What determines the demand for programmes providing local environmental public goods?

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Abstract

Benefits from providing a local public good such as landscape protection may depend on individuals' physical surroundings, as well as on socio-economic factors such as income. A framework is formulated that describes public support for regional landscape protection as a function of socio-economic variables and land use patterns. Models are then estimated using data from a referendum on increasing public funding for local landscape protection in the Swiss canton of Zurich, using detailed land use statistics. These represent proportions of open landscape and landscape features that are viewed as particularly valuable for aesthetic and other reasons. Cross-sectional estimation results suggest that attitudes towards public landscape protection are indeed strongly influenced by the local landscape and its recent dynamics. A comparison of results for this local environmental public good with referendum outcomes on national-level environmental issues and non-environmental public goods is also presented.

Keywords: agricultural landscape; amenity values; referendum voting; public goods; agricultural policy.

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1. Introduction

In industrialised societies the public good character of rural landscapes is becoming increasingly important. Landscapes near urban centres in particular are an important source of recreation opportunities, whilst landscape quality itself generates utility both to rural and urban dwellers. Efficient allocation of land between competing uses deserves high attention, due both to market failure and government intervention failures.

Until recently, little of the enormous public subsidies for agriculture in highly industrialized countries such as Switzerland, the UK or the US went into securing these landscape benefits (OECD, 1996; Brunstad et al., 1999); indeed, the pattern of intervention was argued to produce a loss of landscape quality. However, subsidies with undesired effects on production or on international trade are currently being scaled down, and there is an increasing use of alternative instruments to increase the supply of landscape amenities. One way to secure these benefits is through public payments to farmers who agree to provide these landscape amenities through appropriate land management (Hanley et al., 1998). In the case of the traditional European agricultural landscapes, payments are typically linked with the management of special landscape elements such as orchards, hedgerows, flower meadows or wetlands.

In order to devise efficient compensation regimes for the management of such landscape amenities, it is important to understand individuals' preferences. Moreover, considering the fast pace of landscape change, a particularly interesting question is whether and how this change may affect the demand for recreational landscape amenities in the future. A promising approach to answering this question may be to analyse how ambient landscape settings and their recent dynamics influence the individuals' preferences for landscape protection as revealed in voting behaviour. If attitudes toward public spending for landscape amenities are conditional on perceptions of local landscape setting, then the appropriate supply of public good amenities could be based on projected demographic and economic changes that affect the landscape.

The main objective of this study is to investigate the links between preferences for landscape protection as evidenced in actual voting behaviour, and aspects of local landscapes. This approach, based on actual behaviour, may be contrasted with investigations of the determinants of the demand for public environmental goods based on stated preference techniques such as contingent valuation and choice experiments. Preferences derived from referenda have been found by others to be consistent with the basic economic premises of individual behaviour (Deacon and Shapiro, 1975). Referendum data have been used to characterize the preferences for a variety of public environmental goods including public transportation (Deacon and Shapiro, 1975), the location of polluting industry (Fischel, 1979), farmland preservation (Kline and Wichelns, 1994) and flood control (Shabman and Stevenson, 1996). Data from referenda on public financing of landscape amenities could be a basis from which to characterize this demand based on local landscape descriptors.

In this paper we analyse voting data from a referendum on increasing public financing for the protection and management of valuable landscape elements in the canton of Zurich, Switzerland. We examine how local landscape patterns determine voter support for landscape quality improvements, and whether urban development may thus predictably affect the demand for landscape quality. Comparison with referendum outcomes on environmental issues unrelated to landscape protection provides a coarse assessment of the validity of our results.

2. Previous Literature

One strand of literature has framed the landscape preservation issue as a question of the proportional allocation of land to agricultural uses as opposed to urban use or forestry (Kline and Wichelns, 1994; Lopez et al., 1994; Brunstad et al., 1999). However, when special subsidies for the management of landscape amenities are considered, additional degrees of freedom are introduced. Subsidies can be paid in ways to induce land managers to provide or maintain special landscape features that increase the recreational and amenity value of their land.

Analyses on whether particular land management regimes are desired by the public are therefore of substantial interest for the design of agri-environmental policies. For this reason, increasing efforts are under way to estimate the value of enhancing landscape amenities. Applications of the contingent valuation method to farm landscapes in Europe demonstrates substantial willingness to pay for maintaining amenities linked with traditional agricultural practices (Willis and Garrod, 1991; Drake, 1992; Pruckner, 1995; Hanley, Whitby and Simpson, 1999). A contingent valuation study performed in a region of the canton of Zurich (our case study area in this paper) suggests a mean willingness to pay for agricultural landscape protection in the order of SFR 240 per person per year (Roschewitz, 1999).

