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The RFS, Fuel and Food Prices, and the Need for Statutory Flexibility

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Executive Summary

Current U.S. biofuels policy contains escalating corn-based ethanol blending requirements (the Renewable Fuel Standard - or RFS) that do not automatically adjust to energy and corn market realities. That same policy contains cellulosic ethanol requirements that do not reflect the fact that the biofuels industry, despite decades of effort and large subsidies, has failed to develop a commercially viable process for converting cellulosic biomass to ethanol.

Corn-based ethanol blending requirements have pushed corn prices, and thus ethanol production costs, so high that the market for ethanol blends higher than 10 percent is essentially non-existent. That same policy has also destabilized corn and ethanol prices by offering an almost risk-free demand volume guarantee to the corn-based ethanol industry. Domestic and export corn users other than ethanol producers have been forced to bear a disproportionate share of market and price risk.

Increases in ethanol production since 2007 have made little, or no, contribution to U.S. energy supplies, or dependence on foreign crude oil. Rather, those increases have pushed gasoline supplies into the export market. Gasoline production and crude oil use have not been reduced. If the RFS is made more flexible, and ethanol production shrinks due to market forces, we can easily replace ethanol with gasoline currently being exported.

This paper will argue that it is time to reform the current RFS. Corn users other than the ethanol industry need assurance of automatic market access in the event of a natural disaster and a sharp reduction in corn production. Ethanol producers should bear the burden of market adjustments, along with domestic food producers and corn export customers. Ethanol prices should reflect the fuel's energy value relative to gasoline, not a corn price that is both inflated and destabilized by the inflexible RFS.

Finally, the RFS schedule should be revised to reflect the ethanol industry's inability to produce commercially viable cellulosic fuels. Policy should reflect reality when that reality does not reflect substantial and undeniable barriers to achieving policy goals.

Key Points

- Current ethanol policy has increased and destabilized corn and related commodity prices to the detriment of both food and fuel producers. Corn price volatility has more than doubled since 2007.
- Following the late 2007 increase in the RFS, food price inflation relative to all other goods and services accelerated sharply to twice its 2005-2007 rate.
- Post-2007 higher rates of food price inflation are associated with sharp increases in corn, soybean and wheat prices.
- On an energy basis, ethanol has never been priced competitively with gasoline.
- Ethanol production costs and prices have ruled out U.S. ethanol use at levels higher than E10. As a result, we exported 1.2 billion gallons of ethanol in 2011.
- Due to its higher energy cost and negative effect on fuel mileage, ethanol adds to the overall cost of motor fuels. In 2011 the higher cost of ethanol energy compared to gasoline added approximately $14.5 billion, or about 10 cents per gallon, to the cost of U.S. gasoline consumption. Ethanol tax credits (since discontinued) added another 4 cents per gallon.
- Using four different measures of gasoline prices and oil refiner margins, from 2000 through 2011, there was no statistically significant effect of increased ethanol production on gasoline prices or oil refiner margins.

  - All four of these statistical models showed a weak, statistically insignificant, positive association between increased ethanol production and gasoline prices and oil refiner margins.
  - Factors that do account for gasoline prices and refining margins include: crude oil prices, crude oil inventories, gasoline inventories, net gasoline exports (exports minus imports), seasonality, and supply disruptions caused by hurricane Katrina, refinery outages, and methyl tertiary butyl ether (MTBE) gasoline additive withdrawal.
  - A similar model from Iowa State University found a negative effect of increased ethanol production on refiner margins. That model used flawed methodology. Projected 2011 effects are unrealistic.
- In the U.S., the January 2007, through February 2012, increase in ethanol production had no effect on: 1) gasoline production; 2) crude oil imports; 3) crude oil consumption; or 3) refinery utilization.
- From January 2007, through February 2012, increased ethanol production displaced gasoline in the U.S. fuel supply, but did not cause reduced gasoline production. The displaced gasoline was exported. Gasoline consumption declined by more than the ethanol displacement, further boosting gasoline exports. In effect, the 2007 to 2011 increase in ethanol production has been exported.
- Declining U.S. oil imports are being caused by increased U.S. crude oil production, and higher refinery yields, not increased ethanol production.
- Adoption of market-based adjustments to the RFS would not affect U.S. fuel supplies, but tend to reduce the volatility and level of corn prices to the benefit of both food and fuel producers.
- Given the realities of cellulosic biofuels, the RFS schedule should be amended to reflect the lack of technological progress in this area, and potential risks to the environment.

Ethanol Prices and Production Costs

Supporters of current ethanol policy have claimed that ethanol is saving American motorists money. That claim is partially based on the fact that ethanol typically sells for less per gallon than gasoline. The problem with that claim is that engines do not run on gallons, they run on energy. On an energy basis gasoline and ethanol are very different fuels.

Earlier in the modern history of ethanol use in motor fuels its main purpose was for a combination of octane enhancement and as a fuel oxygenator. In more recent times, with the dramatic increase in ethanol production, those limited markets have become saturated. To go beyond use as an additive, and compete with gasoline as a fuel, ethanol must be priced competitively based on its energy content. This section will show that ethanol continues to be priced at a premium that prevents its widespread use beyond the universally authorized E10 (90% gasoline, 10% ethanol) blend level. The fact that substantial amounts of ethanol were exported in 2011 when the E10 market became saturated supports that fact.

Ethanol's value as a fuel is established by its energy content relative to competing fuels. Despite its higher octane rating, gallon of ethanol has only 67 percent of the net energy of a gallon of gasoline[1]. As a result, in current gasoline engine technology, fuel mileage per gallon declines as ethanol content increases. Fuel mileage per BTU is approximately equal between gasoline and ethanol. This fact was born out in a tightly controlled test performed by Oak Ridge National Laboratory and the National Renewable Energy Laboratory[2]. To quote from that study (page 3-1):

[1] Ethanol contains 76,100 BTUs per gallon compared to 114,100 for 87 octane gasoline.
[2] National Renewable Energy Laboratory. "Effects of Intermediate Ethanol Blends on Legacy Vehicles and Small Non-Road Engines, Report 1 – Updated." NREL/TP-540-43543. February 2009.

"The following trends from E0 to E20 were found to be statistically significant. Fuel economy decreased (7.7% on average), consistent with the energy density reduction associated with ethanol blending (in limited tests, this trend was observed to continue to E30)."

Ethanol must sell at a significant discount to gasoline to achieve equal fuel cost per mile. If ethanol blends higher than 10 percent are not competitively priced, the result will be failure of those fuels to achieve significant sales. That has been the fate of E85. According to recent Department of Energy statistics, ethanol blends of more than 55 percent account for only 2,000 barrels per week out of total gasoline production of about 8.7 million barrels per week. Ethanol blends under 55 percent, almost entirely E10, account for about 95 percent of U.S. gasoline production[3]. There is little, or no, room for E10 to grow further, and E85 cannot grow due to its high cost. E15 will likely suffer a similar fate.

The Nebraska Energy Office publishes monthly averages of 87 octane unleaded gasoline and ethanol prices at Omaha fuel terminal rack locations[4]. These averages represent ethanol prices near the center of U.S. ethanol production. They are among the lowest ethanol and gasoline prices in the country. This comparison is thought to be representative of relative prices across much of the United States.

