UNDERSTANDING HOUSEHOLD PREFERENCES FOR PRICE VERSUS QUANTITY INSTRUMENTS ON LAWN-CARE PRACTICES: IMPLICATIONS FOR NONPOINT NUTRIENT REDUCTIONS

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Importance of nonpoint emission reductions

- Achieving water quality requirements (e.g., nutrient reductions) through continued reductions in point source emissions is costly
- Improved management of nonpoint sources is increasingly viewed as a key component of cost-effective strategies to comply with water quality regulations, such as the US Clean Water Act
- Efforts to reduce nonpoint source emissions were traditionally focused on the agricultural sector (e.g., nutrient trading)
- Recently, greater attention has been given to other sources of nonpoint nutrient emissions, such as fertilizer runoff from residential lawns
- Environmental impacts and management of residential lawn care have been substantially studied by non-economists (e.g., Whitney 2010; Larson et al. 2020)
- But the economics literature has been largely silent on the feasibility of targeted changes in residential fertilizer use as a means to achieve nutrient reductions

Managing household behaviors for environmental purposes

- Management of household behaviors that are linked to nonpoint source emissions—such as lawn fertilizer use—is important for achieving environmental goals, including nutrient reductions in many US water bodies
- These behaviors can be influenced by various policy instruments, such as direct restrictions and price-based instruments such as surcharges
- Yet, widespread ***assumptions*** exist that such policy instruments are opposed by the public (e.g., Whitney 2010)
- In turn, the economics literature provides ***little empirical evidence*** on households' preferences for policy instruments that might be applied to influence behaviors such as lawn fertilizer use

(Scarcity of) previous studies

- This relative lack of empirical evidence is surprising
  - The literature—particularly, stated preference literature—has produced thousands of articles exploring various public preferences
  - These methods can be applied to study preferences for management of household behaviors
  - But studies of this type are uncommon and focus on a few areas such as water restrictions, waste management, and energy use (e.g., Mansur and Olmstead 2012; Broberg and Persson 2016)
- Some work has evaluated preferences related to households' adoption of stormwater best management practices such as rain gardens (e.g., Newburn and Alberini 2016)
- Yet, no similar work has studied tradeoffs in alternative types of regulatory instruments to manage residential fertilizer use, including price and quantity instruments
- *Absent empirical insight* of this type, decisions on management of household behaviors continue to be informed by *speculations* about instruments that the public would support

Our objectives

- We evaluate systematic preferences of households for price, quantity and other instruments that might be used to regulate residential fertilizer use and attendant nutrient runoff

- We aim to help identify policy options that would increase household support for regulatory instruments

Empirical data

- Discrete choice experiment of households in the Baltimore metro region
- "Assume that Programs A and C were offered as two possible options to manage lawn care and improve streams and rivers in the Baltimore area. Given a choice between the two, how would you vote?"
  - I Vote for Program A
  - I Vote for Program C
- Each respondent was asked 3 voting questions

Method or Effect	Program A (Current Conditions)	Program C (Proposed Program)
 Fertilizer Application Restriction	**No** No new restriction on fertilizer	**Yes** Fertilizer restricted to **1 application** per year
 Free Lawn Assessments	**No** No new assessment program	**Yes** Free lawn assessments (Help get similar results with less fertilizer & chemicals)
 River & Stream Health	**29%** River/stream miles in fair or better health (71% in poor health)	**50%** River/stream miles in fair or better health (50% in poor health)
 Reduce Chemical Exposure	**0%** No change	**30%** Local children and pets exposed to **30% less** lawn chemicals
 Fertilizer & Chemical Surcharge	**0%** None	**30%** $0.30 per dollar price increase
$ Cost to Your Household Per Year	**$0** Increase in taxes and fees	**$100** Increase in taxes and fees

The number of times per year that you can apply fertilizer to your lawn. The number of applications could be limited to 1, 2, or 3 per year.

Whether certified landscaping experts are available to visit your home free of charge, once per year. These experts would conduct "lawn assessments" and provide guidance to help you obtain desired lawn appearance while reducing fertilizer and chemicals.

The percent (from 29% to 50%) of river and stream miles in the Baltimore area that are in fair, good or excellent health. This is measured by the diversity of fish and small animals that live there.

The decrease in exposure of local children and pets to lawn chemicals such as fertilizers, weed killers and pesticides (from 0% to 40%). This can be measured using medical tests.

An added percent surcharge (from 0% to 30%) on prices that you would pay for lawn fertilizer and chemicals. The surcharge would also apply to those who hire companies to care for their lawns.

How much the program will cost your household in unavoidable annual taxes and fees (from $0 to $100).

