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

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The deterministic model

- Global system, produces one Outlook projection
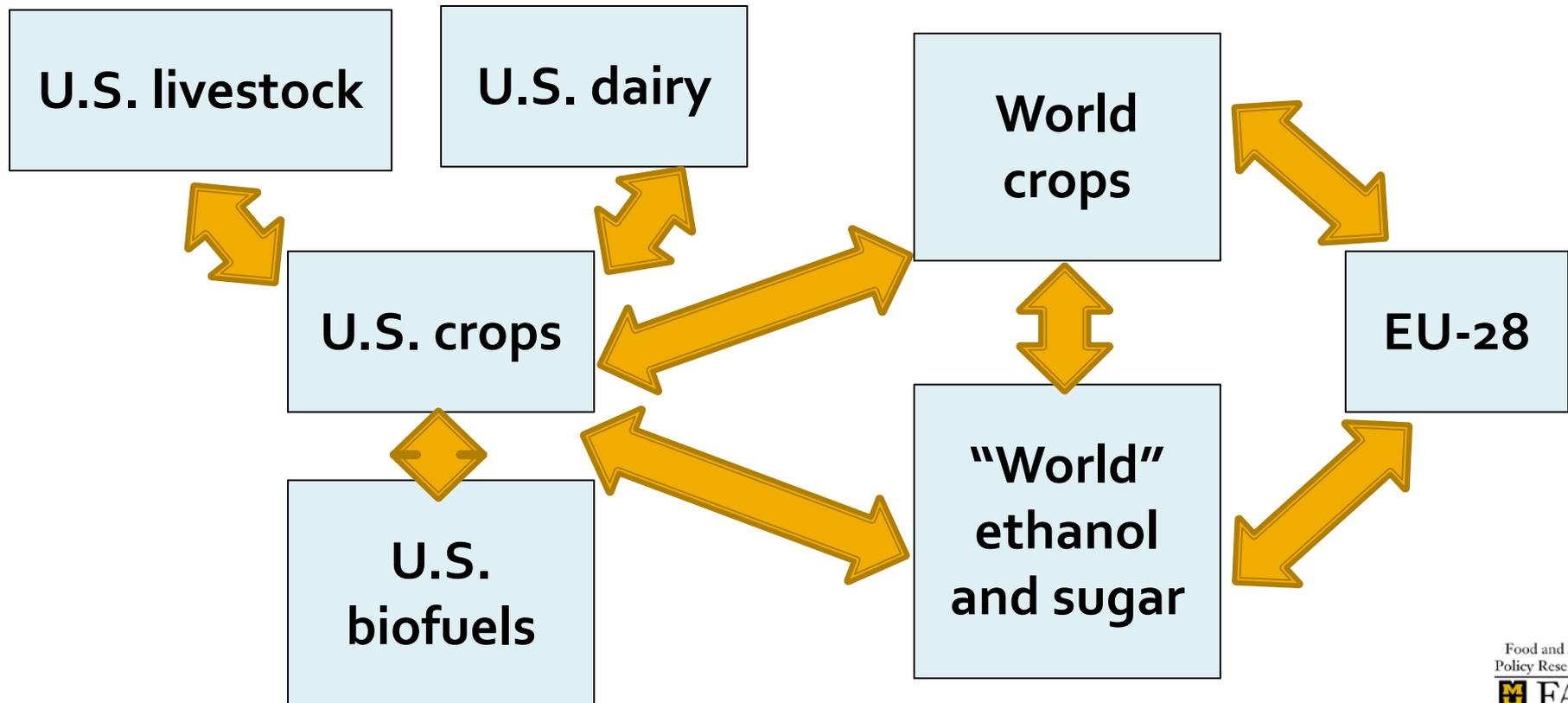
Features of the deterministic model

- **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**
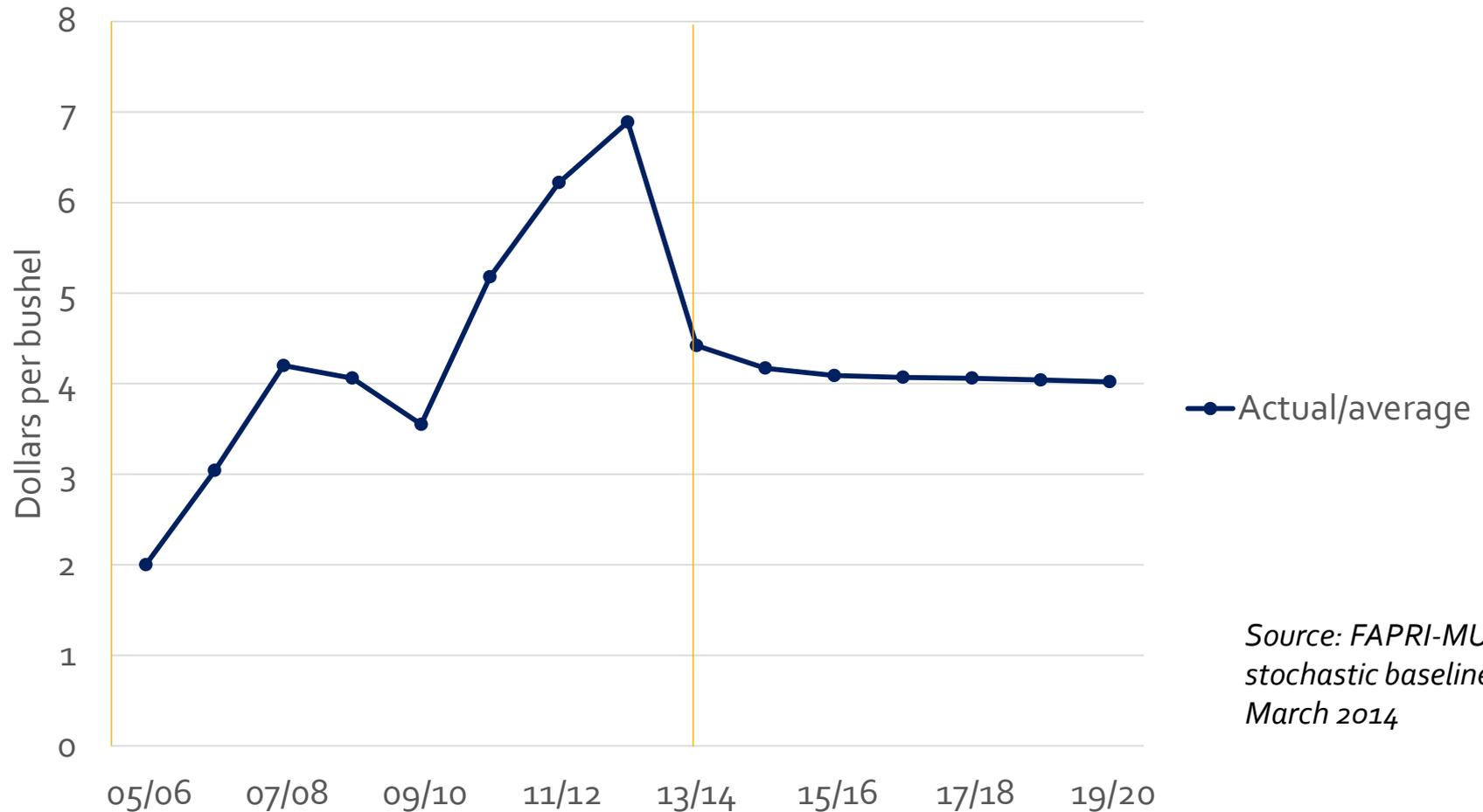- **Iterative process with frequent industry feedback**