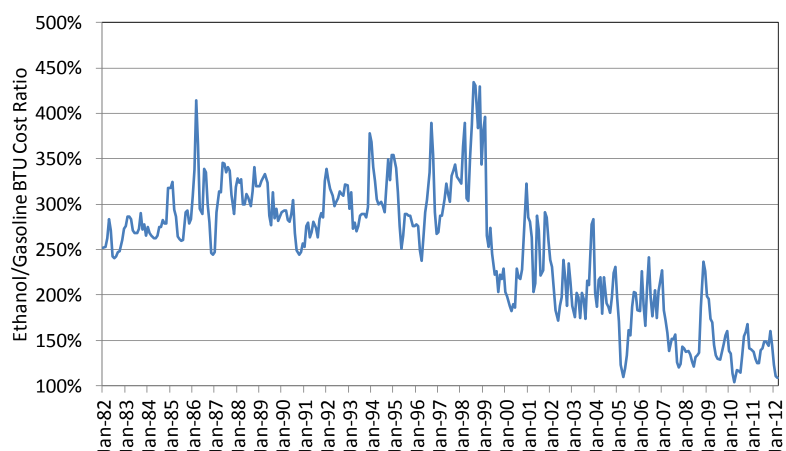
From January 1982, until March 2012, ethanol has never been priced at energy parity with 87 octane unleaded gasoline. The relative ethanol price has declined since 2000 as the octane and oxygenator markets have become saturated. However, since the current RFS was adopted in late 2007, ethanol energy has remained at a 44 percent average premium to gasoline at Omaha blending locations.

Key Point:

Ethanol is an expensive fuel. Compared to 87 octane unleaded gasoline at Omaha, Nebraska fuel terminals the cost of ethanol per gallon of gasoline energy has been higher than gasoline every month since 1982. Higher relative values prior to 2007 reflect an ethanol octane enhancement and oxygenator value premium. Recent declines in the ratio reflect a spike in wholesale gasoline prices.

Ethanol Price as Percent of 87 Octane Gasoline Energy

Omaha, Nebraska, January 1982 to March 2012



In 2011, the United States exported 1.2 billion gallons of ethanol. A major reason was that ethanol's energy is more expensive than gasoline, and thus E85 cannot be priced competitively in the U.S. market.

Another way to look at the ethanol price premium compared to gasoline is ethanol's price difference per gallon of gasoline energy. As the next chart shows, the energy-equivalent per gallon price difference has declined only slightly since the 1980s. Since the current RFS was enacted in late 2007, the average price

[3] Department of Energy. Weekly Refiner & Blender Net Production, 4 Week Average. Found at http://www.eia.gov/dnav/pet/pet_pnp_wprodrb_dcu_nus_w.htm. Accessed 5/10/2012.
[4] Nebraska Energy Office. Ethanol and Unleaded Gasoline Average Rack Prices. Found at http://www.neo.ne.gov/statshtml/66.html, Accessed 5/7/2012.

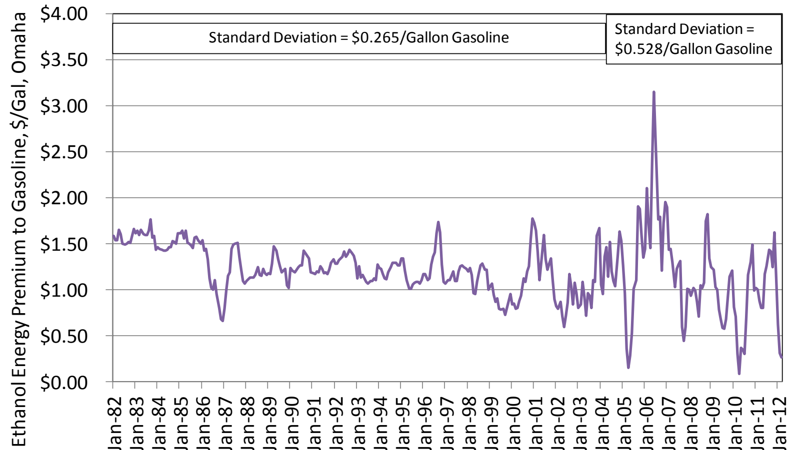
difference was $0.95 per gallon premium for ethanol energy versus gasoline energy. From January, 1982 until December 2007, the average was a $1.25 per gallon premium for ethanol energy. Again, ethanol energy has not been priced competitively with gasoline since 1982.

Not only has the ethanol energy price premium remained at high levels, the volatility of the premium has doubled. The standard deviation of the ethanol energy premium was $0.265 per gallon from 1982 to mid-2005, when the first RFS was enacted. Since then the standard deviation was $0.528 per gallon. A recent journal article by Bruce A. Babcock and Lihong Lu McPhaila shows that the RFS is a major cause of this increased volatility for both ethanol and corn prices[5].

Key Point:

Ethanol is an expensive fuel. Since 1982, relative to 87 octane gasoline, ethanol energy has been priced at about a $1.30 higher per gallon of gasoline energy. That premium has declined slightly since 2007, but remains nearly as high on average as it was prior to the current RFS. Since the original 2005 RFS, the volatility of the price premium has doubled.

Ethanol Price Premium/Gallon Gasoline Energy
Omaha, Nebraska, January, 1982 to March, 2012



The impact of this increased volatility on fuel markets is difficult to understate. Gasoline blenders and their retail customers who might want to sell E85 have been discouraged by the state of flux in gasoline versus ethanol pricing. This pricing instability has likely been a detriment to installation of E85 fueling stations and flex-fuel auto purchases. As will be shown later, much of this increased volatility can be traced back to the impact of the inflexible RFS on corn use, corn inventories, and corn prices.

The most significant ethanol production cost is corn. Since the first RFS schedule in 2005, the corn cost in a gallon of ethanol has increased from about 50 percent to more than 80 percent of total ethanol production costs. Corn costs for ethanol producers have also been much more volatile. The increased volatility of corn costs is directly attributable to large increases in mandated corn use for ethanol production, resulting lower corn stocks, and increased corn price volatility.

Increases in corn prices since 2005 are primarily the result of both higher mandates for corn-based ethanol production and higher energy prices. Each played a significant role, and they reinforced each other in their corn price effects. Absent the RFS mandates and higher oil prices, corn prices would be much lower today. How much each of the driving forces affected corn prices and ethanol production is debatable, but there is no doubt that both were important.

[5] Bruce A. Babcock and Lihong Lu McPhaila. Impact of US biofuel policy on US corn and gasoline price variability. Energy. Volume 37, Issue 1. January 2012.

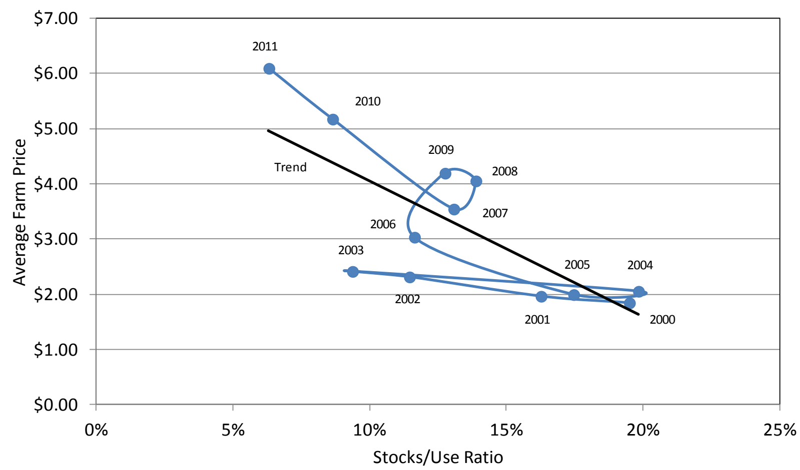
The next chart shows the 2000-2011 crop year average farm level corn prices versus the ratio of ending stocks-to-use. Clearly, as the stocks-to-use ratio declines there is a tendency for corn prices to rise.

Season-Average Corn Price vs. Stocks-to-Use Ratio

(Year is Year of Harvest, Black Line is Trend))

Key Point:

The increased demand for corn that has been partially the result of the inflexible RFS has caused corn stocks to decline to near-record low levels relative to total corn use. Tighter stocks have caused higher corn prices for all users, including ethanol producers.