Possible influences of residential landscape settings on individual demand have so far not been examined in studies using stated preferences. Most existing studies on landscape valuation based on surveys have not allowed detailed analysis of ambient landscape effects on demand due to the limited variation (or limited comparability in the case of landscape visitor surveys) of respondents' residential areas in terms of the landscape pattern. However, that local landscape features are being important is evident from studies on hedonic prices of residential locations (Garrod and Willis, 1994; Earnhart, 2001).

An alternative way to investigate the determinants of preferences for landscape conservation is with voting outcomes from referenda. Deacon and Shapiro (1975) developed a framework to examine aggregate voting behaviour on public goods issues and used their model to characterize preferences for coastal zone preservation and investments in public transportation. Fischel (1979) applied the Deacon and Shapiro model to individual voter choices over air quality improvements, and found that the ex post level of environmental quality of the community had a significant influence on voter behaviour. In a study on the public support for purchasing development rights to farmland, Kline and Wichelns (1994) showed that approval for maintaining open space in Pennsylvania and Rhode Island (USA) is affected by several variables

related to the local environment including the recent growth of the population, proportion of land in farms, recent loss of agricultural land and recent increases in property values. They further found some evidence that the presence of broadly defined 'sensitive resources', including important agricultural soils, groundwater resources and wildlife habitats, increased approval, although only in Rhode Island. Apparently, the local environment had influenced the perception of the land preservation issue. Other papers applying this framework include Kahn and Matsusaka (1997).

Our paper is complementary to Kline and Wichelns (1994) in that the data allows analysis of the support for improving landscape *quality*, rather than preserving a certain quantity of agricultural land. We also compare voter preferences for a local environmental good (landscape quality) with preferences for a national environmental, public good (air pollution) and a non-environmental public good.

3. Choice of Conceptual Framework

In the case of environmental pollution, the demand for pollution control as a public good is typically conceived as a function of actual levels of pollution exposure (e.g., Poe, 1999). There is much reason to expect that demand for the public good 'landscape amenities protection' should be similarly dependent on the perceived local abundance or scarcity of landscape quality. The support for landscape protection can thus be framed as a function of land use descriptors related to the quantity and quality of undeveloped local landscapes, along with socio-economic variables such as income. (Demand for environmental quality is generally found to be positively and significantly related to income in stated preference studies.)

Using the basic framework developed by Deacon and Shapiro (1975), we take the perspective that an individual voter has a utility function with a vector of public goods and a vector of private goods as arguments. The level of collectively chosen public goods determines the individual's tax liability for the provision of these goods. The individual's vector of private

goods is subject to a budget constraint that is equal to the difference between income and tax liability. The individual reaches a voting decision in his or her perceived self-interest by comparing attainable utilities under alternative policies.

In a general model of voting, the individual would weigh the expected benefit from voting with the costs of going to the polls at all. In such a model the voting turnout itself could yield important information on the demand for the public good in question. In the context of the referendum data analysed here such additional information is not useful due to the presence of three other issues in the same ballot. Deacon and Shapiro estimated two joint equations, one describing approval of the voting proposition and the other describing voter participation among those going to the polls. Unlike in the Deacon/Shapiro referenda, which were held together with presidential elections, there were only few citizens at the polls not casting a vote regarding the nature and heritage protection issue analysed here. Thus the present analysis takes a single equation approach.

It could be argued that citizens with particularly high preferences for environmental quality tend to live in places with high landscape quality, which would produce tautologous results. To control for this possibility we also apply the model to referendum data on other public goods which are not related to the local landscape. If the state of the local landscape, and not the self-selection of residence, produced the observed pattern in voting outcomes, this pattern should be unique to the landscape protection referendum. Recent voting decisions within the same constituency on national energy taxes and insurance schemes for pensioners are used for this comparison. These referenda, held on the same date, were selected to be (1) related to (perceived) additional expenditures and (2) strongly controversial in terms of nearly equal numbers of ‘yes’ and ‘no’ votes to ensure sufficient voter interest and information.

4. Empirical Analysis

Our case study uses detailed land use statistics and referendum data from Switzerland. In the canton of Zurich, there were roughly ten thousand hectares (or five percent of the land) allocated to managed landscape elements which have particular importance for landscape amenities in 1996. This total area is composed of thousands of mostly very small parcels of orchards, hedgerows, wetlands, and other landscape features. These features are eligible for compensation payments to land managers, who may be farmers or nature protection societies. According to the significance of these features, payments have the character of compensations for mandatory land use restrictions in the case of some 800 small nature reserves, or of contractual cost-sharing incentives to farmers for a total of roughly 400 hectares of hedgerows, orchards, and meadows. The latter payments are a bonus on particularly valuable amenities supplementing the national environmental scheme of the Federal Office of Agriculture. The payments flow from a cantonal fund for nature and heritage protection established in 1974 (Canton of Zurich, 1997).