The stochastic model

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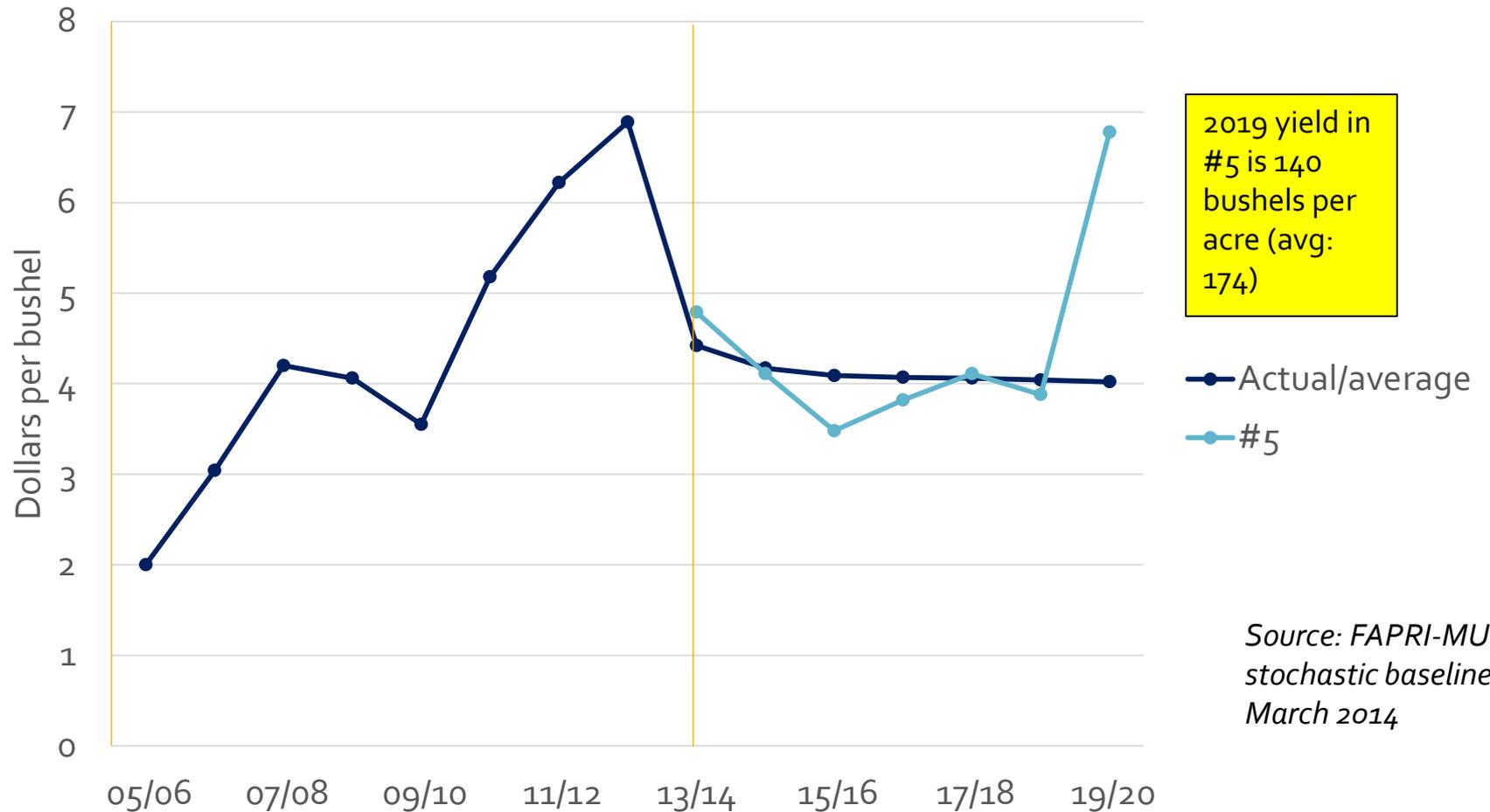- Does not include all sources of uncertainty

The outlook

- "U.S. Baseline Briefing Book,"
  www.fapri.missouri.edu

- 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
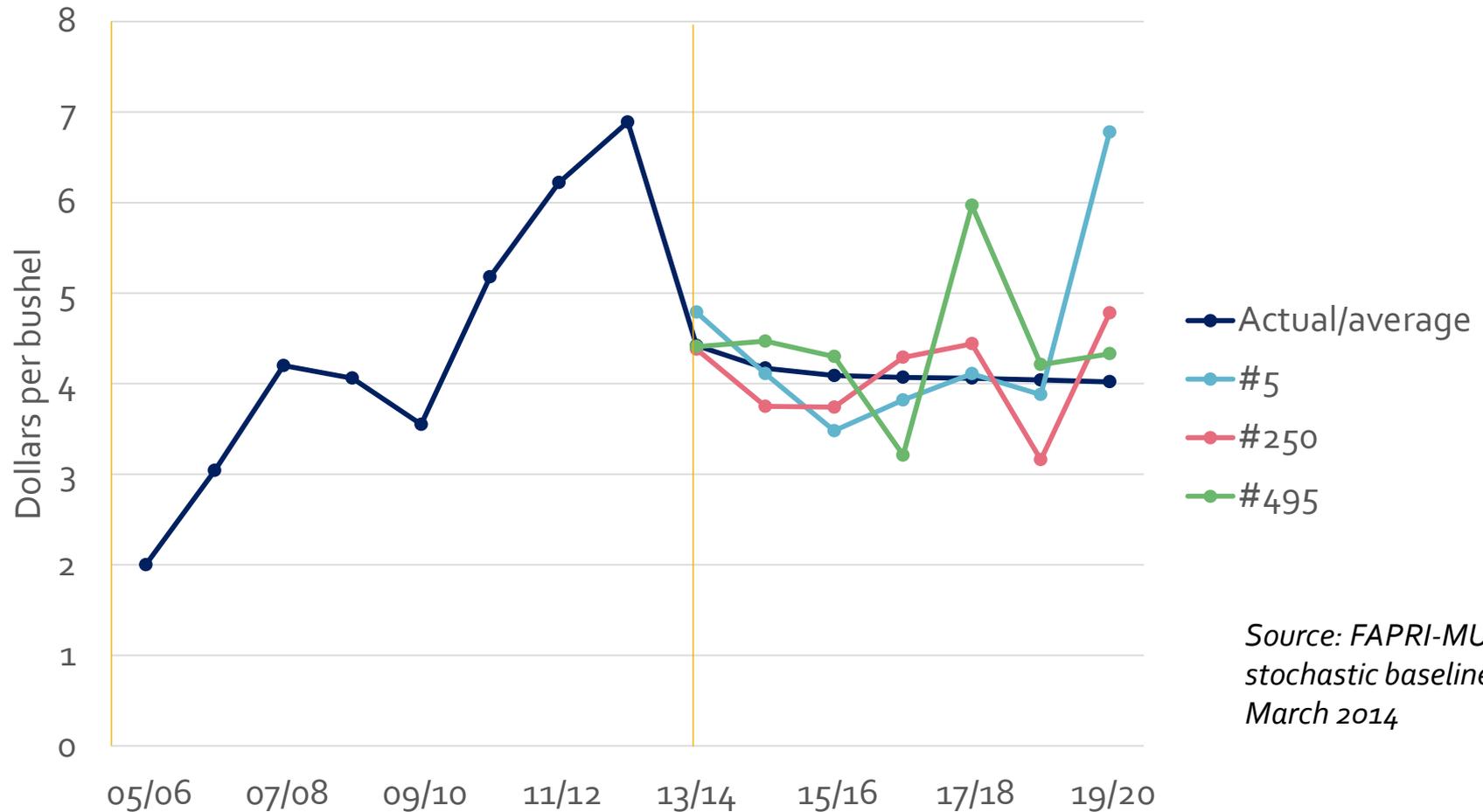
U.S. farm prices for corn