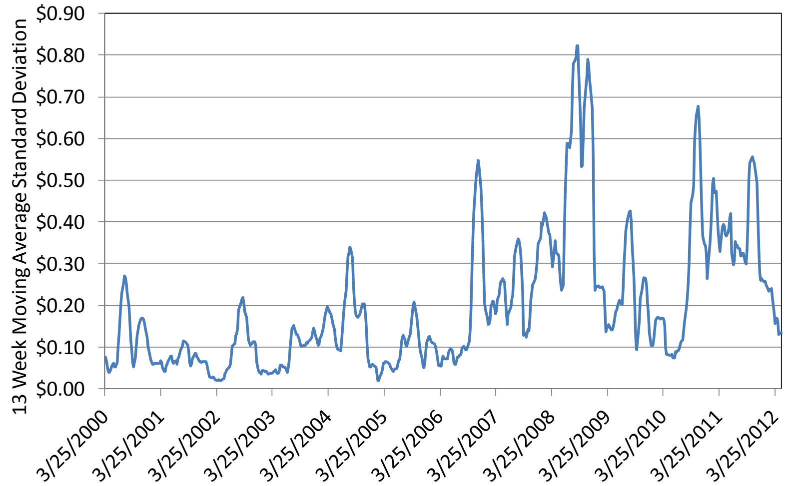


Less obvious than the increase in corn prices has been in the increase in their volatility. The next graph shows the 13 week standard deviation of weekly Central Illinois elevator corn bids. The volatility obviously increases markedly after the 2007 RFS. This higher volatility has increased business risks for all corn users. The result has been the bankruptcy of a number of ethanol companies and food producers.

13 Week Standard Deviation of Central IL Elevator Corn Bids

Key Point:

Tighter stocks shown in the chart above have also caused much higher corn price volatility for all users, including ethanol producers. This higher volatility has substantially increased business risks, resulting in a number of bankruptcies of ethanol and food producers.

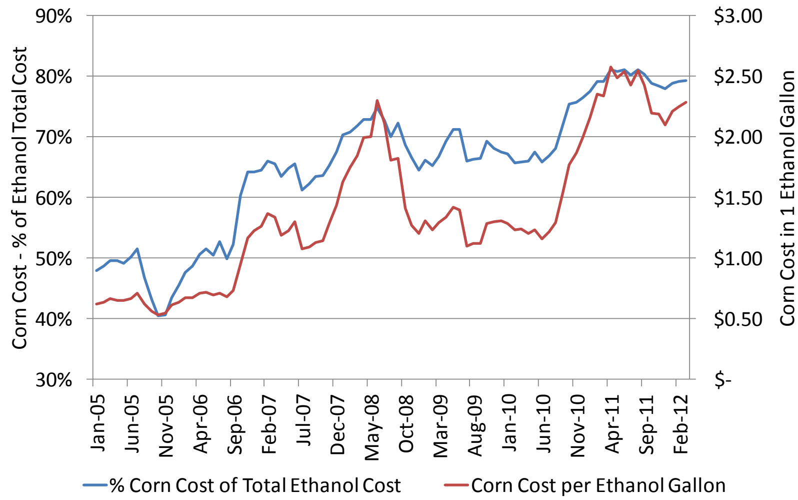


The impact of higher corn prices on ethanol production costs is shown in the following chart. Prior to the RFS, corn accounted for about a $0.60 cost per gallon of ethanol. The corn cost per gallon is now in the $2.00 to $2.50 range. Looking at the cost of just the corn used in ethanol per 100,000 BTUs of fuel energy produced, that cost is currently in the $2.65 to $3.30 range. This is roughly comparable to recent wholesale prices for 87 octane unleaded gasoline. Past costs for the corn used in ethanol have been substantially higher than the recent relationship.

Key Point:

Higher corn prices have increased the cost of ethanol production. Corn now represents about 80 percent of the cost of ethanol versus 40-50 percent prior to the RFS. Higher ethanol prices are acting as a choke point on use of ethanol at blends higher than 10 percent.

Corn Cost Impact on Ethanol Production Cost[6]



Corn Prices and Food Production Costs

Corn is one of the key commodities used in U.S. food production. It enters the food chain via a wide range of products, but meat, poultry and dairy are the major users. Ranked by wholesale value of primary commodities, corn dwarfs the second and third ranking commodities, soybean products and wheat. Distiller's Grains (DGs), an animal feed by-product of ethanol production, are included with corn to arrive at the total value of corn used for U.S. food production.

Top Three U.S. Food Production Commodities, by Value, 2011/2012 Crop Year[7]

Commodity	Units	Domestic Food Production Use	Price	Value/Cost, $ Million
Corn				
Corn as Grain	Bushels	5,955	$6.05	$36,028
DGs from Corn	Tons	33.5	$200	$6,700
Total Corn				$42,728
Soybeans				
Soybean Meal	Tons	30,900	$360	$11,124
Soybean Oil	Million Pounds	14,000	$0.54	$7,490
Total Soybeans				$18,614
Wheat	Bushels	1,110	$7.25	$8,048

Not only is corn important on its own, corn prices also influence wheat, soybeans and other important commodities. As corn prices have risen, so have prices of the other two major commodities. Increases in

[6] Source: Iowa State Ethanol Plant Profitability Model. Found at http://www.extension.iastate.edu/agdm/energy/xls/d1-10ethanolprofitability.xls. Accessed 5/10/2012

[7] USDA. World Agricultural Supply and Demand Estimates. May, 2012. DGs are estimated based on ethanol production and exports.

prices of these three major food production items have driven costs of U.S. food production significantly higher since the first RFS was introduced in 2005.

Cost of Corn, Soybean Products and Wheat Used In U.S. Food Production[8]
Corn Crop Years 2005-2011

Commodity	2005	2006	2007	2008	2009	2010	2011	% Increase 2005-2011
Corn								
Corn as Grain	$12,310	$17,017	$24,940	$21,039	$18,194	$24,828	$36,028	193%
DDGS from Corn	$879	$1,653	$3,069	$2,869	$3,173	$5,982	$6,700	662%
Total Corn	$13,189	$18,671	$28,009	$23,908	$21,366	$30,809	$42,728	224%
Soybeans								
Soybean Meal	$5,782	$7,059	$11,138	$10,181	$9,537	$10,444	$11,124	92%
Soybean Oil	$3,845	$4,947	$7,985	$4,656	$5,081	$7,578	$7,490	95%
Total Soybeans	$9,626	$12,006	$19,123	$14,837	$14,618	$18,022	$18,614	93%
Wheat	$3,677	$4,507	$6,234	$8,034	$5,206	$6,088	$8,048	119%
Total Cost	**$26,492**	**$35,183**	**$53,365**	**$46,779**	**$41,191**	**$54,919**	**$69,389**	**162%**
Cumulative Increase		**$8,692**	**$35,565**	**$55,852**	**$70,551**	**$98,979**	**$141,877**	

By 2011, the annual cost of the three commodities to U.S. food producers had risen from $26.5 billion in 2005 to $69.4 billion. The cumulative cost increase over the 2005-2011 was $141.9 billion.

It should then come as no surprise that the cost of food has increased much faster than overall inflation since 2005. The following table shows consumer level price inflation for selected food categories, and all items other than food, between calendar years 2005 and 2011. The time periods are before and after the 2007 RFS came into force. Overall price inflation of items other than food, even including energy, declined dramatically after December, 2007. The decrease was largely due to the 2008-2009 recession. In 2005 to 2007, food prices were increasing slower than all items other than food.

U.S. Price Inflation, Food and All Items Other than Food[9]
Before and After the 2007 RFS

CPI Category and Ratio	From: To:	January-2005 December-2007	January-2008 December-2011	Rate Change
All CPI Items Other Than Food (Includes Energy)		10.5%	6.2%	-41.1%
All Food		9.6%	11.3%	17.8%
Cereals and Bakery Products		9.4%	16.6%	76.6%
Meats, Poultry, Fish, and Eggs		8.2%	14.6%	78.8%
Fats and Oils		5.0%	27.2%	444.5%
Ratios to All Items Other Than Food				
All Food to All Items Other Than Food		91.7%	183.2%	99.9%
Meats, Poultry, Fish, and Eggs to All Items Other Than Food		78.0%	236.6%	203.4%
Cereals and Bakery Products		90.0%	269.7%	199.8%
Fats and Oils to All Items Other Than Food		47.7%	441.2%	824.2%

[8] USDA. World Agricultural Supply and Demand Estimates. Various issues, 2005-2012. Value is domestic use times price.
[9] Bureau of Labor Statistics. Consumer Price Index Database. Found at http://www.bls.gov/cpi/data.htm. Accessed 5-10-2012.

