Modeling International Biofuel Markets

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Who are FAPRI?

- Providing objective and independent policy analysis for the agricultural sector for 30 years
- Primary focus has been providing analysis for DC policy makers
- Growth of biofuels has meant that we have to move into energy markets
- Our strength: integrating changing levels of biofuels demands into an agricultural framework
The modeling team

- **Julian Binfield.** International projects and global models. EU biofuel model and the small “world” ethanol and sugar model
- **Jarrett Whistance.** U.S. biofuels and energy markets
- **Wyatt Thompson.** Lots of work on biofuels and energy markets
The deterministic model

- Global system, produces one Outlook projection

- U.S. livestock
- U.S. dairy
- U.S. crops
- U.S. biofuels
- World crops
- "World" ethanol and sugar
- EU-28
Partial equilibrium

- Feedback impacts on wider economy of different levels of fuel use or feed prices generally not incorporated

System of single equations

- Some estimated, some not

Focus on correct incorporation of economics, biology and policy

Iterative process with frequent industry feedback
The stochastic model

- After the deterministic model is run then we use a smaller (U.S. only) system to generate 500 alternate futures
- Take some of our exogenous variables and errors, construct distributions, then generate 500 correlated alternatives
- Oil price. Errors from yield equations, some demand equations, trade equations
- Does not include all sources of uncertainty
The outlook

- "U.S. Baseline Briefing Book,"
  [www.fapri.missouri.edu](http://www.fapri.missouri.edu)

- Based on market information from January 2014

- Incorporates provisions of new farm bill

- Not a “forecast,” but a projection of what might happen under a continuation of current policies and other specific assumptions
U.S. farm prices for corn

Source: FAPRI-MU stochastic baseline, March 2014
2019 yield in #5 is 140 bushels per acre (avg: 174)

Source: FAPRI-MU stochastic baseline, March 2014
U.S. farm prices for corn

Source: FAPRI-MU stochastic baseline, March 2014
U.S. farm prices for corn

Source: FAPRI-MU stochastic baseline, March 2014
Other work going on at FAPRI:

- Thompson, Whistance and Meyer, U.S. ag. and biofuels models with a global petroleum and petroleum products market (Energy Policy, 2011)
- Whistance, Thompson and Meyer, ethanol effects on US natural gas prices and quantities (AER, 2010)
- Some work going on regarding issues related to the U.S. such as on LFCS
Challenges: Overview

- Data
- Modeling a “new” industry
- Specification and calibration of model
  - Linking agriculture and energy markets
  - Determining fuel demands
- Policy
  - Correctly modelling current policy
  - Biofuels policy is endogenous
Data challenges

- For me, the biggest headache in modelling biofuels
- To do it properly need a lot of data, e.g. production capacity
- Data is either costly, incomplete, not up to date, ends abruptly etc
- Currently have to use data from different sources
Data used in models

- For Brazil use UNICA (often collected from other sources, MAPA etc)
- For the EU use “Strategie Grains” as we need up to date member state data
- FO Lichts for prices
- For U.S use data from many places, EIA, USDA, National Biodiesel Board, Renewable Fuels Association
- Macro from IHS Global Insight
Energy prices

W. Texas intermediate oil

Henry Hub natural gas

Source: IHS Global Insight, Jan. 2014

Source: IHS Global Insight, Jan. 2014
For the U.S. and the EU biofuels production has grown rapidly for the last 10 years.

- Not enough history for estimations
- Few studies to draw on for key parameters
- Had to build the model from scratch
- Impose parameters, validate through:
  - Testing
  - Expert review
  - Peer review
Basic structure of U.S. ethanol model: Supply

- Capacity and utilization rates determined by returns
- Returns include plant level price, costs
- Separate between dry mill and wet mill
- Also have ethanol from other sources
  - Small amount from non-corn
  - Cellulosic, separate model attempting to account for different raw materials (also includes biomass for electricity production)
Basic structure of U.S. ethanol model: Demand

- Separate use into:
  - Additive use
  - E-10
  - E-15
  - E-85
- In each case we determine a potential market and how much of this is filled
- Based on the attractiveness of the fuel product
What determines biofuel use in the U.S. model

- Depends on the level of the mandate, the size of potential low blend markets, and the attractiveness of fuel markets
- In the past when mandates have not been binding, size of E-10 market main driver
- Now mandate is binding, and determines use
- Blend wall driven by total gasoline market
- But still possible to consume above mandate
Biofuel policy assumptions