Source: FAPRI-MU stochastic baseline, March 2014

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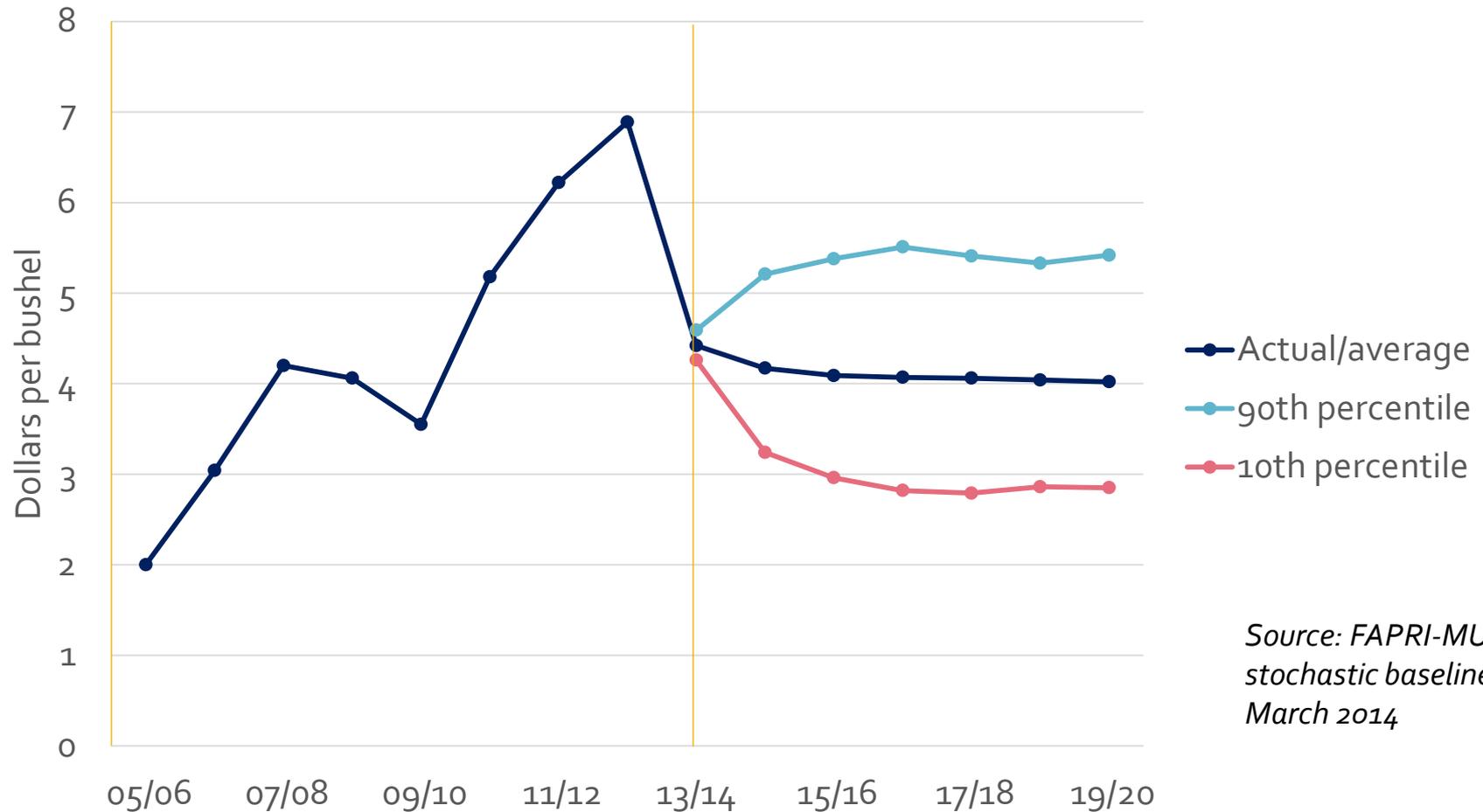Policy Research Institute
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U.S. farm prices for corn

2019 yield in #5 is 140 bushels per acre (avg: 174)

Actual/average

#5

Source: FAPRI-MU stochastic baseline, March 2014

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U.S. farm prices for corn

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U.S. farm prices for corn

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Other models

- 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

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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
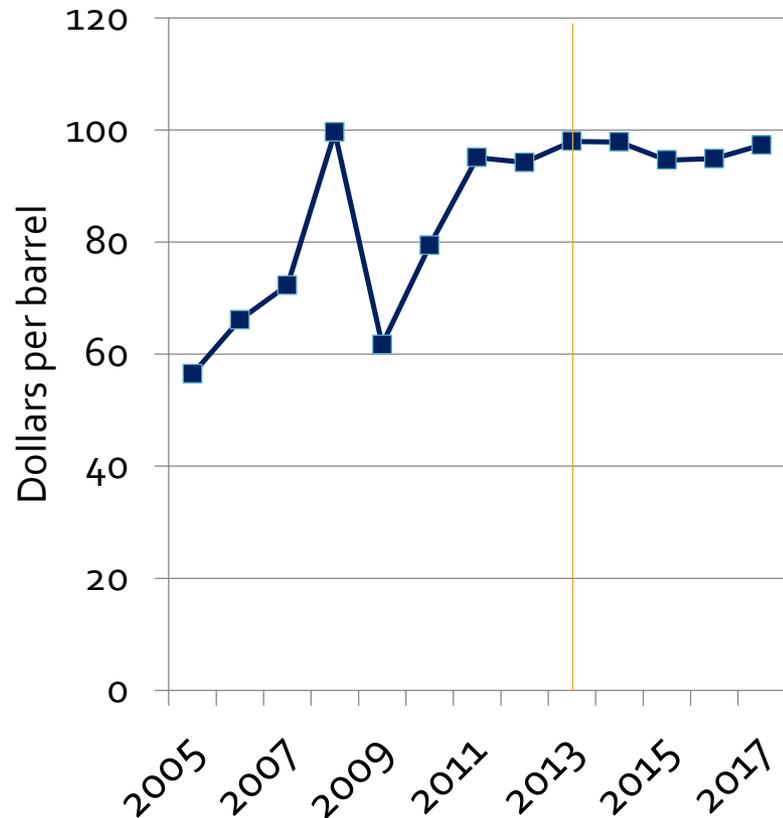 - Biofuels policy is endogenous