However, post-RFS food price inflation accelerated, even in the face of the recession. The grain and soybean-intensive food categories of cereals and bakery products, meats, poultry, fish and eggs, and fats and oils all increased at a much faster rate than overall food prices, and all items other than food.

The rapid increase in those three categories should come as no surprise. They all make heavy use of the three basic commodities shown in the table above. Ethanol from corn and biodiesel from soybean oil are both targeted by the 2007 RFS fuel blending mandates. Wheat and soybean prices have risen with corn due to the potential for corn to take wheat and soybean acreage, and the potential for wheat to substitute for corn in animal feeding.

The last four lines of the preceding table compare Consumer Price Index (CPI) food categories to all items other than food for the two sub-periods. Prior to the 2007 RFS, all four food categories had price inflation that was less than all items other than food. After 2007, all of the three food categories were increasing much faster than the all items other than food index. After 2007, all-food inflation increased about doubled relative to all items other than food before 2007. Fats and oils, which had been increasing at only 47.7 percent of the all items other than food, accelerated to an astounding 444.5 percent relative rate after 2007. The acceleration in this category's rate relative to the pre-RFS rate was an incredible eight-fold.

Some studies have shown little or no contemporaneous, month-to-month, relationship between corn prices and consumer food prices. However, the effects are not month-to-month or limited to corn, but cumulative and spread across other basic commodities. Post-2007 food prices, especially categories that make heavy use of corn, wheat and soybean products, accelerated much faster than overall inflation. The 2008-2009 recession had little negative effect on longer term food prices because those were being pushed up by the artificial demand of RFS mandates that increased faster than the ability to produce corn, wheat and soybeans.

In addition, ethanol production costs and ethanol prices were also increased by the 2007 RFS. The result was that ethanol has been priced out of all blends, except E10. Thus, the United Sates is producing surplus ethanol that cannot be sold here, and is having to export surplus ethanol!

Has Increased Ethanol Production Affected Gasoline Prices?

A recent Iowa State working paper[10] claimed to show that increased ethanol production lowered the average 2011 gasoline price by $1.09 per gallon. To get that result the authors used an indirect, convoluted, calculation based on a highly dubious statistical model.

With a more direct approach using actual (not the deflated data used in the Iowa State study) energy prices, several statistical models were estimated. All show that increased ethanol production from January 2000 through February 2012 had no statistically significant effect on gasoline prices or oil refiner margins. Furthermore, simple trends of gasoline energy equivalent ethanol production and U.S. gasoline exports show that increased ethanol production since 2007 has added nothing to the U.S. fuel supply. Rather, the increase in ethanol production has simply shifted U.S. gasoline production from domestic use to exports.

[10] Xiaodong Du and Dermot J. Hayes. The Impact of Ethanol Production on U.S. and Regional Gasoline Markets: An Update to 2012, Working Paper 12-WP 528. Center for Agricultural and Rural Development. Iowa State University. May 2012.

It will also be shown that with no impact on gasoline prices, the lower energy content of ethanol has actually increased the cost of U.S. automobile motor fuel.

Statistical Models

To estimate an impact of ethanol production on gasoline prices or oil refiner margins, an approach similar to the Iowa State paper was taken. Several models were used. All of the models are based on monthly data for January 2000 through February 2012. All energy data are from the U.S. Department of Energy, Energy Information Administration.

Model 1: Gasoline Prices, Crude Oil Prices, Ethanol Production and Other Related Factors:

The New York harbor conventional gasoline, regular grade, monthly average price (cents per gallon) was explained using the following factors:

1. U.S. Crude Oil Composite Acquisition Cost by Refiners (Dollars per Barrel)
2. U.S. Fuel Ethanol Production (Thousand Barrels)
3. U.S. Percent Utilization of Refinery Operable Capacity (Percent)
4. U.S. Ending Stocks Excluding Strategic Reserves (Thousand Barrels)
5. U.S. Motor Gasoline Ending Stocks (Thousand Barrels)
6. Net Gasoline Exports (Exports-Imports, Thousand Barrels)
7. Monthly Seasonal Effects
8. Katrina Effect, September to October 2005
9. MTBE Effect, April to August 2006
10. 2007 Refinery Outages Effect, March to July 2007

Except for ethanol production and net gasoline exports, all of the factors were statistically significant. The model shows that ethanol production had a positive, but statistically insignificant, effect on gasoline prices. The estimated equation explained 98.8 percent of the variation in gasoline prices. Crude oil prices were by far the leading driver of gasoline prices.

The model shows that increasing ethanol production was very weakly associated with higher, not lower, gasoline prices. While interesting, the model really shows that increasing ethanol production did not depress, or increase, gasoline prices. Crude oil prices are the major driver.

Detailed results for all four models are in the appendix to this study.

Model 2: 3:2:1 Crack Spread, Crude Oil Prices, Ethanol Production and Other Related Factors:

This model closely resembles the Iowa State paper 3:2:1 crack spread model. There are two major differences. The Iowa State paper deflated the crack spread by the Producer Price Index (PPI) of crude energy material. This version uses the actual, non-deflated, crack spread. The Iowa State model also did not include crude oil prices as a driver of the margin, or the MTBE and refinery outage events.

The “Crack Spread” is a common measure of refiner margins above the cost of crude oil. It is the weighted value of two major refiner products, gasoline and distillate fuel oil, minus crude oil cost. It is the value of 2 barrels (84 gallons) of gasoline, 1 barrel (42 gallons) of distillate fuel oil, versus the total value of the price of three barrels of crude oil. For February 2012 the crack spread was:

Gasoline Value: \$3.044/gallon x 42 gallons per barrel x 2 barrels = \$255.70
+ Fuel Oil Value: \$3.196/gallon x 42 gallons per barrel x 1 barrel = \$134.23
<u>- Crude Oil Value: \$107.19/barrel x 3 barrels = \$321.57</u>
= \$68.36 per 3 barrels of crude oil; or \$22.79 per barrel of crude oil, the value used in the model.

The variables used to explain the crack spread are the same as used in Model 1. The results are also almost the same. Ethanol production had a positive, but statistically insignificant, effect on the crack spread. Net gasoline exports were statistically significant, but just above the threshold level. Except for ethanol production, all of the variables had the expected direction of influence on the crack spread.

The model explained 74 percent of the variation in the crack spread.

Model 3: Gasoline Crack Ratio, Crude Oil Prices, Ethanol Production and Other Related Factors:

This model closely resembles the Iowa State paper crack ratio model. The "Gasoline Crack Ratio" is the ratio of the price of gasoline to the price of crude oil. For February 2012, the crack ratio was:

Gasoline Price: \$3.044/gallon x 42 gallons per barrel = \$127.85
Crude Oil Price: \$107.19/barrel
Gasoline Crack Ratio = \$127.85/\$107.19 = 1.193

The variables used to explain the gasoline crack ratio are the same as used in Model 1. Except for ethanol production and net gasoline exports, all of the factors were statistically significant and had the expected direction of influence. The estimated equation explained 68 percent of the variation in the gasoline crack ratio.

While it was not statistically meaningful, the model also shows that increasing ethanol production was actually associated with higher, not lower, gasoline prices. While interesting, the model really shows that increasing ethanol production was not statistically important to gasoline prices.

