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Incentives for Local Authorities to Supply Environmental Benefits through Afforestation

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Abstract

In 1989 the Danish Parliament announced it an official goal of the forest policy to double the Danish forest area in 60-100 years. One of the goals of this policy was to improve the recreational possibilities for the urban population. Therefore focus has been on furthering public afforestation projects close to cities with little forest nearby. We know from previous research that mature urban forests possess significant amenity values for urban areas; the question is whether the same holds for afforestation projects? Thus, the aim of this analysis is to examine the inhabitants' willingness to pay for proximity to urban afforestation projects. We use a hedonic pricing approach to estimate the willingness to pay for the environmental benefits related to the proximity for two afforestation projects Bakkely Forest and True Forest. The model used enables us to calculate the WTP for each house depending on the distance from the forest and the total WTP for the two areas. The study also examines the impact of the observed raise in house prices on the property taxes that the inhabitants pay. As the property tax depends on the value of the house, higher prices. This increase in the tax burden has to be included in the total WTP measure to avoid a serious under-estimation of the total WTP. We show that the present value of the extra property tax may lie between 20 and 100 % of the increase in property value.

Keywords: Afforestation, amenities, recreation, hedonic pricing, property tax, WTP.

Introduction

In urbanized Europe, the welfare-economic importance of forests consists to an increasing extent of their ability to produce positive externalities. In Denmark, urban afforestation programs are established and financed partly by the Government and partly by the EU to ensure the provision of such externalities, especially recreational opportunities for local population. However, increased budget restrictions in the state agency administering the program have raised the question whether other actors could take over part of the financial burden. In particular those who stand to gain the most from the program.

In this paper, we use a valuation study to examine the link between the new recreational benefits and tax revenues for the local authorities, which could be a possible financing mechanism for nature projects close to urban centers. In 2002 a hedonic pricing study was made to evaluate the willingness to pay (WTP) for proximity to new forests (Anthon 2003, Anthon & Thorsen 2002). Other hedonic studies (Tyrväinen and Miettinen 2000, Præstholm et al. 2002) have shown that proximity to existing forests increases the market value of houses. This increase represents a windfall gain to the house owners, but for many reasons they are not likely to formulate the demand for and secure the supply of the benefits related to urban-fringe afforestation projects. These reasons include the absence of organization and in particular the incentive to free-riding on possible investments. However, other actors benefit from the

increased hedonic values. The increase in house prices can lead to higher tax revenues, both property taxes and in the long run higher income taxes too. We assess the quantitative effect of these increased taxes and discuss the extent to which this can be used as an incentive to finance afforestation projects. Two forests are used as case areas.

The hedonic pricing study

The hedonic pricing theory and estimation techniques will not be described in detail here. The core idea is that a property like a house is a composite good and that the price of given house *i* (P_i) is determined by its structural (S), neighborhood (N) and environmental (Q) characteristics (Freeman 1993):

$$P_i = P(S_i, 1_i, Q_i)$$

When a new forest is planted near the house, the environmental characteristics change while all other characteristics remain constant. If proximity to forest is considered a benefit, one would expect the house price to change marginally as a reflection of the willingness to pay (WTP) for living near the new forest.

The hedonic pricing study estimates these changes in two areas, where new forests were in the mid-1990s planted close to the town border. True Forest was planted close to a large suburb (Skjoldhøjparken) of Århus, the second largest town in Denmark, and Bakkely Forest is located close to a small town called Vemmelev. The two afforestation projects are very much alike as to area, species, etc. The data consist of prices of houses sold in the period 1984-2001 and a number of house characteristics, e.g. floorage, age, and proximity to motorways or railways. The effect of the new forest on the price of a given house is modeled using a formulation that allows for an effect of distance to the forest.

The econometric results are presented and discussed thoroughly in Anthon (2003) and Anthon and Thorsen (2002). They showed a significant, positive value of the new forest reflected in house prices. They also showed that the willingness to pay was three times higher at True Forest compared to Bakkely Forest. Figure 2 shows the percentage price increase as a function of distance to the forest. It is seen that the inhabitants were willing to pay for proximity to the forest, and that the effect was highest for the houses situated close to the forest border. The houses closest to True Forest were situated at a distance of 150 meters and experienced an estimated price increase of 9%. At Bakkely Forest, the highest price increase was 10% for a house situated only 50 meters from the forest border. The WTP decreased rather fast - houses located 500 meters from True Forest and Bakkely Forest experienced an estimated increase of only 3 and 1%, respectively.