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Survey design and administration

- D-efficient design included 48 profiles blocked into 16 versions, each with 3 voting questions
- Standard survey structure: questions about respondent's property and lawn, voting on the programs, reasons for voting choices, and socio-demographics
- Data collected from November to December 2019
- Mixed-mode, push-to-web approach: invitation letters with the survey link, two reminders at weekly intervals
- Letters mailed to a random sample of 13,000 homeowners in Baltimore City and County
  - Drawn from the spatially explicit parcel-level tax assessor database from the Maryland Tax and Assessment Office
- Screened to select single-family, owner-occupied households with parcel sizes from 0.1 to 5 acres, and at least 250 square feet of lawn area
  - Based on high-resolution (one meter) land cover data from the Chesapeake Conservancy
- 1,473 questionnaires with no missing data are used in the analysis

Modelling approach

- Latent class multinomial logit model in preference space – heterogeneity in preferences captured by discrete distributions
- Two classes (c = {1,2})
- Utility of household *h* from choosing policy scenario *p* in choice task *j*

$$U_{pjh}^{c}(\cdot) = \boldsymbol{\beta}_c' \boldsymbol{X}_{pjh} - \alpha_c C_{pjh} + \varepsilon_{pjh}$$

- We estimate the probability with which a household is a member of a given class
- Vector $\boldsymbol{V}$ of socio-demographic and revealed preference variables is used to explain class membership probabilities

$$\pi_c = \frac{\exp(\delta_c + \boldsymbol{\varphi}_c' \boldsymbol{V}_h)}{\sum_{m=1}^{2} \exp(\delta_m + \boldsymbol{\varphi}_m' \boldsymbol{S} \boldsymbol{V}_h)}$$

where δ_c and $\boldsymbol{\varphi}_c$ are to be estimated for c = 1. For identification, the parameters for class 2 are equal to zero (a reference category)

Sample

	Mean	St. dev.	Min	Max
Number of fertilizer applications per year	1.29	1.84	0	17
Parcel size (acres)	0.57	0.78	0.10	4.94
Lawn share (%)	0.33	0.19	0.01	0.96
Fertilizing: Hire a pro	0.21	0.41	0	1
Fertilizing: DIY	0.32	0.47	0	1
Belong to HOA	0.12	0.33	0	1
Belong to NHA	0.28	0.45	0	1
Have outdoor pets	0.50	0.50	0	1
Male	0.68	0.47	0	1
Master's or higher degree	0.39	0.49	0	1
Bachelor's degree	0.31	0.46	0	1
House age (in years)	58.57	27.70	2	203
House total assessed value (in million)	0.31	0.16	0.09	1.50

Results

Latent class multinomial logit model in preference space

Class membership for Class 1			
Number of fertilizer applications	0.09* (0.05)	Have outdoor pets	-0.19 (0.12)
Parcel size (acres)	0.02 (0.09)	Male	0.44*** (0.13)
Lawn share (%)	1.02*** (0.34)	Master's or higher degree	-0.98*** (0.16)
Fertilizing: Hire a pro	0.08 (0.22)	Bachelor's degree	-0.80*** (0.16)
Fertilizing: DIY	0.32** (0.15)	House age	-0.01** (0.00)
Belong to HOA	-0.15 (0.21)	House total assessed value	-1.11** (0.52)
Belong to NHA	-0.20 (0.14)	Constant	0.82** (0.33)

Notes: Mean estimates with standard errors in brackets are reported.

	Class 1	**Class 2**
Status quo	1.59*** (0.24)	-1.87*** (0.34)
1 application/yr allowed	-0.85*** (0.25)	0.04 (0.25)
2 applications/yr allowed	-0.27 (0.22)	0.13 (0.25)
3 applications/yr allowed	0.21 (0.19)	1.08*** (0.28)
Free lawn assessments	1.08*** (0.17)	-0.17 (0.20)
River health	7.71*** (1.36)	11.60*** (1.98)
Less chemical exposure	2.81*** (0.72)	2.04*** (0.71)
Fertilizer surcharge	-1.52*** (0.58)	2.18** (0.98)
Cost (100 USD)	-1.54*** (0.15)	-1.04*** (0.14)

Average class probabilities (%)		
	Class 1	Class 2
	54.47 (1.64)	45.53 (1.64)

Results

Latent class multir

Two distinct classes:
Class 1 against restrictions and surcharges
Class 2 for them

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Conclusions

- Grounded in information on households' current behavior, the model finds heterogeneous and non-linear preferences for different types and magnitudes of regulatory instruments
- These findings stay in contrast to widespread assumptions that policy instruments regulating residential fertilizer use are generally opposed by the public
- They are not:
  - About half of the sample strongly supports price surcharges and quantity restrictions
  - Even those who do not support fertilizer application restrictions only have significant (negative) preferences for the most stringent restrictions (1 application per year allowed)
  - For less severe restrictions (2 or 3 applications per year), preferences for both classes are either positive or insignificant—people do not oppose modest restrictions
- As a result, the common wisdom on public preferences for regulations of this type may lead to suboptimal policy choices
- These findings suggest that it might be possible to identify win-win regulatory options that would simultaneously reduce anticipated fertilizer use and increase household support

THANK YOU!

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