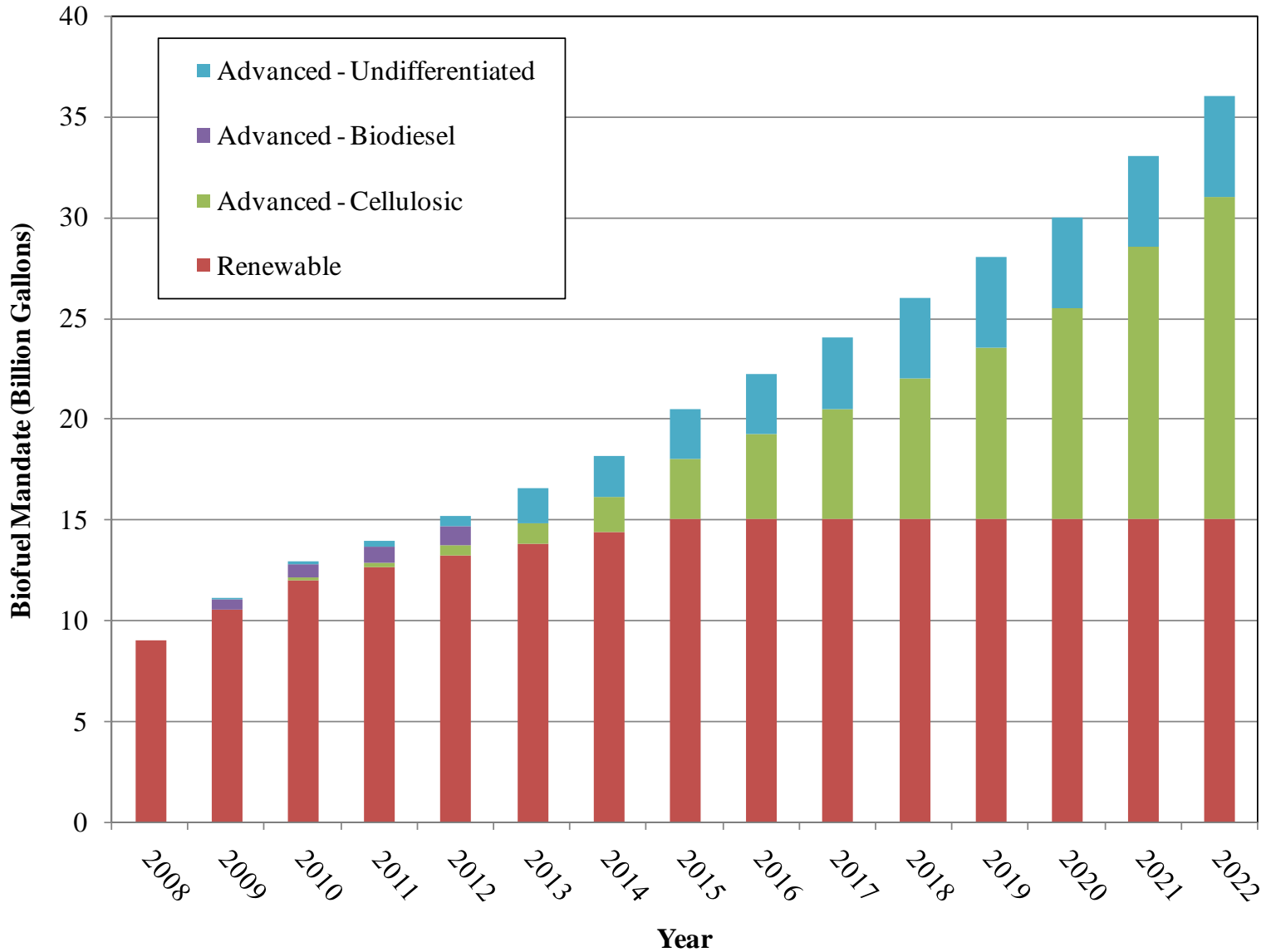


# A Real Option Approach to RINs Pricing

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# Renewable Fuel Standard



# Renewable Fuel Standard

Biofuel Type	Potential Feedstocks	Required Emissions Reductions* (min allowable reduction)
Conventional	Corn starch, sugarcane	20% (10%)
Advanced and Biodiesel	Renewable biomass other than corn starch	50% (40%)
Cellulosic	Cellulose, hemicellulose, or lignin derived from renewable biomass	60% (50%)

