Economic and Land Use Impacts of Biofuels

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June 12 2013

Acknowledgements: This research was supported by the US Department of Energy (DoE) under the Bioenergy Technologies Office (BETO).

Other Contributors: Keith Kline, Paul Leiby, Rocio Uria-Martinez, Maggie Davis, Mark Downing, Laurence Eaton

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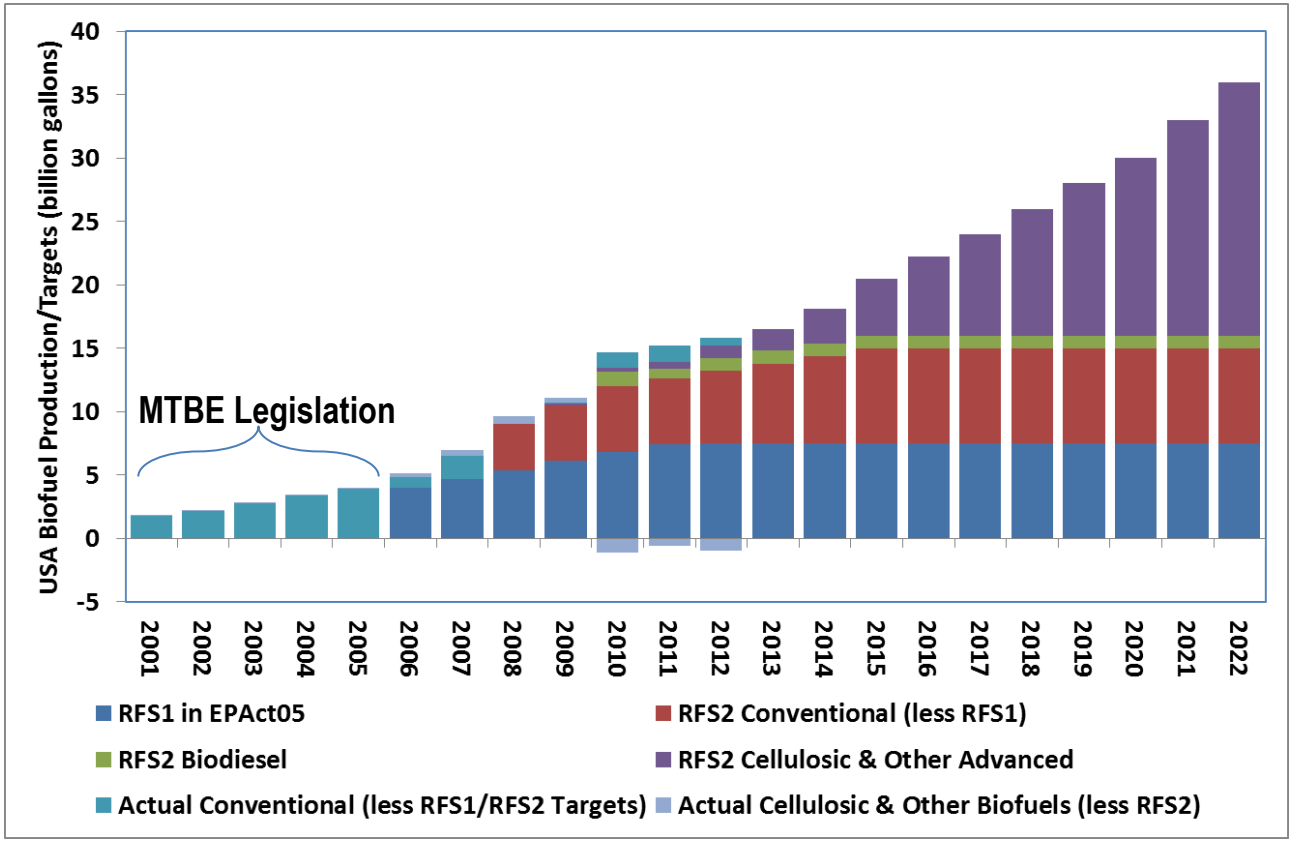
USA biofuels policy: the journey so far

- Policy objectives:
  - Replace about 20% of oil imports by 2022
  - Reduce GHG emissions relative to oil-based fuels



- Production increased from less than 2 to almost 14 billion gallons in 10 years

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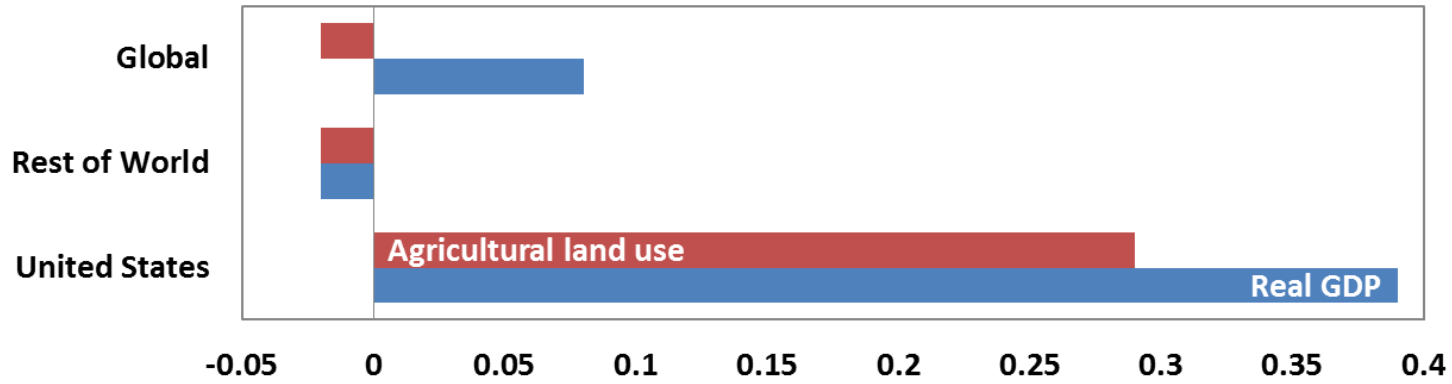
Evaluating the effects of USA biofuels

- Questions:
  - What are the economic benefits from biofuel use in the USA?
  - What are the indirect land use impacts?