From the hedonic pricing model it was possible to calculate the aggregate WTP in the two areas (Table 1). It was estimated to be 3.7 times higher for True Forest than for Bakkely Forest. The higher aggregate WTP for True Forest is due to a higher WTP for each house, combined with a higher number of houses in the nearby area and higher average house prices.

Table 1. Aggregate willingness to pay for the two new forests as reflected in house price changes

	True Forest	Bakkely Forest
Total number of houses	977	500
Average house price	185,000 USD	139,000 USD
Aggregate willingness to pay	5.3 mio. USD	1.4 mio. USD

The result from the hedonic pricing study can also be interpreted in a different but equivalent way: as the total rise in house prices if the houses were sold today. This means that the expected value of the houses has increased by 5.3 mio. USD in Skjoldhøjparken and 1.4 mio. USD in Vemmelev.

The impact on tax revenues for local authorities

The increase in house prices from the hedonic pricing study can be used to calculate the expected impact on tax revenues for local authorities. Higher house prices have a direct effect on property tax and we suspect an indirect effect on income tax.

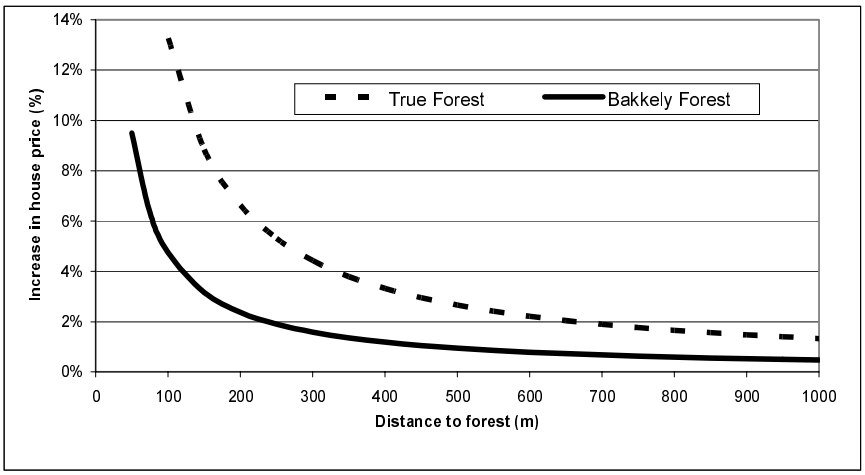

Figure 1. The WTP for the two afforestation projects as a function of distance to the forest

Property tax

In Denmark, house owners pay annual property taxes, which are calculated as a percentage of the assessed market value of their house. Thus, as the proximity to the new forest increases, house prices property taxes increase when the market value assessment has been adjusted. As argued by Anthon et al. (2003) this should be taken into account when assessing the WTP for the proximity to forests. However, in this paper, the interesting aspect is that the property taxes represent a redistribution of wealth – a windfall gain re-allocated to the local authorities, in Denmark counties and municipalities.

The revenue function R_p for property tax can be formulated as:

$$R_p = \frac{p \cdot \Delta h}{r \cdot (1+r)^j}$$

Here p is the property tax percentage levied; Äh is the absolute change in the value of the affected houses. The discount rate used by the community is denoted r and the formulation allows for a possible delay of j years in the administrative adjustment of the market value assessment of the houses in the area.

The calculated R_p is reported in Table 2, showing the increase in annual property taxes caused by the two case afforestations and how it is shared between the two tax levying authorities in each area. The calculations are made using the estimated distance dependent price change of the houses. We have used a discount rate of 3% and assumed a delay of five years, i.e. j = 5, for the adjustment of market value assessment to have effect. Since market values are, in fact, regulated every year, this assumption implies a conservative bias of the property tax effect.