- Conventional mandate caps out at 15 billion gallons (More than 5 billion bushels of corn)
- Blend wall – 2022 mandate would represent 25% of total US fuel use, currently capped at 10%

# Renewable Fuel Standard

- Mandates imposed on fuel blenders based on market share
- Overlap
  - Cellulosic can be applied to any sub-mandate
  - Biodiesel can be applied to all but cellulosic
  - Sugar-based ethanol can be applied to advanced or conventional
- EPA can waive overall or sub-mandates
- Rollover – previous year shortfall can be met in following year

# RINs – Market and Trading

- Renewable Identification Numbers
  - Tracking and enforcement system chosen by EPS
  - RIN is produced for every gallon/batch of biofuel produced/imported
  - Blenders must provide at least their mandated level of RINs each year
  - RINs can be “separated” and sold to others by the blender/importer (not by biofuel producers)
- Primarily OTC trades
  - Electronic exchange now established (RINXCHANGE)

# RINs – Market and Trading

- Speculation
  - Must register with EPA to purchase
- Timing
  - RINs have vintages (current and previous)
  - Prior year (previous RINs) can be applied to up to 20% of current year's mandate
- RIN types and equivalence values
  - Cellulosic, conventional, and biodiesel RINs
  - Biodiesel = 1.5 conventional (higher energy content)

# Previous Work – RINs

- Conceptual overviews
  - Thompson, Meyers, and Westhoff (2009)
  - Wisner (2009)
  - OPIS white paper (2009)
- Modeling: FAPRI
  - Assume cellulosic mandate waiver
  - Estimated data

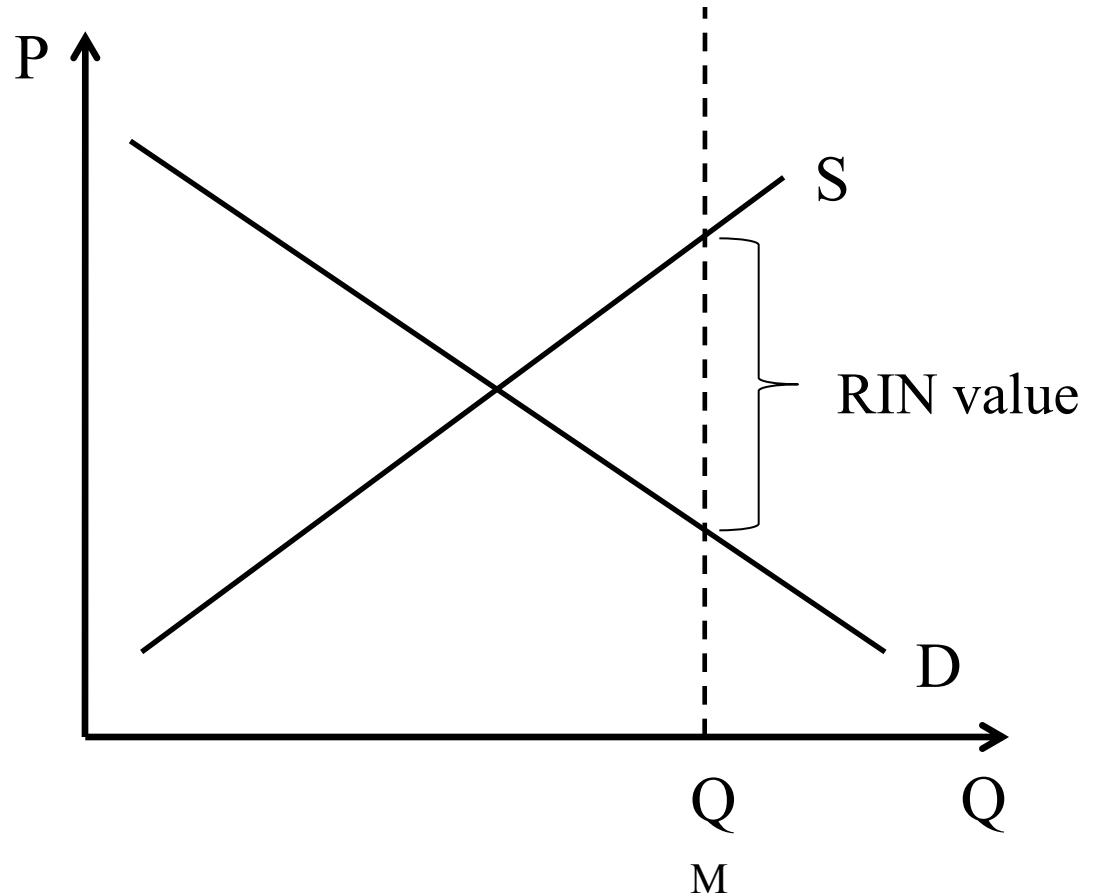
- Babcock (2009, 2010)
  - Mandates
  - Tax credit
  - RINs
  - Import tariffs
- Irwin and Good (2010)
  - Result of mandate + short crop?
    - Waiver, rationing, build reserves
    - Impact on livestock industries



