Bioeconomic feedbacks in microeconometric models of pest control decisions: an application to largescale adoption of Bt corn in the U.S.

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presented by
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Outline

1. Motivation

2. Research Question

3. Data and Methods

4. Thoughts & Current Status

5. Questions?

Motivation

- Landscape-level spillovers from individual farmer decisions:
    - Environmental externalities
    - Bioeconomic feedbacks from pest suppression
    - (Many others. . .)
- There is almost no econometric analysis of areawide pest suppression feedbacks on farmer decisions. . .

Example: Pest suppression spillovers from largescale adoption of transgenic Bt crops?

Areawide Suppression of European Corn Borer with Bt Maize Reaps Savings to Non-Bt Maize Growers

W. D. Hutchison,[1][*] E. C. Burkness,[1] P. D. Mitchell,[2] R. D. Moon,[1] T. W. Leslie,[3] S. J. Fleischer,[4] M. Abrahamson,[5] K. L. Hamilton,[6] K. L. Steffey,[7][†] M. E. Gray,[7] R. L. Hellmich,[8] L. V. Kaster,[9] E. Hunt,[10] R. J. Wright,[11] K. Pecinovsky,[12] T. L. Rabaey,[13] B. R. Flood,[14] E. S. Raun[15][‡]

European Corn Borer (ECB) damages:

- ECB virtually eliminated by Bt corn over last decade
- *$6.9 Billion total farm benefits*
- *62% of these benefits to **non-adopters***
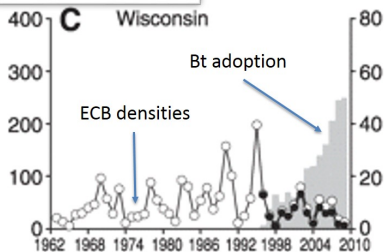
Map of Bt adoption among US corn growers

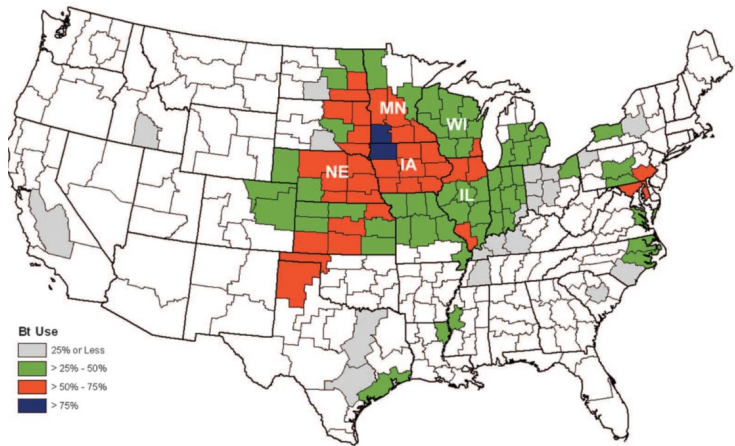Figure 1: Source: Hutchison et al. (2010)- Spatial distribution of maize containing one or more Bt traits for O. nubilalis control in 2006 in the United States.

Research Question

- ◇ So largescale Bacillus thuringiensis (Bt) adoption provides areawide pest suppression benefits to adopters and <u>nonadopters</u>.

- ▶ How do areawide effects feedback into farmer production decisions?

- ▶ Should a smart farmer sit back and let her neighbor pay the Bt seed premium?

- ▶ Do individual incentives to adopt the transgenic varieties really decrease with greater area-wide adoption?
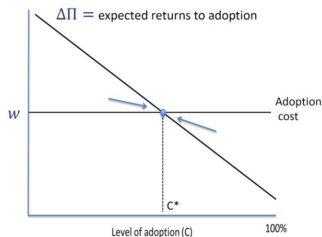
Data

1. Kynetec seed sales data (Shi et al. AJAE 2010) contains farmer-level price and quantity sold for over 300 corn products in the US between 1995-2009, including crucially Bt products.
2. Entomological surveillance data on European corn borer for over 15 years at sub-state regions, from universities
   - Possibly: corn-rootworm data from Monsanto & other biotech firms
3. NASS county-level data on climatological, soil quality and other exogenous factors that might affect utility of different seed products & thereby farmer choices.

