materials, such as maps, which can guide them to the buffer zones. This also includes interpretation as well as information about safety and conduct. No one is formally in charge of providing such materials, including farmers, visitor organizations, and municipalities. Recreational and sports organizations may provide materials themselves, but up until now, little has been accomplished.

4.1.2. Competitive landscape issues

The areas investigated in this study are rural and with a low population density. Citizens and visitors have access to a wide range of landscapes and landscape types which may, from accessibility and aesthetic points of view, deliver a higher user value: Forests, the Wadden Sea, and the fjords all represent a higher extent of variation. These areas have been the subject of intensive interpretation for many years and enjoy a recognition and positive appraisal for their qualities. Town planning has ensured trails that efficiently link urban zones with recognized landscapes in the vicinity. Many buffer zones are "rough" and perhaps uninviting compared to other landscape types, and it is a greater challenge for visitors to not only make their way in, but also to understand the qualities of what they see and experience.

Those organizations that utilize nature as scenery for their sports and activities do not seem to experience a crowding that compromises their use. It is a question of whether buffer zones would represent a higher value for outdoor recreation in areas close to larger cities.

The areas chosen for the studies here are characterized as being mainly rural. There are many areas available for recreation and leisure activities, and they are generally not crowded for most parts of the year. People select a rural area for habitation mainly because of the access to natural amenities (Johansen and Thuesen, 2011), and it is important for them to be able to get out into nature and to be able to select their location for specific leisure activities. There is a favorable access to publicly owned and openly available nature reserves in the areas. It is a question of whether the assessment would be different in more densely populated areas.

4.1.3. Norms and traditions in outdoor recreation

In the study, the organizations refer to what types of landscapes serve their needs best and what they are used to from convenience and safety points of view. Some of them are "conservative" in the sense that they prefer areas that they are well acquainted with and where they know that the benefits they look for can be obtained. It seems to be a barrier for leisure organizations to reconsider the locations and environments, and it is partly an effect of the nature of these activities.

However, some organizations can change the location of their activities, in particular if the amenity values are augmented. If buffer zones become habitats of birds to a greater extent, the ornithologists might shift locations. This underlines the importance of both internal and external determinants for the use of nature areas for recreational purposes.

4.1.4. Formalities of property rights

The areas studied are distinct farming areas. There is a strong tradition in the region for farming, and although employment in farming is very low compared to other trades, everybody in the area is likely to have farmers among their acquaintances or relatives. The media attention suggests that there is a significant recognition of the interests of farmers, including the freedom to make dispositions on their own farmland. The interviewees would like to see that the buffer zones are managed in a way that creates better access for recreational use, but they are careful about placing costly and demanding requirements on the farmers.

There may also be a conflict between nature protection and recreation, as seen by some of the interviewees. If buffer zones should contribute to the biological diversification, they should to some extent be left in peace for birds to thrive and plants to regenerate. Balancing access is a key issue for some nature areas, but this is still not addressed to any extent in the Danish buffer zones, and there is a lack of systematic inquiry.

4.2. Perspectives for multifunctional use of agricultural resources

The implementation of buffer zones is an issue that has been intensively debated in Denmark. An evaluation from a socio-

economic point of view is still not conclusive, and this study delivers only a small picture of the jigsaw puzzle that needs to be assembled.

When taking into account the awareness of and interests in buffer zones as potential future recreational areas and amenity values, there are a range of steps that need to be taken to approach a situation of higher multifunctionality, where space is simultaneously used sustainably and in synergy for several purposes (Maier and Shobayashi, 2001; Marsden and Sonnino, 2008; OECD, 2006). The task is to approach a situation where the social as well as the economic values are recognized in a balanced way. There is also a need to efficiently recognize that Denmark is a country of spatial diversity in terms of amenity values and socio-economic composition, where the contribution of buffer zones to values differs from area to area. Leaning on the literature and addressing the findings of this study, there are three essential groups of measures that can be integrated into future policies:

4.2.1. Interpretation

Interpretation is a key issue. Citizens as well as recreational users lack the sufficient knowledge about the locations and the possibilities and restrictions of access. In addition, users may need to know about routes and trails that are adapted to different kinds of user preconditions, including potential accessibility challenges and safety issues. Interpretation is also about the flora and fauna and about natural phenomena and codes of conduct. Such interpretation can take place in many ways, for example through the use of pamphlets and handbooks, but apps and other modern interpretation and communication forms may be extremely appropriate for this type of nature area. Interpretation is also done through guided tours and by managed activities, where actors from sports and leisure organizations play a significant role. As buffer zones are dynamic in terms of regulation as well as in terms of amenity values, it is a significant challenge to plan and implement interpretation measures.

4.2.2. Infrastructure development

The buffer zones are not well organized and equipped with paths and trails, and this might be a situation that some land owners do not want to change. Wildernesses may be attractive for some categories of users, and of importance in terms of environmental diversity. However, some municipalities and other landowners have started to plan and establish trails, bridges and other infrastructures for the benefit of recreational users, and to link the buffer zones to other nature areas. Thus, there is an opportunity to widen the target group for the buffer zones and to supplement the variety of local recreational resources with new types.

