Additionality and the Adoption of Farm Conservation Practices

(forthcoming in *Land Economics*)

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Farm Conservation Programs

USDA has invested $24 billion in 2002-2007 on conservation programs (e.g. CRP, CSP, EQIP)

Federal conservation programs are designed to provide incentives for farmers to voluntarily adopt conservation practices (e.g. no till, filter strips, cover crops)
Additionality & Policy implications

- **Additionality:**
  The increase in conservation effort by enrolled farmers relative to what they **would have done** without funding.

- If additionality is low, then the government is wasting its money. It’s paying farmers to adopt practices they would have likely adopted anyway.
Goals of this paper

1. Estimate the additional use of six conservation practices *caused* by enrollment in federal conservation programs using data from a survey of Ohio farmers
2. Decompose the additionality between two groups: new adopters and prior adopters.
Additionality Defined as Average Treatment Effect on the Treated (ATT)

\[ ATT = E[Y_1 | D = 1] - E[Y_0 | D = 1]. \]

Practice use with funding

Practice use without funding

We are only interested in those subjects who were treated
Decomposing Additionality

New Adopters

\[ Y_0 = 0 \]

Prior Adopters

\[ Y_0 > 0 \]
Decomposition of the ATT

We decompose ATT into relative contributions from

**New adopters**: Farmers who would NOT adopt without payment

**Prior adopters**: Farmers who would adopt even without payment

\[
ATT = P_n \cdot ATT_n + P_p \cdot ATT_p
\]

**New Adopter:** $Y_0 = 0$

\[
P_n = P(Y_0 = 0 | D = 1)
\]

\[
ATT_n = E[Y_1 - Y_0 | Y_0 = 0, D = 1]
\]

**Prior Adopter:** $Y_0 > 0$

\[
P_p = P(Y_0 > 0 | D = 1)
\]

\[
ATT_p = E[Y_1 - Y_0 | Y_0 > 0, D = 1]
\]
Farmer Survey

Study Region
- 25 counties in southwest Ohio

Survey
- 2009
- Administered through NASS
- Mailed to 2000 farmers with follow-up phone calls
- 771 respondents
Key variables

- Proportion of farm used for conservation practice in 2009
  - Whole field practices
    - conservation tillage
    - cover crops
    - hayfields or grasslands
    - grid sampling
  - Practices for environmentally sensitive areas
    - grass waterways
    - filter strips
- Received cost-share payment for that practice from ANY program
  CRP, CREP, CSP, EQIP, WQTP, and Other
Whole field practices

Conservation tillage

Cover Crops

Grid Sampling

Hayfield establishment

Practices for environmentally sensitive areas

- Filter strip
- Grass waterway

USDA NRCS, Ohio
## Summary Statistics: Conservation practices and enrollment

<table>
<thead>
<tr>
<th>Practice Type</th>
<th>No Adoption</th>
<th>Adoption without Enrollment</th>
<th>Adoption with Enrollment</th>
<th>Total(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation Tillage</td>
<td>97</td>
<td>379</td>
<td>87</td>
<td>563</td>
</tr>
<tr>
<td>Cover Crops</td>
<td>513</td>
<td>68</td>
<td>24</td>
<td>605</td>
</tr>
<tr>
<td>Hayfield Establishment</td>
<td>522</td>
<td>53</td>
<td>19</td>
<td>594</td>
</tr>
<tr>
<td>Grid Sampling</td>
<td>323</td>
<td>161</td>
<td>55</td>
<td>539</td>
</tr>
<tr>
<td>Grass Waterways</td>
<td>243</td>
<td>137</td>
<td>146</td>
<td>526</td>
</tr>
<tr>
<td>Filter Strips</td>
<td>395</td>
<td>56</td>
<td>93</td>
<td>544</td>
</tr>
</tbody>
</table>

\(^a\) The number of useable observations varies by practice type due to missing or incomplete survey information.
## Summary Statistics: Conservation practices and enrollment

The number of useable observations varies by practice type due to missing or incomplete survey information.

<table>
<thead>
<tr>
<th>Practice Type</th>
<th>Average Proportion for Non-Enrolled&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Average Proportion for Enrolled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation Tillage</td>
<td>0.554</td>
<td>0.779</td>
</tr>
<tr>
<td>Cover Crops</td>
<td>0.023</td>
<td>0.262</td>
</tr>
<tr>
<td>Hayfield Establishment</td>
<td>0.014</td>
<td>0.287</td>
</tr>
<tr>
<td>Grid Sampling</td>
<td>0.212</td>
<td>0.749</td>
</tr>
<tr>
<td>Grass Waterways</td>
<td>0.007</td>
<td>0.018</td>
</tr>
<tr>
<td>Filter Strips</td>
<td>0.001</td>
<td>0.011</td>
</tr>
</tbody>
</table>

<sup>a</sup> The number of useable observations varies by practice type due to missing or incomplete survey information.
Matching Estimators: key choices

**Propensity Score Matching**
- Propensity to enroll in cost-share program using probit

**Matching specifications**
- Kernel and local linear matching
- Gaussian and Epan kernel
- Bandwidth = 0.02, 0.06, 0.2
Covariates for Matching Estimation

Farmer characteristics
- Age
- Education
- Household income

Farm management
- Farm size
- Farm revenue
- Percent of farm rented
- Percent of acreage in grain (corn, soybean, wheat)
- Livestock

Land characteristics
- Stream on property
- Soil type
- Slope
Balancing test (grass waterways): Difference in means pre & post matching