Estimates of the Potential Economic and Land Use Impacts of USA Conventional Biofuels in 2022 (% change)



	United States	Rest of World	Global
Agricultural land use	0.29	-0.02	-0.02
Real GDP	0.39	-0.02	0.08

Change in Regional Gross Domestic Product and Agricultural Land Use (%)

- Positive economic effects on the USA economy
- Largely neutral economic effect in rest of world
- Land use change is concentrated in the USA

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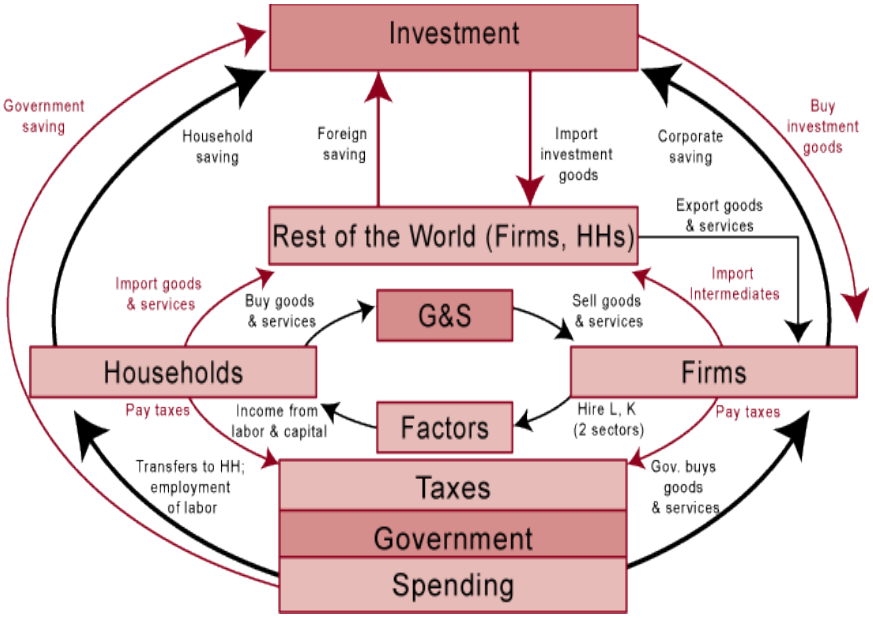
Overview of methodology

- Computable General Equilibrium (CGE) Model: System of equations that describes the economic behavior and interactions of agents in a given economy

Economic Agents

- **Households/Consumer**
- **Producers/Firms**
- **Governments**
- **Investors**
- **Rest of the world**
- **Etc.**



Cycle of Economic Transactions

- CGE-based evaluation of the economic effects of biofuels enable modeling of:
  - Links between two important sectors (agriculture and energy) through biofuels
  - Wide range of interactions between biofuels and the national/global economy

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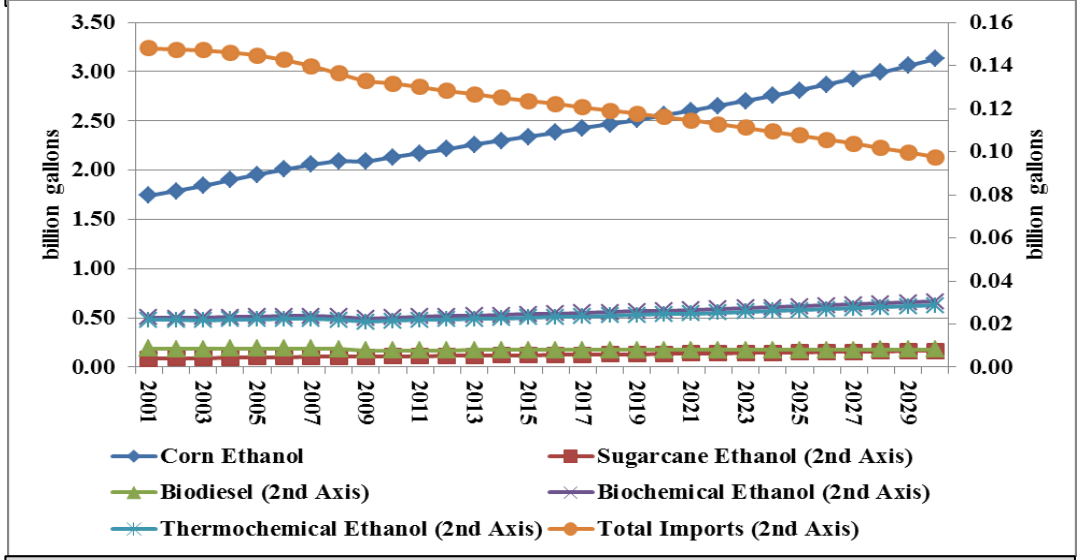
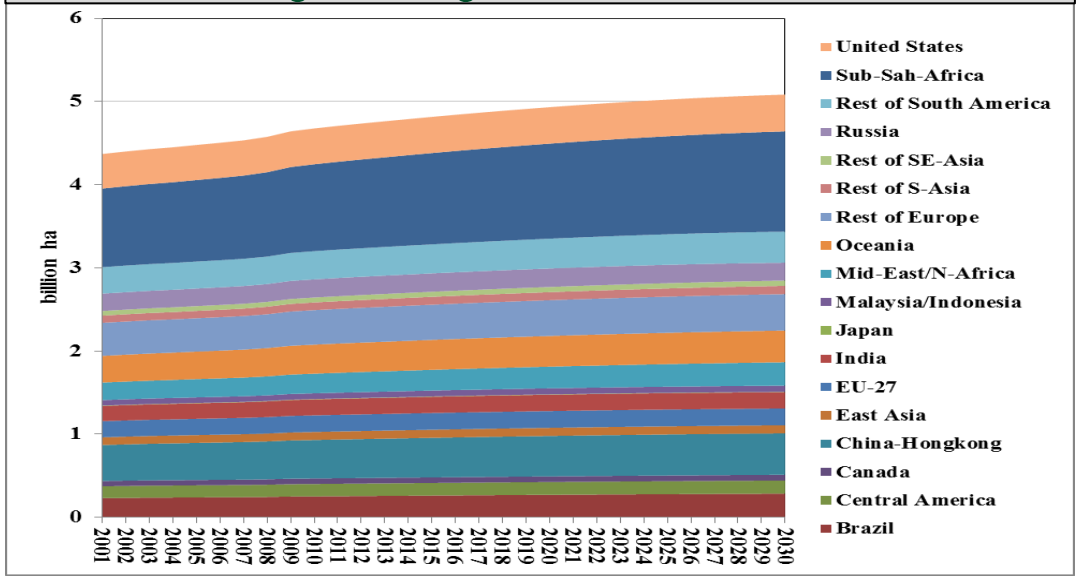
Baseline simulation: biofuels and land use