Model 4: Gasoline Crack Price Spread, Crude Oil Prices, Ethanol Production and Other Related Factors:

The "Gasoline Crack Price Spread" is defined as the difference between the value of a gallon of gasoline and the value of a gallon of crude oil. For February 2012, the gasoline crack price spread was:

Gasoline Price: \$3.044/gallon
Crude Oil Price: \$107.19/barrel/42 = \$2.552/gallon
Gasoline Crack Price Spread = \$3.044 - \$2.55 = \$0.492/gallon

This price spread is a rough measure of the gasoline gross margin above crude oil costs. It is not refiner profits, only crude oil costs are included.

The variables used to explain the gasoline crack price spread are the same as used in Model 1. Except for ethanol production and net gasoline exports, all of the factors were statistically significant and had the expected direction of influence. The estimated equation explained 64 percent of the variation in the gasoline crack price spread.

While it was not statistically meaningful, the model again shows that increasing ethanol production was actually associated with higher, not lower, gasoline prices. The model shows that increasing ethanol production was not statistically important to gasoline prices.

Conclusions

Four different measures of gasoline prices and oil refiner margins were used to model the effect of increasing ethanol production on those prices and margins. The monthly data used spanned January 2000 through February 2012. In all four attempts increasing ethanol production showed a positive, but statistically insignificant, effect on wholesale gasoline prices or refiner margins.

The overall conclusion is that increasing ethanol production over the 2000-2012 period tested had no significant effect on wholesale gasoline pricing or refiner margins. The fact that all four models showed a positive, but statistically insignificant, effect indicates that it is highly unlikely that increasing ethanol production depressed wholesale gasoline prices or refiner margins.

In one of the models, net gasoline exports did show a weakly significant negative effect on refiner gasoline margins. Increased ethanol production has caused gasoline exports to increase. That might be an indication of an indirect negative gasoline price effect, but the results are not consistent across the models. If there is an effect, it is contradicted by the weak positive effects of increasing ethanol production on gasoline prices and refiner margins.

Why Do These Results Differ from Iowa State's Paper?

There are several items that contribute to the differences between the Iowa State results and these.

For the 3:2:1 Crack Spread version there are three major differences. The Iowa State version deflated the spread by a Producer Price Index (PPI) for crude energy materials. This study did not deflate the crack spread, but used actual data. This study also included crude oil price effects, an important variable.

The deflation of the crack spread may have produced a spurious result in the Iowa State version. Their model showed a statistically significant negative effect of increasing ethanol production on the spread. However, deflating that spread by the cost of energy materials causes it to not increase as fast as the actual raw data. Thus, with the crack spread increases held down in a time of increasing ethanol production and energy costs, there is a measured negative effect, even if one does not exist in the actual, non-deflated, data.

A second major difference is that the models in this paper included crude oil prices as a variable to explain the crack spread. The reason is that oil refineries use some oil in their processing. As crude oil prices increase, the crack margin should also increase to cover those higher costs. The model results confirm this effect. The effect of crude oil cost is positive, highly significant, and contributes to the different model results.

Finally, all of this paper's price and margin models include the effects of major March-July 2007 refinery outages that caused petroleum product prices and margins to increase over those months. The effect is statistically significant. Also included is an April-August 2006 gasoline price and margin increase associated with the withdrawal of the MTBE additive in several areas of the country. The effect is statistically significant. Neither of these market disruptions was considered in the Iowa State paper.

Using a more complete model, and actual prices and refiner margins, the effects of increased ethanol production on gasoline prices and oil refiner margins shown in the Iowa State model disappear.

Other Iowa State Paper Issues

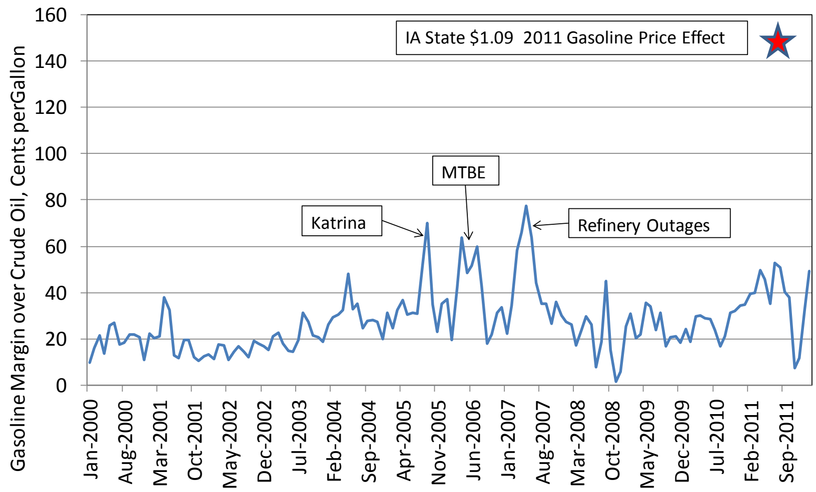
There are several other issues with the Iowa State paper's results. The Iowa State 3:2:1 crack spread model uses a deflated spread to estimate the impact of increasing ethanol production. They then use that result to project an actual price difference for gasoline. Mixing deflated model results and actual non-deflated price data is statistically problematic.

More significantly, the Iowa State authors do not seem to realize that their extrapolated $1.09 per gallon increase in gasoline price relative to the crude oil price would cause major changes in supply-side market behavior. The 2000-2011 average gasoline crack price spread was 27.8 cents per gallon. The 2011 margin averaged 37.1 cents. A $1.09 increase in that margin would lead to refineries quickly increasing gasoline production and reducing gasoline exports. The increase in gasoline supply available to the U.S. market would largely, likely entirely, wipe out the higher gasoline price.

Key Point:

The Iowa State finding that 2011 gasoline prices would have been $1.09 higher without ethanol production increases is out of line with historical prices and the fact that we are producing large gasoline exports. The actual 2011 gasoline premium to crude oil was 37.1 cents/gallon. An added $1.09 makes that margin $1.46.

Gasoline Price Margin over Crude Oil Price, 2000-February, 2011



Put simply, a $1.09 gasoline price increase in 2011 would have never happened. There is enough U.S. and global spare capacity to produce more gasoline, or the United States could export less, and bring gasoline prices down relative to crude oil.

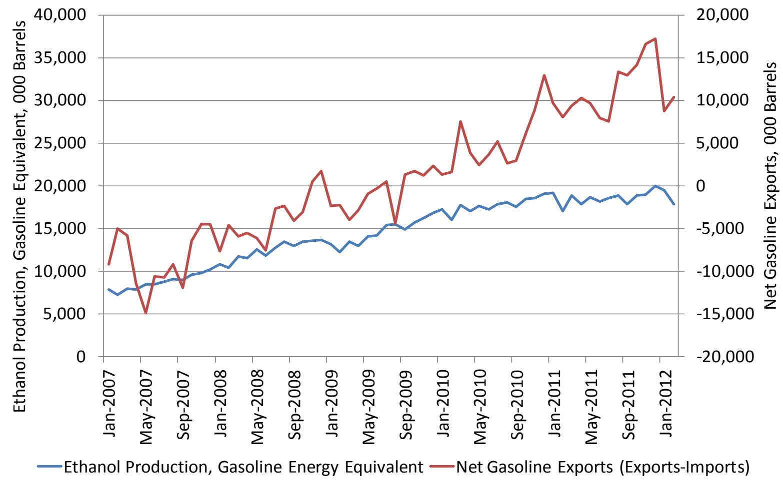
Has Increased Ethanol Production Increased U.S. Energy Supplies?

Another fact that supports the lack of impact of increased ethanol production on gasoline prices is that more ethanol production has not added to the U.S. energy supply. Rather, ethanol has displaced some U.S. gasoline consumption, but not production. The gasoline that was displaced from 2007 to 2011 was exported (next chart). In recent years the United States is also producing more ethanol than can be sold in the U.S. market, and ethanol exports increased to 1.2 billion gallons, 8.6 percent of production, in 2011.

Monthly Ethanol Production (Gasoline Energy Equivalent) and Gasoline Exports

Key Point:

The entire increase in ethanol production since 2007 has simply displaced U.S. gasoline consumption, not added to the domestic energy supply. All of the energy produced by the added ethanol has left the country in the form of higher gasoline exports and reduced gasoline imports.



