The Demand for Groundwater Quality Legislation - An Economic Analysis of Voting Behavior

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Washington, D.C.

Paper presented at the Annual Meeting of the American Agricultural Economics Association, Knoxville, August 1 - 3, 1988.

#5303

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I. Introduction

Protection of groundwater quality has emerged as one of the major environmental issues of the 1980's. Even a cursory review of the public record reveals that a considerable amount of legislation directed at preventing groundwater quality degradation has been promulgated during this decade and that a lively debate over the form of future regulations has been common during the past several sessions of Congress. While a high degree of scientific uncertainty complicates the implementation of risk-benefit analyses typically used to weigh regulatory decisions, some insight into the risk management process can be gained by examining public choices regarding groundwater quality by various factions of society.

Unlike consumer preferences for private goods, the public demand for collective goods may be driven both by self-interest and by political ideology. In the case of environmental quality, the demand price may be viewed as an opportunity cost composed of foregone revenues paid by industries forced to modify production practices. Voters are assumed to cast votes reflecting their perceived self-interest and political orientation. Thus, economic costs such as lost wages are presumably weighed against any gains derived from improved environmental quality (e.g. safer drinking water) and any gains associated with one's political outlook.

The purpose of this paper is to examine the factors that influence

the demand for groundwater quality protection. In particular, we wish to test the hypothesis that economic self-interest dominates political ideology in driving the demand for groundwater quality protection. Failure to reject this hypothesis suggests that economists and economic models may be productively employed in understanding who is concerned about changes in environmental quality and the factors that motivate their concern. Conversely, rejecting the hypothesis suggests that other disciplines may be better suited to developing models for understanding/predicting public behavior regarding groundwater quality.

The remainder of this paper proceeds as follows. A brief overview of the policy settings used to test hypotheses are presented in Section II. A stochastic choice model of voting behavior is presented in Section III. The econometric specification and data are discussed in Section IV. Section V presents the results of the analysis and the conclusions are presented in Section VI.

II. Policy Settings

Two case studies of voting behavior are used to reveal preference information: California's Proposition 65 (the Safe Drinking Water and Toxic Enforcement Act of 1986) and the Iowa Groundwater Protection Act of 1987. Proposition 65 (P65) is a state initiative that passed a statewide referendum by a comfortable margin with 63 percent of the voters casting votes for the proposition. Violation of two key provisions in Propostion 65 subjects violators to civil liability suits. The first provision prohibits persons from knowingly discharging a chemical known to the state to cause cancer or reproductive toxicity into

a drinking water source. The second provision requires warnings before exposing persons to chemicals known to cause cancer or reproductive toxicity. The burden of proof rests with industry to prove that violation of a provision does not cause damage. Although Proposition 65 was not targeted exclusively at the agricultural industry, agricultural interests perceived that passage of the initiative would have a large negative impact on the way farming was conducted in California and spent large amounts of money in an effort to defeat the proposition.

The Iowa Groundwater Protection Act (IGPA) is the result of a legislative action that grew out of broad public concern with agricultural and other industrial contaminants being discovered in the state's groundwater. Public sentiment was reflected in two well publicized public opinion polls. While taking a broad based approach to controlling groundwater contamination from diverse sources, the IGPA makes provisions to help farmers reduce their dependency on chemical use by providing an institutional structure that is intended to provide research and demonstration information on low input production technology. Financing is provided by a variety of fees or taxes on agricultural chemicals. The taxes are not Pigouvian in the sense of approximating marginal social damages, but are calculated to cover the estimated costs of the program. Other accounts are established by the Act to cover other sources of contamination such as household hazardous wastes and landfills.

While the Act easily passed the state House and Senate, reflecting it's broad public appeal and endorsement by the Governor, a closer "battle" was fought on a key amendment to the Act known as the Tabor

amendment. This amendment amounted to a stringency clause which prohibited state regulations from exceeding federal regulations. By investigating the vote on this amendment in conjunction with the vote on the final bill, a richer model allowing the possibility of "strategic voting" by legislators is explored.