# RINs Modeling

- Factors

- Blending margins
- Transactions costs
- Expectations
- Vintage
- Type



# Real Option Facing Blenders

- Blend a gallon of biofuel today, or wait until tomorrow

Subject to:

- (1) Total blending  $\geq$  Mandate
- (2) Capacity constraints

# Real Option w/ RINs

- Blend a gallon of biofuel today, or wait until tomorrow

Subject to:

(1\*) Total blending (RINs) + RINs Purchases  $\geq$   
Mandate

(2\*) Capacity constraints

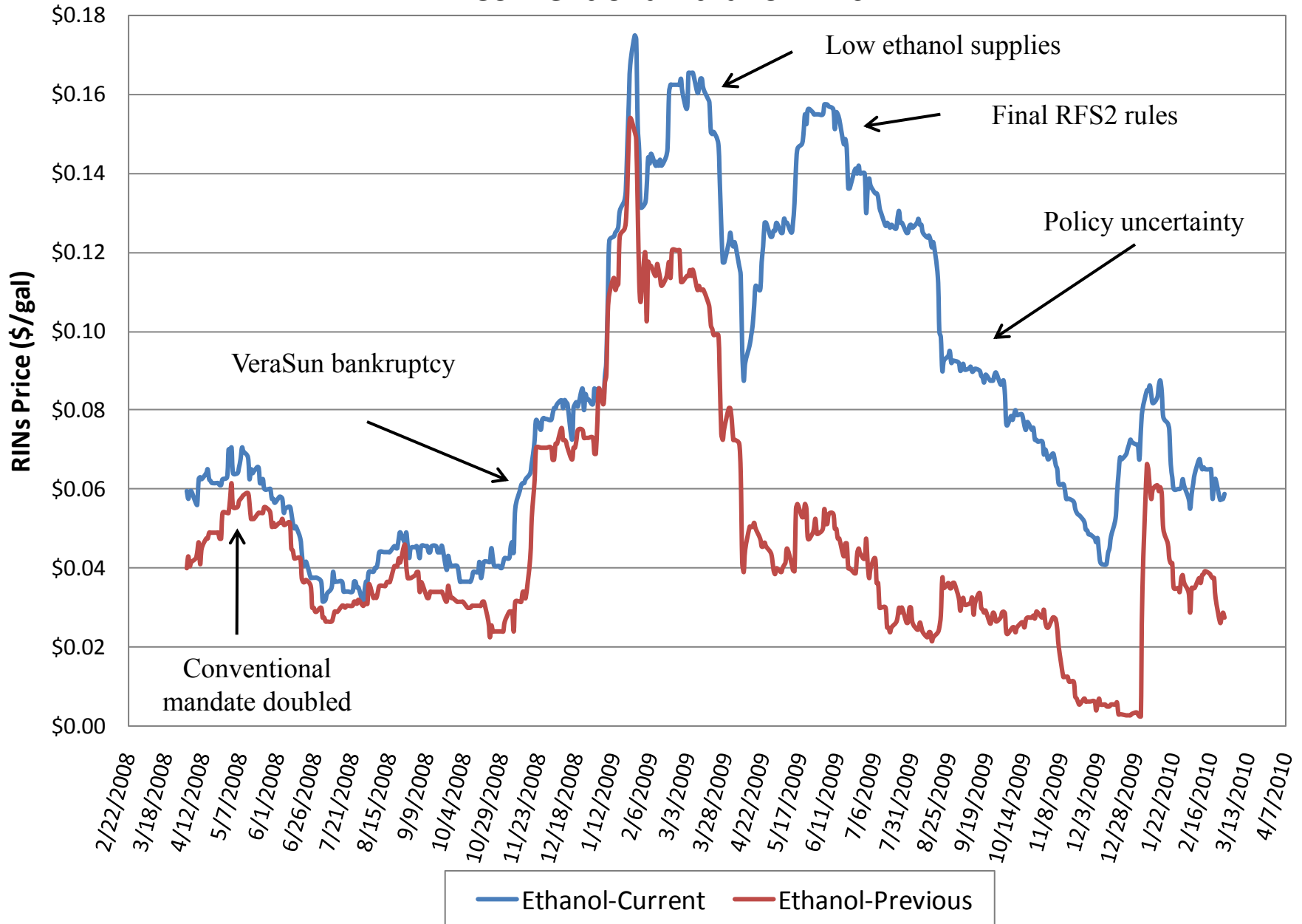
Introduction of RINs relaxes both constraints

Blenders better off in the absence of RINs transactions costs

# RINs Data

- Collected from Oil Price Information Service (OPIS)
- RIN prices reported daily since April 2008
- Based on national survey of blenders and brokers

### Conventional Ethanol RINs



# Valuing RINs

- (Somewhat) Objective
  - Blending margins
  - Production margins
- Subjective expectations
  - Policy uncertainty
    - Mandates waived, redefined
    - Import tariff/taxes
  - Assumed to be captured by gas and ethanol futures markets

# Modeling Approach

- Monte Carlo simulation
  - Lognormal gas and ethanol prices
  - Futures settlement prices
    - CME ethanol and RBOB Gasoline
  - Implied volatilities from ATM options
  - Historical correlation structure
    - 0.8 to 0.9 for gas/ethanol

