Emerging Biofuels: Outlook of Effects on U.S. Grain, Oilseed, and Livestock Markets

Simla Tokgoz
stokgoz@iastate.edu
515-294 6357

Center for Agricultural and Rural Development
Iowa State University
Outline

- Based on the CARD study “Emerging Biofuels: Outlook of Effects on U.S. Grain, Oilseed, and Livestock Markets”
- S. Tokgoz, A. Elobeid, J. Fabiosa, D.J. Hayes, B.A. Babcock, T. Yu, F. Dong, C.E. Hart, and J.C. Beghin
- http://www.card.iastate.edu
Objectives

- To estimate how large the U.S. corn-based ethanol sector can become in the long-run
- To estimate the impact of the emerging U.S. ethanol sector on
  - U.S. grain, oilseed, livestock, and dairy sectors
  - International agricultural markets
General Description of the Models

- Broad modeling system of world agricultural economy
- Non-spatial multi-market deterministic partial equilibrium models of supply and demand for agricultural commodities
- Behavioral equations for production, consumption, stocks, and net trade
- Solve for a representative world price in each market
- Domestic prices linked to world price through price transmission equations
- Linkages between all agricultural commodity markets and energy markets
Model Interactions

Model Interactions
Trade, Prices, and Physical Flows

Macroeconomic Variables
Policy Parameters

International Dairy
International Livestock
International Grains
Ethanol
U.S. Dairy
U.S. Livestock
U.S. Crops
International Oilseeds
International Sugar
International Rice
We first set up a baseline for all agricultural markets. Then, we ran a number of scenarios, including:
- high crude oil price with no bottleneck
- high crude oil price with bottleneck
- drought with an ethanol mandate
- removal of CRP land for ethanol production
Baseline

- All models are calibrated on 2006 historical data and projections cover the period between 2007 and 2016 (2007/08 and 2016/17 marketing year)
- Existing domestic and trade policies remain unchanged
- Counted operating and plants under construction to determine ethanol sector capacity till 2009/10; used economic models to determine the subsequent capacity building to 2016/17 based on net returns over costs
Baseline Assumptions

- No impact on trend yields from changes in planted acreage
- No impact on meat quality from feeding distillers’ grains (DDG) at less than maximum inclusion rates
- All potential bottlenecks involved in transporting ethanol, DDG, corn and fertilizer are solved
- Cellulosic ethanol is not competitive under current policy incentives
- Only direct food price increases caused by increased feed costs are accounted for
Long-run Equilibrium

- The ethanol industry grows until the net profit margin for corn-based ethanol sector is zero; and
- Enough flex-fuel vehicles are sold to accommodate the additional ethanol production

> How large will the U.S. ethanol industry become and how does the rest of world agriculture adjust to let this happen?
Key Determinants of Impacts

- Crude oil prices
  - Used NYMEX futures prices as a guide
  - Computed RAC of crude oil price
- Policy incentives in the U.S.
  - $0.51/gallon ethanol blenders credit
  - $0.54/gallon and 2.5% import tariff
- Demand for E-85 included
- Response of Rest-of-the-World to higher grain prices
  - Let models dictate the equilibrium
Projected Crude Oil Price

$/barrel


Refiner's Acquisition Crude Oil Price
Projected Ethanol and Gasoline Prices

$/gallon

Graph showing the projected prices of Unleaded Gasoline and Ethanol from 2006 to 2016.
Projected Dry Mill Margins

$/gallon

Margin over Operating Cost
Margin over Total Cost
Projected Ethanol Production


million gallons

0 2,000 4,000 6,000 8,000 10,000 12,000 14,000 16,000

Production
Projected Corn Planted Acreage

million acres

$/bushel

Area Planted

Price
Projected Soybean Planted Acreage

<table>
<thead>
<tr>
<th>Year</th>
<th>Area Planted (million acres)</th>
<th>Price ($/bushel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006/07</td>
<td>60</td>
<td>4.50</td>
</tr>
<tr>
<td>2008/09</td>
<td>30</td>
<td>6.00</td>
</tr>
<tr>
<td>2010/11</td>
<td>15</td>
<td>7.50</td>
</tr>
<tr>
<td>2012/13</td>
<td>5</td>
<td>8.00</td>
</tr>
<tr>
<td>2014/15</td>
<td>0</td>
<td>6.00</td>
</tr>
<tr>
<td>2016/17</td>
<td>0</td>
<td>4.50</td>
</tr>
</tbody>
</table>