There have been several national referenda on agricultural policy reform in Switzerland in recent years, in which the future management of the landscape by farmers has been an important issue. However, consent to or rejection of these proposals is difficult to interpret because important landscape-preservation objectives were coupled with regional policy objectives and equity issues. The best information on public demand for landscape protection should therefore be sought in referenda that are not so obviously linked with farm income. The 1996 referendum on increasing the public funding for nature and heritage protection in the canton of Zurich meets this requirement and thus provides an appropriate data set for this analysis.

The amendment to the canton of Zurich's 'act on measures for nature and heritage protection and for recreation areas' (NHP) was submitted to the voters (and adopted with 57 % approval) in September 1996 (Office of the Parliament, 1996). The proposition envisaged increasing the annual instalments into the public (cantonal) fund for nature and heritage

protection up from SFR 10-20 million to SFR 20-30 million. Further, the amendment empowered the parliament to decide on an additional yearly instalment of SFR 10 million into the fund to pay off debts. The changes to the act were justified by 'increasing expenditures for the maintenance, restoration and management of the objects of nature and heritage protection', and by inflation since the fund was established in 1974. The use of the fund's money was described in the voter information booklet as: 'From the fund for nature and heritage protection the canton finances measures for creating, maintaining, enabling access to, improving or managing landscapes, townscapes, natural and cultural objects, and recreation areas worthy of protection.' Use of the fund is decided upon by the administration. With 82 votes in favour and 74 against, the cantonal parliament recommended adopting the proposition (Executive Council, 1996).

4.1 Data and Analysis

Since individual ballot decisions are not disclosed, only the aggregate responses of each municipal constituency are observed. As in Deacon and Shapiro and in Kline and Wichelns, the dependent variable we use is a logit transformation of the ratio of votes approving the referendum, *logit*(Y). The voting aggregates used in the empirical analysis were the 171 municipalities of the canton of Zurich. Data provided by the cantonal office of statistics were used to calculate the percentage of approving votes among valid votes.

Census data were used to construct relevant socio-economic variables. Observations on average net income of taxpayers, percent children in higher education, and percent of the populace in different age classes were obtained from the cantonal office of statistics. All data were available for the year 1996, and where required also for 1984. Data from both census and aerial photography were used for the land use variables. Land areas in settlements (including industry and traffic), agriculture, and forest for 1984 and 1996 were constructed from the coarse

version (15 land use categories) of the Swiss area statistics, editions 1979/85 and 1992/97 (FSO, 1979/85 and 1992/97).

The land use variables represent important quantitative and qualitative aspects of the local landscape, which citizens are expected to perceive and which may influence citizens' demand for landscape protection (see Table 1). The proportion of cultivated land among all non-forested land (CULTIV) is suggested to be appropriate to describe the extent of the remaining open landscape relative to the land that has already been developed[2]. Municipality-level land area in managed landscape features with high amenity value (AMENITY) was derived from the detailed version of Swiss area statistics (FSO, 1979/85 and 1992/97). It includes 15 out of 74 distinct land use categories and sums to 9214 hectares or 5.3 % of the total surface[3]. The canton Zurich inventory of townscapes 'of supra-municipal significance' yielded a dummy variable indicating whether a municipality has a particularly valuable visible historical heritage (DHERITAGE).

Coefficient signs were expected as follows (Table 1). Although environmental quality is typically expected to be a normal good the expected coefficient sign for income is ambiguous, since expected tax increase is higher for the higher income groups. Due to decreasing marginal utility, the quantitative static measures of open landscape (CULTIV) should negatively influence demand. The related dynamic measure (ΔCULTIV), which represents the recent change of open landscape, would be expected to have a positive coefficient if faster rates of loss increase demand for future protection. With the measures for landscape and townscape quality (AMENITY, DHERITAGE) the sign expectations are ambiguous. On one side, there may be an effect of decreasing marginal utility when more land is in high-quality landscape elements.

[2] Cultivated land includes the categories 'fruit trees, vinyards and horticulture'; 'meadows, fields and pastures'; and 'alpine pastures'.

[3] These are (with hectares for 1996): orchards (row and scattered) (2460), hedgerows (1905), groups of trees (796), small woods (521), shrubs (80), wetlands (1247), shore vegetation (75), thin forest on unproductive land (27), thin forest on agricultural land (21), forest strips (1818), meadows and pastures in early stage of succession (31), alpine pastures (158), herbal vegetation (51), and rocks, sand, or rubble (24). The area statistic is based on a 100m by 100m grid sampling procedure.