Table 2 7KHSURSHUWWD[HIIHFWRUWKHWRDOIRUHVWDWRQVDQG WKHWRORFDOXWKRUWLHV OHvyIQJ WKHWD[. + HUH j 5 DQG r 0.03.

Tax authority	Annual increase (1000 USD)	NPV 3% (1000 USD)
True Forest, total	87	2632
Municipality	59	1684
County	33	948
Bakkely Forest, total	24	697
Municipality	16	463
County	8	234

It is seen from Table 2 that the annual increase in property taxes is 87,000 USD for True Forest and 24,000 USD for Bakkely Forest. In total, the local authorities can expect an increase of 2,632,000 USD after the establishment of True Forest and 697,000 USD for Bakkely Forest.

Income tax

Another aspect to consider is the potential long-run effect on income levels in the areas near the forests. If the individual is assumed to be willing to spend only a certain share of the income on housing expenses, then increases in house prices will tend to result in current owners moving out and new owners with higher income levels will move in. At least if the implied costs of higher prices exceed transaction costs. However, since the price changes here have rather marginal cost effects compared to transaction costs of moving, we assume that the rate of turn-over in the group of owners will not change. Thus, only slowly will new owners with higher income move into the area. To the extent that such movements occur across local community boarders they become interesting because they imply that high-income households are attracted and hence, for given tax rates, more tax income will accrue to the local community as such.

In Denmark, counties and municipalities both levy income taxes on their community members. However, as we shall see below, only municipalities are small enough as to make likely a significant amount of cross-community boarder movements. Thus, not only the affected house owners, but also the local communities and authorities stand to benefit from the hedonic effects of afforestation projects – in a very direct way.

Assuming that the marginal propensity to pay for housing is constant across the income ranges considered, it is quite easy to show that a proportional change, Äh/h, in house prices must in the long run lead to a similar proportional change in taxable income levels, Y, of the households occupying the houses. The revenue function R_I – in present values - for the community can be formulated as:

$$R_I = \gamma \cdot s \cdot Y \cdot \Delta h/h \sum_{t=0}^{\infty} \frac{\min\{1, mt\}}{(1+r)^t} . \qquad (1)$$

R_I captures the increased revenue from levying the income tax percentage s on taxable income Y. The taxable income is suspected to increase only slowly over time with the moving rate m towards a total change of Äh/h percent, obtained when all houses in the area have been traded, i.e. mt=1. Not all new households in the area come from outside the community, but ã measures the proportion of new households entering from outside. Again, the discount rate r is used to calculate the present value of these revenue changes.

Assuming the propensity to spend income on housing expenditures to be constant across income levels, we have argued above that proportional change in house prices must in the long run lead to higher income households living in the area. This assumption is not completely unqualified - figures from Danish Statistics show that households with quite low income use a higher percentage of it for housing than do households with rather high income. However, average pre-tax household income per year is in Vemmelev (Korsør Municipality) 61,000 USD and in Århus 74,000 USD, and since the change in house prices are after all limited, the average household will – before and after houses have been traded - in both municipalities lie in the same official income bracket (50,000- 83,000 USD/yr.). Thus, because house price changes are marginal we find the assumption of constant propensity justified.

Another key factor pointed out above is whether the household moving into the neighborhood did not already live in the municipality or county. If they did, no higher net tax revenue will result. Since the counties are rather large entities – in household numbers as well as geographically - most moves are found to be within-counties. Thus, in general the effect is probably higher for the municipalities.

Data from Danish Statistics show that in Korsør Municipality 28% of households moving takes place from another municipality, in Århus 22%.This difference most likely reflects the fact that Århus is a rather large municipality with approximately 300,000 inhabitants, whereas Vemmelev has only 3,000 inhabitants and is a part of Korsør Municipality with only 20,000 inhabitants. Thus, for Århus we find ã = 0.22 and for Korsør ã = 0.28.

As argued above the full effect on income tax revenues will not show immediately, since the price change is sufficiently marginal not to exceed transaction costs of moving. Only gradually will the houses be sold to people with higher incomes. Data from Skjoldhøjparken and Vemmelev show that 3-4 % of the houses are sold every year. Therefore, the tax revenues will increase over a period of 25-33 years – within approximately one generation all houses will have been traded. After that the income tax revenue increase will be constant at full effect. Thus, we have m = 0.04 for Vemmelev in Korsør municipality and m = 0.03 for Århus.

