

Modeling Transaction Costs and Barriers for Household Adoption of Lawn Conversion Practices

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Incentives for Stormwater BMPs

- Voluntary incentive programs
 - Over 1,700 local jurisdictions in the US have stormwater utilities serving as a funding source for stormwater management
 - More than 50% of these entities offer incentive programs for homeowners to voluntarily adopt stormwater BMPs
- Household BMP adoption rates are typically low
 - Local programs to increase voluntary adoption
 - Awareness (promotional campaigns)
 - Cost-share incentives
- Transaction costs and barriers reduce impact of cost-share payments

Objectives

- Analyze household factors for enrollment in proposed cost-share incentive programs
 - Conservation landscaping
 - Rain gardens
- Examine effect of transaction costs and other barriers for enrollment in cost-share programs
 - Application paperwork
 - Finding a contractor
 - Mode of payment
 - Final inspection







Survey Sample

- **Baltimore City and County**
 - Random sample using parcel-level tax assessor database
- **Screening criteria**
 - Owner-occupied single-family homes
 - Lot sizes between 0.1 acres and 5 acres
 - Lawn area at least 250 square feet
- **Total population (156,801 homeowners)**
 - 22,985 households in Baltimore City (15%)
 - 110,053 households in Baltimore County inside URDL (70%)
 - 23,043 households in Baltimore County outside URDL (15%)

Survey Mailing Process

- Random sample of 13,000 households
- Mailing in late 2019
 - Initial letter mailed, postcard reminder, and second letter
 - Letter provided instructions to participate in the online survey in Qualtrics
 - Unique ID and password to link to property location
- Total of 1,749 survey respondents (13.5%)







Lawn Conversion Cost-Share Program Elements

Program Elements	What it means
 Type of Conversion Supported	<p>The type of lawn conversions paid for by the program. Options can include:</p> <ul style="list-style-type: none"> • Conservation landscaping • Rain gardens
 Cost-Share Percentage	<p>The percent (50% to 100%) of the total project costs paid by the program, either up-front or as a rebate. For example, with a 75% cost-share, you pay only 25% of the total cost.</p>
 Mode of Payment	<p>How you receive the cost-share payment. Options include:</p> <ul style="list-style-type: none"> • You pay the reduced amount up-front, • You pay the total cost up-front and receive a guaranteed rebate check later.
 Finding a Contractor	<p>How you find a contractor to complete the work. Options include:</p> <ul style="list-style-type: none"> • You find a contractor on your own who is able to complete the lawn conversion under the program rules, • You choose a contractor from a recommended list on a city/county website, or • A certified contractor is provided for you by the city/county.
 Application Paperwork	<p>Who completes the paperwork for city/county approval before the project begins. This includes a technical plan for the conversion project. Options include:</p> <ul style="list-style-type: none"> • You complete the paperwork and must obtain necessary information from the contractor, or • The contractor completes the paperwork and obtains necessary information from you.
 Inspection & Certification	<p>Who is responsible for arranging required city/county inspections and certifications after the project is completed. If these are not completed, you must return all cost-share payments. Options include:</p> <ul style="list-style-type: none"> • You are responsible for arranging inspections, or • The contractor is responsible for arranging inspections.

Attributes and Attribute Levels

Attributes	Levels
Type of Conversion Supported	Rain gardens Conservation landscaping
Cost-Share Percentage	50%, 75%, 100%
Mode of Payment	Pay full amount with rebate later Pay reduced amount up-front
Finding a Contractor	Find your own Choose from recommended list Contractor is provided by program
Application Paperwork	You complete paperwork Contractor completes paperwork
Inspection & Certification	Your responsibility Contractor's responsibility
Installation Cost (\$/square foot)	\$5, \$10, \$15, \$20