Research Methodology

- Structural methods to estimate the feedbacks of spillover effects in endogenous sorting models (Bayer and Timmins 2007; Timmins and Murdock 2007; Klaiber and Phaneuf 2010; Hicks, Horrace and Schnier 2012).
- Random-utility model for farmers (e.g. Useche et al. 2009 AJAE) Decomposing utility as:
    - Individual-specific, time-varying utility component
   - Area-wide time-varying component **which includes endogenous feedback**

        As an example:

        $U_{jih} = \beta x_{ji} + \delta_{jh} + \epsilon_{jih}$
        $\delta_{jh} = \alpha C_{jh} + \lambda p_{jh} + \varepsilon_{jh}$ j=variety, i=grower, h=area\year
- Use Bayer and Timmins (2007) IV approach for spillovers. Identification builds instrument using:
    - Variation in exogenous attributes of *non-chosen alternatives*
    - Variation in choice set over markets

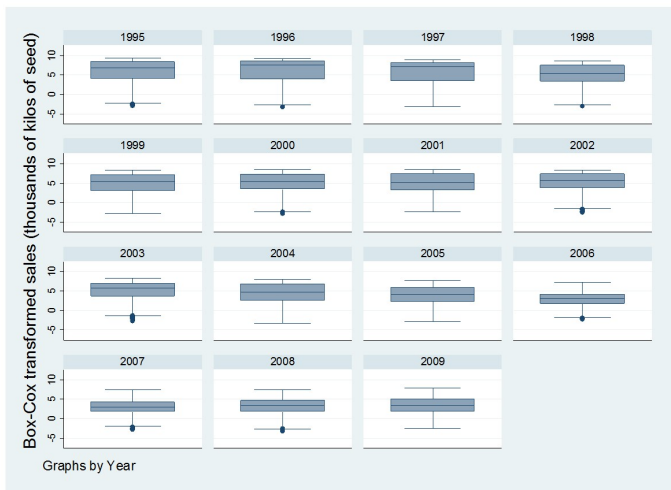# Lots of variation in choice sets over space-time (good for Bayer & Timmins IV)

Graphs by Year
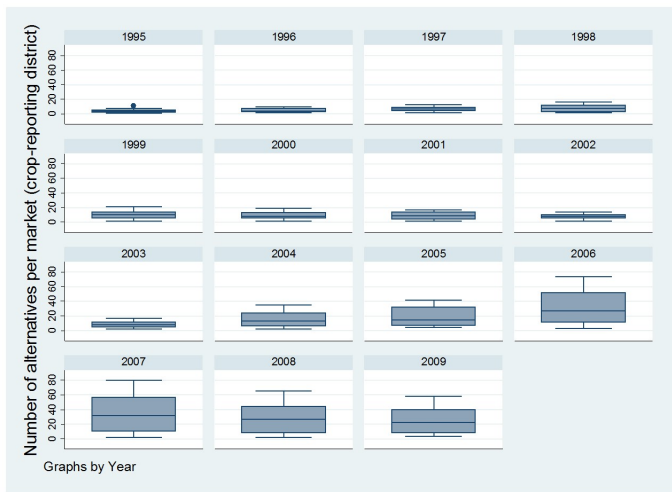
Challenge: Our data is "discrete-continuous": Multiple products purchased per choice occasion. . .

Avg. Number of products purchased per choice occasion
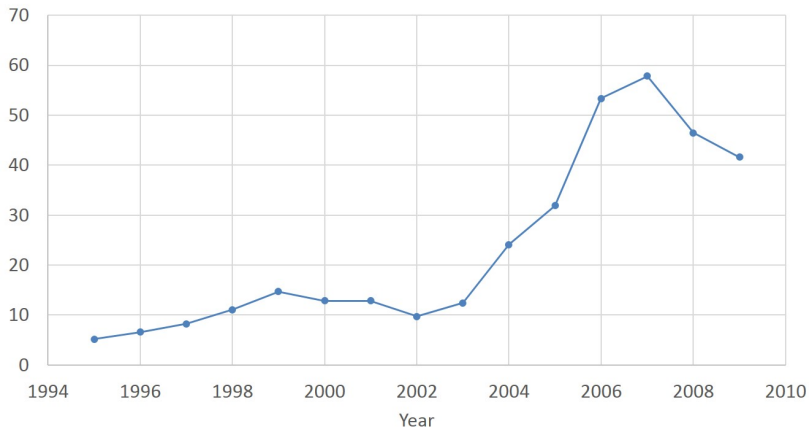
Challenge: Our data is "discrete-continuous": Large variation in seed sales volumes

Graphs by Year

Research Methodology

- Require econometric models for discrete-continuous demand (a.k.a. Kuhn-Tucker models, corner solution models, etc.)
- We use Bhat's (2005,2008) multiple discrete-continuous extreme value (MDCEV) model.
    - But we require a method for estimating a large number of fixed effects
    - BLP algorithm of conditional logit no longer applies. . .
- **Current status:** We are currently testing a latent-class method for approximating the fixed effects
    - Evaluating in OLS, conditional logit before applying to Bhat's model

Questions? & Advice?

THANK YOU!