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-</th>
<th>Post-</th>
<th>Variable</th>
<th>Pre-</th>
<th>Post-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm Rev. &gt; $250k</td>
<td>0.108*</td>
<td>0.007</td>
<td>Prop. of farm rented</td>
<td>0.053</td>
<td>0.003</td>
</tr>
<tr>
<td>Farm Planning Horizon</td>
<td>0.036</td>
<td>0.000</td>
<td>Prop. of farm in grain crops</td>
<td>0.090**</td>
<td>0.009</td>
</tr>
<tr>
<td>Age</td>
<td>-0.963</td>
<td>0.132</td>
<td>Prop. of farm w/ slope 0%-2%</td>
<td>-0.138**</td>
<td>-0.027</td>
</tr>
<tr>
<td>Education&gt;HS</td>
<td>0.076</td>
<td>0.025</td>
<td>Prop. of farm w/ slope 2%-6%</td>
<td>0.120**</td>
<td>0.020</td>
</tr>
<tr>
<td>Soil type = clay</td>
<td>0.063</td>
<td>0.010</td>
<td>Prop. of farm w/ &gt; 6% slope</td>
<td>0.018</td>
<td>0.007</td>
</tr>
<tr>
<td>Soil type = loam or sandy</td>
<td>-0.063</td>
<td>-0.010</td>
<td>log of total farm acreage</td>
<td>0.435**</td>
<td>0.080</td>
</tr>
<tr>
<td>Highly Erodible Land</td>
<td>0.293**</td>
<td>0.010</td>
<td>Stream borders or on property</td>
<td>0.123**</td>
<td>0.028</td>
</tr>
<tr>
<td>HH inc</td>
<td></td>
<td></td>
<td>Livestock on farm</td>
<td>-0.098*</td>
<td>0.009</td>
</tr>
<tr>
<td>0 - 10% from farming</td>
<td>0.033</td>
<td>-0.008</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 - 50% from farming</td>
<td>-0.020</td>
<td>0.002</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;50% from farming</td>
<td>-0.013</td>
<td>0.006</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Results on ATT and % ATT

Average treatment effect on the treated (ATT)

\[
ATT = E[Y_1 - Y_0 | D = 1]
\]

\[
%\ ATT = \frac{E[Y_1 - Y_0 | D = 1]}{E[Y_1 | D = 1]} \cdot 100
\]
### Results:

Measures of additionality by practice

\[
%ATT = \frac{ATT}{E[Y_i | D = 1]} \cdot 100 \%
\]

<table>
<thead>
<tr>
<th>Whole field practices</th>
<th>ATT * Estimate</th>
<th>95% CI</th>
<th>% ATT * Estimate</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation tillage</td>
<td>0.160</td>
<td>[0.091, 0.216]</td>
<td>20.5</td>
<td>[12.3, 26.5]</td>
</tr>
<tr>
<td>Cover crops</td>
<td>0.233</td>
<td>[0.145, 0.327]</td>
<td>88.9</td>
<td>[76.5, 94.3]</td>
</tr>
<tr>
<td>Hayfield establishment</td>
<td>0.227</td>
<td>[0.074, 0.344]</td>
<td>92.9</td>
<td>[78.3, 96.4]</td>
</tr>
<tr>
<td>Grid sampling</td>
<td>0.503</td>
<td>[0.378, 0.583]</td>
<td>66.3</td>
<td>[54.8, 72.9]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Practices for environmentally sensitive areas</th>
<th>ATT * Estimate</th>
<th>95% CI</th>
<th>% ATT * Estimate</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass waterways</td>
<td>0.012</td>
<td>[0.008, 0.017]</td>
<td>65.0</td>
<td>[51.3, 75.1]</td>
</tr>
<tr>
<td>Filter strips</td>
<td>0.010</td>
<td>[0.007, 0.014]</td>
<td>89.1</td>
<td>[75.8, 95.7]</td>
</tr>
</tbody>
</table>

*ATT and %ATT for all practices are significantly different from zero at the 95% level based on bootstrapped confidence intervals.
## Results: \[ ATT = P_n \cdot ATT_n + P_p \cdot ATT_p \]

### Decomposition of additionality

<table>
<thead>
<tr>
<th>New Adopters</th>
<th>Prior Adopters</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion</td>
<td>ATT_n</td>
<td>Proportion</td>
</tr>
<tr>
<td>Whole field practices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conservation tillage</td>
<td>0.14</td>
<td>0.745</td>
</tr>
<tr>
<td>Cover crops</td>
<td>0.87</td>
<td>0.262</td>
</tr>
<tr>
<td>Hayfield establishment</td>
<td>0.90</td>
<td>0.240</td>
</tr>
<tr>
<td>Grid sampling</td>
<td>0.60</td>
<td>0.756</td>
</tr>
</tbody>
</table>

| Practices for environmentally sensitive areas | | | | | |
| Grass waterways | 0.58 | 0.019 | 0.42 | 0.003 | 0.012 | 65.0 |
| Filter strips | 0.83 | 0.011 | 0.17 | 0.004 | 0.010 | 89.1 |
Conclusions

Additionality is statistically significant for all practices

%ATT varies considerably between practice types
- Highest for filter strips (89.1%), hayfields (92.9%), and cover crops (88.9%)
- Moderate for grid sampling (66.3%) and grass waterways (65.0%)
- Lowest for conservation tillage (20.5%).

$\text{ATT}_p$ for prior adopters is small
- Prior adopters are not contributing much to the expansion of conservation acreage
- Practices with a larger fraction of prior adopters have smaller values for % ATT
The End