In the chart above ethanol production was corrected for the fact that ethanol has only 67 percent of the energy in gasoline. Net gasoline exports are calculated as exports minus imports. Until about 2009 the U.S. was a net gasoline importer, thus the negative exports until then.

How can the ethanol industry claim that they are adding to the U.S. liquid fuel supply, or affecting prices, when ethanol has had no affect at all on domestic energy supply?

The ethanol industry has claimed that "Ethanol is now 10 percent of the U.S. motor fuel supply." This is a very misleading statement.

In 2011, about 95 percent of U.S. gasoline was sold as E10, containing 10 percent ethanol by volume, but only 6.7 percent by energy content. Measured by volume, and for gasoline alone, the claim is very close to the fact. That is far from the whole story. A gallon of ethanol is not a gallon of gasoline, and gasoline is a far cry from the entire U.S. liquid fuels supply.

Gasoline is not the only liquid fuel used in the United States. According to the U.S. Department of Energy, 2011 U.S. total liquid fuel consumption was about 6.46 billion barrels. Gasoline-equivalent ethanol consumption was about 199 million barrels (table below). U.S. ethanol energy consumption was only 3.1 percent of U.S. liquid fuel consumption, not 10 percent. On a global scale, U.S. ethanol energy production contributed well under 1 percent of global liquid fuels consumption.

U.S. Ethanol Production Versus U.S. and Global Liquid Fuels Consumption

Item	2011, 000 Barrels
U.S. Ethanol Consumption, Gasoline Equivalent	198,751
Total U.S. Liquid Fuels Consumption	6,456,850
Ethanol Percent of U.S. Liquid Fuels	3.1%
U.S. Ethanol Production, Gasoline Equivalent	222,512
Global Liquid Fuels Consumption	32,090,800
Ethanol Percent of Global Liquid Fuels	0.69%

Does Ethanol Save Motorists Money?

The ethanol industry claims that increased use of ethanol is saving motorists' money. We have already shown that higher ethanol production has had no effect on gasoline prices. That claim is also based in part on the fact that ethanol now typically sells for less per gallon than gasoline. Once again, a gallon of ethanol displaces only 0.67 gallons of gasoline. On an equal energy basis, a gallon of ethanol has never sold for less than a gallon of gasoline.

The next table shows that the 2011 ethanol price premium added about $14.5 billion to motorists' fuel bills. In addition, more than $5.7 billion was paid in direct subsidies in the form of a $0.45 per gallon tax credit (now expired).

The total 2011 motorist and taxpayer cost of U.S. ethanol consumption more than $20 billion. Fortunately that cost will decline this year with the expiration of the ethanol tax credit on January 1, 2012. Still, motorists continue to pay significantly more for fuel than they would if ethanol was not included in gasoline, or was priced at energy parity with gasoline.

2011 Wholesale Level Cost of U.S. Ethanol Consumption[11]

Item	2011
Gasoline Average Price per Gallon	$2.90
Ethanol Average Price per Gallon, Gasoline Equivalent	$4.03
Ethanol Price Premium per Gallon	$1.13
Billion Gallons of Ethanol Consumed	12.79
Ethanol Cost to Motorists, $Billion	$14.49
Tax Credit Costs, $Billion	$5.76
Total Motorist and Taxpayer Cost, $Billion	$20.24
Actual Ethanol Average Price per Gallon	$2.70

Has Increased Ethanol Production Reduced U.S. Crude Oil Imports?

One claim made by the ethanol Industry is that ethanol substantially reduces U.S. oil imports. On the surface, that may seem obvious. The logic is that ethanol replaces gasoline, and if less gasoline is consumed we need to import less oil. The real world is not that simple. Increased ethanol production since 2007 has not replaced U.S. crude oil imports. Rather, since 2007, increased ethanol production has increased gasoline exports.

The Renewable Fuels Association claims that 2011 ethanol production reduced U.S. oil imports by 485 million barrels[12]. However, on an energy basis the U.S. consumed only 199 million barrels of ethanol last year. How can 199 million barrels replace 485 million barrels?

The claim is based on the theory that for every barrel of ethanol production there is no need to import the crude oil used to produce a barrel of gasoline. Since a barrel of crude oil yields about half a barrel of gasoline, the theory is that a barrel of ethanol actually replaces more than one barrel of crude oil

[11] Sources: Ethanol and gasoline prices are from the Nebraska Energy Office. Ethanol consumption is from the Department of Energy, Energy Information Administration.
[12] http://ethanolrfa.org/pages/ethanol-facts-energy-security, Accessed May 19, 2012

imports. The first problem with this theory is that if the U.S. did reduce crude oil imports, there would less production of crude oil-based fuels other than gasoline. The U.S. would then need to import those other fuel products. So, about half of the 485 million barrel claim makes no contribution to reducing dependency on imported petroleum. It does not matter if it is imported crude oil or refined products, both represent dependency on “foreign oil.”

A second problem is that a barrel of ethanol actually replaces only 0.67 barrels of gasoline. U.S. fuel ethanol use in 2011 was about 297 million barrels. That is the energy of 199 million barrels of gasoline, and the most gasoline that fuel ethanol could have replaced.

If there is any replacement of crude oil and refined product imports, the actual maximum reduction in foreign dependency is about 40 percent of the claimed amount. Even that claim may not be true if U.S. gasoline production did not decline in line with the increase in gasoline energy equivalent ethanol production. Data from the Department of Energy can show if U.S. gasoline production declined, or not. If gasoline production declined, it is also expected that there would be declines in the other major refinery production stream, distillate fuel oil used to make diesel, heating oil and jet fuel.

The next table summarizes 2007 to 2011 U.S. production and use for gasoline, ethanol, distillate fuel oil and crude oil use. U.S. finished gasoline production, net of the ethanol it includes, has increased, not declined, since 2007. Since gasoline consumption declined, exports have increased more than production. That means that the U.S. demand for the oil needed for gasoline production has not declined at all. Use of crude oil did decline slightly, but that was due to increased refinery fuel yields coupled with increased U.S. crude oil production, not refined product supply reductions.

U.S. Gasoline and Ethanol, Production, Trade and Consumption, 2007-2011[13]

Year	Finished Gasoline Production - Ethanol Used (Thousand Barrels)	Gasoline Net Exports (Thousand Barrels)	Gasoline Production - Net Exports (Thousand Barrels)	Ethanol Used for Blending (Thousand Barrels, Gasoline Equivalent)	Gasoline Production - Net Exports + Ethanol Used (Thousand Barrels, Gasoline Equivalent)	U.S. Refinery and Blender Net Production of Distillate Fuel Oil (Thousand Barrels)	U.S. Refinery and Blender Net Input of Crude Oil (Thousand Barrels)
2007 Actual	2,914,011	(104,248)	3,018,259	91,524	3,109,783	1,508,530	5,532,097
2008 Actual	2,938,589	(47,541)	2,986,130	127,356	3,113,486	1,571,539	5,361,287
2009 Actual	2,965,771	(10,210)	2,975,981	161,440	3,137,421	1,477,534	5,232,656
2010 Actual	3,020,517	58,954	2,961,563	191,542	3,153,105	1,541,503	5,374,094
2011 Actual	3,001,065	136,544	2,864,521	198,751	3,063,272	1,637,771	5,413,999
2007-11 Change	**87,054**	**240,792**	**(153,738)**	**107,227**	**(46,511)**	**129,241**	**(118,098)**

From 2007 to 2011, actual U.S. gasoline production and gasoline net exports both increased. Gasoline supplied to the U.S. market declined, ethanol use increased, and on balance total gasoline and ethanol (on an energy basis) declined. In 2011 an additional 19 million barrels of ethanol (gasoline energy equivalent) was exported. On balance, all the gasoline displaced by ethanol, plus a significant amount of ethanol, was exported. Crude use declined, but not due to refined product production reductions.