III. A Stochastic Choice Model

The basic model used here is based on the assumption that individuals make decisions based on the utility difference between the conditions expected to obtain under a legislative proposal and the status quo (Deacon and Shapiro, 1975). This model is extended to the case of legislative voting by making the simplifying assumption that legislators maximize their re-election probability by voting in accordance with the desires of the median voter. While a legilator's vote on a major bill is highly visible and may influence re-election probabilities, it is assumed that votes on amendments are less visible to political constituencies and therefore may be subject to personal political agenda's. This modification of the usual median voter model is considered below.

To begin, we define indirect utility as a function of variables which may be affected by the choice of public policy:

$$V(M,P_X,q) = \text{Max } U(x,q) \qquad (1)$$
$$\text{s.t. } P_X x = M$$

where x are private goods which cost P_X, q is the public good, and M is income. Let dq represent an increase in provision of the public good.

Then dq is financed by changes in M (dM), which may represent real or opportunity costs. The maximum willingness to pay for an increase in q is the amount E such that:

$$V(M - E, P_X, q + dq) = V(M, P_X, q). \qquad (2)$$

The individual's decision rule is then vote for the policy if $E > dM$ and vote for the status quo if $E < dM$.

Following McFadden (1973), utility is specified as being composed of two parts - a "representative" component for individuals with a vector of characteristics Z (including political ideology), and a component which captures individual tastes:

$$V(M, P_X, q; Z) = W(M, P_X, q; Z) + \epsilon(M, P_X, q; Z) \qquad (3)$$

where W( ) is representative indirect utility and ϵ is the stochastic effect of individual tastes. The choice probabilities are then defined in terms of the representative utility for each alternative. In the case of two alternative outcomes, the probability that an individual will choose to pay dM to improve environmental quality by amount dq can be written:

$$P(dM, q + dq; Z) = \text{prob}[W(M - dM, q + dq; Z) - W(M, q; Z) > \epsilon(M, q; Z) - \epsilon(M - dM, q + dq; Z). \qquad (4)$$

If the stochastic terms follow a Weibull distribution, then the choice

probability can be written as a logistic function (resulting in a logit model). Likewise, if the stochastic terms follow a normal distribution, then the choice probaility can be written as a function of the cumulative normal distribution (resulting in a probit model).

IV. Econometric Specification and Data

Before we can estimate the empirical model, it is necessary to specify a functional form for the utility difference. Following the lead of earlier work in this field (e.g. Deacon and Shapiro 1975, Peltzman 1984) we specify the utility difference as a linear function of the relevant variables found in the choice theory.

Since observations on individual choices are not available, by necessity we use aggregate observations. In California, repeated observations are available in the sense that choice probabilities can be directly observed for chosen observation units (in this case, the unit is county residence.) In Iowa, repeated observations are not available, requiring the use of a different econometric model.

In California, the proportion π of voters casting votes for P65 were calculated from published news accounts (Los Angeles Times, 1986). The logarithm of the odds ratio $\pi/(1 - \pi)$ is expressed as a linear function of the regressors and a stochastic disturbance term. Since the variance of the disturbance term is not constant, we used generalized least squares to estimate parameters. This method is referred to as the minimum logit chi-square method (Maddala 1983).

In Iowa, a record of the House vote on the IGPA and the Tabor amendment is found in the Journal of the House (1986). Single

observations per measurement unit (House district) are used to estimate the parameters of the model. Since the basic data on the explanatory variables is obtained on a county basis, it is apportioned to the district level. To estimate the parameters of this model, we estimated a probit model using maximum likelihood methods.

A major concern of this study is to compare the influences of economic self-interest and political ideology on voting behavior. As such, it is important to obtain a pure measure of political ideology. Since political ideology may be highly correlated with economic interest, it is necessary to purge the ideology measure of economic factors (Kau and Rubin 1979). This is accomplished by constructing a variable which is orthogonal to the economic variables.

