Farmer Participation in Water Quality Trading Programs

Matthew Winden and Brent Sohngen

Ohio State University
Agricultural, Environmental, and Development Economics
2120 Fyffe Road, Columbus, OH 43210

May 20th, 2012
Voluntary Pollution Control Workshop
State of Water Quality in the U.S.

- 48% Assessed Rivers and Streams Impaired
- 60% Assessed Lakes, Reservoirs and Ponds Impaired
- 61% Assessed Estuaries Threatened or Impaired

(Selman et al 2009)

Result: Demand for Pollution Reductions to Waterways
Credit Trading at Work

- Point Sources Have High Marginal Abatement Costs
  - Technology and Infrastructure Costly

- Non-Point Sources Have Lower Marginal Abatement Costs
  - Farmer Implements BMP that Generates Abatement Credit

- Trading allows Point Sources to “Outsource” Compliance
  - Point Sources Purchase Credits to Meet Regulatory Requirements

- Potential for Overall Costs of Abatement to be Lower
  - $140-235 million annually (Newburn & Woodward 2012; USEPA 2001)
Experience To Date

PS-NPS Programs (Ribaudo & Gottlieb 2011; Morgan & Wolverton 2008)

- Number: 15
- Nutrient Types: P (8), N (1), Both (5), Sediment (1)
- Trades: # (1, 4, 400, 4) in Four Programs
- Success? Cost Savings Have Been Achieved….

Challenges

- Institutional Framework
- Demand Side Regulatory Drivers
- Supply Side Credit Generation

Obstacle

Significant Problems
WQT Necessary Conditions

- Identify Credit and Regulatory Relaxation Equivalency
- Credible Credit Certification and Duration Process
- Clearly Defined Units of Trade
- Determination of a Baseline (Quantification of Credits)
- Compliance, Monitoring and Enforcement Provisions
- Address Uncertainty (Trading Ratios)
- Public Participation and Support

(Hahn & Richards 2011; Selman et al 2009; King & Kuch 2003)
Credit Supply Challenges

• Conservation Effectiveness Dependent on
  (1) Site-Specifics, (2) Implementation, (3) Maintenance
  → Leads to Offset and Financial Uncertainty
• High Transactions Costs to Finding Trade Partners
• Additional Farm Inspection/Scrutiny (Loss of Autonomy)
• Admission of Pollution (Negative Publicity)
• Not Compelled Now, But Future Regulation?
• Competition from Other Subsidies (*Ribaudo & Gottlieb 2011*)
• Mistrust of Regulators and Urban Entities (*Breetz et al 2005*)
Our Contribution

- Ex-Ante Supply Side Examination of Credit Generation
- Establish Preferences Over Major WQT Attributes
  - Role of Financial Certainty
  - Role of Administrator
  - Role of Buyer
  - Role of Contract Length
  - Conservation Practices
  - Farmer Payment Needs
- What WQT Program Would Maximize Enrollment
Upper Scioto Watershed *(USEPA 2006)*

- Total Waterways: 3,064 (mi)
  - 31% Impaired
  - 32% Unassessed
- Contaminated: 5,401 (mi)
  - 41% from NPS
  - 14% from PS
  - 17% from Development
- 300+ Point Sources
- 80% of Watershed in Crops
- 8% Developed Land
- TMDL Implementation
Survey: Administration

Administration
- Sampled 2000 Producers (18 years +)
- Obtained from USDA-NASS
- Mail Survey Design (Zip Code Based)
- 735 Responses (36.75% Response Rate)
- 343 Useable Responses

Experimental Design
- Fractional-Factorial, Generic Attribute
- 145 Choice Scenarios
Survey: Characteristics

- Gender: 96% Male
- Education: 97% High School +
- Average Age: 59 Years
- Average Income: $90,000
- Average Acreage: 567 in Upper Scioto Watershed

<table>
<thead>
<tr>
<th>Crop</th>
<th>Total Acres (2011)</th>
<th>Conventional Tillage</th>
<th>Conservation Tillage</th>
<th>No-Till</th>
<th>Average Yield (bshl/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>214</td>
<td>15</td>
<td>107</td>
<td>90</td>
<td>160</td>
</tr>
<tr>
<td>Soybean</td>
<td>301</td>
<td>7</td>
<td>55</td>
<td>228</td>
<td>53</td>
</tr>
<tr>
<td>Wheat</td>
<td>36</td>
<td>½</td>
<td>11</td>
<td>30</td>
<td>63</td>
</tr>
</tbody>
</table>
## Survey: Experimental Design