A major factor in reduced crude oil imports was increased total refiner fuel yield. As shown in the next table, the total yield increased from 71.6 percent in 2007 to 73.9 percent in 2011. Refiners reduced gasoline yields slightly due to its declining consumption. Versus 2007 yields, that small yield increase saved 125 million barrels of 2011 crude oil use.

[13] These estimates use definitions that are different from the U.S. Department of Energy

Refinery Yields, Two Major Products

Year	Gasoline Yield	Distillate Fuel Oil Yield	Total Gasoline and Distillate Fuel Oil Yield
2007	45.5%	26.1%	71.6%
2008	44.2%	27.8%	72.0%
2009	46.1%	26.9%	73.0%
2010	45.7%	27.5%	73.2%
2011	45.0%	28.9%	73.9%

But, why did oil refiners continue to produce more gasoline when ethanol production was increasing? Gasoline is not the only important fuel produced from crude oil. Diesel, aviation and heating fuels made from distillate fuel oil are also very important to refiners. Total demand for those products was increasing from 2007 to 2011. Ethanol cannot replace any of those other refinery products.

To meet the demand for fuels other than gasoline, and keep refineries running at efficient rates, oil companies had to maintain crude oil use even as ethanol and gasoline supplies grew. With U.S. gasoline demand on the decline, and ethanol adding to the gasoline supply, refiners simply started to export more gasoline to balance their total fuels supply and demand.

The next table is what might have happened if ethanol production and use had not increased after 2007. The only changes are a reduction in gasoline exports and increase in domestic use. Crude oil use does not change. Gasoline exports move from net imports to significant net exports even if ethanol production is held flat.

In summary, the theory that increased ethanol production would reduce U.S. dependence on crude oil imports does not stand up to the facts. It is true that somewhere in the world our 2011 ethanol production may have displaced crude oil and gasoline production, but not here in the United States!

U.S. Gasoline and Ethanol Production, Trade and Consumption, 2077 - 2011
No Ethanol Production Increase Scenario

Year	Finished Gasoline Production - Ethanol Used (Thousand Barrels)	Gasoline Net Exports (Thousand Barrels)	Gasoline Production - Net Exports (Thousand Barrels)	Ethanol Used for Blending (Thousand Barrels, Gasoline Equivalent)	Gasoline Production - Net Exports + Ethanol Used (Thousand Barrels, Gasoline Equivalent)	U.S. Refinery and Blender Net Production of Distillate Fuel Oil (Thousand Barrels)	U.S. Refinery and Blender Net Input of Crude Oil (Thousand Barrels)
2007	2,914,011	(104,248)	3,018,259	91,524	3,109,783	1,508,530	5,532,097
2008	2,938,589	(83,373)	3,021,962	91,524	3,113,486	1,571,539	5,361,287
2009	2,965,771	(93,170)	3,045,897	91,524	3,137,421	1,477,534	5,232,656
2010	3,020,517	(41,064)	3,061,581	91,524	3,153,105	1,541,503	5,374,094
2011	3,001,065	29,317	2,971,748	91,524	3,063,272	1,637,771	5,413,999
2007-2011: No Increase in Ethanol Production	**87,054**	**133,565**	**(46,511)**	**-**	**(46,511)**	**129,241**	**(118,098)**
Actual 2007-2011 Change	**87,054**	**240,792**	**(153,738)**	**107,227**	**(46,511)**	**129,241**	**(118,098)**
Difference	**-**	**(107,227)**	**107,227**	**(107,227)**	**-**	**-**	**-**

In fact, one way to look at what happened is that the RFS has forced almost all of the 2007-2011 ethanol production increase to be used in the U.S. In a very real sense, all of the energy contained in the 2007-2011 ethanol production increase was actually exported in the form of gasoline! We could have exported all of that increased ethanol production, still increased gasoline net exports, and had exactly the same gasoline energy supply for domestic use, with no increase in crude oil use or imports!

In other words, the 2007-2011 increase in ethanol production increased the global energy supply, but that energy was exported from the U.S. Increased ethanol production since 2007 has not increased U.S. motor fuel consumption, or reduced crude oil use or imports. That helps make sense out of the statistical model results that show no impact of increasing ethanol production in gasoline prices.

Statutory RFS Adjustments Based on Corn Market Conditions

In the post-RFS era grain and soybean prices have reached record-high prices, and volatility levels are the highest seen in modern history. Such an outcome is to be expected given the fixed nature and size of the RFS blending mandates versus forces of nature that largely determine biofuel feedstock production.

Consequences of high, volatile, grain and soybean prices have been detrimental to both the food and ethanol fuel sectors, and the overall economy. As was pointed out earlier, since 2007 food price inflation has accelerated to double the pre-2007 rate relative to non-food prices. Higher food prices have acted on a drag to post 2007 economic growth and recovery from the 2008-2009 recession.

The effects of the fixed RFS can be seen in the next table that details the 2005 to 2012 corn supply and use situation. The 2007 RFS promise of guaranteed ethanol use helped drive corn used for ethanol from 1.6 billion bushels in the 2005/2006 crop year to 5.0 billion in 2011/2012. That increase in ethanol use forced higher prices and significant rationing of corn among feed users and export customers.

Feed use of corn declined from 6.2 billion bushels in 2005/2006, to only an estimated 4.6 billion in 2011/2012. Part, but not all, of the decline in corn feeding was offset by the increase in distillers' grains that are a by-product of ethanol production.

There are no official USDA estimates of distillers' grains production or stocks, but export data are available. To estimate distillers' grain feed use a standard yield of 17 pounds of 10 percent moisture distillers' dried grains with solubles (DDGS) per bushel of corn used for fuel ethanol production was assumed. That production volume was then factored up to from 10 percent to 14 percent moisture, the standard for corn. That supply was assumed to substitute for corn on a 1:1 basis. That is, 56 pounds of 14 percent moisture DDGS was assumed to replace one bushel of corn. Exports were subtracted from production to obtain domestic supply. DDGS has no use other than feeding, and inventory data are not available, so the entire domestic supply was assumed to be fed in the year of production.

Even with the add-back of DDGS, total feed use of corn plus DDGS declined from about 6.6 billion bushels in 2005/2006, to an estimated 5.8 billion bushels in 2011/2012.

Corn exports declined from about 2.1 billion bushels in 2005/2006 to an estimated 1.7 billion bushels in 2011/2012.

Both of these declines in use are the result of corn prices increasing from $2.00 for the 2005/2006 crop year to more than $6.00 in 2011/2012. Higher corn prices (and associated increases in wheat and soybean product prices) have dramatically raised the costs of producing meat and poultry.

USDA Corn Production, Supply and Demand Estimates[14]