Our proxy for political ideology is constructed from observation of political party preference. In California, the proxy is measured as the proportion of voters casting votes for a liberal candidate for the U.S. Senate (Cranston) versus a conservative candidate (Zschau). In Iowa, the proxy is measured as the political party of the various representatives. This variable (PTY) is first regressed on the economic independent variables. The new variable (RPTY) is obtained by subtracting from the actual values of PTY the computed values obtained from the regression. This residualization technique is derived from Goldberger (1964) and used by Kau and Rubin (1979), among others.

The economic variables suggested by the probabilistic choice model include income and cost variables. Median household income statistics are drawn from the U.S. Census of Population (1980) and are used to test the hypothesis that environmental quality is a normal good. The cost

variables used for model estimation reflect opportunity cost of industries expected to be impacted by the proposed legislation. Two industries were considered, agriculture and manufacturing, and were measured by the proportion of the labor force employed by those industries. Data were obtained from the U.S. Census of Population (1980).

The choice model also suggests that the expected change in environmental quality influences voting behavior. Reliable information on the degree of groundwater contamination, or more importantly the perception of contamination, by the relevant observation units was not available. As a proxy, we use information on drinking water supply source. Public sources are probably viewed as the safest source of drinking water due to their greater depth and monitoring programs. Private drilled wells are likely to be viewed as next safest, and private dug wells the least safe due to their generally shallow depth. These variables are measured as percentages of total wells falling within each category. The basic data were obtained from the U.S. Census of Housing (1980).

V. Results

Results for California are discussed first and parameter estimates used in the analysis are presented in Tables 1 and 2. While we have no theory about the way in which specific economic variables influence political preference, we can see in Table 1 that economic variables are significant in explaning nearly one-fourth of the variation in our measure of political orientation. In particular, liberalism is

positively associated with higher income levels and negatively asoociated with the percentage of the labor force employed in agriculture. Using this result to obtain a measure of liberalism that is not multicollinear with the economic variables, we turn to the results in Table 2.

Economic self-interest, political ideology, and environmental condition are seen to explain about ninety-one percent of the variation in voting behavior on Proposition 65. The variable measuring agricultural opportunity cost has the expected sign and is significant at the 0.01 level. The variable measuring opportunity cost to the manufacturing industry, while not very significant, also has the expected sign. The parameter estimate on income is significant at the 0.10 level and suggests that environmental quality is a normal good. Surprisingly, the coefficient on the percentage of households using private wells is significant at the 0.01 and yet has the opposite sign than was expected. This result may be explained by the fact that private wells are associated with nonmetropolitan areas and apparently these areas were threatened by the initiative. The residual measure of political ideology is significant at the 0.01 level and has the expected sign (liberals are expected to vote for environmental quality.)

Examining the last column of the table, it is seen that the elasticity estimates of agricultural opportunity cost and income are about equal to each other and are over thirty times larger than the elasticity estimate for the ideology variable. This result supports our main hypothesis regarding the importance of economic self-interest in determining public choices.

Results for Iowa are presented in Tables 3 - 5. A look at Table 3

reveals that, in Iowa, the economic variables did not explain very much of the variation in the ideology variable. However, the percentage of the work force employed by agriculture was significant at the 0.01 level, and suggests that agricutural interests are aligned with the Republican party. While the income variable is only significant at about the 0.3 level, the sign of the parameter estimate suggests that higher incomes may also associated with a preference for the Republican party.

Table 4 demonstrates that none of the variables, except the variable measuring the percentage of dug wells, were significant in explaining the final vote on the IGPA. This result is explained by the fact that the Act was very popular, very visible to constituencies, and approved overwhelmingly (the vote being 81 to 16 with 3 not voting). Of interest, however, is the analysis of the vote on the stringency clause presented in Table 5. In reading this Table, keep in mind that a vote for the amendment is a vote for a less stringent regulatory framework. The variables representing agricultural opportunity cost and political ideology both had the expected sign and were significant at the 0.01 level. The one big surprise in these results is the fact that income is found to be significant at the 0.05 level and yet has the opposite sign than was expected. This result may be explained by the fact that income could be correlated with other economic activities that perceive the amendment as a threat to doing business.