- Renewable Fuel Standard (RFS) requirements based on method outlined in EPA’s 2014 proposal

- Biodiesel blender’s tax credit expired and is not reinstated

- 2nd generation biofuel tax credit expired and is not reinstated
Renewable Fuel Standard – previous assumption

Source: “U.S. Baseline Briefing Book,” March 2013, page 3
Renewable Fuel Standard – current assumption

RFS requirements based on EPA proposed method

<table>
<thead>
<tr>
<th>Year</th>
<th>Billion gallons (ethanol eq.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>14.5</td>
</tr>
<tr>
<td>2016</td>
<td>15.0</td>
</tr>
<tr>
<td>2018</td>
<td>15.5</td>
</tr>
<tr>
<td>2020</td>
<td>16.0</td>
</tr>
<tr>
<td>2022</td>
<td>16.5</td>
</tr>
</tbody>
</table>

Calendar year

- Conventional gap
- Advanced gap
- Biomass-based diesel
- Cellulosic

RIN production is included in the model, as well as stocks.
RIN prices generated for biomass-based diesel, cellulosic, advanced and conventional ethanols.
Hierarchy of RIN values maintained.
## Fuel domestic use - baseline

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2014</th>
<th>2023</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(million gallons)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasoline</td>
<td>135,025</td>
<td>133,571</td>
<td>127,219</td>
</tr>
<tr>
<td>Ethanol - total</td>
<td>13,230</td>
<td>13,541</td>
<td>14,353</td>
</tr>
<tr>
<td>- 10% blends</td>
<td>13,054</td>
<td>13,088</td>
<td>12,028</td>
</tr>
<tr>
<td>- 10-15% blends</td>
<td>3</td>
<td>48</td>
<td>790</td>
</tr>
<tr>
<td>- Higher blends</td>
<td>172</td>
<td>405</td>
<td>1535</td>
</tr>
<tr>
<td>Biodiesel</td>
<td>1,552</td>
<td>1,286</td>
<td>1,424</td>
</tr>
</tbody>
</table>
The EU model

- Separated into 5 regions. UK, Germany, Italy, France and “other”
- Issues with Europe:
  - There is an overall EU policy
  - But, that policy is in flux, especially concerning sustainability criteria
  - Member states have responsibility in implementing policy
- Used to try and track policies, RTFO, TGAP
EU biodiesel sector
EU ethanol sector

![Graph showing the EU ethanol sector](image)
- Closely linked to the sugar industry
- Have a mandated level of ethanol use, but also have a large flex fuel fleet
Brazil

- We have a simple sugar model for Brazil
  - Ethanol and sugar policy closely linked, so difficult to project future sugar area growth
  - Government policies can change, uncertainty
- Have a simple ethanol model
  - Don’t want Brazilian ethanol price to fall below energy equivalent of gasoline price, use trigger
  - But what
Brazil prices in Real

![Graph showing Brazil prices in Real over time. The graph includes lines for Gasoline - SP, Pump hyd - SP, Gasoline*.7, and Fuel anhy. SP. The x-axis represents dates from Dec-10 to Sep-13, and the y-axis represents price per liter ranging from 0.00 to 3.00.]
Brazil and US prices in U.S. $
Modeling trade

- Up to now the challenge has been capturing Brazil/EU/U.S. triangle
- Trade flows have changed frequently, mostly as a result of policy changes
- So hard to know even where fuel will go
- What’s in the trade figures? Blended fuels
- Now emerging markets for low level blends? How will that impact trade? How big is that market?
The stochastic process

Conventional RIN price

$\text{gallon}$


10\% 90\% Stochastic Average Deterministic Baseline
Future path for FAPRI models

- Develop a better world market for biodiesel
  - Add Argentina, Malaysia, Indonesia, Brazil
- Add coverage for ethanol
  - Canada, some estimate of the market for blended fuel
- Better representation of Brazilian markets and policy
Issue for our energy models

- OPEC behaviour, especially supply response. Behaviour of state owned enterprises
- For stochastic modelling, what should supply look like? Symmetric? Kinks?
- Elasticities for fuel demand
  - Hard to find for developing countries
  - Gasoline vs diesel vs other?
Thank you!

- Do contact any of our team with questions:
  - Julian Binfield (binfieldj@missouri.edu)
  - Jarrett Whistance (whistancejl@missouri.edu)
  - Wyatt Thompson (thompsonw@missouri.edu)
- Watch the website for Outlooks, biofuel model documentation coming soon:
  - www.fapri.missouri.edu