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
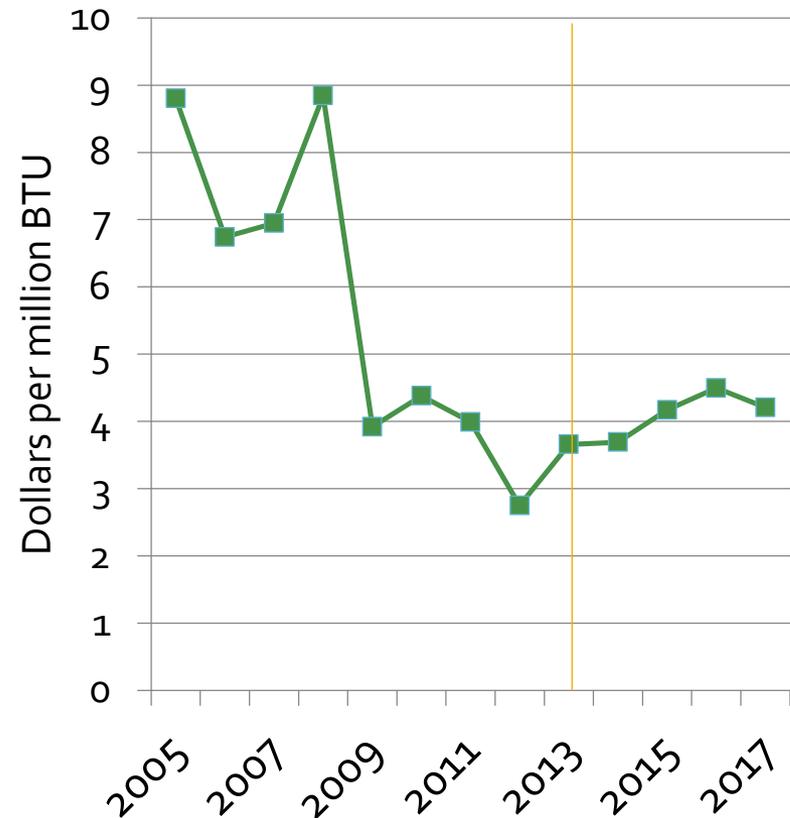- Macro from IHS Global Insight

Energy prices

W. Texas intermediate oil

Dollars per barrel

2005 2007 2009 2011 2013 2015 2017

Source: IHS Global Insight, Jan. 2014

Henry Hub natural gas

Dollars per million BTU

2005 2007 2009 2011 2013 2015 2017

Source: IHS Global Insight, Jan. 2014

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Modeling a "new" industry

- 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

Renewable Fuel Standard mandates biofuel use
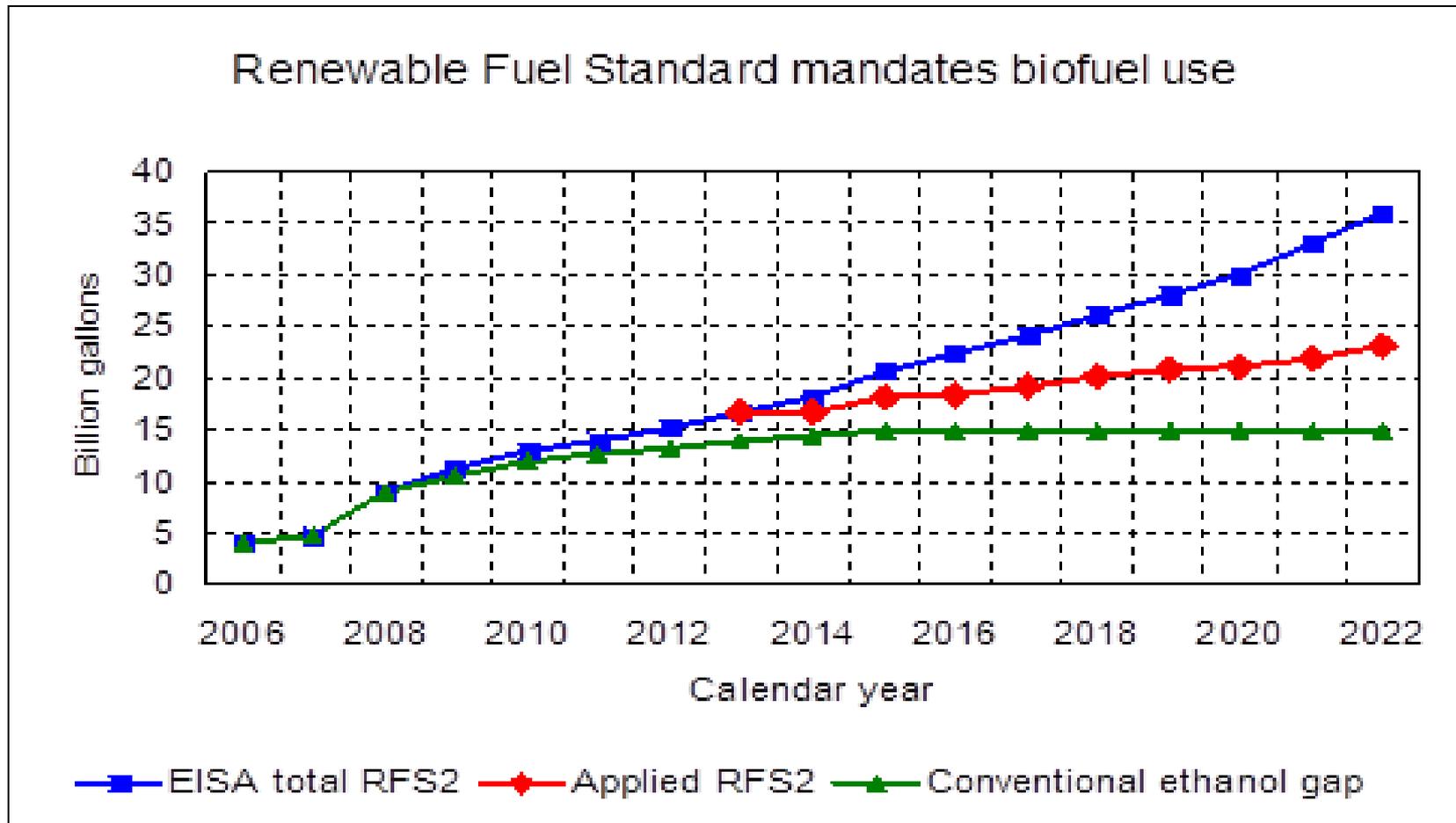
Source: "U.S. Baseline Briefing Book," March 2013, page 3