Negotiating and planning infrastructures is part of the planning process of municipalities, and leisure and tourism organizations tend to encourage the municipalities to ensure a more holistic approach in order to enhance social as well as economic values. There is still lack of evidence and practice in the planning of landscapes, and a lack of appropriate attention to the issue in general, both in Denmark and in other countries, although the issue has greatly caught the attention of the EU as a topic for future policy interventions (Bateman et al., 2013). Working with land owners for this purpose is a novel discipline for many municipalities.

4.2.3. Invention of experiences

The recreational organizations and the users of nature areas are found to be bound to traditions to quite some extent, and therefore they tend to prefer other nature areas over buffer zones for their activities. There is a need to initiate processes of "experience design" in order to invent new types of leisure and recreational activities that may fit with the physical conditions and the environmental requirements of buffers zones. In other countries, the outdoor sector is growing and launching new offers on a continual basis (Fredman and Tyrväinen, 2010), but a similar trend is not visible to the same extent in Denmark. Likewise, the reinvention of nature resources from a health and wellbeing perspective is also only emerging gradually (Godbey, 2009), and in Denmark new ways of farming practice and related production and interpretation are less often exploited by agriculture and visitor industries in collaboration. The experience design might also include landscape designs that enhance aesthetic values and biodiversity, including the use of crops and animal holdings that do not compromise the environmental objectives of buffer zones (Pettersson et al., 2013).

5. Conclusion

The questions to be answered in this study were whether (1) the extended buffer zones add significant value in terms of open space for recreational use, and this value is recognized by stakeholders; and (2) the buffer zones are enhancing the aesthetic values of nature/landscapes for those who live nearby and hereby affect the property values positively.

Regarding the first research focus, interviews with stakeholders showed that the extended buffer zone is appreciated if access and information for the potential usage is given. Many interviewees lacked the knowledge on where and how they are allowed to use the extended buffer zone. Although being aware of the establishment of the buffer zone as the result of an extensive public debate, the buffer zones are still not integrated in the recreational activity sphere. There is still unutilized potential for improving social benefits of the nature conservation measure ‘buffer zone’. The interviewees also suggest that the organized recreational use of landscapes is concentrated in forests and other areas that have been open for access for a long time and where the infrastructure is well developed. It may take time for people to change their recreational habits, and relocate their activities to other types of landscapes.

Access and management seem to be the crucial part, in particular if we also add the results of the quantitative approach. House buyers were willing to pay a premium for the house if it was close to a buffer zone access point. Although this premium differed between the two regions, Ribe and Skjern/Tarm, a direct significant relationship between the closeness to a buffer zone access point and the house could be shown. It can be therefore be assumed that the buffer zone creating already a recreational value, also the utilization potential is yet not fully used. The buffer zones are most often not equipped with pathways, may be muddy, fenced and thereby some recreational activities might be limited. There are also issues related to safety and convenience, particularly when users are children or older people.

Regarding the aesthetic value of the buffer zone, changes in house prices since 2008 could not significantly be related to the linear distance towards the buffer zone. A fact, which is not surprising considering that the riparian buffer zones were just recently introduced. Hence, again management of the riparian buffer zones and time may change the results.

An interesting finding is the discrepancy between the two areas considering the impact the discussion of the regulation has had since 2008 on the house prices if the property was subject to the regulation. In Skjern/Tarm, the houses potentially affected by the regulation were sold for significantly lower prices (ca. 30 percent), while the houses in Ribe yielded no significant change in sales price if the property was intended to be subject to the extended buffer zone regulation.

To conclude, in the debate, a concern has been raised that agricultural areas might be invaded by recreational users and citizens and that economic opportunities for farmers could suffer as a consequence, due to, for example, littering and the disturbance of crops

and farm animals. The interviews indicated that there is hardly such a risk due to the relatively low traffic and exploitation of the areas. However, this study also demonstrates that there is a plea for a broader perspective on the natural resources including the buffer zones as part of a long term development of a sustainable rural multifunctional land use.

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Appendix 1

Table A1
Descriptive Statistic - Municipality Ribe.