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Projected Utilization of Corn


million bushels

- Feed
- Fuel Alcohol
- HFCS
- Food, Other
Projected Livestock Production

- Beef
- Pork
- Broiler

Million pounds:

- Beef: 20,000 to 25,000
- Pork: 15,000 to 20,000
- Broiler: 35,000 to 40,000

Years: 2006 to 2016
Projected Livestock Exports

million pounds


Pork  Broiler

Projected Livestock Exports

IOWA STATE UNIVERSITY
Scenario Analysis

- What if the crude oil price rises?
  - Increase the crude oil price by $10 per barrel throughout the projection period
- Estimate the impact on the U.S. and world agricultural sector
- How sensitive is the agricultural sector to the crude oil price?
- We assume no bottleneck in the ethanol demand, i.e. enough flex-fuel vehicles sold to meet the production capacity
- Net profit margins of ethanol plants reach zero
Projected Crude Oil Price

$/barrel


Crude Oil Price
Impacts of Higher Crude Oil Price

- Profit margins on ethanol plants increase
- New incentive to invest in added capacity for ethanol production
- Eventually, a new equilibrium reached where there is no incentive to invest in or exit the ethanol industry
- Will demand for ethanol be enough?
  - E-10 market will saturate around 15 billion gallons
  - Drop in ethanol price will eventually encourage increase in demand by the flex-fuel vehicles
## Corn Market

<table>
<thead>
<tr>
<th></th>
<th>Baseline (2016)</th>
<th>Crude Oil Price Scenario</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn Price ($/bushel)</td>
<td>3.16</td>
<td>4.42</td>
<td>39.9%</td>
</tr>
<tr>
<td>Corn Area (million acres)</td>
<td>92.4</td>
<td>112.7</td>
<td>22.0%</td>
</tr>
<tr>
<td>Corn Production (million bushels)</td>
<td>14,733</td>
<td>18,013</td>
<td>22.3%</td>
</tr>
<tr>
<td>Corn Use in Ethanol (million bushels)</td>
<td>5,013</td>
<td>10,819</td>
<td>115.8%</td>
</tr>
<tr>
<td>Corn Feed Use (million bushels)</td>
<td>5,7468</td>
<td>4,904</td>
<td>-91.5%</td>
</tr>
<tr>
<td>Corn Exports (million bushels)</td>
<td>2,458</td>
<td>935</td>
<td>-62.0%</td>
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</tbody>
</table>
### Ethanol and Distillers Grains Markets

<table>
<thead>
<tr>
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<th>Baseline (2016)</th>
<th>Crude Oil Price Scenario</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol Production from Corn (million gallons)</td>
<td>14,807</td>
<td>29,632</td>
<td>100.1%</td>
</tr>
<tr>
<td>Ethanol Consumption (million gallons)</td>
<td>15,122</td>
<td>29,864</td>
<td>97.5%</td>
</tr>
<tr>
<td>Ethanol Wholesale Price (US$/gallon)</td>
<td>1.58</td>
<td>1.92</td>
<td>21.5%</td>
</tr>
<tr>
<td>Ethanol Net Imports (million gallons)</td>
<td>315</td>
<td>338</td>
<td>7.3%</td>
</tr>
<tr>
<td>Distillers Grains Production (thousand tons)</td>
<td>39,929</td>
<td>87,678</td>
<td>119.6%</td>
</tr>
<tr>
<td>Distillers Grains Price (US$/ton)</td>
<td>105.49</td>
<td>143.79</td>
<td>36.3%</td>
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<tr>
<td>Distillers Grains Domestic Use (thousand tons)</td>
<td>37,491</td>
<td>63,410</td>
<td>69.1%</td>
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</tbody>
</table>
## Soybean Market

<table>
<thead>
<tr>
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<th>Baseline (2016)</th>
<th>Crude Oil Price Scenario</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean Planted Area (million acres)</td>
<td>68.5</td>
<td>58.8</td>
<td>-14.2%</td>
</tr>
<tr>
<td>Soybean Production (million bushels)</td>
<td>3,051</td>
<td>2,585</td>
<td>-15.3%</td>
</tr>
<tr>
<td>Soybean Domestic Use (million bushels)</td>
<td>2,166</td>
<td>1,956</td>
<td>-9.7%</td>
</tr>
<tr>
<td>Soybean Exports (million bushels)</td>
<td>882</td>
<td>624</td>
<td>-29.3%</td>
</tr>
<tr>
<td>Soybean Price (US$/bushel)</td>
<td>6.56</td>
<td>7.85</td>
<td>19.7%</td>
</tr>
<tr>
<td>Soybean Meal Price (US$/ton)</td>
<td>158.6</td>
<td>185.6</td>
<td>17.02%</td>
</tr>
<tr>
<td>Soybean Meal Use (thousand tons)</td>
<td>38,822</td>
<td>34,672</td>
<td>-10.7%</td>
</tr>
</tbody>
</table>
## Livestock Market