Example: Proposed Cost-Share Program

Program Element	Program A
 Type of Conversion Supported	<input checked="" type="checkbox"/> Conservation Landscaping <input type="checkbox"/> Rain Gardens
 Cost-Share Percentage	50% Program pays 50% of total cost (You pay 50%, or \$5.00 per square foot)
 Mode of Payment	<input checked="" type="checkbox"/> You pay less up front <input type="checkbox"/> You pay full amount and receive rebate later
 Finding a Contractor	<input type="checkbox"/> You find on your own <input checked="" type="checkbox"/> You choose from recommended list <input checked="" type="checkbox"/> City/county provides certified contractor
 Application Paperwork	<input type="checkbox"/> You are responsible <input checked="" type="checkbox"/> Contractor is responsible
 Inspection & Certification	<input type="checkbox"/> You are responsible <input checked="" type="checkbox"/> Contractor is responsible

Would you enroll under this program? (Yes/No)

Project size

You indicated “yes” that you would be willing to enroll.
What amount of lawn area (in square feet) would you convert and enroll in the proposed program?

Cost Guide

Lawn Area Converted (square feet)	Total Cost Without Cost-Share	Net Cost to Your Household After Cost-Share		
		50% Cost-Share	75% Cost-Share	100% Cost-Share
100 - 250	\$1,000 - \$2,500	\$500 - \$1,250	\$250 - \$625	\$0
251 - 500	\$2,500 - \$5,000	\$1,250 - \$2,500	\$625 - \$1,250	\$0
501 - 1,000	\$5,000 - \$10,000	\$2,500 - \$5,000	\$1,250 - \$2,500	\$0
1,001 - 2,000	\$10,000 - \$20,000	\$5,000 - \$10,000	\$2,500 - \$5,000	\$0
2,001 - 4,000	\$20,000 - \$40,000	\$10,000 - \$20,000	\$5,000 - \$10,000	\$0

Demographics for Survey Respondents

Variable	Mean
Gender (male=1)	64.5%
Senior citizen (age >= 65)	32.8%
Household size	2.8
Have 0-18 years old children (yes=1)	57.9%
Highest degree of education	
No college	9.1%
College	51.3%
Advanced degree	39.6%
Total gross household income	
<= \$25,000	2.9%
\$25,000 - \$50,000	8.0%
\$50,000 - \$100,000	24.7%
\$100,000 - \$200,000	29.3%
> \$200,000	10.0%
I'd rather not answer	25.0%
Financial hardship (yes=1)	13.6%
Pets spending time outdoors (yes=1)	46.4%
Living in home 10+ years (yes=1)	66.8%
Homeowners association (yes=1)	38.3%

Housing Characteristics for Survey Respondents

Variable	Mean
Lot size (acres)	0.6
House age (years)	58.8
House size (in 1,000 square feet)	2.0
Housing structural quality	
Below average	28.5%
Average	48.0%
Above average	23.5%

Two-stage Lawn Conversion Regression

Probability of program enrollment: Probit model used to estimate probability of enrollment in cost-share program as a function of program attributes, demographics, and housing characteristics (Enroll=1, Not enroll=0)

$$\text{Prob [yes=1]} = f(\text{install cost, subsidy payment, etc.})$$

Area of lawn conversion: Cragg hurdle model used to estimate the area of lawn conversion enrolled as a function of program attributes, demographics, and housing characteristics (Lawn area converted = 100, ..., 4,000 square feet)

$$\text{Area} = f(\text{install cost, subsidy payment, etc.})$$

Lawn Conversion Regression

Variable	Probability of Converting Lawn	Amount of Lawn Conversion
Rain gardens (yes=1)	0	0
Installation cost	--	--
Subsidy payment	++	++
Pay full amount * Rebate	-	0
Finding a contractor		
Certified contractor provided (baseline)		
Find on your own	0	N/A
Choose from recommended list	0	N/A
You are responsible for paperwork (yes=1)	--	N/A
You are responsible for inspection (yes=1)	--	N/A

