Returns over operating costs for a corn ethanol plant

US cents per liter
US Ethanol Production

Down 1.8% in 2012


million gallons
US Gasoline Consumption Has Declined Substantially More than Fuel Consumption

Finished Motor Gasoline

Gasoline

Billion Gallons

2002 2003 2004 2005 2006 2007 2008 2009 2010 2011

Billion Gallons

Finished Motor Gasoline

Gasoline

2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Value Offered by Ethanol

• Source of energy to drive autos
  – Ethanol has 2/3rds the energy as gasoline

• Source of octane
  – Ethanol is a high octane (rating = 110) fuel

• Source of oxygenate
  – Allows fuel to burn more completely, thereby reducing emissions
Willingness to Pay for Ethanol

• Source of energy?
  – 70% of the price of gasoline

• Source of octane?
  – Toulene costs $4.00 per gallon
  – Production of toulene is 4 billion liters versus 50 billion liters of ethanol
Willingness to Pay for Ethanol

- Ethanol is a high octane fuel (octane = 110)
- 90% blend of 84.4 octane gasoline plus 10% ethanol = “regular” US gasoline (87 octane)
Cap on Corn Ethanol, Floor on Conventional Biofuels
Willingness to Pay for Corn by Ethanol Plants

- **Price of corn in 2006**: $100 per ton
- **WTP for corn at ethanol’s energy value**: $200 per ton
- **Energy value of ethanol at today’s crude oil prices**: $200 per ton
- **$100 per ton arbitrage profit**

Graph elements:
- Vertical axis: $ per ton
- Horizontal axis: US Cents per liter

Legend:
- Red line: Price of corn in 2006
- Green line: WTP for corn at ethanol’s energy value
- Blue line: Energy value of ethanol at today’s crude oil prices
Impacts of Drought on Corn Supplies

• Expected 2012 Production
  – 360 million tons

• USDA August 10th Projections
  – 275 million tons of corn (down 24%)
The Problem

• US corn use was 317 million tons in 2011
  – 127 million for ethanol
  – 117 million for feed
  – 40 million for exports
  – 36 million for food and seed

• With total supplies of 285 million tons and 2011 use of 317, U.S. is “short” 32 million tons of corn
Price Movement

$ per bushel

7/21/2010 to 7/21/2012
Some elasticity arithmetic

- Supply contracted by about 25%
- Price increased by about 50%
- Implied total demand elasticity = -0.5

- But price likely would have fallen in the summer without a drought
  - Price elasticity lower than -0.5 because demand for ethanol is likely quite price inelastic
US Mandate Has Not Been Binding Until Perhaps This Year

Mandated Consumption US Ethanol Consumption
Mandated versus Actual Consumption of Ethanol

- Actual Consumption
- Mandated Consumption

Jan-2009: 0.060
Apr-2009: 0.065
Jul-2009: 0.070
Oct-2009: 0.075
Jan-2010: 0.080
Apr-2010: 0.085
Jul-2010: 0.090
Oct-2010: 0.095
Jan-2011: 0.100
Apr-2011: 0.105
Jul-2011: 0.110
Oct-2011: 0.115
Jan-2012: 0.120
Apr-2012: 0.125
Jul-2012: 0.130
Current Situation

• Two U.S. governors at the behest of livestock industries have asked for a mandate waiver

• U.S. will be short of feed.

• Will waiver reduce ethanol consumption?
What is Demand Elasticity for Ethanol?

• Is ethanol a close substitute for gasoline?
  – In Brazil, yes if FFVs are using ethanol
  – In US, yes if ethanol is being used for its energy value as a fuel

• Or is ethanol a complement to gasoline?
  – Yes if Brazilian FFVS are running on gasoline and there is a 20% blend mandate
  – Yes if refineries are configured to need octane to produce 87 octane gasoline
  – Yes if oil companies are mandated to use ethanol
Will Refineries Switch from Ethanol?

- If switching costs are greater than the cost of using ethanol, refineries will not switch.
- If waiver lasts 12 months, refineries will need to switch back in the fall of 2013.
- If price of ethanol < price of gasoline, no benefit from switching.
- Some price of ethanol above price of gasoline will result in a benefit to switching.
Switching Costs

• Fuel attributes regulated by EPA
• Different methods of meeting fuel standards, but costs of switching from one method to another are significant.

• Difficult for a non-insider to estimate
Price of gasoline

Price of ethanol where switching makes sense

Quantity at 10% Blend

$2.90/gal = $320/ton = $8.60 futures

$3.40/gal = $380/ton = $10.00 futures
Observations

• Importance of reality of short-run inelasticities often overlooked by market-oriented economists
• Degree of long-run flexibility underestimated by industry-following economists
• Prediction:
  – Some low-cost, reversible flexibilities will be found by refineries if a waiver is granted so prices will not increase to $10.00
  – But price of corn is too low now to induce switching. Price will have to rise
Lessons Learned

• Thought that corn use for ethanol could be turned off if supplies are short was misguided.
  – High price of crude oil combined with short-run inflexibilities limit the ability to switch from corn to crude
• Idea of a flexible mandate makes no sense if crude is high and switching costs are important
• Better to be like Brazil and to be in the elastic portion of ethanol demand
• US is not ready to embrace biofuels to the extent that demand will be elastic