Production/imports of biofuels in the USA



Regional agricultural land use



- Baseline simulations:
  Performed to evaluate the values of model variables **without recent biofuel policy changes**

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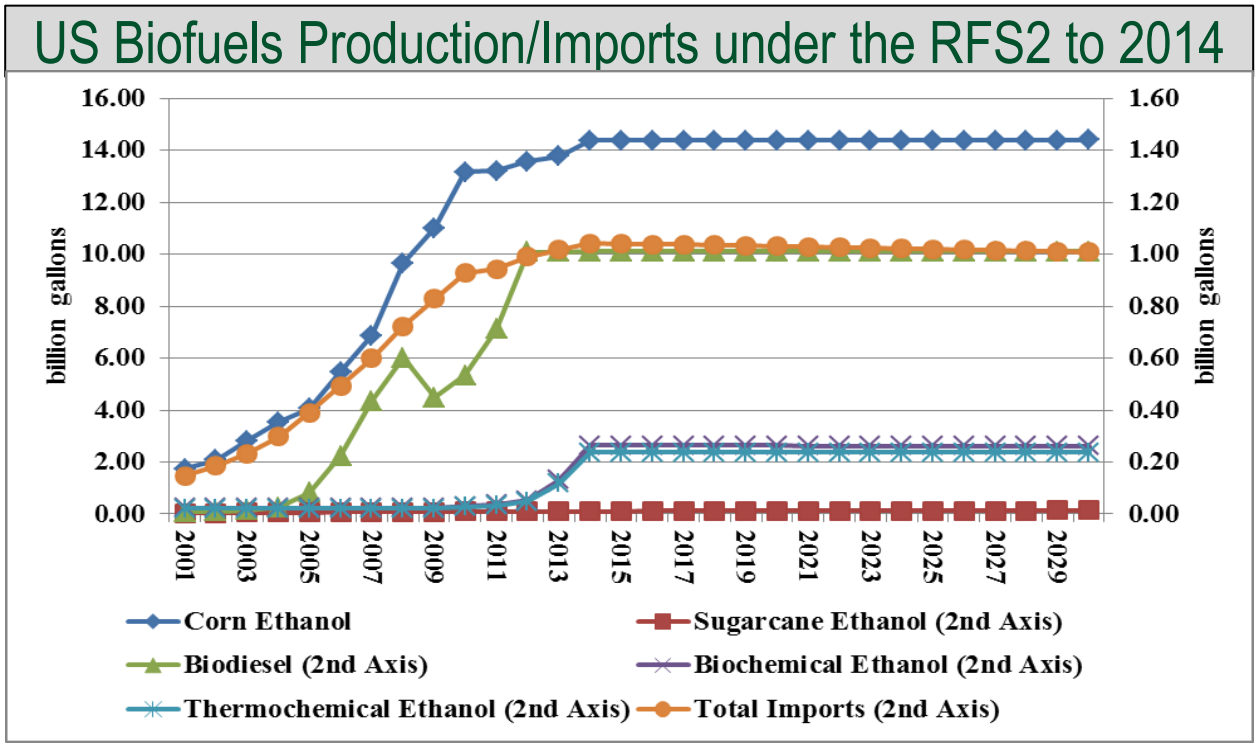
Policy simulation: Changes in USA biofuel under RFS2 to 2014

- Simulation of policy targets: RFS2 targets up to 2014



- Differences between policy and baseline results are the effects of policy

Factors driving the economic and land use effects of biofuel policy

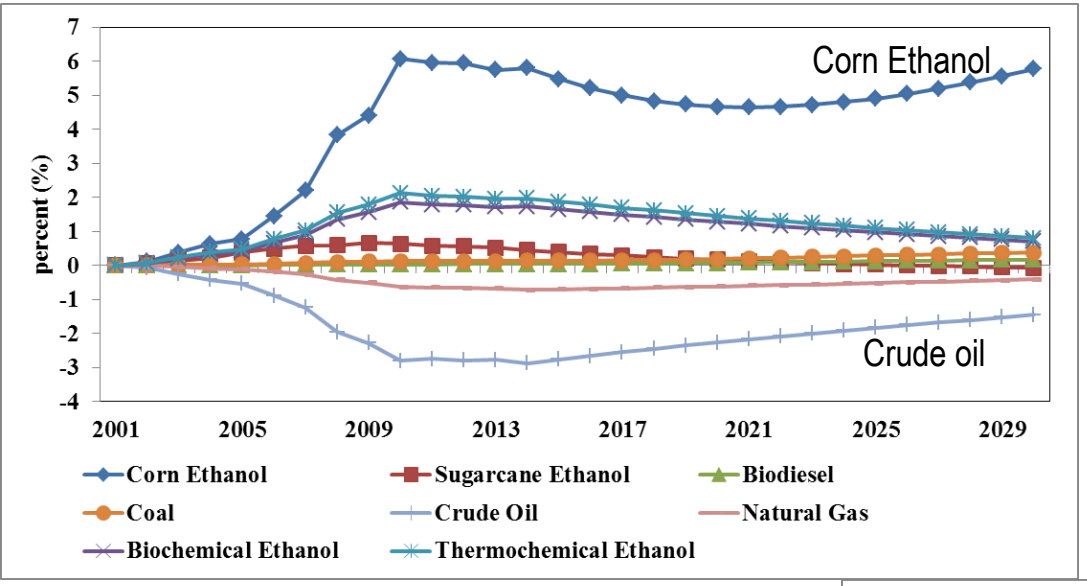
- Displacement of oil by biofuels: expands domestic output/reduces import
- Price changes in agricultural, **oil** and other markets
- Land use change driven by biofuel production, relative prices and income effects