+, ++ positive at 5%, 1% level respectively

0 no significance

-, -- negative at 5%, 1% level respectively

N/A indicates that the variable is not included in the model

Lawn Conversion Regression

Variable	Probability of Converting Lawn	Amount of Lawn Conversion
Lot size (acres)	0	++
House age (years)	++	++
House size (square feet)	0	++
Housing structural quality		
Below average (baseline)		
Average	+	0
Above average	+	0
Gender (male=1)	--	0
Age over 65 (yes=1)	--	0
Household size	0	0
Have 0-18 years old children (yes=1)	0	0
Total gross household income		
<= \$25,000	--	0
\$25,000 - \$50,000	-	0
\$50,000 - \$100,000	--	0
\$100,000 - \$200,000	0	0
I'd rather not answer	--	0
> \$200,000 (baseline)		
Highest degree of education		
No college	-	0
College	--	0
Advance degree (baseline)		

++: positive at 1% level

+: positive at 5% level

0: no significance

--: negative at 1% level

-: negative at 5% level

Transaction cost effects

- Scenario for enrollment in proposed cost-share incentive program
 - Installation costs = \$12.50/sqft
 - Cost-share payment (75%) = \$9.38/sqft
 - Household pays (25%) = \$3.12/sqft
- Estimated effect of transaction costs
 - Rebate payment = \$2.68/sqft
 - You responsible for final inspection = \$2.80/sqft
 - You responsible for application paperwork = \$2.05/sqft
 - You find a contractor = not significant

Conclusions

- Increased % enrollment when eliminating transaction costs
 - Rebate payment = 33%
 - You responsible for final inspection = 25%
 - You responsible for application paperwork = 19%
- Invest staff time to streamline application process
- Turn-key projects
 - Solar panel industry
 - Contractor more familiar with process than individual homeowner who only applies once

Household Lawn Fertilizer Analysis



Residential Lawn Fertilizer Use in 2019

Number of lawn fertilizer applications	Mean
0	47.7%
1	19.5%
2	13.9%
3	6.5%
4	6.4%
5	2.2%
6	2.6%
≥ 7	1.2%

N=3,708 households

Two-stage Lawn Fertilizer Regression

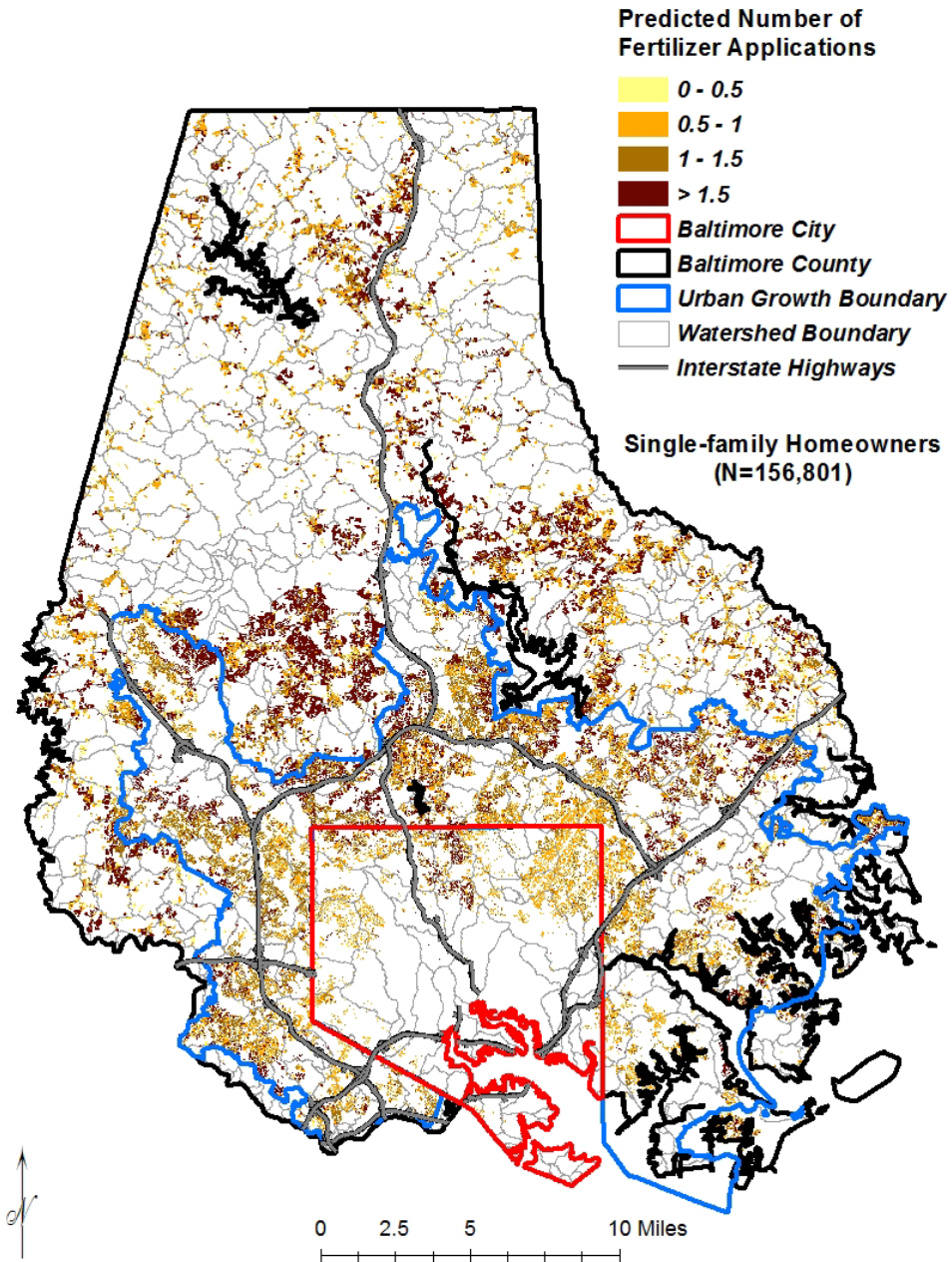
Probability of lawn fertilizing: Probit model used to estimate the probability of lawn fertilizing as a function of household characteristics (Fertilize=1, Not fertilize=0)