Alternatively, the presence of high quality landscapes may for some people initially establish or increase the perception of benefits from these public goods. The present data allow an interesting test of these alternative hypotheses. Change in high quality landscape elements (ΔAMENITY) may be relatively difficult to perceive and should have only slight, if any, effects on voting decisions. The interpretation is restricted to coefficient signs because the magnitudes are effects on the probability of voting in favour of the proposition, and not on expected welfare changes.

The percentage of the population in different age segments, and a variable for educational achievement were both strongly correlated with income ($\rho > +/-0.55$). These variables were dropped because income was expected to be the more directly relevant variable affecting the attitude toward higher tax payments for landscape protection, even though both age and education might be expected to affect demand for landscape protection. All land use variables had correlations with income lower than +/- 0.34.

4.2 Results

All independent variables described in Table 1 were incorporated in a regression equation to explain *logit*(Y). Regression results are shown in Table 2. As may be seen, 51% of the variability in voter approval for NHP is explained by the model. Where theory suggested a clear expectation of the sign, the resulting coefficients corresponded to these expectations (Table 2). The effect of INCOME was strongly positive and highly significant. With the progressive tax system taken into consideration, this suggests that landscape protection in the canton of Zurich is a luxury good. Income variability accounts for only 18% of the variability in voter approval. The negative sign of the ratio of cultivated land (CULTIV) clearly indicates a decreasing marginal utility of the benefits from landscape protection, which is consistent with other studies. The rate of decrease in cultivated land (ΔCULTIV) is also significant in explaining approval of NHP, with higher rates increasing approval for the proposition, which should not come as a surprise given the high absolute rates of recent development.

From the positive coefficient for high amenity landscape elements (AMENITY) it appears that of the two competing expectations, a possible effect of decreasing marginal utility from additional landscape protection is outweighed by a generally positive effect these landscape elements may have on the perception of the landscape protection issue. The positive tendency observed for the dummy variable DHERITAGE for aesthetically significant townscapes can be interpreted similarly, although this is not statistically significant. The *change* of high recreational amenity landscape elements (ΔAMENITY) was also not significant in explaining voter behaviour.

4.3 Comparison with referenda on other public goods

We might anticipate that local environmental variables, and changes in these, would have a greater influence on preferences for local environmental goods, such as with the nature and heritage fund, than would be the case in voting over a national environmental good. As an example of voting on such a public good, we use results from a referendum proposing a national tax on non-renewable energy use[4]. Table 3 shows results for this referendum, using the same dependent variables as in Table 2. As may be seen from examining the elasticity estimates, levels of local environmental amenity have a smaller effect on voting patterns than is the case with the NHP fund, although effects are still in the same direction. Changes in the percentage of cultivated land, however, no longer produce any significant effect on voting. With regard to the amenity variables, LG(AMENITY) still has a significant effect on voting, although the effect is smaller than with the nature and heritage fund. Income is again significant and positively signed[5].

[4] The proposition envisaged raising a refundable tax on non-renewable energy use to protect environment, landscape, and climate. Voter turnout in the canton of Zurich was 47%. The approval rate was 52%. This and the following issue were both voted on in September 2000.

[5] However, self-selection of residency by citizens with a high demand for environmental protection cannot be ruled out as an explanation for voting patterns.

Finally, we compare the local environmental preferences results with a referendum on a non-environmental public good, namely a proposal to reduce the cantonal supplements to the national old age insurance[6]. Results are shown also in Table 3. As may be seen, income has a very strong effect on voting patterns, contributing 45% of the explanatory power. Landscape features as measured by the CULTIV and AMENITY variables have insignificant impacts on voting behaviour, as our conceptual framework suggests should be the case.

5. Discussion and Conclusions

In this paper we have presented evidence that support for public efforts to protect landscapes is conditional on ambient quantitative and qualitative aspects of the landscape pattern. While Kline and Wichelns (1994) analyse the support for a quantity preservation of landscape by purchasing development rights to farmland, our data allow complementary analyses of the support for improving landscape quality. Similar results in terms of explanatory patterns in the canton of Zurich and in New Jersey indicate that voter motives may be comparable in spite of referendum propositions relating to landscape amenities protection in one case and agricultural land preservation in the other. We find that local landscapes, and the change in these over time, significantly explain demand for this public good, as measured by voting behaviour. Higher incomes also increase the approval rate for the NHP fund, with an income elasticity of voting approval greater than one[7].