Simplified Description of the Expected Impacts of a Biofuel Mandate

	Regional Characteristics			
	Net Oil Importer/ Net Agric. Exporter	Net Oil Importer/ Net Agric. Importer	Net Oil Exporter/ Net Agric.Exporter	Net Oil Exporter/ Net Agric. Importer
Main Sources of Economic Effects				
Oil Price Decrease	+	+	-	-
Corn Price Increase	+	-	+	-
Oil Displacement	+	*NA*	*NA*	*NA*
Biofuel Cost Increase	-	*NA*	*NA*	*NA*
Overall Effects				
Economic Performance	+	+/-	+/-	-
Agricultural Land Use Change	+	+/-	+/-	-
Example Region	USA	Others	Others	Saudi Arabia

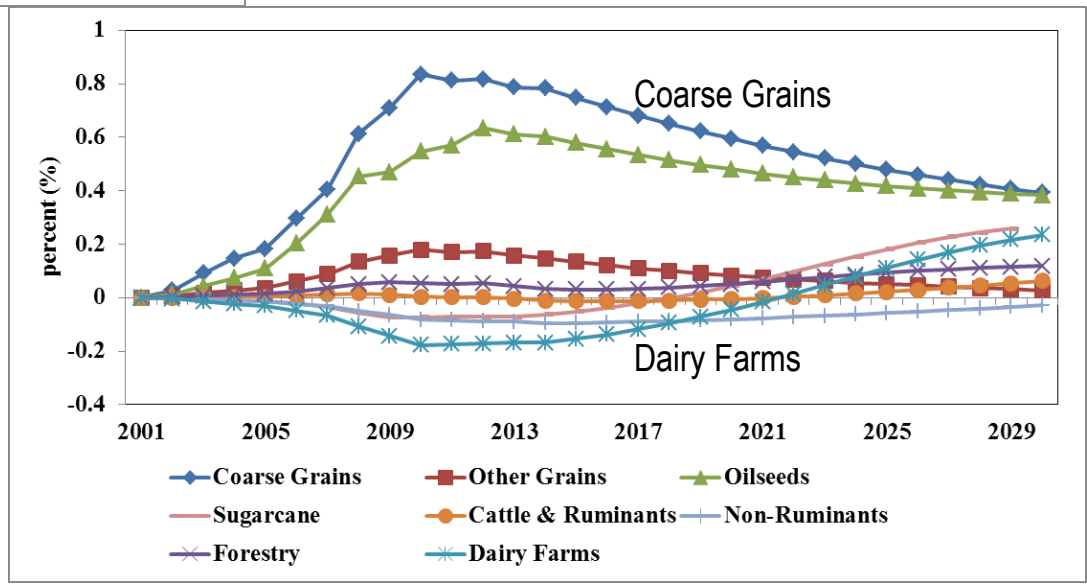
NA = Not Applicable (only USA is assumed to enact biofuel policy)

Results: agricultural and energy prices under RFS2 to 2014



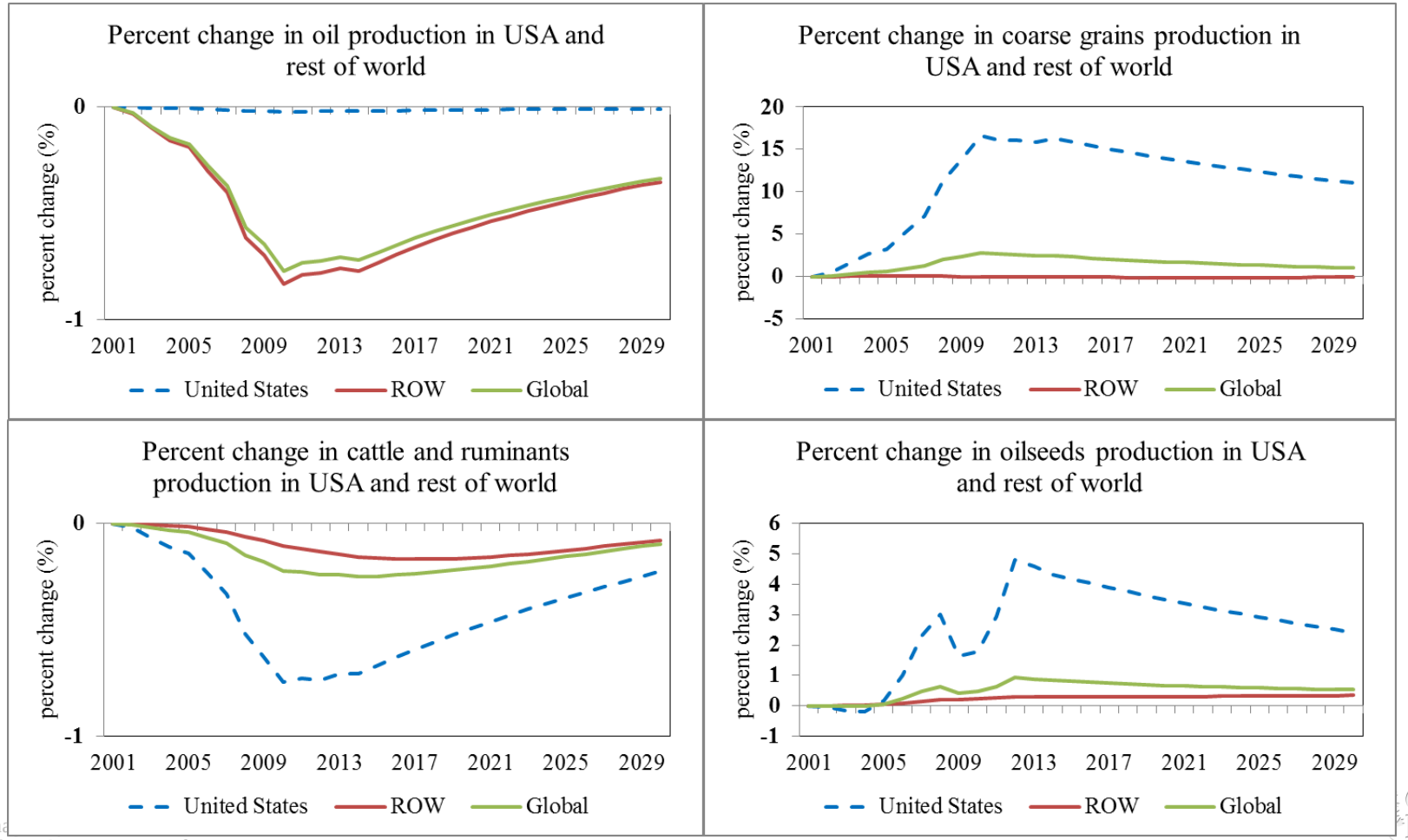
- Biofuel production cost increases
  - Leads to improved efficiency (not captured here)
- Crude oil price declines

