Environmental Valuation of Unlabeled Technology Adoption:

Theory and Application to Tomato Production and Consumption

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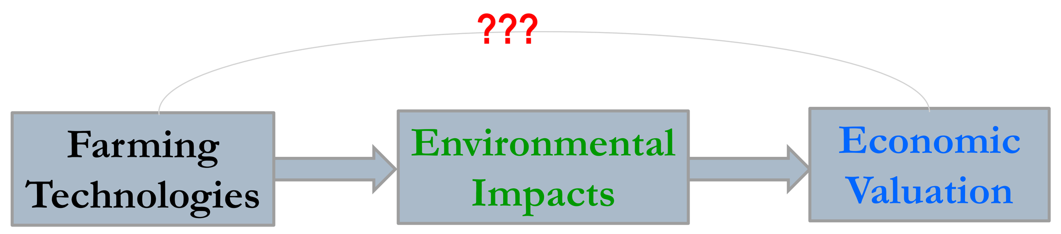
INTRODUCTION

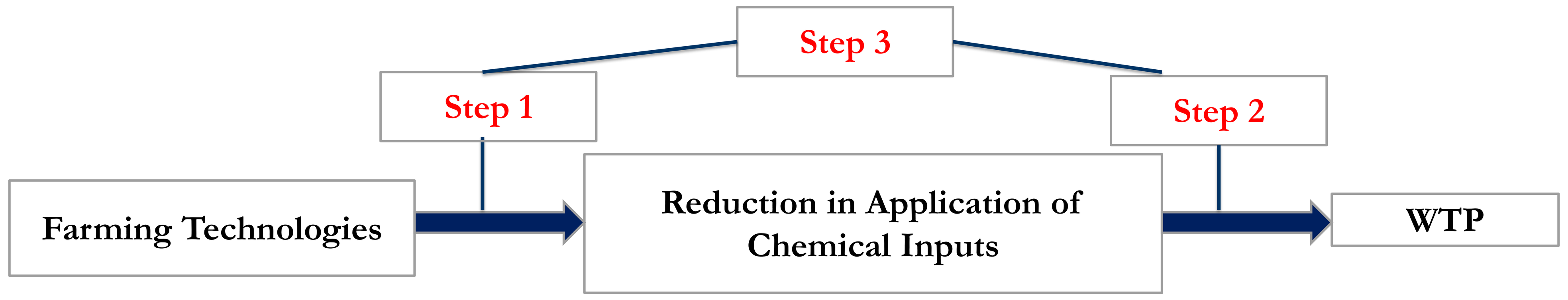
- How much more are you willing to pay if the above tomatoes were produced in a greenhouse instead of open field?
- You may find it difficult to answer this question, since the greenhouse technology is neither labeled on the tomatoes, nor familiar to you
- But in theory, farmers' adoption of new technologies can alter environmental quality and hence your welfare. So **the question**: how can we elicit consumer's preference for unlabeled farming technologies?



OBJECTIVES

- To develop a theoretical framework for estimating consumers' general and partial equilibrium WTP for producers' unlabeled technology adoption choices
- To apply the framework to two unique datasets on the production and consumption of vine-ripened tomatoes in northeastern United States

METHODOLOGY



Step 1: Solving the producer's problem

- Consider a representative vegetable grower with arable land A and some adopted technologies T. Assuming constant returns to scale in inputs X and A, we can write production as Y=Af(x;T), where f is yield function and x is a vector of per acre inputs. Then the producer's problem is to maximize profits conditioned on A and T:

$$\max_{\mathbf{x}} A[p^p f(\mathbf{x};\ \mathbf{T}) - \mathbf{w}\cdot\mathbf{x}],$$

where p^p is the price of output received by the producer, and w is a vector of prices of inputs

- Solving this problem yields the per acre demand functions for pesticides and fertilizers:

$$pest = g_1(p^p, \mathbf{w}, \mathbf{T}), \qquad fert = g_2(p^p, \mathbf{w}, \mathbf{T})$$

Step 2: Solving the consumer's problem

- A choice experiment is designed in which each consumer faces J alternatives, and the utility that consumer n obtains from alternative j is given by $U_n(c_{n1},\cdots,c_{nJ};z_n) = U\left[c_{n1}(pest_{n1}, fert_{n1}, p^c_{n1}),\cdots,c_{nJ}(pest_{nJ}, fert_{nJ}, p^c_{nJ}); z_n\right]$, where the c's are alternatives and are functions of their attributes (per acre application of pesticides, per acre application of fertilizers, and retail price), and z is the numeraire. Then the consumer's problem is to maximize her utility subject to budget constraint and that each consumer can only choose one alternative
- Solving the problem yields the indirect utility function that consumer n obtains from alternative j:

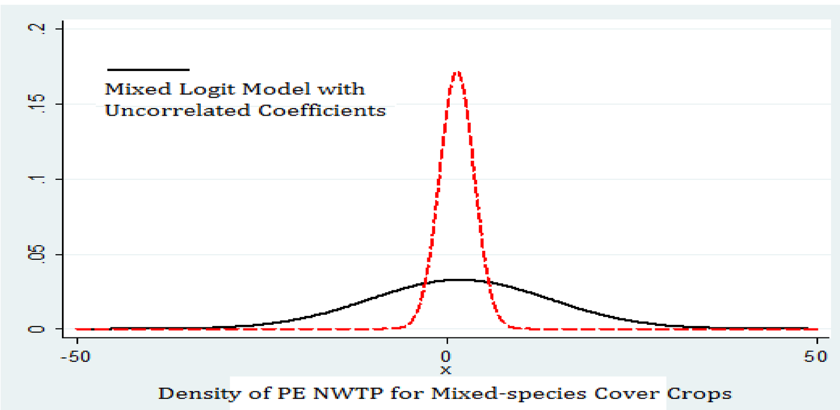
$$V_{nj} = V_n(pest_{nj}, fert_{nj}, p^c_{nj}, y_n).$$

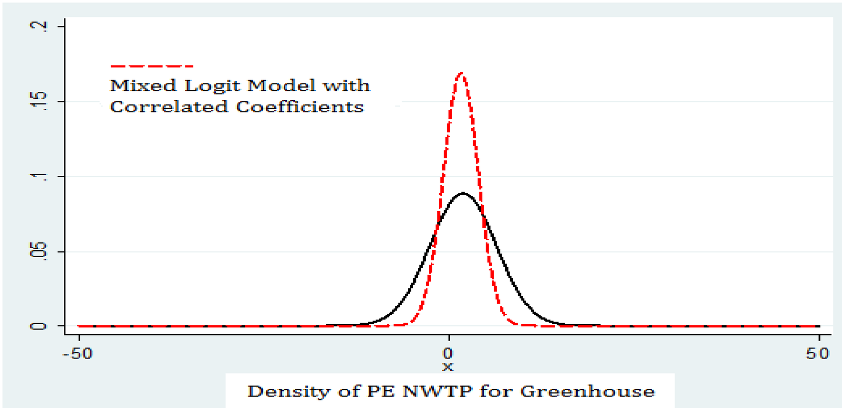
Step 3: Measuring welfare changes

- For alternative j with retail price p^c_j, pesticide application $pest_j = g_1(p^p_j, \mathbf{w}_j, \mathbf{T}_j)$, and fertilizer application $fert_j = g_2(p^p_j, \mathbf{w}_j, \mathbf{T}_j)$, consumer n obtains utility $V_{nj} = V_n(g_1(p^p_j, \mathbf{w}_j, \mathbf{T}_j), g_2(p^p_j, \mathbf{w}_j, \mathbf{T}_j), p^c_j, y_n) \triangleq H_n(p^p_j, p^c_j, \mathbf{w}_j, \mathbf{T}_j, y_n)$.
- Now consider an exogenous change in Tm from 0 to 1. In partial equilibrium & general equilibrium, at the individual level the consumer' marginal WTP (MWTP) for the adoption of technology Tm can be solved from the following identities

$$H_n(p^p, p^c, \mathbf{w}, \mathbf{T}, y)\Big|_{T_m=0} = H_n(p^p, p^c + MWTP^p_{nT_m}, \mathbf{w}, \mathbf{T}, y)\Big|_{T_m=1} \ (p^p \text{ and } p^c \text{ are independent}),$$

$$H_n(p, p, \mathbf{w}, \mathbf{T}, y)\Big|_{T_m=0} = H_n(p + MWTP^g_{nT_m}, p + MWTP^g_{nT_m}, \mathbf{w}, \mathbf{T}, y)\Big|_{T_m=1} \ (\text{assuming } p^p = p^c).$$





SURVEYS & DATA

- Survey mailed to all tomato growers in Maryland, New York, and Ohio, conducted by USDA NASS
  - Collected information about technologies adopted, production, inputs and demographics
  - 222 valid observations
- Online survey to tomato consumers in Maryland, New York, and Ohio, conducted by QuestionPro
  - Collected information about hypothetical choice experiment questions, attitudes and perception of chemicals, and demographics
  - 498 valid responses

FINDINGS & CONCLUSION

- Baseline scenario: No cover crops and greenhouses
- Consumers' average NWTP for tomato growers' adoption of single-species cover crops:
  - Partial equilibrium (PE): -1.28 to -1.78 $/lb
  - General equilibrium (GE): -0.98 to -1.15 $/lb
- For mixed-species cover crops:
  - PE: 1.36 to 1.76 $/lb; GE: 1.30 to 1.67 $/lb
- For environmentally-sound greenhouses:
  - PE: 1.63 to 1.94 $/lb; GE: 0.24 to 0.32 $/lb
- Consumers are willing to pay more for environmental friendly farming technologies
- The magnitude of PE NWTP is greater than GE one