Assessing the Impact of Cap-and-Trade Climate Legislation on Agriculture in the Northern Plains: A Policy Simulation with Farmer Preference and Adaption

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Research Objective

- Investigate farmer preference to carbon sequestration potential under cap-and-trade.
- Examine the production cost impact of carbon pricing due to cap-and-trade.
- Simulate acreage enrollment in carbon sequestration, carbon supply, and the impact of cap-and-trade on farm income and its distributional effect.

Policy Background and Motivation

- Pending cap-and-trade climate legislation – The American Clean Energy and Security Act of 2009.
- Co-existence of both opportunity and challenge for agriculture.
- Divided view and debate on the net impact of cap-and-trade on farm income.

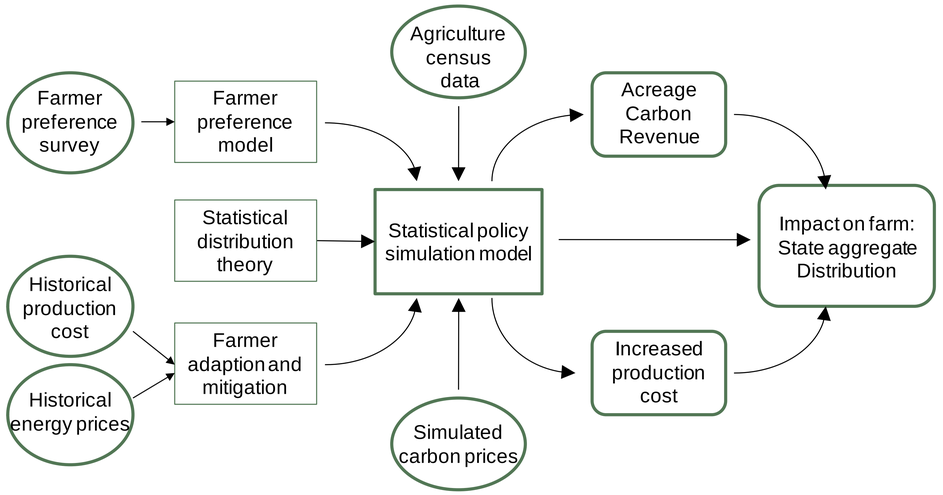
Research Challenges and Issues

- Farmer production behavior
  Farmers might not be willing to tradeoff the potential revenue from carbon sequestration with restrictions on production management over a 5 year period and transaction costs.
- Farmer capacity of adaption
  While cap-and-trade can increase prices for energy-intensive inputs, farmers may adjust production practice to mitigate the production cost impact.
- Heterogeneity in farmer and distribution effect of cap-and-trade
  Some farmers may gain and others may lose, depending on farming attributes.

Methodology

- Approach:
  - benefit-cost analysis
  - stated preference approach
  - reduced production cost function
  - statistical simulation
- Modeling tool: Matlab programming

Assessing the Agricultural Impact of Cap-and-Trade: Research Framework



Farmer Behavior Model

Preference to Carbon Sequestration

- **Assumption**: farmers tend to maximize their profits
- **Derived Kuhn-Tucker condition**: farmers would participate in carbon sequestration only if the benefit is greater than farmer perceived costs.
- **Empirical Specification**:
  Probability (carbon sequestration) = binomial logit
- **Data for Empirical Estimation**: farmer stated preference survey

Adaption to Manage Production Cost

- **Economic Production Theory**:
  - Production cost function: production cost is a function of output quantity and input prices.
  - Farmer adaption: profit-maximizing farmers will adjust production to reduce their production costs as relative input prices change.
- **Hypothesis**:
  - Variable production costs are an implicit function of energy prices (given that agriculture production is energy intensive in terms of input).
  - Variable production costs are a non-linear function of energy prices (due to farmer adaption).
- **Empirical Specification**: Variable production costs per unit land are a quadratic function of energy prices.
- **Data for Empirical Estimation**: state level variable production costs, acreage of cropland in active production, and energy prices (1945-2008).

Farmer Preference to Carbon Sequestration Survey

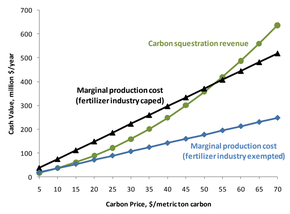
Survey Design:

- Structure of survey questionnaire: preference to participate in carbon sequestration, socio-economic background and attitude to climate legislation, and current production practice.
- Versions of survey questionnaire: 6 different versions corresponding to 6 levels of carbon prices ranging from $5 to $70 per metric ton.
- Sample sizes: 500 for each version of questionnaire with a given carbon price
- Survey administration: a random sample of 3000 farmers in the USDA ND Agricultural Statistic Service database selected

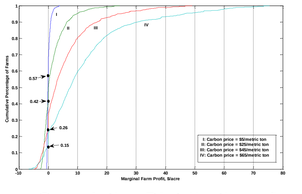
Survey Result:

- No. of usable returned survey = 281
- farmer distributions by attributes between participation and not participation

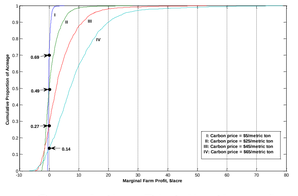
Simulated Agricultural Impact of Cap-and-Trade Climate Legislation



Aggregate Margin Production Cost v.s. Carbon Revenue



Cumulative Distribution of Marginal Profits by Farms (Fertilizer Industry Exempted)



Cumulative Distribution of Marginal Profits by Acreage (Fertilizer Industry Exempted)

Note: Marginal production costs were estimated based on 2009 ND production cost for different carbon prices and may vary depending on the base year production cost.

Some Caveats

- The study did not consider the effects of higher commodity prices and increased demand for bio-energy feedstock.
- Simulated ex ante carbon revenue based on farmer stated preference might underestimate ex post actual carbon revenue after cap-and-trade climate legislation becomes effective.
- Production cost impact of cap-and-trade might be underestimated as well since the effect of GHG emission regulation on prices for non-energy intensive input was not considered.

United States Department of Agriculture
National Institute of Food and Agriculture