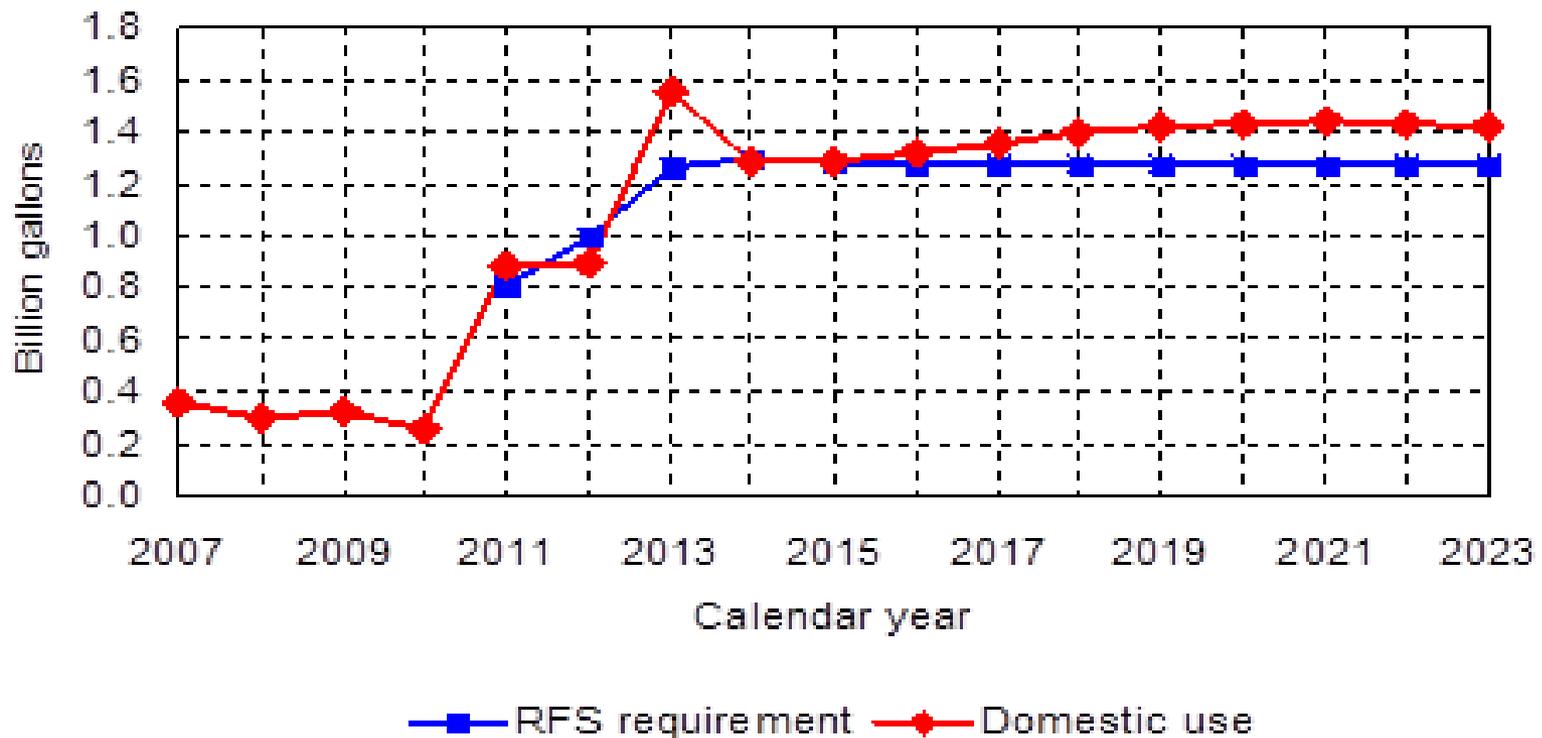# Renewable Fuel Standard – current assumption
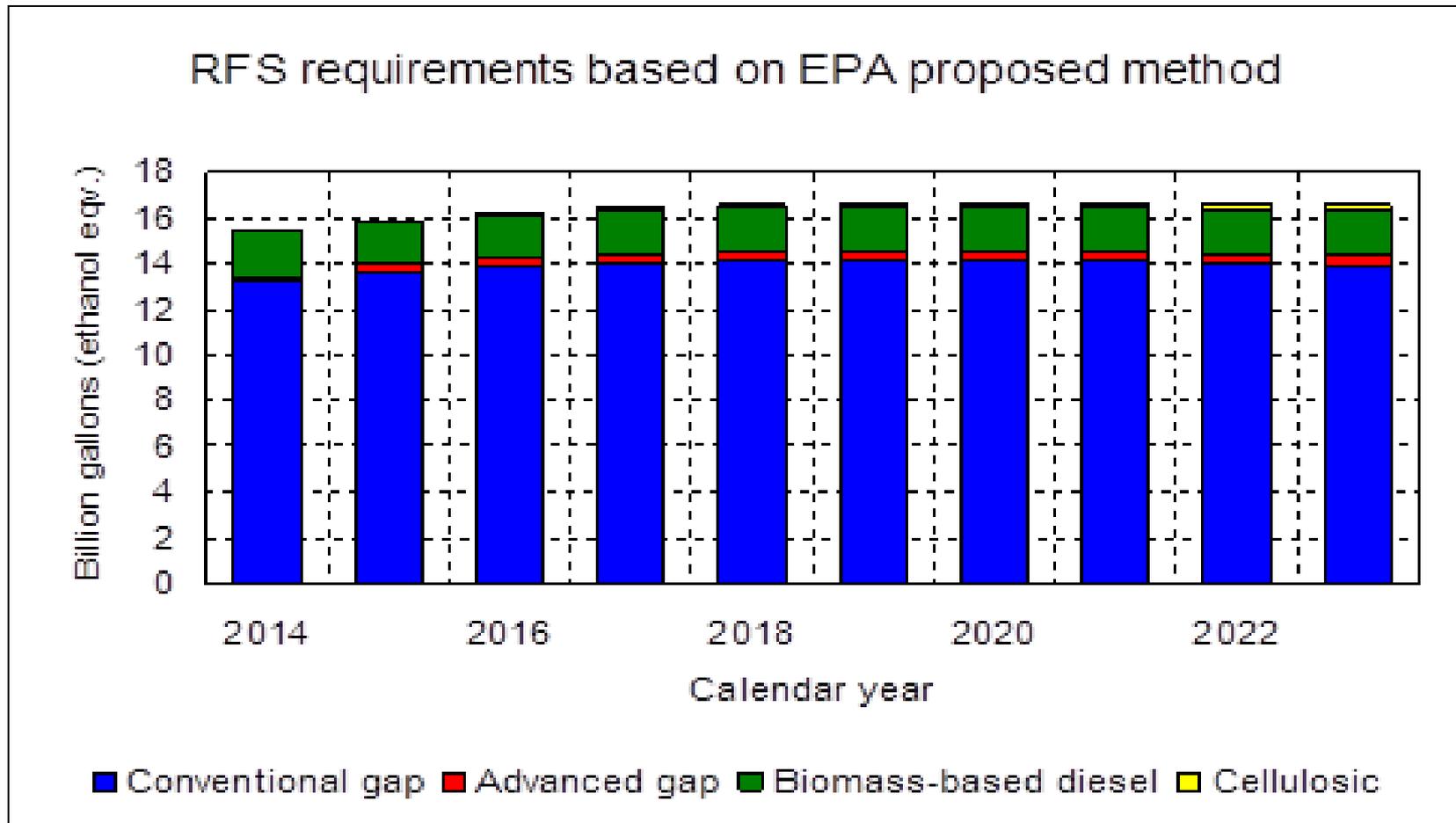
Source: "U.S. Baseline Briefing Book," March 2014, page 35

Rins

- 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

Biomass-based diesel use exceeds RFS mandate

Source: "U.S. Baseline Briefing Book," March 2014, page 37

Fuel domestic use - baseline

|	2013	2014	2023
		(million gallons)	
Gasoline	135,025	133,571	127,219
Ethanol - total	13,230	13,541	14,353
- 10% blends	13,054	13,088	12,028
- 10-15% blends	3	48	790
- Higher blends	172	405	1535
Biodiesel	1,552	1,286	1,424