$$\text{Prob [yes=1]} = f(\text{lot size, house built year, house size, etc.})$$

Number of lawn fertilizer applications: Zero-truncated negative binomial model used to estimate the number of lawn fertilizer applications as a function of household characteristics (Number=1, 2, 3, ...)

$$\text{Number} = f(\text{lot size, house built year, house size, etc.})$$

Predicted Number of Fertilizer Applications



Probability of Lawn Fertilizing

Year built	House size (square feet)				Total
	< 1500	1500 – 2000	2000 – 2500	> 2500	
Pre-1950s	0.33	0.38	0.41	0.44	0.36
1950s – 1970s	0.48	0.53	0.55	0.59	0.50
1970s – 1990s	0.57	0.62	0.63	0.64	0.61
Post-1990s	0.65	0.70	0.74	0.74	0.72
Total	0.45	0.52	0.59	0.65	0.52

Predicted Number of Fertilizer Applications

Year built	House size (square feet)				Total
	< 1500	1500 – 2000	2000 – 2500	> 2500	
Pre-1950s	0.63	0.79	0.89	1.16	0.76
1950s – 1970s	0.99	1.18	1.29	1.61	1.11
1970s – 1990s	1.33	1.55	1.60	1.85	1.54
Post-1990s	1.60	1.89	2.07	2.47	2.18
Total	0.94	1.22	1.49	1.99	1.26