Using the estimated hedonic price function, a discount rate of 3%, and the reported values of m and ã, we find the income tax effects shown in Table 3. Even with the large effect of the slow moving rate, combined with discounting and the low proportion of newcomers, the total effect is still rather large and in fact is seen to be of the same order of magnitude as the property tax effect. Also, the combined tax effects are seen to reach the same magnitude as the estimated aggregate windfall gain to the house owners. Thus, house owners and local communities both stand to gain from afforestation projects.

It is seen that the NPV of the increase in income tax is of the same magnitude as the increase in property tax. But it is only the municipalities that experience a rise in tax revenues. Århus Municipality can expect a total of 2,073,000 USD and Korsør Municipality 891,000

USD.

Discussion on incentives to supply environmental benefits

This paper has documented that the environmental benefits of urban fringe afforestation do not only imply a windfall gain to nearby house owners, but may also imply rather large gains for the community as such through increased property taxes (in fact reflecting part of the welfare gain) and increased income taxes.

Municipalities in Denmark supply a number of (public) goods to their inhabitants, e.g. childcare, schools, certain health programs, and sport facilities. Supplying these goods in high quality and at low (tax) costs are important goals for the municipalities. It will enable them to attract high income households, which in turn increases tax revenues and allow for either quality and quantity improvements or reductions in the relative tax burden. Thus, municipalities in many ways compete to attract high income citizens.

Providing nice, quiet and beautiful living surroundings is just another way to increase local wealth and in the long run income too. Thus, municipalities and counties may stand to benefit from, e.g. urban fringe afforestation projects, and hence they may have an incentive to

Table 3. Assessing the income tax effect for the municipalities benefiting from the increased attractiveness of the involved residential areas. For parameter assumptions, see text.

	Newcomers	House sales per year	NPV 3% (1000 USD)
True Forest (Århus Municipality)	22%	3 %	2073
Bakkely Forest (Korsør Municipality)	28%	4 %	891

secure this kind of benefits to their inhabitants. Furthermore - unlike the individual household - they have the organizational and financial capacity to handle projects of this size, and they have no incentive to free-riding.

In Table 4 we provide a rough and conservative calculation (based on Anthon and Thorsen 2002) of the net gain for the local authorities, if they themselves had financed the two case afforestation projects. Note that the highest cost burden of public afforestation projects is the acquisition of agricultural land and establishment of the new forest. Forest production does not contribute much to the overall economic value of the project. Note that in this calculation, the community ends up owning the forestland. Once the forest is in place, it is in fact possible to sell the forestland as such because it becomes forest reserve. This will substantially improve the balance.

When we compare the estimated costs of the project with the estimated future tax revenue, it is evident that the possibility of financing afforestation projects through increased tax revenues is not unambiguous, at least not for these two cases. The large differences between the two areas are among other things due to:

· The households in Skjoldhøjparken have a higher average income than those in Vemmelev
· There are more houses close to True Forest compared to Bakkely Forest
· There is a higher increase in house prices in Skjoldhøjparken compared to Vemmelev

However, even without taking this option into account we find that for True Skov, the local authorities stand to benefit substantially and could easily have financed the afforestation projects. For Bakkely Skov at Vemmelev, the balance is more ambiguous. But again, the 60

Table 4. A rough calculation of the net gain for the local authorities in the to case areas, had they themselves invested in establishing the afforestation areas.

	True Forest 1,000 USD	Bakkely Forest, 1,000 USD
Agricultural land	-1.667	-1.000
Establishment	-1.100	-700
Forest management	0	33
Total costs	-2.767	-1.667
Property tax revenue delayed 5 years	2.632	697
Income tax revenue delayed response	2.073	890
Total tax revenue	4.706	1.587
Balance	2061	-80

hectares of forest in Bakkely Skov represent a value of some 300,000 USD, which has not been included here.

Thus, we find that due to the tax revenue changes following hedonic effects of the environmental benefits caused by urban fringe afforestation, local communities may have a clear incentive to actively secure the supply of these benefits to their inhabitants.

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