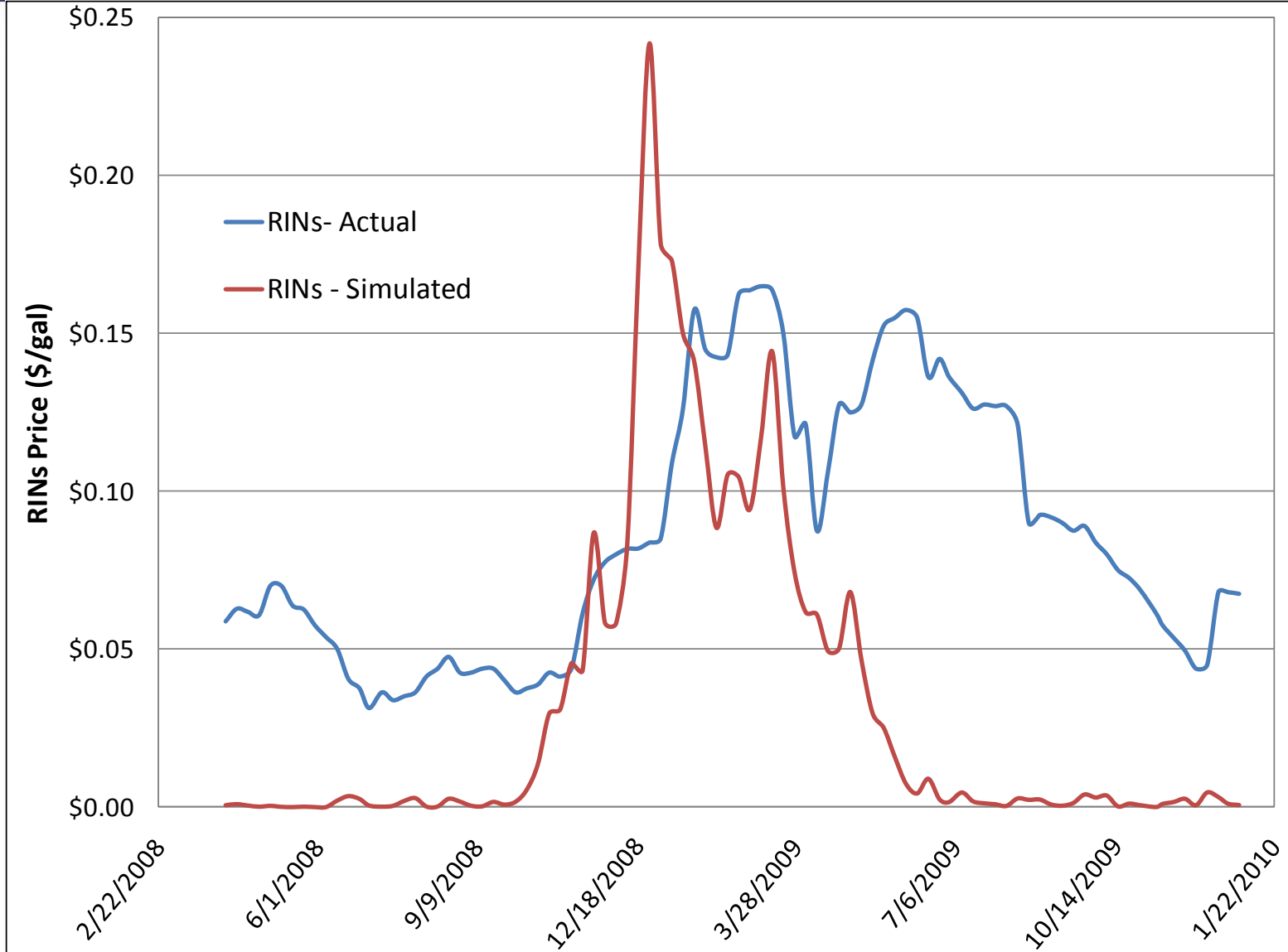
$$RIN_t = E_t \left[ \max \left( 0, Ethanol_t - TC_t - Gasoline_t \right) \right]$$

