Adoption of Phosphorus-free Lawn Fertilizer Laws in the U.S.

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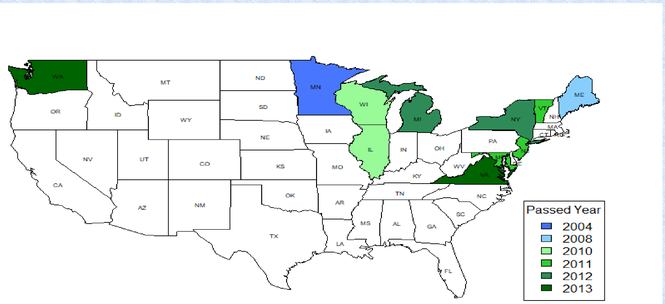
Background

- Phosphorus (P) is an essential nutrient for plant growth.
- However excessive nutrients can cause harmful algal blooms.
- Algal blooms can result in eutrophication and fish kills.
- They can also affect municipal water supplies; a toxic algal bloom in Toledo, Ohio in 2014 made tap water for over 500,000 residents undrinkable.
- P and algal blooms can thus have negative effects on the economy.
- The P source is both agricultural and urban nonpoint pollution.
- Established lawns do not need P.
- Eleven states have passed a law that bans the use of P fertilizer on lawns in urban areas to reduce water pollution.
- There is no research analyzing the factors affecting state regulation of P in lawn fertilizer.



Conceptual model

A number of factors are hypothesized to influence enactment of P-free laws:

- Private interest: adopt a policy to maximize industry's benefits (Stigler 1971)
  - The number of fertilizer companies (-)
- Public interest: regulate to fix market failure (pollution; Joskow and Noll 1981)
  - State's water quality problems (+), water area (+), and tourism employment (+)
- Ideology: political ideology drives policy making decisions (Kalt and Zupan 1984)
  - State's government's ideology – liberal (+) (Berry et al. 1998)
- Internal determinants and diffusion (Walker 1969)
  - Policy adoption can be explained as a function of political, social and economic factors (household income (+)).
  - As more states adopt the law, more information is available (+).

Objectives

- Identify the factors affecting the passage of P-free lawn fertilizer laws in the U.S.
- Use these results to provide guidance for policy in order to improve water quality.

Data

- Yearly state data from 2005 to 2013 (50 states, 421 observations)
- Dependent variable: Whether a state had passed the law
- Four categories of independent variables (source: USGS, U.S. Census, etc.)
  - Environment and natural resources, States' economy, Employment, and Political ideology
- We checked for multicollinearity using correlations as well as variance inflation factor (VIF) and excluded some variables that were problematic.

Model

- Probit model in a pooled data setting was used due to the dichotomous nature of the dependent variable:

$$\mathrm{P}(y_{it} = 1|X_{it}) = \Phi(X_{it}\beta + v_i)$$

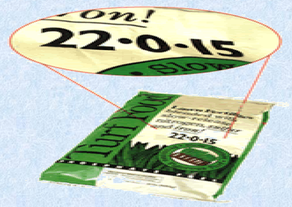
where $X_{it} = (x_{1t}, \cdots, x_{Nt})$ is a transposed matrix including vectors of the independent variables, and $\Phi(\cdot)$ is the cumulative standard normal distribution

- Used clustering of errors to account for heterogeneity across states in the pooled model:

$$Var(\beta) = E[[X'X]^{-1}X'\Omega X[X'X]^{-1}]$$

Results

- States with higher lagged total P levels were more likely to pass the law.
- Those having more water area were more likely to require P-free fertilizer.
- States were more likely to pass the law as more other states had passed the law.
- A higher percentage of employment in art and tourism was associated with being less likely to pass the law, contrary to expectations.



Cluster-Probit Regression Results

VARIABLES	Probit
The number of fertilizer companies	0.0226
Lagged level of TP (mg/L)	0.0010***
Employment in ag and natural resources (%)	0.0657
Employment in accommodation and food (%)	-0.6670***
Liberal government ideology (0:conservative to 100: liberal)	0.0089
Percentage of water area (%)	4.3030***
The number of states that passed the law	0.2250***
Median household income (thousand $)	-0.0044
Constant	1.1810
Pseudo R2	0.2743
*** p<0.01, ** p<0.05, * p<0.1	

Conclusions

- The excessive use of P can cause water pollution. Thus, water related variables (water quality and area) are significant in the results.
- The public interest theory for adjusting water pollution seems to have an important role in the enactment of P-free laws.
- There was no support for the capture theory in the final model which controlled for heteroscedasticity.
- As more states adopt the laws (diffusion), it provides not only more information but also less uncertainty (Grossback et al. 2004).
- One surprising result was that the percentage of employment in accommodation and food (which would be related to tourism) had a negative relationship with passage of the law, *ceteris paribus*. This may be due to warm, coastal destinations having less of a problem with phosphorous, which is the limiting nutrient in fresh water systems.

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