Pathways for Fulfilling the RFS Mandate

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Structure

- Motivation
- Data and Assumptions
- Empirical Results
- Conclusions
Biofuels Forecasts and RFS

- RFS Corn
- RFS advanced
- EPA Corn
- EPA Other
- EIA Corn
- EIA Other
What explains the difference with EPA?

EPA notes that “E85 needs to be priced competitively with (if not lower than) conventional gasoline based on its reduced energy content, increased time spent at the pump, and limited availability.”
What explains the difference with EIA?

- EIA suggests “the rate of technology development and market penetration of cellulosic biofuel will be insufficient to meet the RFS targets.”
Effect of Subsidy

Price vs. Quantity

Supply
Demand + Subsidy
Demand

\[ \text{Price} \]
\[ \text{Quantity} \]

\[ P^* \]
\[ P_{\text{mkt}} \]
\[ Q_{\text{mkt}} \]
\[ Q^* \]
The blend wall puts a maximum on $Q$ demanded.

$P^*$

$P_{mkt}$

$P_{bw}$

$Q_{bw}$

$Q_{mkt}$

$Q^*$

$P$
In contrast, the RFS sets a minimum $Q$ for demand.
Problem and Our Goal

• The growing RFS requires more biofuels each year out to 2022

• A physical blend wall prevents the growth of E10 consumption beyond present levels

• We examine alternative pathways to reach the RFS biofuel targets and consider the implications of each pathway
Pathways considered

- Scenarios 1 and 2 - Ethanol as biofuel and blend limit stays at **10% (E10)**, or rises to **15% (E15)**
- Scenarios 3 and 4 - All cellulosic biofuel is thermochemically produced bio-gasoline or equivalent and blend limit stays at **10% (E10)**, or rises to **15% (E15)**
- Scenarios 5 and 6 - Cellulosic technology is so expensive that EPA waives the cellulosic part of the RFS and blend limit stays at **10% (E10)**, or rises to **15% (E15)**
Data

- EIA annual forecasts from 2010 to 2022 for the transportation energy consumption of:
  - gasoline blend for (BTU_{E85}),
  - gasoline blend for (BTU_{E10}),
  - energy content for ethanol (BTU_{Eth})

or,

\[ BTU_{E85} + BTU_{E10} = BTU_{Transport} = BTU_{eth} + BTU_{Gas} \]
Step 1 - Two sets of relationships must hold:

1. Blends for different fuels
   - $\text{BTU}_{E85} = \text{Ethanol}_{E85} + \text{Gas}_{E85}$ (74% ethanol)
   - $\text{BTU}_{E10} = \text{Ethanol}_{E10} + \text{Gas}_{E10}$ (9.5% ethanol)

2. RFS increases total energy from ethanol
   - $\text{BTU}_{\text{Ethanol}} = \text{Ethanol}_{E85} + \text{Ethanol}_{E10}$
   - $\text{BTU}_{\text{Gas}} = \text{Gas}_{E85} + \text{Gas}_{E10}$
Step 2 – blending and RFS

• If the RFS is greater than the EIA forecast for ethanol usage, the additional ethanol needed to meet the mandate is first allocated to E10.

• Once the blend wall is reached, additional ethanol to meet RFS can only come from E85.
  • E85 is a substitute for E10.

• Effect is to lower the blend wall further.
Step 3 – FFVS and stations

- In 2010, 8 million FFVs
  - At peak, annual demand is around 350 gallons per FFV
  - Adjust EIA stock of FFVs to keep E85 usage rate under 50%
  - Cost $100 per vehicle

In 2010, 2,100 of 162,000 gas stations have E85 pumps
- Use EPA low, mid, and high E85 adoption
- Number of pumps tracks E85 usage
- Cost of $154,000 per station
Number of FFVs, by Scenario

M FFVs

Year

EIA

E10

E15
Scenarios 1 and 2

- With E10/E85
  - Need 97 million FFVs by 2022 (EIA would have 39 M)
  - 28,300 stations with E85 pumps
  - NPV cost of $5.7 billion

- With E15/E85, hit the blend wall in 2016
  - Need 72 million FFVs by 2022
  - 28,300 stations with E85 pumps
  - NPV cost of $4.3 billion
Number of FFVs, by Scenario

M FFVs

Year

EIA
E10
E15
E15 therm
Scenarios 3 and 4

• With E10/E85/thermo,
  • Need 39 million FFVs by 2022
  • 24,300 stations with E85 pumps
  • NPV cost of $3.1 billion
  • But need investment in thermochemical plants

• With E15/E85/thermo,
  • Need 8 million FFVs by 2022
  • 6,100 stations with E85 pumps
  • NPV cost of $1.5 billion
Scenarios 5/6 mirror scenarios 3/4

- With waivers, numbers are the same as Scenarios 3 and 4
- Avoid investment cost in thermochemical plants
- However, do not achieve the policy goals of EISA of 2007
Conclusions

• Given the blend wall, the only way to meet RFS is widespread adoption of E85 (plus flex fuel vehicles, E85 stations, and associated infrastructure)

• Raising the blend level from E10 to E15 buys time to invest in infrastructure and lowers reliance on E85

• Thermochemical biofuels offset investment costs in E85 vehicles and infrastructure