Variable	Abbr.	Mean	Std. Dev.	Min	Max
Sales price (in DKK)	Sales price	2,177,132	3,038,950	33,000	89,700,000
House characteristics (S_{it})					
Year of construction (Basis for Age)	Age			1600	2012
Year of rebuilding (Basis for Rebuild)	Rebuild			–	2013
Building size (m^2)	Building size	136.14	50.18	25	421
Lot size (m^2)	Lot size	1,828.13	16,327.27	73	633,336
No of toilets (water flushed)	Toilet	1.60	0.57	0	4
Economic (dis-) amenities (L_{it})					
Distance to city center (in m)	City	3,475.94	3,102.95	0	15,205.38
Distance to parking facilities (in m)	Parking	902.41	1,484.39	6.16	9,343.71
Distance to main street (in m)	Street	108.62	113.91	6.86	846.26
Natural (dis-) amenities (in m) (N_{it})					
Distance to river (in m)	River	222.95	135.90	6.50	1,020.72
Distance to river > 2.5 m (in m)	River > 2.5 m	546.15	446.92	8.01	2,585.12
Distance to lake (in m)	Lake	377.68	204.70	25.60	1,634.52
Distance to forest (in m)	Forest	231.64	215.89	5.60	1,612.81
Distance to beach (in m)	Beach	6,165.20	2,761.88	515.68	16,660.32
Distance to farmland (in m)	Farmland	162.16	159.87	5.94	690.11
Distance to windmill (in m)	Windmill	3,837.52	1,459.69	594.44	9,675.30
Distance to 10m buffer zone (in m)	10 m buffer	206.67	125.52	0	1,009.75
Distance to access of 10m buffer (in m)	Access 10 m buffer	351.67	210.86	0	1,158.82
Landscape Fragmentation (F_i)					
Patch Fragmentation	MPFD	1.68	0.08	1.23	1.79
N	1529				

Table A2
Descriptive Statistic - Municipalities Skjern/Tarm.

Variable	Abbr.	Mean	Std. Dev.	Min	Max
Sales price (in DKK)	Sales price	1,664,133	1,249,934	17,000	20,200,000
House characteristics (S_{it})					
Year of construction (Basis for Age)	Age			1847	2013
Year of rebuilding (Basis for Rebuild)	Rebuild			–	2011
Building size (m^2)	Building size	130.87	48.46	32	376
Lot size (m^2)	Lot size	1,304.64	10,090.06	–	497,631
No of toilets (water flushed)	Toilet	1.49	0.55	0	4
Economic (dis-) amenities (L_{it})					
Distance to city center (in m)	City	4,694.14	4,207.97	0	17,937.73
Distance to parking (in m)	Parking	770.97	1,319.02	8.37	6,633.08
Distance to street (in m)	Street	30.99	47.17	5.08	825.93
Natural (dis-) amenities (N_{it})					
Distance to river (in m)	River	338.94	176.97	12.03	1268.80
Distance to river >2.5 m (in m)	River>2.5m	399.87	242.11	12.66	1,747.89
Distance to lake (in m)	Lake	389.15	202.24	18.10	1,367.44
Distance to forest (in m)	Forest	228.03	193.17	0	950.03
Distance to beach (in m)	Beach	8,954.72	4,335.60	65.73	27,724.13
Distance to farmland (in m)	Farmland	257.89	212.30	6.31	842.62
Distance to windmill (in m)	Windmill	2,676.00	1,036.70	42.99	4,928.17
Distance to 10 m buffer zone (in m)	10m buffer	272.58	152.65	0	1,035.99
Distance to access of 10 m buffer (in m)	Access to 10m buffer	426.90	213.80	0	1,382.17
Landscape fragmentation (F_i)					
Patch Fragmentation	MPFD	1.70	0.07	1.26	1.83
N	2473				

Table A3
Two-sample *t*-test: Difference between Ribe & Skjern/Tarm (unequal variances).

Variable	Mean-Diff*	Std. Error (Diff)	Ha: diff <0; Pr(T < t)	Ha: diff ! = 0; Pr(|T| > |t|)	Ha: diff >0; Pr(T > t)
Sales price (defl.)	−512,998.7	81,681.04	0.00	0.00	1.00
Age	−4.69	2.23	0.02	0.04	0.98
Building size (m^2)	−5.28	1.61	0.00	0.00	0.99
Lot size	−523.49	464.24	0.13	0.26	0.87
Distance city center	1218.20	116.01	1.00	0.00	0.00
Distance parking	−131.45	46.31	0.00	0.00	0.99
Distance street	−77.62	3.06	0.00	0.00	1.00
Distance river	115.99	4.97	1.00	0.00	0.00
Distance river > 2.5 m	−146.28	12.42	0.00	0.00	1.00
Distance lake	11.47	6.63	0.96	0.08	0.04
Distance forest	−3.60	6.75	0.30	0.59	0.70
Distance beach	2789.52	112.20	1.00	0.00	0.00
Distance farmland	95.73	5.91	1.00	0.00	0.00
Distance windmill	−1161.52	42.76	0.00	0.00	1.00
Distance 1st 10m buffer zone	65.91	4.44	1.00	0.00	0.00
Distance 2nd 10m buffer zone	65.26	4.72	1.00	0.00	0.00
Distance 3rd 10 m buffer zone	321.58	262.65	0.89	0.22	0.11
Access 10 m buffer zone	75.22	6.89	1.00	0.00	0.00
MPFD	0.015	0.003	1.00	0.00	0.00

*diff = mean(Skjern/Tarm)−mean(Ribe), i.e., diff<0 means that the mean of the respective variable in the sample Skjern/Tarm is smaller than the mean of the variable in the sample Ribe. Significant results are in bold.

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