Comparison with referenda on other environmental issues supports the finding that perception of the local landscape setting exerts a stronger influence on the support for local landscape protection, than for a national public good such as air quality. Although urban-rural differences in the perception of many environmental issues are well known, these differences

[6] Voter turnout was 47%. The rejection rate (favouring higher expenditures) was 56%.

[7] Marginal income taxes in the canton of Zurich range from zero to thirteen percent across incomes. At the average income, a one percent increase of income affects income tax by 1.57 %. From regression results for referendum approval elasticity for the landscape good must therefore be well above 1.57.

seem to be particularly pronounced in the case of landscape amenities protection. As expected, no consistent effect of local landscape could be found for a non-environmental public good.

Given a continued rapid land development in the canton of Zurich, our results suggest that the demand for landscape protection will increase in the near future as this local public good gets scarcer. Efforts to maintain or improve landscapes appear to be in greater demand where landscape elements with high amenity value are already present. In contrast, rural municipalities with much agricultural land but a small proportion of high amenity landscape elements show little interest in improving their landscapes. As agricultural policies, in accordance with WTO agreements, continue shifting from production support to incentives for the contribution of amenity values of the landscape, these rural regions may run the risk of loosing public support and employment opportunities.

Finally, results suggest that amenity characteristics of cultivated landscapes can be organised into consistent and meaningful empirical measures that move beyond a mere distinction of developed *vs.* undeveloped land. Against the background of continuing urbanization, a benefits function approach accounting for citizens' residential landscape setting could help to derive future demand functions which could be useful in setting priorities for landscape preservation and zoning. In addition, it might also be useful from a benefits transfer perspective.

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Table 1. Descriptive statistics of (untransformed) model variables

Variable	Description	Mean (SD)	Sign expectation
INCOME	Average income of workforce in 1000 CHF	58.7 (11.8)	?
CULTIV	Ratio of cultivated to non-forested land in 1996	0.717 (0.173)	–
ΔCULTIV	Relative change (reduction) in the ratio of cultivated to non-forest land over 12-year perod	0.043 (0.048)	+
AMENITY	Percentage of near-natural and traditional landscape elements area on non-forest land	7.6 (3.8)	?
ΔAMENITY	Percentage change (reduction) of AMENITY over 12-year period	12.7 (11.5)	(+)
DHERITAGE	Dummy variable for historical heritage townscape: 1 = present; 0 = absent	.46	?

Note: There are 171 observations in the dataset.

Table 2. Ordinary least squares estimates for approval of the nature and heritage protection (NHP) proposal.

Dependent variable: *logit* (percent of votes in favour of higher expenditure)			
Variable	Coefficient estimate	t-Statistic	Marginal effect[a]
Intercept	-5.414	-3.581 ***	
LG(INCOME)	0.469	3.482 ***	0.229
LG(CULTIV)	-0.443	-4.691 ***	-0.216
LG(ΔCULTIV)	0.114	3.797 ***	0.056
LG(AMENITY)	0.180	3.834 ***	0.088
ΔAMENITY	-0.002	-0.890	0.012
DHERITAGE	0.075	1.727*	
Adjusted R^2		0.51	
Partial R-sq. of INCOME		0.18	

[a]: Absolute effect of a 1% increase in the (untransformed) variable on the percentage of votes in favour of the higher expenditure.

Note: *,**,***: Significant at 0.05, 0.01, and 0.001 levels, respectively.

Table 3. Ordinary least squares estimates for approval of the non-renewable energy tax and old age insurance proposals.

Dependent variable: *logit* (precent of votes in favour of proposal)						
	Non-renewable energy proposal (national environmental public good)			Insurance proposal (non-environmental public good)		
Variable	Coefficient estimate	t-Statistic	Marginal effect[a]	Coefficient estimate	t-Statistic	Marginal effect[a]
Intercept	-2.754	-2.14*		9.35	9.70***	
LG(INCOME)	0.208	1.85	0.107	-0.842	-9.83***	-0.200
LG(CULTIV)	-0.186	-2.22*	-0.096	0.027	0.45	0.006
LG(ΔCULTIV)	0.017	0.85	0.009	-0.036	-1.16	-0.009
LG(AMENITY)	0.118	3.07**	0.061	-0.037	-1.33	-0.009
ΔAMENITY	0.001	-0.31	0.008	-0.0003	-2.08*	-0.001
DHERITAGE	0.099	2.76		-0.014	-0.49	
Adjusted R^2		0.15			0.48	
Partial R-sq. of INCOME		0.04			0.45	

[a]: See Table 2.

Note: *, **, ***: See Table 2.