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
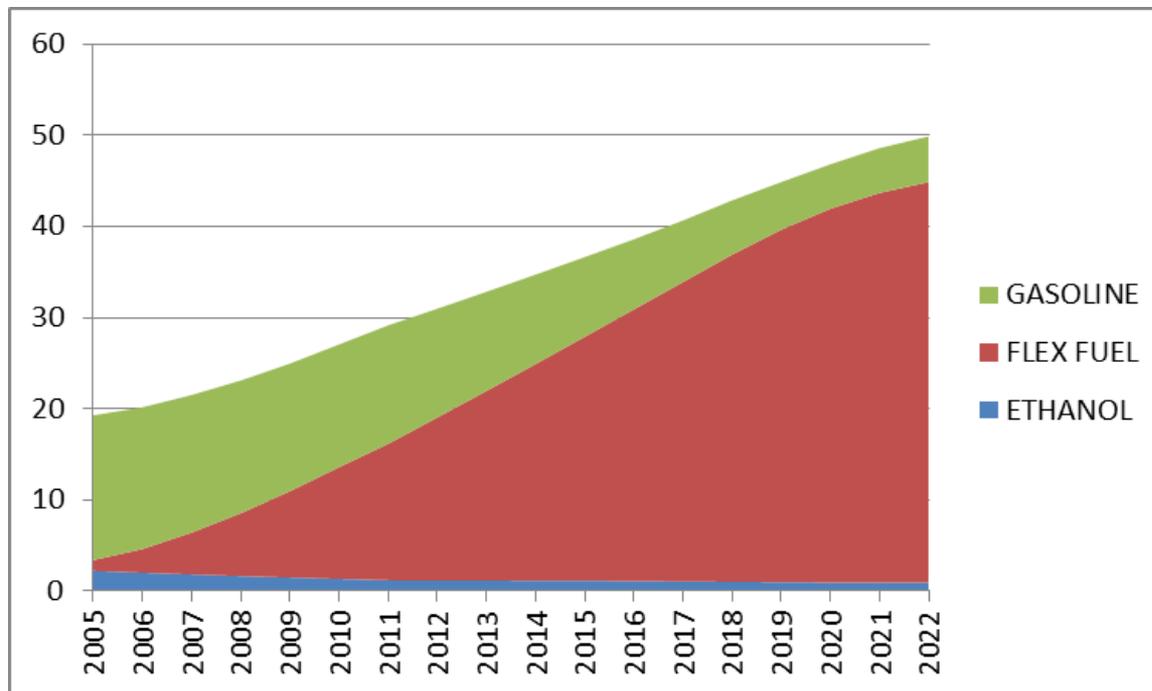- Used to try and track policies, RTFO, TGAP

EU biodiesel sector
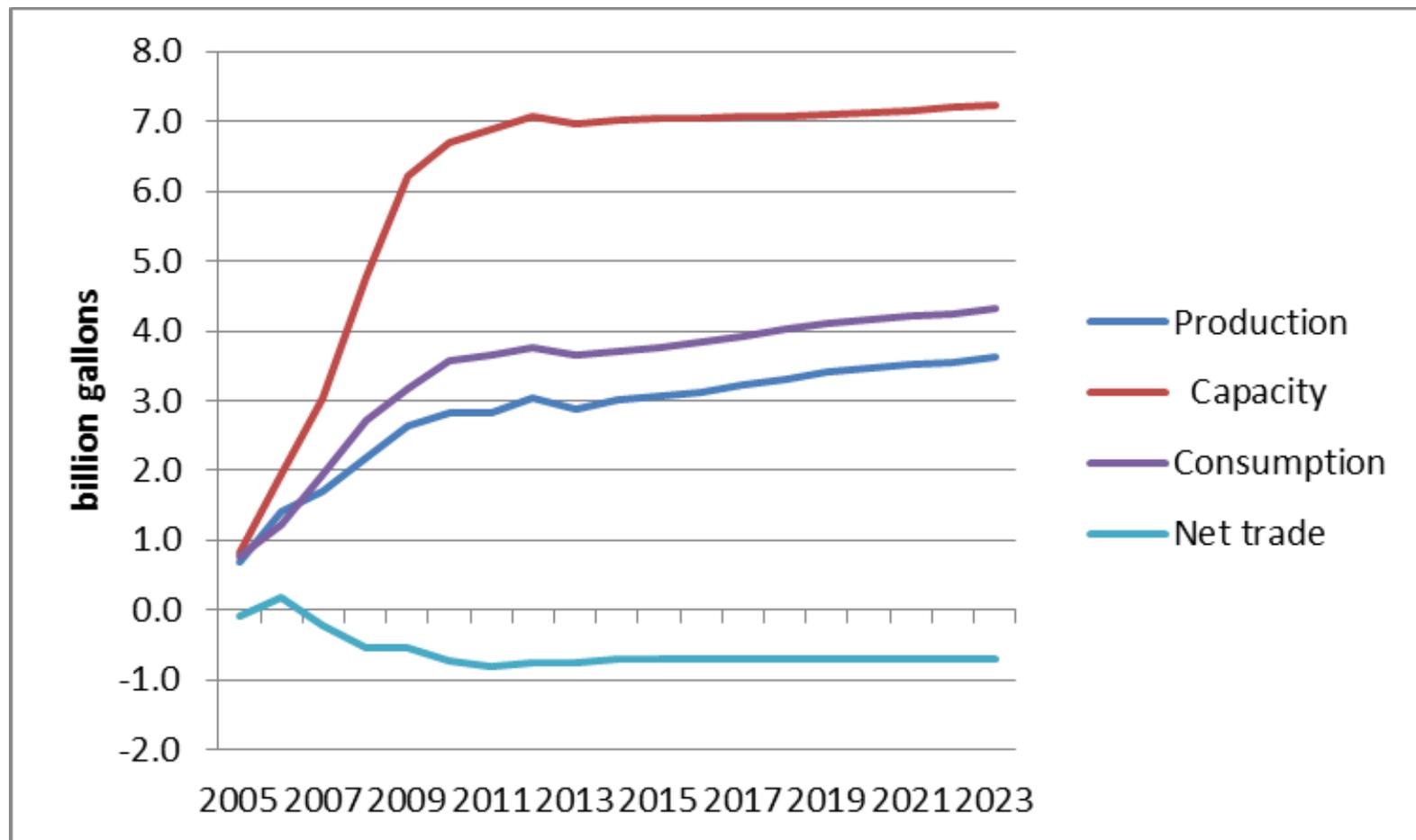
EU ethanol sector
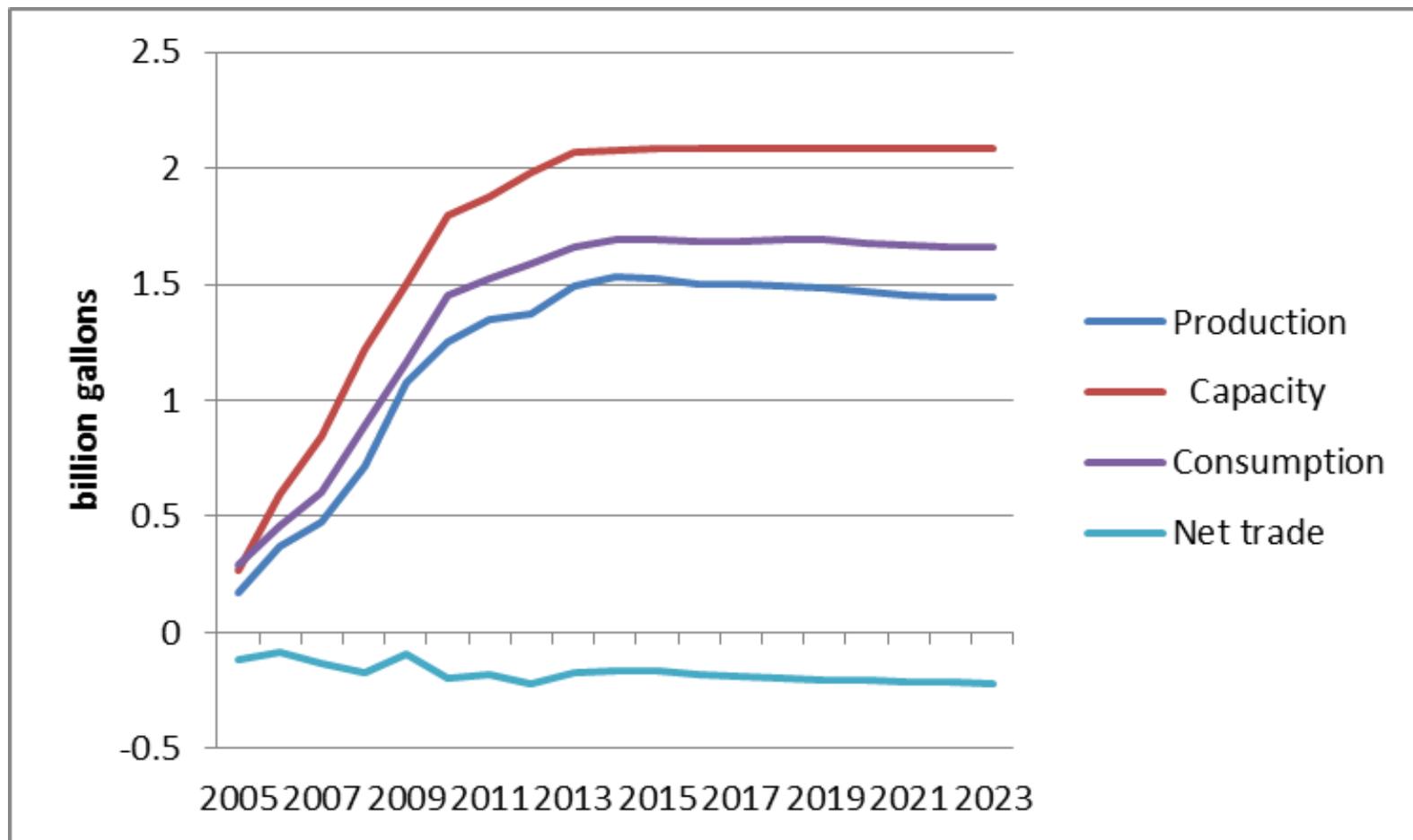
Brazil