<table>
<thead>
<tr>
<th>Product</th>
<th>Baseline (2016)</th>
<th>Crude Oil Price Scenario</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef Production (million pounds)</td>
<td>28,295</td>
<td>27,500</td>
<td>-2.8%</td>
</tr>
<tr>
<td>Pork Production (million pounds)</td>
<td>22,920</td>
<td>21,855</td>
<td>-4.6%</td>
</tr>
<tr>
<td>Broiler Production (million pounds)</td>
<td>40,944</td>
<td>38,905</td>
<td>-5.0%</td>
</tr>
<tr>
<td>Turkey Production (million pounds)</td>
<td>6,275</td>
<td>6,090</td>
<td>-2.9%</td>
</tr>
<tr>
<td>Egg Production (million dozen)</td>
<td>8,257</td>
<td>8,144</td>
<td>-1.4%</td>
</tr>
<tr>
<td>Milk Production (million pounds)</td>
<td>204,112</td>
<td>202,726</td>
<td>-0.7%</td>
</tr>
</tbody>
</table>
# Livestock Market

<table>
<thead>
<tr>
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<th>Baseline (2016)</th>
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</thead>
<tbody>
<tr>
<td>Beef Retail Price (US$/pound)</td>
<td>4.52</td>
<td>4.72</td>
<td>4.4%</td>
</tr>
<tr>
<td>Pork Retail Price (US$/pound)</td>
<td>3.30</td>
<td>3.42</td>
<td>3.6%</td>
</tr>
<tr>
<td>Broiler Retail Price (US¢/pound)</td>
<td>196.01</td>
<td>204.13</td>
<td>4.1%</td>
</tr>
<tr>
<td>Turkey Retail Price (US¢/pound)</td>
<td>126.25</td>
<td>135.57</td>
<td>7.4%</td>
</tr>
<tr>
<td>Egg Retail Price (US¢/dozen)</td>
<td>162.96</td>
<td>175.32</td>
<td>7.6%</td>
</tr>
<tr>
<td>Milk Retail Price (US$/cwt)</td>
<td>14.64</td>
<td>18.04</td>
<td>23.2%</td>
</tr>
</tbody>
</table>
Impact on Rest of the World

- World grain and oilseed prices increase
- This translates into higher feed prices
- Higher feed prices mean higher livestock production costs
- Food prices in the U.S. and the world increase
- Countries in South America and Asia fill the gap in the demand for corn and soybeans by higher production
We introduce a drought in 2012, similar to 1988 U.S. drought.
- Regional yields of corn, soybeans, wheat and barley change from trend levels.
- Yields fall by 25% for corn, 18% for soybeans, 11% for wheat, and 30% for barley.
- Ethanol mandate for 2012-onwards assumed to be 14.7 billion gallons.
Corn, Soybean and Ethanol Markets

- Corn price increases by 44% above baseline levels
- Soybean price rises by 22%
- Corn exports and stock levels decline by more than 60%
- Corn exports from South America, China, etc. fill part of the gap from decline in U.S. corn and soybean exports
- Corn feed use declines by 16%
- Ethanol net imports increase moderately
Livestock Market

Higher feed costs affect the livestock sector, but to a lesser extent as the shock is perceived as temporary.

- Production declines
  - Broiler production declines the most (over 2.7%)
  - Milk production declines the least (0.5%)
  - Decline for beef, pork and turkey ranges between 1.3% and 2.4%

- Retail prices increase
  - Egg prices increase the most (about 5.4%)
  - Prices of other products increase by a range between 2% and 4%
Conclusions

- Crude oil price increase expands the U.S. ethanol sector’s production capacity, but the final impact depends on the vehicle fleet’s ability in the U.S. to absorb the production and therefore the relative price of ethanol to gasoline
  - We have “no bottleneck” and “bottleneck” crude oil price shock scenarios.
- A drought with an ethanol mandate will keep the ethanol demand from falling, therefore other sectors will adjust to a short-crop situation
Thank you!