- Most crop prices increase
  …but by less than 1%
- Livestock prices decline
  …demand reductions important



Results: agricultural/energy production changes under RFS2 to 2014

- Global oil production decreases – mostly in the rest of world
- Small decreases in livestock production as some of the land moves to crops



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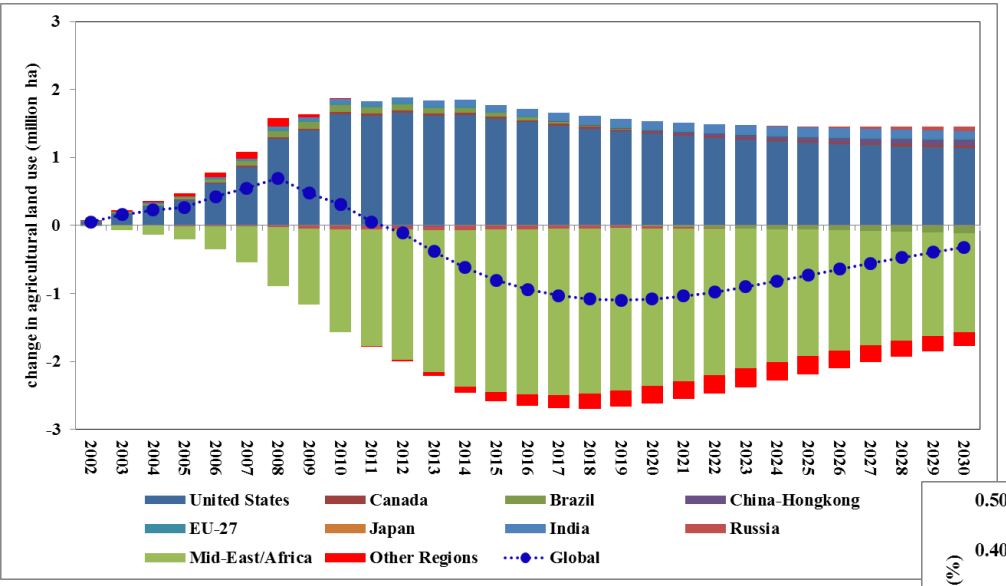
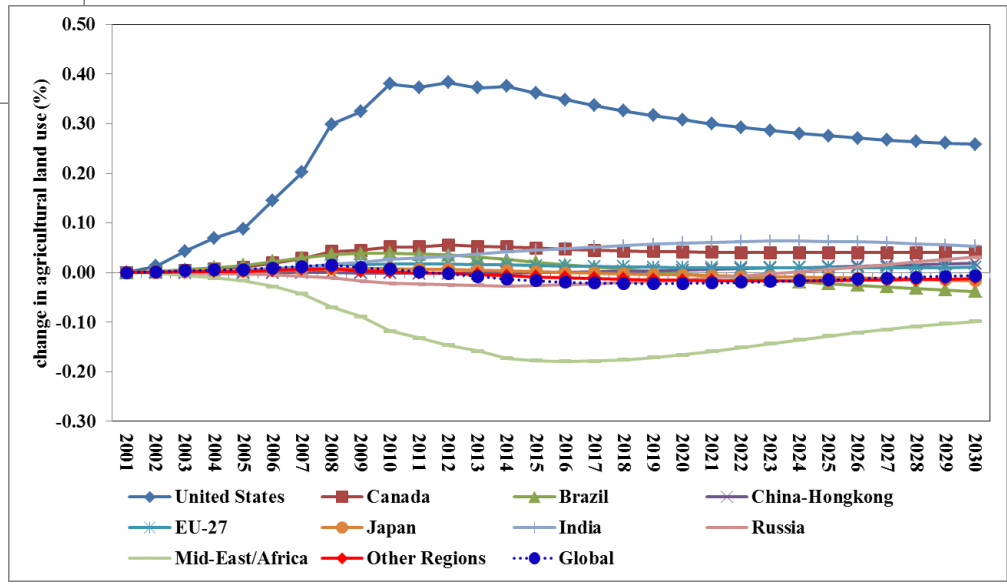
Results: land use change effects under RFS2 to 2014



- Agricultural land use expansion occurred mainly in the USA
- Important dynamics in the patter of land use change over time

- Income effects of oil displacement and price reduction produce offsetting land use change effects in some regions of the world