- Closely linked to the sugar industry
- Have a mandated level of ethanol use, but also have a large flex fuel fleet
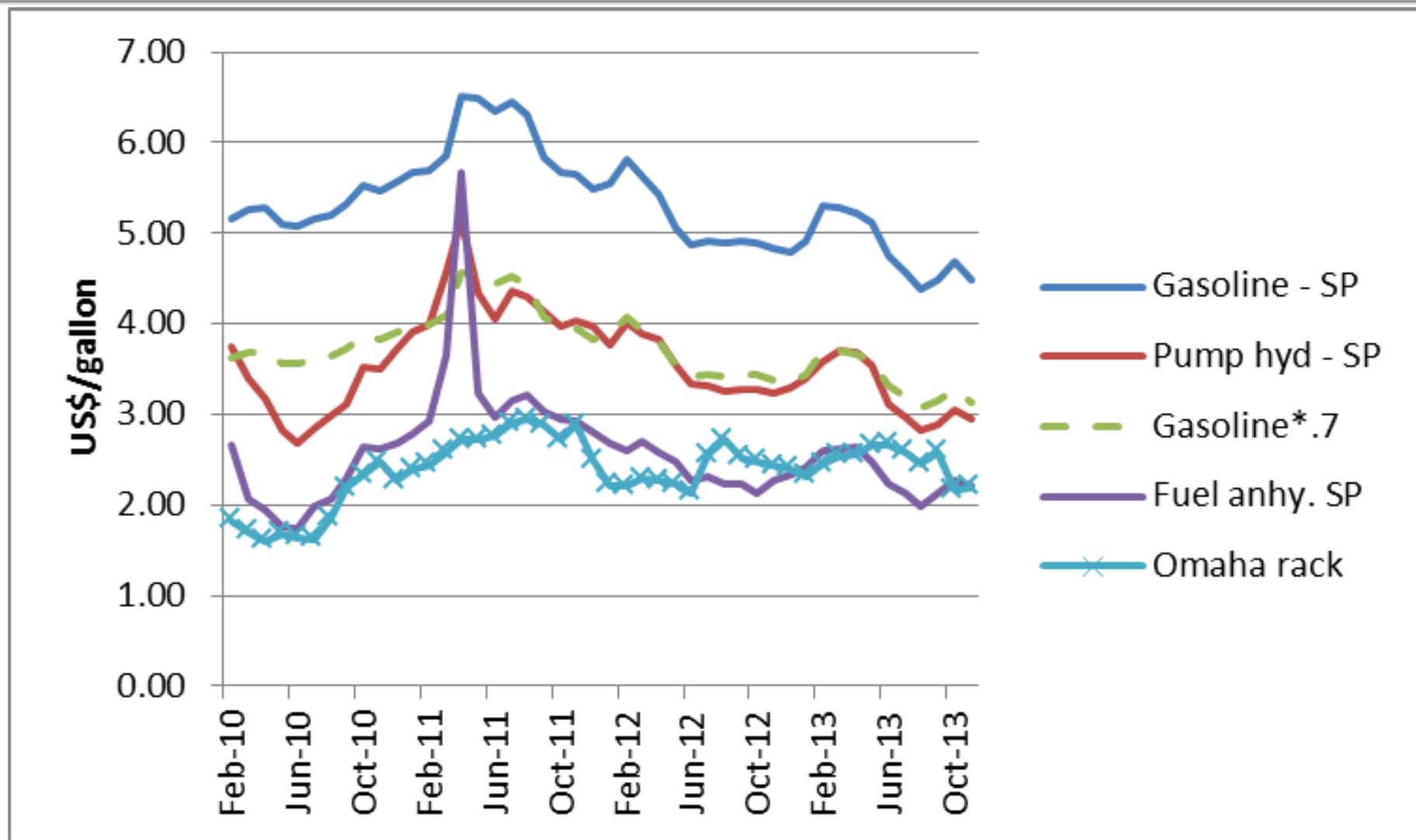
Brazil

