Empirical Analysis of the Sources of Corn Used for Ethanol Production in the United States: 2001-2009

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Outline

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Indirect Land Use Change (ILUC) Unobservable; Estimation Involves Many Assumptions

- ILUC is unobservable and depends on a multitude of factors
- Modeling the complex interactions of these factors involves many assumptions
- Rapid growth in ethanol production over the last decade
- Provides empirical data to begin evaluating these assumptions
Review of the Empirical Corn Data: Harvested Area Changed Little from 2001-2009

- Harvested cropland changed little since 1990
- Corn share of major crops area around 30%
- Oilseeds share about 37%
Review of the Empirical Corn Data: Exports Up By 50% from 2002 to 2007; Use for Ethanol Quintupled

- Export share stable from 2001-2007
- Ethanol use share - 2001-2009: +26%
- Other uses share - 2001-2009: -23%
Index Decomposition Analysis (IDA): Isolates the Contributions of Individual Factors

- Used extensively for energy decomposition analysis (see references)
- Allocates the change in a given variable (y) to each contributing factor *ceteris paribus* - if all other factors were held constant
- Decomposition analysis is based on the total differential of a general function of the following form:

\[ y = x_1 \cdot x_2 \cdot \ldots \cdot x_n \]

- The log. mean divisia index (LMDI I) formulation:

\[ \Delta y^D = \sum_{i=1}^{n} \left( \frac{y_{t1} - y_{t0}}{ln \left( \frac{y_{t1}}{y_{t0}} \right)} \right) ln \left( \frac{x_{i,t1}}{x_{i,t0}} \right) = \sum_{i=1}^{n} \Delta y \frac{g_{xi}}{g_y} \]

- Addresses need to isolate the role of individual factors
Decomposition Analysis: Corn Use for Ethanol Relationship with Demand/Supply Factors

Corn Supply and Distribution

- Corn Production
- Beginning Stocks
- Total Corn Supply

Corn Imports
- Domestic Corn Uses
- Ending Stocks

- Food, Fuel, Seed and Industrial Uses
- Feed and Residual Uses

- Corn Use for Ethanol Production
- Other Food, Seed and Industrial Use

Corn Land Use

- All Harvested Cropland
  - Harvested Other Crops Land
    - Harvested Grain & Oil Seeds Land
  - Harvested All Grains Land
    - Harvested Corn Area
      - Corn Yield

- Corn Production

➢ Index Decomposition Analysis traces the pathway highlighted by red arrows
Decomposition Analysis: Multiplicative Relationship Describes the Role of Factors in Corn Use for Ethanol

\[ Q_{ce} = \left( \frac{Q_{ce}}{Q_{ffsi}} \right) \left( \frac{Q_{ffsi}}{Q_{dom}} \right) \left( \frac{Q_{dom}}{Q_{sup}} \right) \left( \frac{Q_{sup}}{Q_{prd}} \right) Q_{prd} \]

\[ = \left( \frac{Y_{corn}}{A_{corn}} \right) \left( \frac{A_{corn}}{A_{cgrn}} \right) \left( \frac{A_{cgrn}}{A_{grn}} \right) \left( \frac{A_{grn}}{A_{grn+oilsd}} \right) \left( \frac{A_{grn+oilsd}}{A_{all}} \right) \]

Inter-Crop Land Transfers

\[ Q_{ce} = \text{Corn use for ethanol production (million tons)} \]
\[ Q_{ffsi} = \text{Corn use for food, fuel, seed and industrial purposes (million tons)} \]
\[ Q_{dom} = \text{Total domestic corn use (million tons)} \]
\[ Q_{prd} = \text{Total corn production (million tons)} \]
\[ Q_{sup} = \text{Total corn supply (million tons)} \]

\[ Y_{corn} = \text{Annual corn yield in (tons/ha)} \]
\[ A_{corn} = \text{Annual corn harvested area (mha)} \]
\[ A_{cgrn} = \text{Annual coarse grain harvested area (mha)} \]
\[ A_{grn} = \text{Annual all grain* harvested area (mha)} \]
\[ A_{grn+oilsd} = \text{Annual all grain plus oilseeds** harvested area (mha)} \]
\[ A_{all} = \text{Annual total harvested cropland area (mha)} \]

* Grains include corn, barley, oats, rye, sorghum (coarse grains), wheat, milled rice (other grains)
** Oilseeds include soybean, cottonseed, peanut, rapeseed, and sunflower seed
Decomposition Results 2001-2008*: Domestic Use Reallocations and Production Accounted for Most of the Change in Corn Use for Ethanol

- Net Contribution from domestic use reallocation - 2001-2008: 85%
- Net Contribution from domestic share of supply - 2001-2008: 5%
- Net contribution from supply/production ratio - 2001-2008: -2%
- Net Contribution from production - 2001-2008: 12%

* The decomposition analysis did not include 2009 because data on total harvested cropland area was not available.
Decomposition Results 2001-2008: Yield Provided About Half of Total Production Contribution

- Net contribution from yield from 2001-2008: ~6%
- 50% of production contribution
- Net Contribution from Land Expansion: 3%
- Net Contribution from Inter-Crop Land Transfers: 2%
Decomposition Results 2001-2008: Factor Contributions Vary from Year to Year

- All years
  - Contribution from domestic use re-allocations were significant in all years

- 2003, 2004 & 2007: All years of healthy economic growth
  - Production contributions large in all years
  - Contribution from domestic share of supply decreased
  - Demand increases met by production rather than diversion of exports

- 2001, 2002 & 2008: All years of market decline
  - Production contributions declined in all years
  - Contribution from domestic share of supply increased
  - Export demand reductions

  - Production contributions declined in both years
  - Contributions from domestic share of supply decreased in 2005, but increased in 2006
Conclusions: Key Assumptions Associated with ILUC Played A Small Role in the 2001-2008 Data Based on Decomposition Results

- Net increase in corn use for ethanol from 2001-2008 mainly from:
  - Re-allocation of domestic corn use in favor of ethanol
  - Increased production (half due to yield change)

- Contributions from factors behind ILUC not large in 2001-2008 data
  - Contribution from the domestic use share of supply small
    - Export share changes were small
  - Contributions from land factors were also small

- Domestic market’s response to corn use for ethanol very flexible

- Year to year variations in factor contributions
  - Cannot use single year observation or two-point comparisons to predict long-term ILUC
  - Crucial dynamics in the determinants of ILUC require further examination
Additional Slides
Economic Conditions Has Crucial Influence on the Domestic and Export Crop Markets

- **2001 & 2002**: economy in recovery
  - Corn production declines; corn ethanol begins to increase
- **2003, 2004**: economic growth
  - Corn production increases; corn ethanol increases rapidly
- **2005, 2007**: economic growth
  - Corn production declined in 2005, increased in 2007; corn ethanol keeps increasing
- **2006**: economic slowdown
  - Corn production declines; corn ethanol keeps increasing
- **2008**: economic decline
  - Corn production declines; corn ethanol keeps increasing
Corn ethanol returns between 30-40% of corn use as DDGS
Exports of DDGS estimated at 6 million tons of corn by 2008
In addition to the increase in corn exports during the period
Studies suggest higher efficiency of DDGS relative to corn/soybean (Bremer et al, 2010)

Domestic use declined slightly from 2002-2007

Exports increased in 2003 & 2007
- Oilseeds production increased in 2003 and was flat through 2006; corn production increased in 2003, 2004 & 2007
- Domestic use rose slightly from 2003-2006; declined in 2007 & 2008
- Exports increased from 2003 – 2007, with a slight dip in 2005
References