Earlier it was hypothesized that legislative voting on amendments allows greater latitude for pursuing one's own political agenda due to the low public visibility of such votes. If this hypothesis is true, then the influence of political ideology would be expected to be

relatively large relative to other factors determining choice. However, an examination of the last column of Table 5 shows that, again, the elasticity estimates of the economic variables are again many times larger than the elasticity estimate related to political ideology.

VI. Conclusion

In both case studies examined, economic self-interest dominated political ideology in driving the demand for groundwater quality legislation. This result suggests that economists and economic models can be fruitfully employed in further efforts to understand factors motivating public choice and to make predictions regarding future outcomes.

Our conclusion that environmental quality is a normal good provides a case in point. Our results indicate that continued growth in personal income will increase the demand for groundwater quality. Using California as an example, a twenty-five percent increase in personal income over, say, the next decade would increase the demand for groundwater quality protection by about two and one-half percent, ceteris paribus. While not large per se, this growth in demand may be significant at the margin, that is, large enough so that the proportion of the population that supports environmantal quality legislation exceeds the proportion against such legislation.

Future research needs to focus greater attention on how the components of personal income interact with various sectors of the economy in terms of generating income and pollution. It is expected that controlling for these sources of multicollinearity would improve the

explanatory power of the public choice model.

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Table 1. Economic Determinants of Political Preference, California

Variable	Coefficient	t-statistic	Significance
Int	0.35	7.01	0.00
agpct	-0.37	-2.51	0.02
mpct	0.07	0.45	0.66
inc	0.00001	3.05	0.00

Adjusted R^2 = 0.23

F-statistic = 6.37

N = 58

Table 2. Parameter Estimates of Logit Model, Proposition 65

Variable	Coefficient	t-statistic	Significance	Elasticity
Int	0.43	2.21	0.03	--
agpct	-4.22	-6.40	0.00	-0.11
mpct	-3.45	-1.04	0.30	-0.02
inc	0.00003	1.83	0.07	0.10
privpct	-2.50	-2.66	0.01	0.08
dugpct	11.02	1.15	0.26	0.02
rpty	1.30	4.76	0.00	0.003

Adjusted R^2 = 0.91

F-statistic = 95.04

N = 58

Table 3. Economic Determinants of Political Preference, Iowa

Variable	Coefficient	t-statistic	Significance
Int	1.51	2.18	0.03
agpct	-2.54	-2.58	0.01
mpct	-0.03	-0.04	0.97
inc	-0.00004	-1.02	0.31

Adjusted R^2 = 0.06

F-statistic = 2.91

N = 100

Table 4. Parameter Estimates of Probit Model, Iowa Groundwater Protection Act

Variable	Coefficient	t-statistic	Significance	Elasticity
Int	12.00	0.76	0.45	
agpct	-15.78	-0.63	0.53	-0.27
mpct	0.75	0.19	0.85	0.03
inc	-0.0004	-0.81	0.42	-1.02
pubpct	-1.29	-0.27	0.79	0.19
dugpct	-21.94	-1.76	0.08	0.06
rpty	4.34	0.46	0.65	0.004

Table 5. Parameter Estiamtes of Probit Model, Tabor Amendment

Variable	Coefficient	t-statistic	Significance	Elasticity
Int	-24.97	-2.93	0.00	
agpct	36.85	3.87	0.00	1.75
mpct	3.52	1.01	0.32	0.34
inc	0.0004	2.11	0.04	3.14
pubpct	15.42	2.46	0.02	6.45
dugpct	25.18	1.37	0.17	0.25
rpty	-2.93	-5.12	0.00	-0.007