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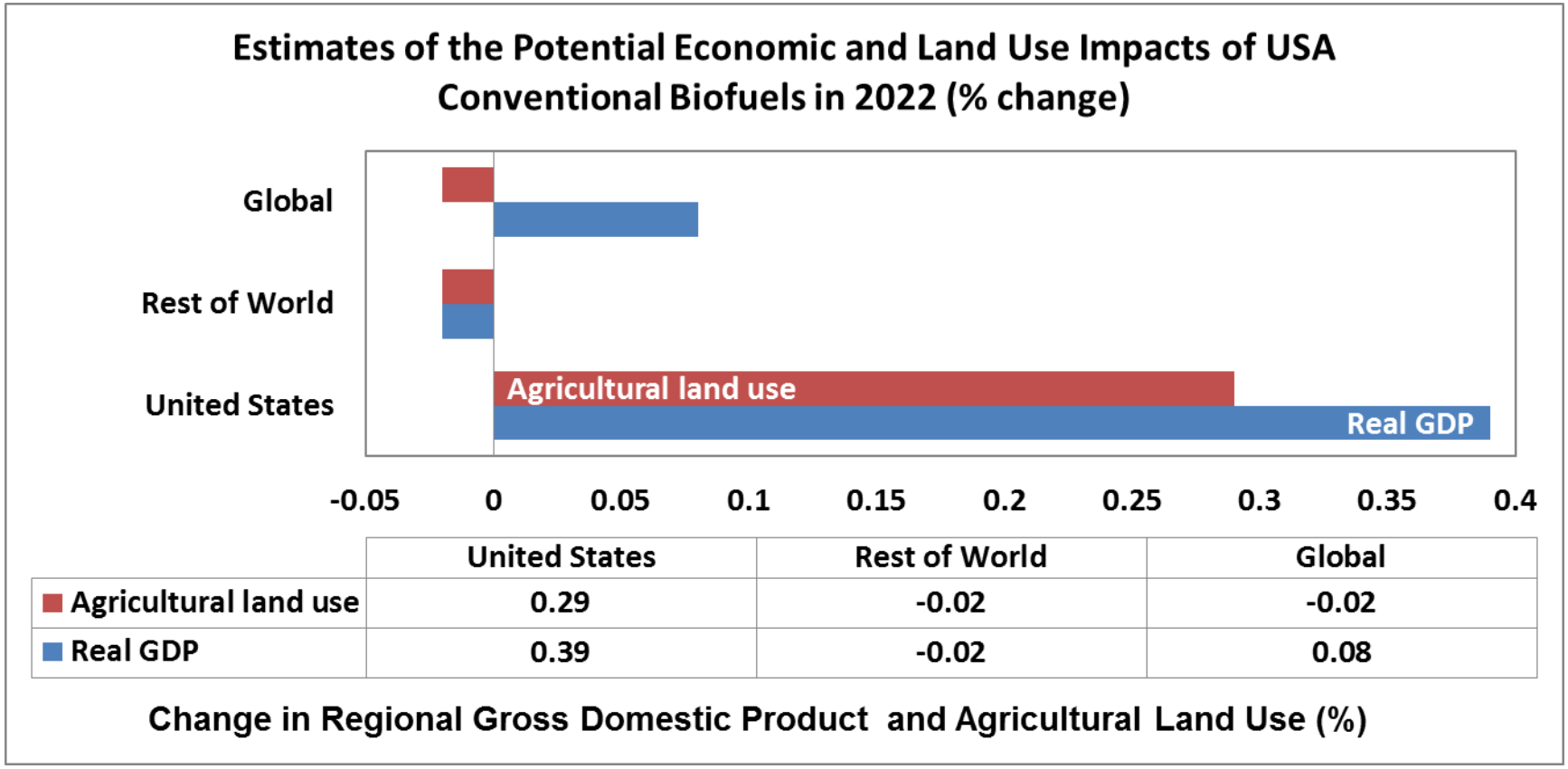
Summary: RGDP and agricultural land use change in 2022 under to RFS2 to 2014



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National Benefits Analysis of Biofuels

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June 12 2013

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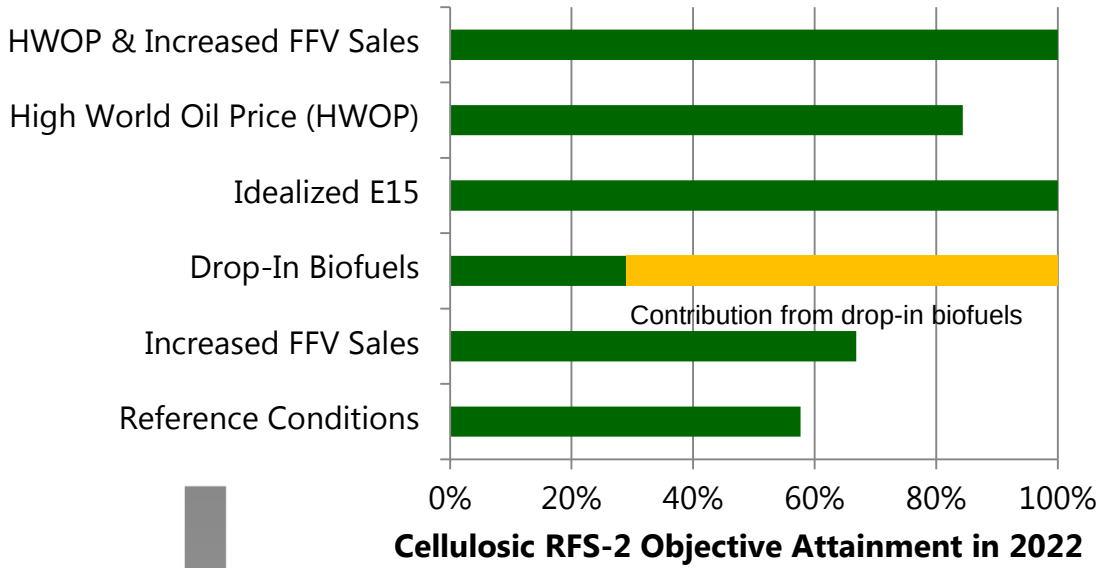
Feasibility and Costs of Various Levels of RFS-2 Achievement*

