The Subsidy for Adopting Conservation Tillage: Estimation from Observed Behavior

Lyubov Kurkalova, Catherine Kling, and Jinhua Zhao

CARD, Department of Economics

Iowa State University

Paper presented at the AAEA Annual Meeting, Chicago, IL, August 2001
Introduction and Objectives

- What does it take for farmers to adopt conservation tillage practices? Or what compensations are needed?
  - Profit loss from switching
  - Reluctance (or premium) due to uncertainty
    - Risk aversion, option value (or incentive to learn more)
- New modeling strategy to estimate the two elements based on observed behavior
- The subsidy ($) needed for adoption
- Decomposing the subsidy into profit loss and adoption premium
- Estimate the “supply curve” of conservation tillage
  - The subsidy needed for each level of adoption
Model

Traditional approach (e.g., Soule, Tegene, and Wiebe (2000), Uri (1998))

\[
\Pr[\text{adopt}] = \Pr[\pi_1 \geq \pi_0 + \sigma_{\varepsilon} \varepsilon] = \Pr[\pi_1 - \pi_0 \geq \sigma_{\varepsilon} \varepsilon] \\
= \Pr[\delta x \geq \sigma_{\varepsilon} \varepsilon] \\
= \Pr\left[\frac{\delta x}{\sigma_{\varepsilon}} \geq \varepsilon\right]
\]

Pautsch, Kurkalova, Babcock, and Kling (2001)

\[
\Pr[\text{adopt}] = \Pr[\pi_1 \geq \pi_0 + \sigma_{\varepsilon} \varepsilon] = \Pr[\pi_1 - \pi_0 \geq \sigma_{\varepsilon} \varepsilon] \\
= \Pr[\beta x - \pi_0 \geq \sigma_{\varepsilon} \varepsilon] \\
= \Pr\left[\frac{\beta x}{\sigma_{\varepsilon}} - \frac{\pi_0}{\sigma_{\varepsilon}} \geq \varepsilon\right]
\]
Model (continued)

\[ \Pr[\text{adopt}] = \Pr \left[ \pi_1 \geq \pi_0 + P + \sigma_{\varepsilon} \varepsilon \right] \]

\[ = \Pr \left[ \beta x \geq \pi_0 + \alpha \sigma_{\text{profit}} + \sigma_{\varepsilon} \varepsilon \right] \]

\[ = \Pr \left[ \frac{\beta x - \pi_0}{\sigma_{\varepsilon}} - \frac{\alpha \sigma_{\text{profit}}}{\sigma_{\varepsilon}} \geq \varepsilon \right] \]
Data

- Random sub-sample (1,339 observations) of Iowa 1992 NRI data (soil and tillage) supplemented with Census of Ag. (farmer characteristics) and climate data of NCDA

- 63% of farmers already use conservation till without any subsidy
Model Specification and Data (Continued)

\[ Pr(\text{adopt}) = Pr \left[ \frac{\beta x}{\sigma_\varepsilon} - \frac{\pi_0}{\sigma_\varepsilon} - \frac{\alpha \sigma_{\text{profit}}}{\sigma_\varepsilon} \geq \varepsilon \right] \]

- **Expected profit of conservation tillage** (\( x \))
  - Depends on soil characteristics, climate, and farmer characteristics

- **Expected profit of conventional tillage** (\( \pi_0 \))
  - County level estimates for each crop based on budget estimates

- **Adoption premium** (\( \sigma_{\text{profit}} \))
  - Depends on historical (20 years) precipitation variability
  - Vary by crop, net returns, and farmer characteristics
Results (standard errors in parenthesis)

Net returns to conservation tillage

\[ \pi_1 = 41 \cdot I_{\text{corn}} + 0.022 \cdot SLOPE + 0.63 \cdot PM + 73 \cdot AWC + 2.57 \cdot TMAX \]
\[ - 2.48 \cdot TMIN + 76 \cdot PRECIP + 194 \cdot TENANT \]

Premium (corn producers)

\[ P_{\text{corn}} = \sigma_{\text{precip}} \left\{ 1400 - 2.79 \cdot \pi_0 - 103 \cdot OFFFARM \right\} \]
\[ + 607 \cdot TENANT - 5.1 \cdot AGE - 763 \cdot MALE \]
Results

- Average required subsidy and decomposition for current non-adopters

<table>
<thead>
<tr>
<th>Average/Current non-adopters</th>
<th>Corn ($/acre)</th>
<th>Soybean ($/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profit loss</td>
<td>-10.6</td>
<td>-34.8</td>
</tr>
<tr>
<td>Premium</td>
<td>13.1</td>
<td>38.4</td>
</tr>
<tr>
<td>Subsidy</td>
<td>2.5</td>
<td>3.6</td>
</tr>
</tbody>
</table>
Conservation Tillage “Supply Curve”

Total Subsidy to Achieve 90% Adoption

= $247 M
= $29 M + $36 M + $182 M
Conclusions

- The proposed methodology allows for **full recovery of the structural coefficients**
  - Adoption subsidies are computed for a sample of Iowa farmers
- **Income transfer** relative to the adoption cost can be huge
  - May be less important in states with low existing adoption and less heterogeneous adoption costs
- **Adoption premium** plays a significant role in farmers’ adoption decisions
  - Future work is needed to understand the source of premium
  - Risk aversion vs. option value require different government responses