Number of Households

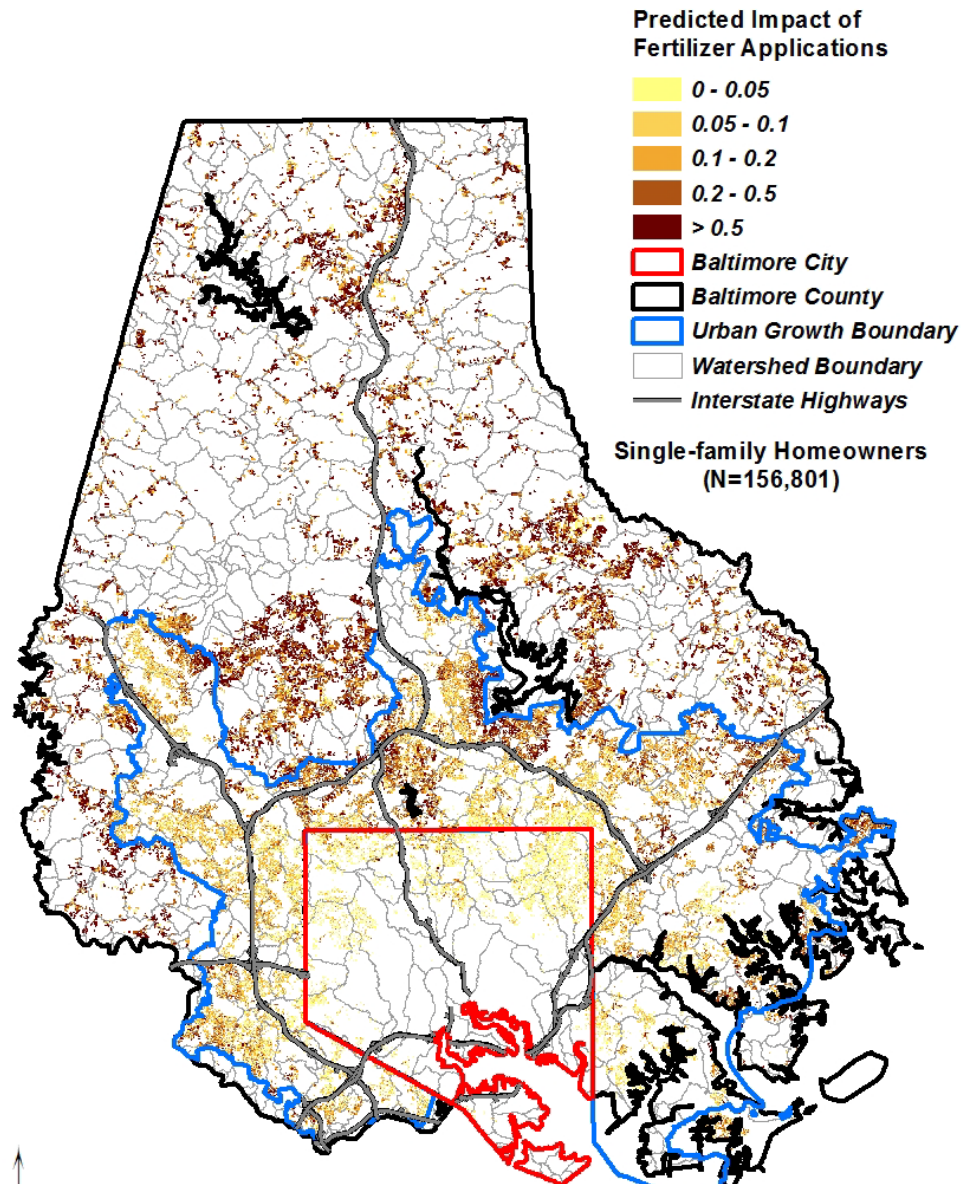
Lot size (acres)	Baltimore City	Baltimore County inside URDL	Baltimore County outside URDL	Total
<= 1/4	18,527	75,221	1,204	94,952
1/4 - 1/2	3,705	24,115	2,296	30,116
1/2 - 1	593	7,728	3,589	11,910
1 - 5	160	2,989	15,954	19,103
Total	22,985	110,053	23,043	156,801

Predicted Cumulative Impact of Fertilizer Applications

Lot size (acres)	Baltimore City	Baltimore County inside URDL	Baltimore County outside URDL	Total
<= 1/4	671	6,600	119	7,199
1/4 - 1/2	263	4,136	430	4,785
1/2 - 1	63	2,386	1,152	3,612
1 - 5	25	1,353	14,396	15,573
Total	1,005	14,694	16,090	31,184

Note: Predicted cumulative impact of fertilizer applications is calculated as the predicted average number of fertilizer applications multiplied by the cumulative lawn acreage summed for all the single-family households in that subgroup cell.

Predicted Fertilizer Impact per Household



Predicted fertilizer impact per HH = predicted number of fertilizer applications \times lawn acreage