*Note: 2022 RFS2 cellulosic target is 16 billion gallons



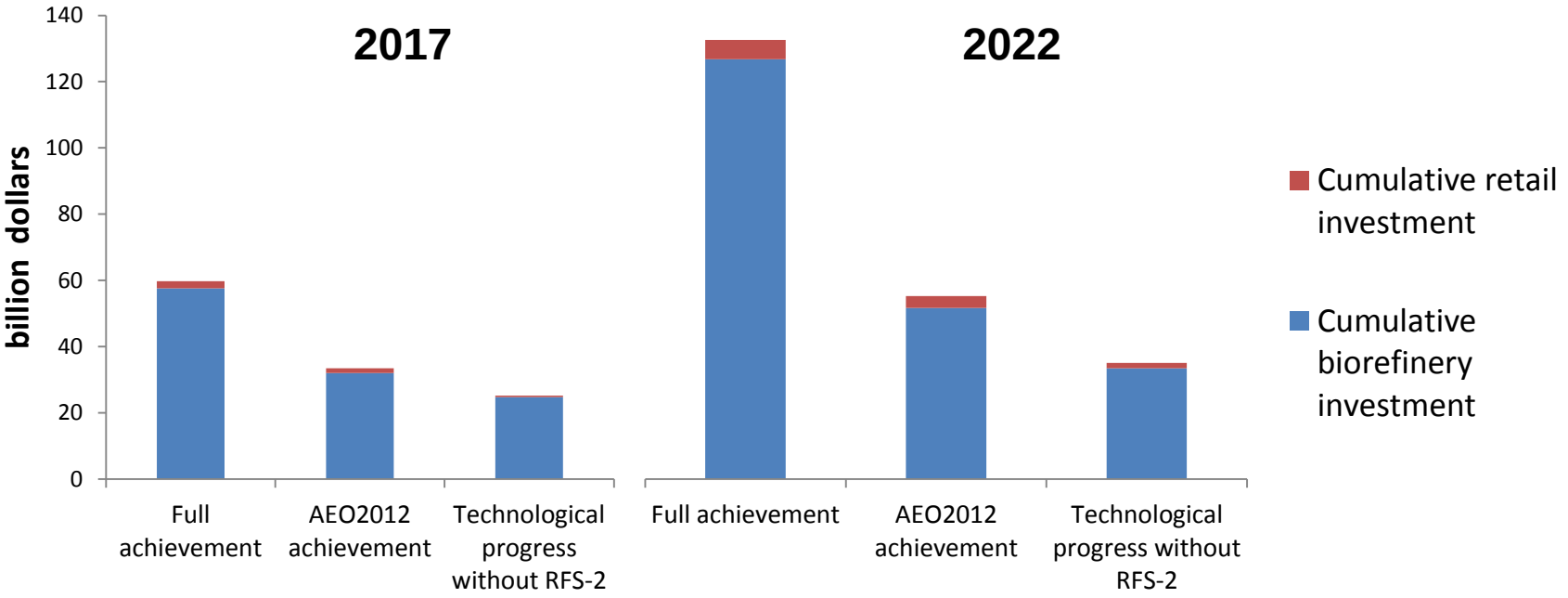
KEY BARRIERS:

- E10 "blend wall"
- FFV stock size
- Retail infrastructure introduction rate
- Inconvenience cost of E85 refueling
- Biorefinery investment rate limits

Reference Conditions:
-Grower payments $50/dry ton
-Biomass densification starting in 2017
-No drop-in biofuels
-Cellulosic ethanol n^{th} plant costs reached in 2017
-AEO2012 reference case oil prices
-Window for RIN banking and borrowing
-Current expiration dates for biofuel policy incentives

Retail Infrastructure Investment is Modest in Comparison to Biorefinery Investment, but risk may deter it.

Simulated cumulative investment expenditure for various levels of RFS-2 attainment



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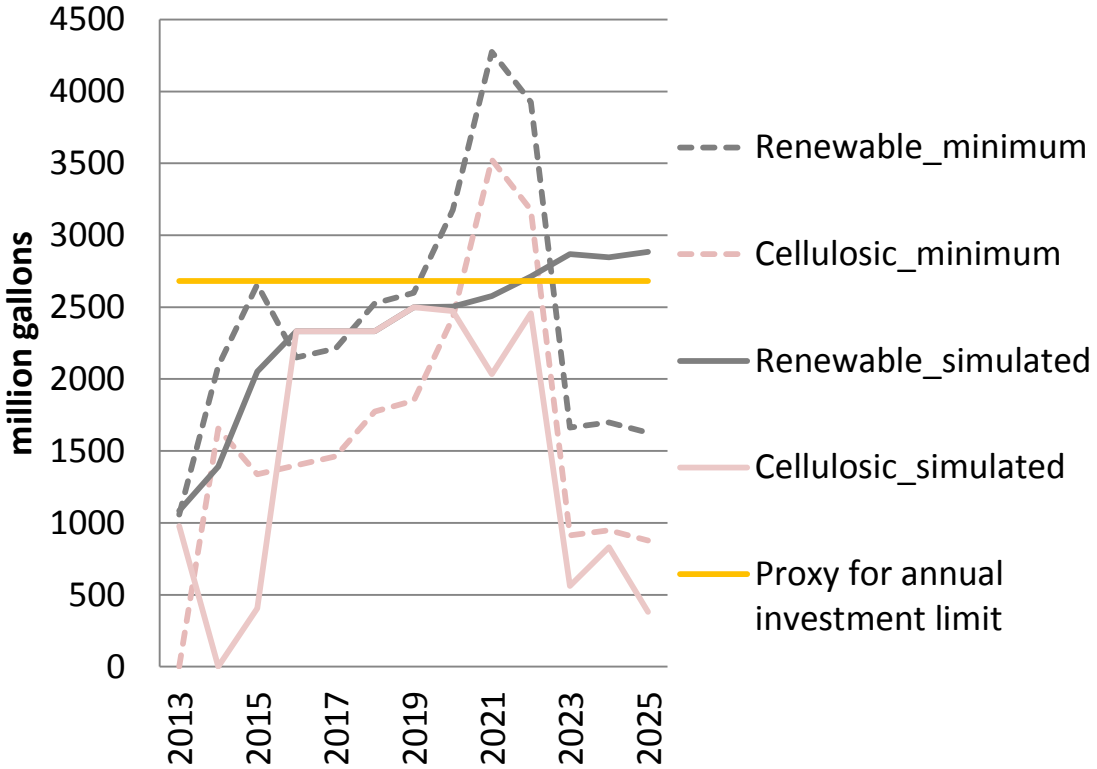
Biorefinery Investment Levels Required for RFS-2 Compliance with ethanol are Difficult to Attain