# Modeling Approach

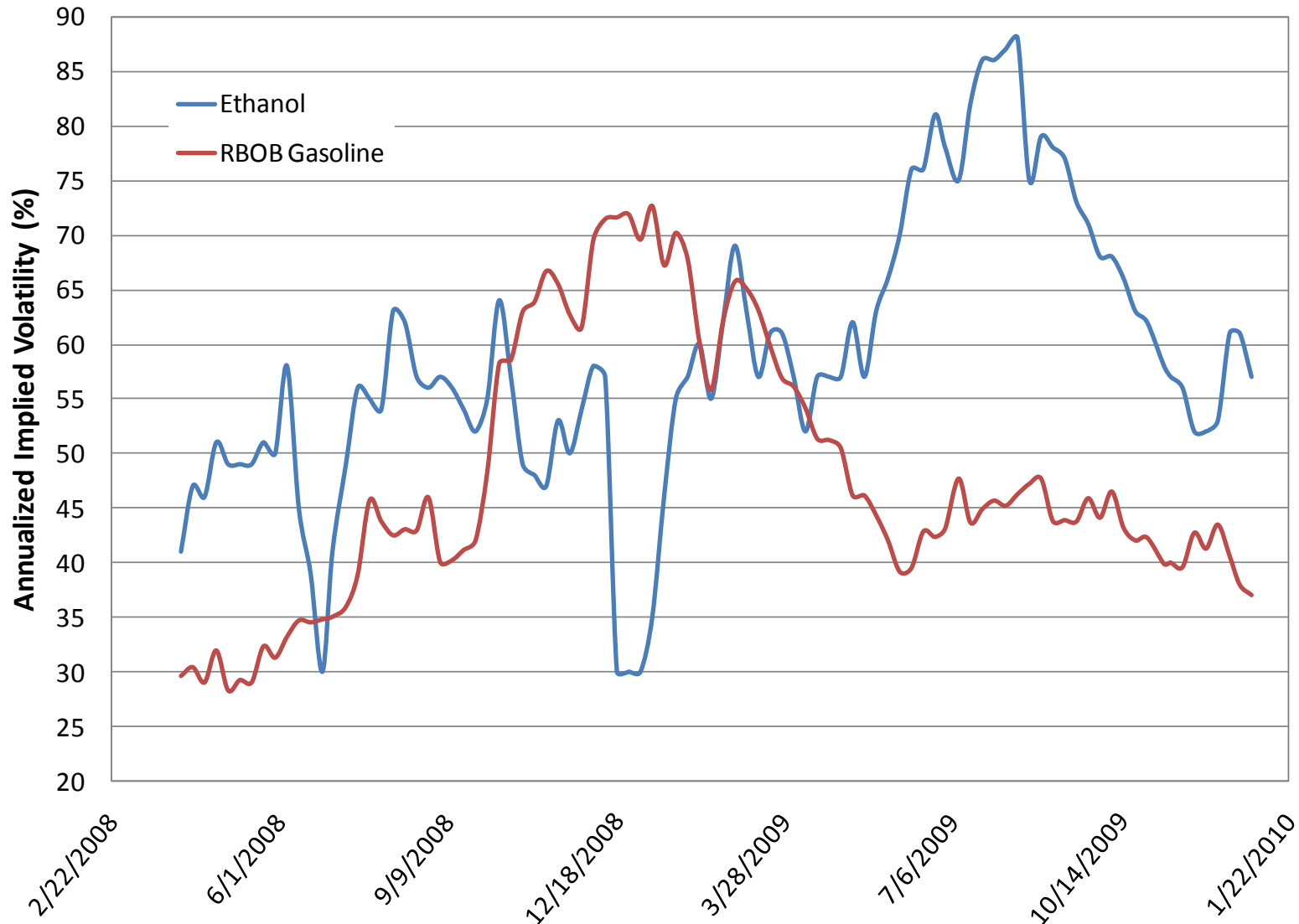
- What future time period(s) are relevant?
  - 6 months out
- Ethanol implied volatilities (new, zero volume options market)
  - (1) Assume equal to gasoline
  - (2) Use RINs to estimate



# Simulated RINs



# Estimated Implied Volatilities



# Conclusions

- Assuming equal volatilities for ethanol and gasoline may not be appropriate
- RINs may allow for estimation of implied volatilities for ethanol
- Future work
  - Cellulosic and biodiesel RINs
    - Short(er) histories, strange relationships
  - Other factors
    - Dynamics: rollover of mandates & RIN use
    - Blending economics