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation</td>
<td>Cover Crop</td>
</tr>
<tr>
<td>Measure</td>
<td>Nutrient Management Plan</td>
</tr>
<tr>
<td></td>
<td>Conservation Tillage</td>
</tr>
<tr>
<td></td>
<td>Filter Strips</td>
</tr>
<tr>
<td></td>
<td>None</td>
</tr>
<tr>
<td>Contract Length</td>
<td>5 years</td>
</tr>
<tr>
<td></td>
<td>10 years</td>
</tr>
<tr>
<td></td>
<td>15 years</td>
</tr>
<tr>
<td></td>
<td>None</td>
</tr>
<tr>
<td>Payment</td>
<td>$50 per acre per year</td>
</tr>
<tr>
<td></td>
<td>$100 per acre per year</td>
</tr>
<tr>
<td></td>
<td>$150 per acre per year</td>
</tr>
<tr>
<td></td>
<td>None</td>
</tr>
<tr>
<td>Administrator</td>
<td>Government Agency</td>
</tr>
<tr>
<td></td>
<td>Private Agency</td>
</tr>
<tr>
<td></td>
<td>None</td>
</tr>
<tr>
<td>Buyer</td>
<td>Within the county (Local)</td>
</tr>
<tr>
<td></td>
<td>Outside of the county (Non-Local)</td>
</tr>
<tr>
<td></td>
<td>None</td>
</tr>
</tbody>
</table>
# Survey: Choice Scenario

<table>
<thead>
<tr>
<th>Program Features</th>
<th>Program A</th>
<th>Program B</th>
</tr>
</thead>
<tbody>
<tr>
<td>How long is the <strong>contract length</strong>?</td>
<td>15 years</td>
<td>10 years</td>
</tr>
<tr>
<td>Who is the <strong>program administrator</strong>?</td>
<td>Government agency</td>
<td>Private agency</td>
</tr>
<tr>
<td>Who is the <strong>buyer</strong>?</td>
<td>Buyer from within county</td>
<td>Buyer from outside county</td>
</tr>
<tr>
<td>Which <strong>conservation practice</strong> should I adopt?</td>
<td>Filter Strips</td>
<td>Conservation Tillage</td>
</tr>
<tr>
<td>How much is the <strong>payment</strong>?</td>
<td>$ 150 per acre per year</td>
<td>$ 50 per acre per year</td>
</tr>
<tr>
<td><strong>I would choose</strong></td>
<td>Program A □</td>
<td>Program B: □</td>
</tr>
<tr>
<td><strong>I would not choose either program</strong></td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>
Random Utility Model

\[ U_{ij} = \beta_0 + x_{ij} \beta_l + (M_i + p_{ij}) \beta_M + \epsilon_{ij} \]

- \( i \) indexes individual respondent
- \( j \) indexes alternative
- \( l \) indexes attribute
- \( x \) denotes attribute value
- \( M \) denotes individual respondent income
- \( p \) denotes payment
<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>T-Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payment</td>
<td>0.01**</td>
<td>8.26</td>
</tr>
<tr>
<td>Contract Length (Mean)</td>
<td>-0.16**</td>
<td>-6.46</td>
</tr>
<tr>
<td>Contract Length (St. Dev)</td>
<td>0.26**</td>
<td>10.35</td>
</tr>
<tr>
<td>Conservation Measure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cover Crop</td>
<td>-0.21</td>
<td>-1.00</td>
</tr>
<tr>
<td>Nutrient Management Plan</td>
<td>-0.37**</td>
<td>-2.20</td>
</tr>
<tr>
<td>Conservation Tillage</td>
<td>0.72**</td>
<td>4.32</td>
</tr>
<tr>
<td>Filter Strips</td>
<td>-0.81**</td>
<td>-5.23</td>
</tr>
<tr>
<td>Administrator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government Entity</td>
<td>0.25</td>
<td>1.57</td>
</tr>
<tr>
<td>Private Entity</td>
<td>0.03</td>
<td>0.22</td>
</tr>
<tr>
<td>Buyer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within County (Local)</td>
<td>-0.02</td>
<td>-0.13</td>
</tr>
<tr>
<td>Outside County (Nonlocal)</td>
<td>0.28**</td>
<td>2.05</td>
</tr>
<tr>
<td>ASC</td>
<td>-0.15</td>
<td>-1.18</td>
</tr>
<tr>
<td>N</td>
<td>1169</td>
<td></td>
</tr>
<tr>
<td>Adjusted R$^2$</td>
<td>.28</td>
<td></td>
</tr>
<tr>
<td>Log-Likelihood</td>
<td>-1022.24</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions

- Participation Increases with:
  - Size of Payment
  - Non-local Credit Buyer
  - Conservation Tillage

- Participation Decreases with:
  - Contract Length
  - Filter Strips ($69) (average CRP payment $47.33 (USDA 2012))
  - Nutrient Management Plans ($31)

- Administrator Had No Discernible Impact
- Conservation Tillage Popular, but Additionality Likely Small
- Cost Still Most Likely Underlying Driver
Future Work

- Link with SWAT Model
- Determination of Best Program Design
  - Calculation of Changes in Probability of Participation
- Split Sample By CRP Participation
- Examination of Other Conservation Measures (Livestock)
- Choice Comparison Against CRP, CREP, EQIP, etc.
Thank You!

- Abdoul Sam and VPC Workshop
- US EPA
- USDA-NASS
- OSU Environmental Policy Initiative
- Allen Klaiber
- Brian Roe
- William McGuire
Appendix: Citations