Simulated biorefinery investment timing (solid lines) compared to:

- timing implied by RFS-2 annual mandate increments (dashed lines)
- peak historical annual dry mill capacity addition



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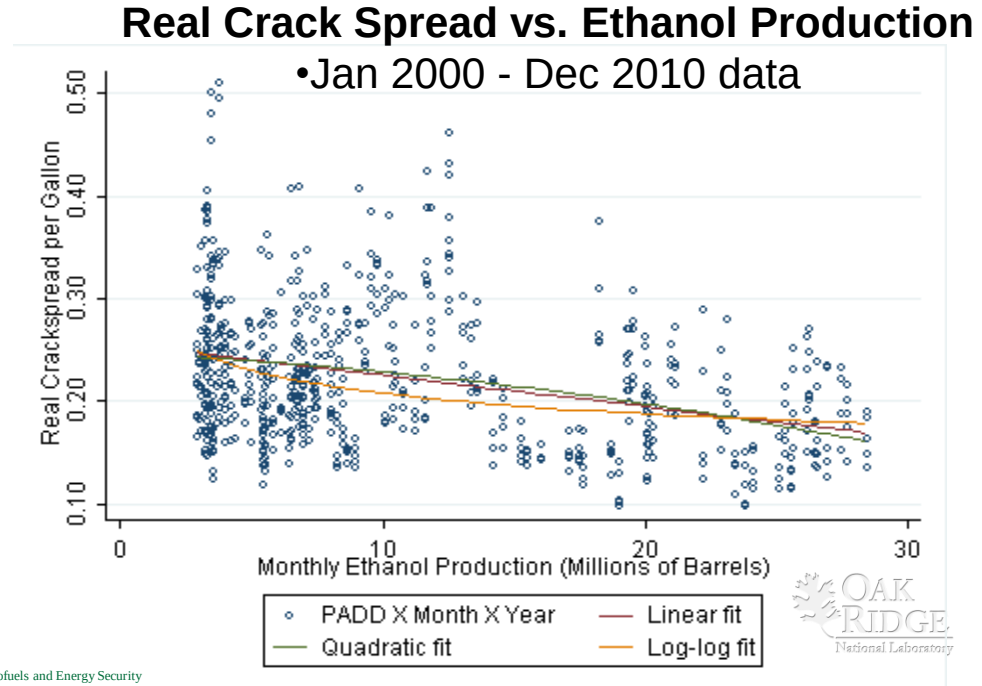
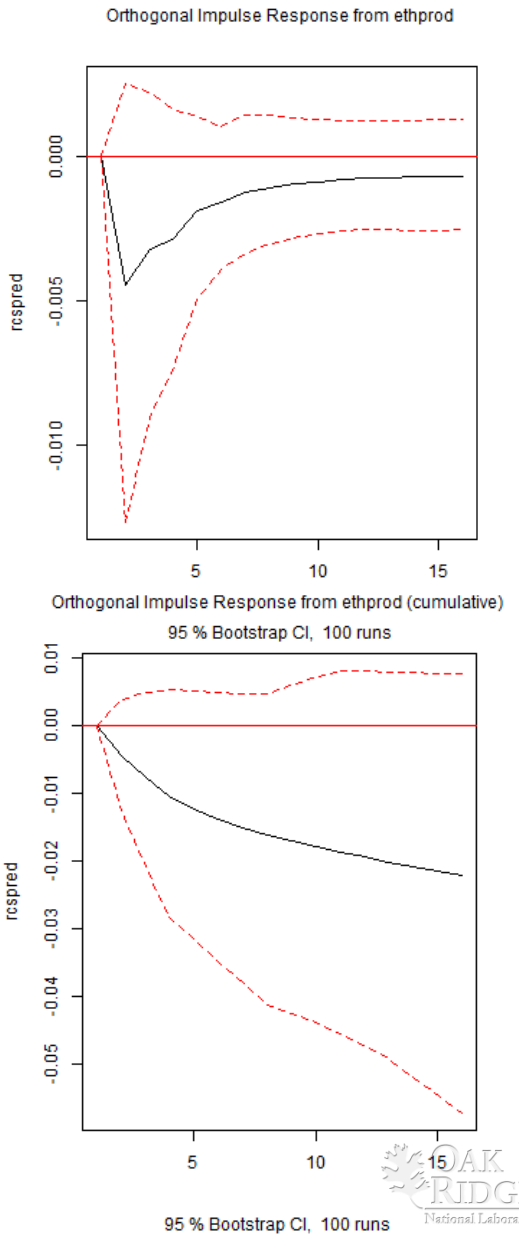
Analysis of the Effect of Biofuels on Gasoline Price Levels and Volatility

- Relevance: Biofuels *economic* benefits depend on their fuel market impacts (products and crude):
  - fuel price levels (costs/benefits)
  - price stability (energy security – another topic)
- Context: controversial papers suggested ethanol production had very large gasoline price reduction effect
  - Need for careful reconsideration, to support DOE analysis
- Approach:
  - Empirical - statistical analysis of multiple monthly time series
  - Conceptual - identify possible channels for ethanol production to affect gasoline price



Analysis of the Effect of Biofuels on Gasoline Price – Results

- Replicated Du and Hayes (2012)
  - Extended time range, tested alternative specifications, identified issues
- Applied two improved time series methods
  - VAR and VECM with corrections for nonstationarity
  - These methods provide much more modest, but more defensible, estimates of ethanol price impact.
  - Effects vary by region and time, indistinguishable from zero in many, but support modest (~10c/gal) in some regions
- Paper in draft to be revised and submitted for publication in Q3



Additional Information

- **Acknowledgements:** This research was supported by the US Department of Energy (DoE) under the Bioenergy Technologies Program (BETO).

- **Office of Biomass Programs**: http://www.eere.energy.gov/biomass

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