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# Estimation of Spillover Effects from Large Scale Adoption of Transgenic (Bt) Corn in the Philippines


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## Introduction

**Large scale adoption of Bt corn has been associated with reduction in pest numbers for all farmers within the area (Hutchison et al 2010). Such area-level adoption may decrease individual incentives to adopt pest control measures. We propose an endogenous sorting modeling approach to econometrically estimate this spillover. This represents the first application of this method in the agricultural literature and provides an alternative approach for recovering these spillover estimates and, potentially, incorporating them in cost-benefit analyses of transgenic crops.**

## Objective

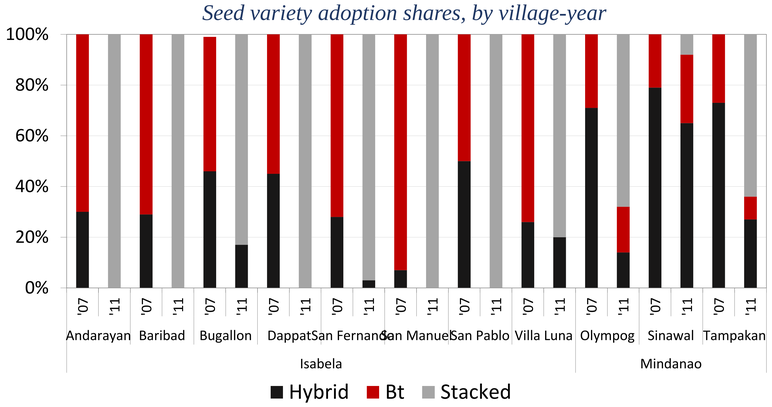
*To estimate average grower response to large scale adoption of transgenic corn in the Philippines. This value represents a measure of the pest suppression spillover on non-adopters of transgenic varieties.*

## Data

We use data from a two year panel survey of farmers in the South Cotabato and Isabela provinces in the Philippines. In total 278 farmers were sampled in 2007 and 2010. In 2007, effectively only hybrid and a single trait Bt variety were available. In 2011 an additional "stacked" trait variety as available with Bt and herbicide tolerance. The data also contain information on variety-specific prices, distance roads and seed supply shops, farm size and basic slope indicators, and levels of grower experience in corn farming.


*Surveyed provinces*

*Seed variety adoption shares, by village-year*




## Theoretical Framework

We first invoke a theoretical model that permits large scale adoption to affect farmer behavior. Define the following variables:

*Area-wide adoption:* $C$

*Expected profits per ha of Bt & non-Bt varieties:* $\Pi_{Bt}$, $\Pi_{Non-Bt}$

*Bt seed price premium:* $w$ *Own-farm Asian corn borer densities:* $d$

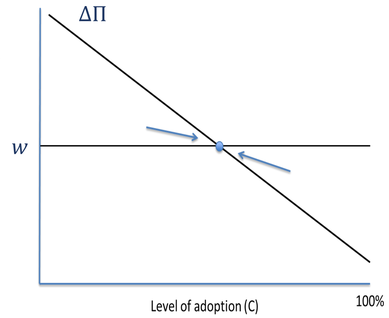
Then an individual grower will adopt Bt if:

$$\Delta\Pi := \Pi_{Bt} - \Pi_{Non-Bt}[y_{Non-Bt}(d)] > w$$

$$\frac{\partial(\Delta\Pi)}{\partial C} = -\frac{\partial \Pi_{NBt}}{\partial d}\frac{\partial d}{\partial C} = -\overbrace{\underbrace{\frac{\partial \Pi_{Non-Bt}}{\partial y_{Non-Bt}}}_{+}\underbrace{\frac{\partial y_{Non-Bt}}{\partial d}}_{-}\underbrace{\frac{\partial d}{\partial C}}_{-}}^{+} < 0$$

This says that greater area-level adoption reduces individual incentives to adopt Bt, suggesting a negative spillover.

This spillover is similar to congestion externalities analyzed in the urban, environmental economics, and natural resources literatures (Timmins & Murdock 2007; Klaiber & Phaneuf 2010; Hicks et al. 2012). This suggests using structural econometric methods from this literature for the present question.




## Empirical Framework: Random Utility Modeling

$$\Pr\left[U_{jih} \geq U_{kih}\ \forall k\right] = \frac{\exp(\beta x_{ji} + \alpha C_{jh} - \eta p_{jh})}{\sum_{k\in h}\exp(\beta x_{ki} + \alpha C_{kh} - \eta p_{kh})}$$

Seed variety, Individual, Area; Individual-variety specific variables

Area-variety fixed effects: $\delta_{jh} = \bar{\delta_j} + \alpha C_{jh} - \eta p_{jh} + \xi_{jh}$ ← Area-level residual

Area-variety-specific prices

Village-level endogeneity: $E\left(C_{jh}\xi_{jh}\right) \neq 0$

Instrumental variables strategy from Bayer & Timmins (2007):

$$\tilde{C}_{jh} := \frac{1}{n_h}\sum_{i=1}^{n_h}\frac{\exp(\tilde{\beta}x_{ji} + \tilde{\delta}_j - \tilde{\eta}p_{jh})}{\sum_{k\in h}\exp(\tilde{\beta}x_{ki} + \tilde{\delta}_k - \tilde{\eta}p_{kh})}$$

This creates predicted area-level adoption shares based on exogenous variables, using inter-area variation in exogenous characteristics determining adoption.

## Econometric Results

| *IV model* | *Unweighted* | | *Area-weighted* | |
|---|---|---|---|---|
| | *Tobit* | *Quantile* | *Tobit* | *Quantile* |
| **Seed price (PHP)** | -0.01 | -0.020 | -0.018** | -0.0961** |
| | (0.01) | (0.018) | (0.086) | (0.0404) |
| **Bt single-trait** | 0.86 | 1.28 | 1.64 | 17.37*** |
| | (1.00) | (2.81) | (1.30) | (5.952) |
| **Stacked-trait** | 4.62 | 7.26* | 7.16* | 50.06*** |
| | (3.51) | (4.33) | (4.14) | (9.429) |
| **Spillover** | -0.97 | -2.75 | -3.60 | -35.69*** |
| | (3.69) | (4.72) | (4.06) | (10.36) |
| **Constant** | 5.36 | 7.68 | 7.34** | 29.95** |
| | (2.78) | (5.80) | (3.013) | (13.54) |
| **Observations** | 55 | 55 | 55 | 55 |

**Standard errors in parentheses**
**∗ p < 0.05, ∗∗ p < 0.01, ∗∗∗ p < 0.001**

## Discussion and Conclusion

- Significant spillover effect found to be associated with the use of Bt corn in the Philippines.
- This spillover as pointed out by Hutchison is expected to accrue primarily to non-adopting farmers.
- This positive externality should be accounted for in cost benefit analyses of the effects of Bt technology as ignoring them likely underestimates the value to farmers.
- Further work involves using this approach on US data and performing yield regressions that account for this effect.

## References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