- 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
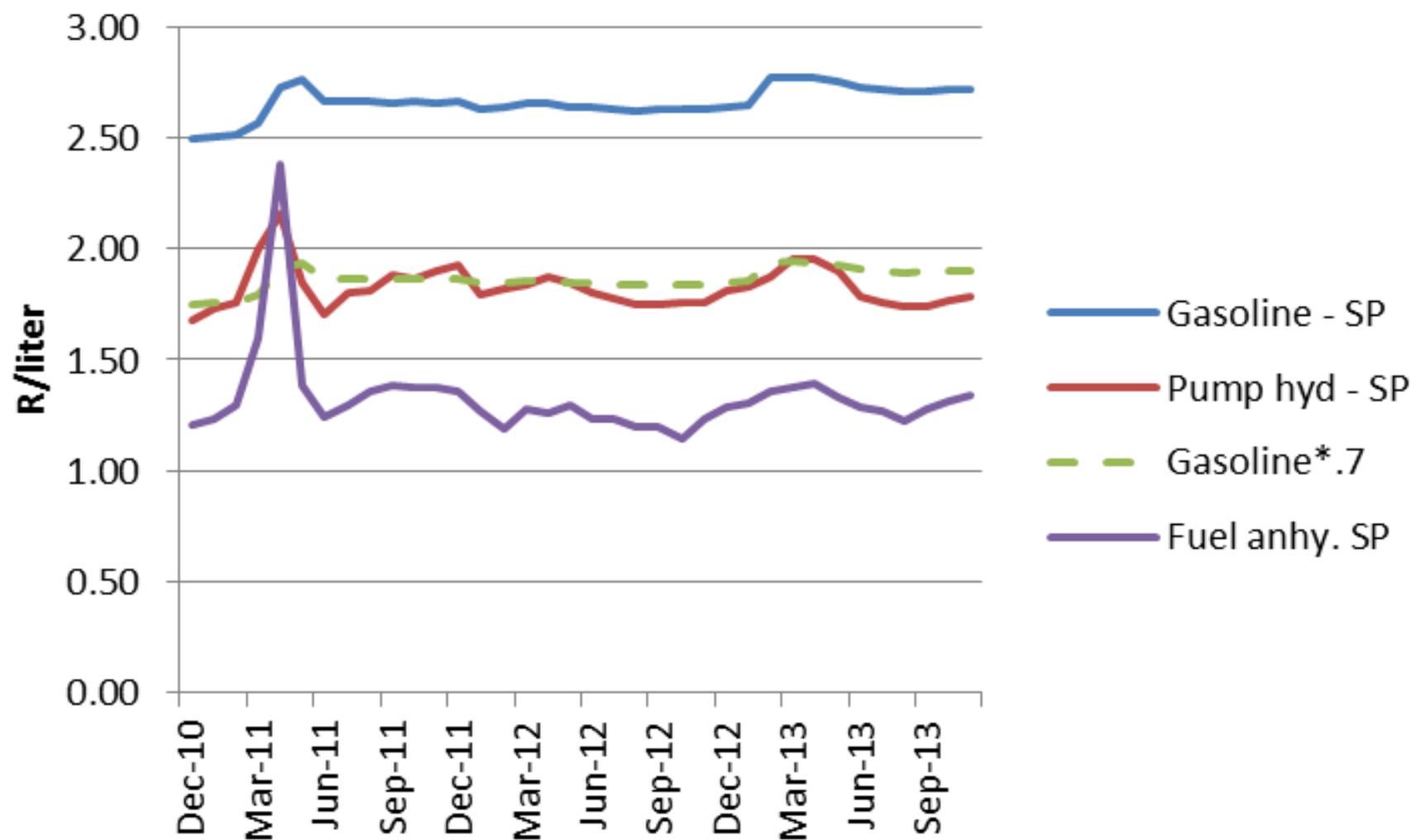
Brazil and US prices in U.S. $

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
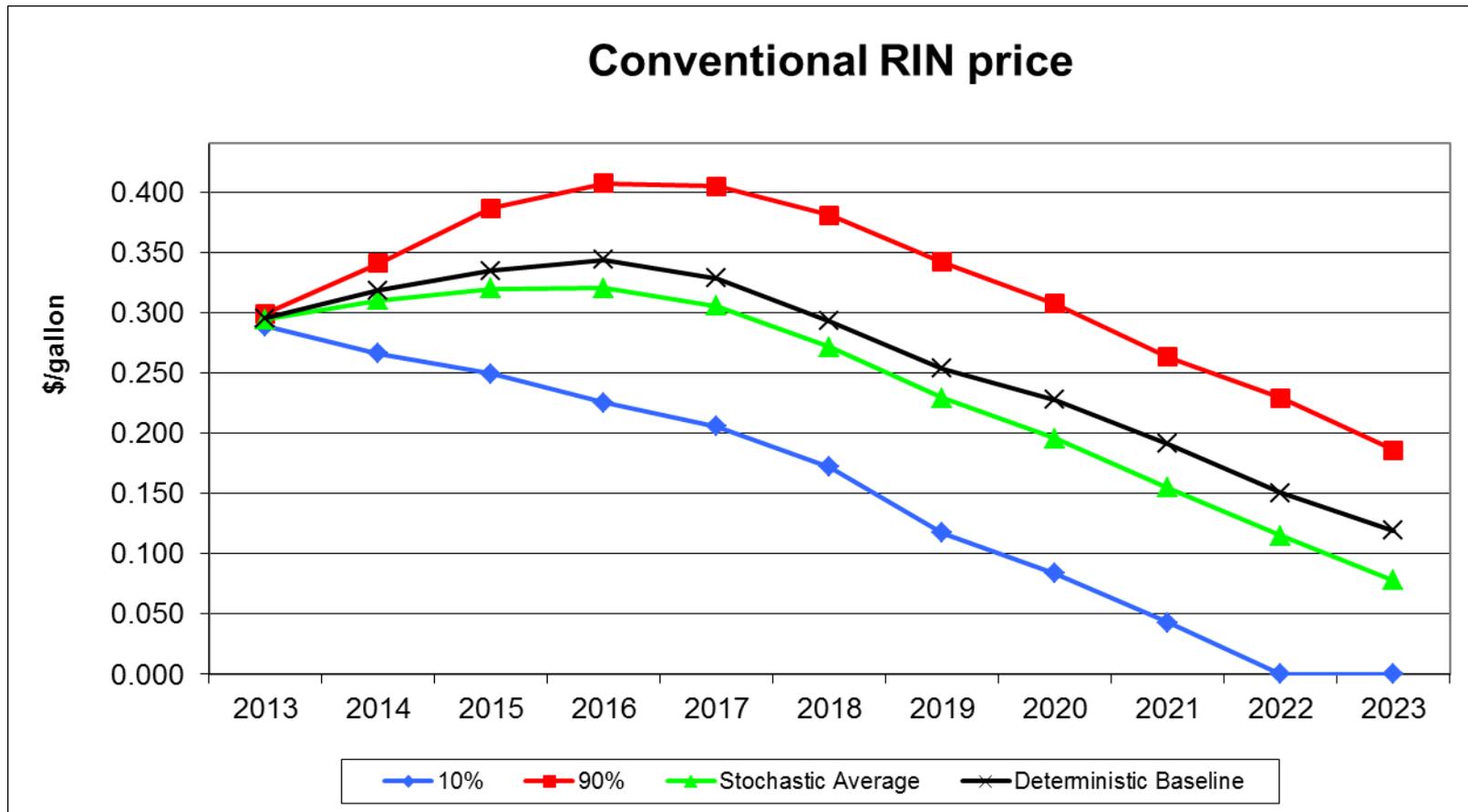
Future path for FAPRI models

- 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

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