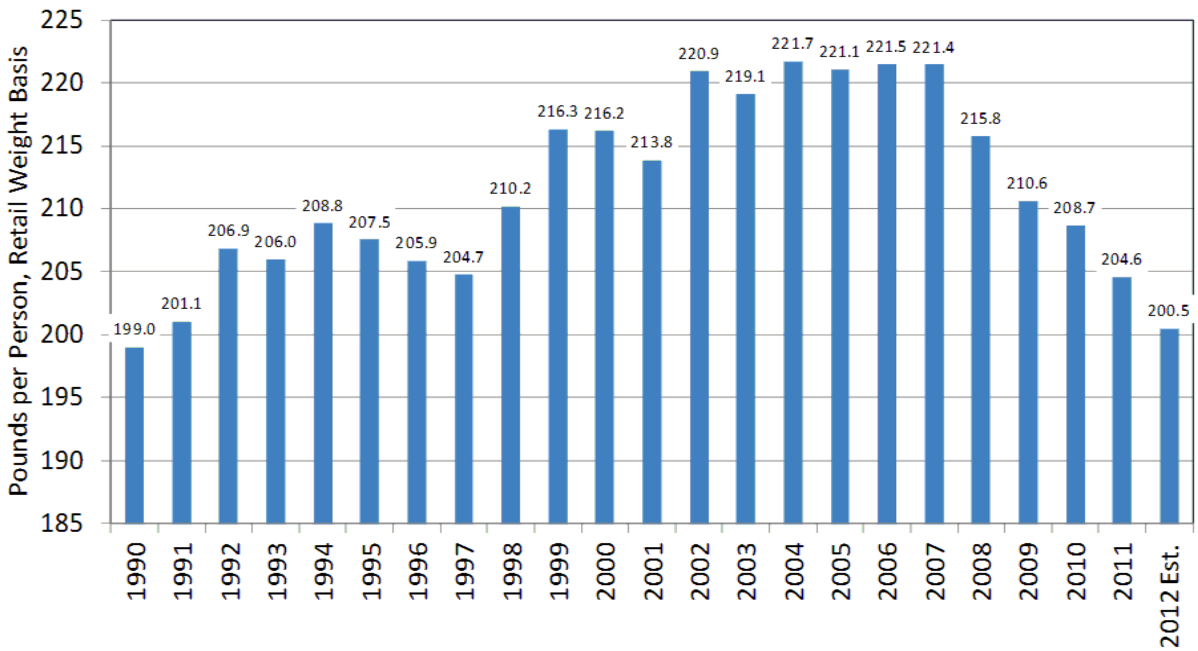
Item	2005/ 2006	2006/ 2007	2007/ 2008	2008/ 2009	2009/ 2010	2010/ 2011	2011/2012 Proj.
Area Planted (Mill. Ac.)	81.8	78.3	93.5	86.0	86.4	88.2	91.9
Area Harvested (Mill. Ac.)	75.1	70.6	86.5	78.6	79.5	81.4	84.0
Yield (Bu/Ac.)	148.0	149.1	150.7	153.9	164.7	152.8	147.2
Beg. Corn Stocks (Mill. Bu.)	2,114	1,967	1,304	1,624	1,673	1,707	1,128
Corn Production (Mill. Bu.)	11,114	10,535	13,038	12,092	13,092	12,447	12,358
Corn Imports (Mill. Bu.)	9	12	20	14	8	28	20
Total Corn Supply (Mill. Bu.)	13,237	12,514	14,362	13,729	14,773	14,182	13,506
Corn Feed Use (Mill. Bu.)	6,155	5,598	5,938	5,182	5,125	4,793	4,550
Corn+DDGS Feed Use	6,612	6,195	6,735	6,153	6,238	6,072	5,805
Food/Seed/Ind. Use (Mill. Bu.)	2,981	3,488	4,363	5,025	5,961	6,428	6,405
Fuel Ethanol Use (Mill. Bu.)	1,603	2,117	3,026	3,709	4,591	5,021	5,000
Est. DDGS Prod. (Mill. Bu. Equiv.)	508	670	958	1,175	1,454	1,590	1,583
DDGS Exports (Mill. Bu. Equiv.)	50	73	161	204	340	311	328
DDGS Feed Use (Mill. Bu. Equiv.)	457	597	797	971	1,113	1,279	1,255
Other Food/Seed/Ind. Use (Mill. Bu.)	1,378	1,371	1,337	1,316	1,370	1,407	1,405
Corn Exports (Mill. Bu.)	2,134	2,125	2,436	1,849	1,980	1,835	1,700
Total Corn Use (Mill. Bu.)	11,270	11,210	12,737	12,056	13,066	13,056	12,655
Ending Corn Stocks (Mill. Bu.)	1,967	1,304	1,624	1,673	1,707	1,128	851
U.S. Average Farm Price, Corn, $/Bu.	$2.00	$3.04	$4.20	$4.06	$3.55	$5.18	$6.20
% Corn Production Used for Fuel Ethanol	14%	20%	23%	31%	35%	40%	40%
Corn Ending Stocks to Total Use Ratio	17%	12%	13%	14%	13%	8.6%	6.7%

In the domestic market, the sharp increases in corn prices after 2007 have led to higher prices for foods that make heavy use of corn. Meat and poultry production has been heavily affected. Higher prices for these commodities have forced price rationing among consumers, and per capita consumption has declined to the lowest level since 1990 (next chart).

The post-2007 decline in U.S. meat and poultry consumption is unprecedented. But, so is the current RFS that reduces this industry's access to its basic feedstock, corn. By encouraging the diversion of corn to ethanol production, even in times when corn stocks were dangerously low, the RFS has forced all other users to reduce production to accommodate higher costs. It is no accident that the decline in meat and poultry consumption started in 2008, the first year of the current RFS.

[14] USDA, World Agricultural Supply and Demand Estimates, May 10, 2012. Years are September 1 crop years.

USDA Estimates of Per Capita Total Meat and Poultry Consumption, 1990-2012[15]



Had the RFS contained automatic adjustments to the tight corn stocks since 2007, the corn market could have been allowed to better adjust to the realities of corn production and market demand. The next table contains proposed adjustments to the RFS based on a draft bill prepared by Rep. Bob Goodlatte of Virginia.

Proposed Schedule of RFS Adjustments
Stocks-to-Use Based on the November USDA World Agricultural Supply and Demand Estimates

U.S. Corn Stocks-to-Use Ratio for the Current Crop Year (percent)	Reduction in national quantity of renewable fuel required
Above 10.0	No adjustment
10.0-7.5	10 percent reduction
7.49-6.0	15 percent reduction
5.99-5.0	25 percent reduction
Below 5.0	50 percent reduction

The next table contains estimates of how this adjustment mechanism might have affected corn use and prices had it been in effect for the 2005/2006 through 2011/2012 corn marketing years. Estimates by marketing year are as follows:

2005/2006: No change; the November 2005 Stocks/Use Ratio was well above the upper threshold of 10 percent.

2006/2007: No change; the November 2006 Stocks/Use Ratio was below 10 percent. Corn prices were not yet high enough to materially affect use, and ethanol plants were extremely profitable.

[15] USDA, World Agricultural Supply and Demand Estimates, May 10, 2012 and prior editions.

2007/2008: No change; the November 2007 Stocks/Use Ratio was above the 10 percent threshold.

2008/2009: The 9 percent November 2008 Stocks/Use Ratio was below 10 percent, and corn prices high enough to materially ration use. The RFS was reduced by 10 percent. Corn prices were also extremely volatile during the year. Major broiler and ethanol producer bankruptcies occurred. Ethanol use was adjusted down by 185 million bushels and corn feed use up by 118 million. The net result is a 67 million bushel increase in ending stocks. The season average price was adjusted downward by a small $0.06 per bushel. Corn prices during the 2008/2009 crop year could have been much less volatile had the lower RFS been in effect.

2009/2010: No change; the November 2009 Stocks/Use Ratio was above the upper threshold of 10 percent. Beginning inventories are slightly higher due to the use effects from the prior year. The season average price was not adjusted for the small impact on stocks/use ratio.

2010/2011: The 6.2 percent November 2010 Stocks/Use Ratio was well below 10 percent, and corn prices high enough to materially ration use. The RFS was reduced by 15 percent. Estimated fuel ethanol use was decreased by 321 million bushels. Estimated feed use was increased by 207 million bushels. The resulting change in the actual stocks-to-use ratio from 8.6 percent to over 10 percent caused the estimated season average corn price to decline by $0.93 per bushel versus the actual corn price.

2011/2012: Even with larger carryover stocks from 2010/2011, the November 2012 stocks-to-use ratio of 6.7% was still well below 10 percent, and corn prices high enough to materially ration use. The RFS was again reduced by 15 percent. Estimated fuel ethanol use was decreased by 200 million bushels. Estimated feed use was increased by 200 million bushels. The stocks-to-use ratio changes from 6.7 percent to 8.1 percent as a result of higher stocks from the prior year. The estimated season average corn price declined by $0.95 per bushel versus the actual corn price.

USDA Corn Production, Supply and Demand Estimates Adjusted for a Flexible RFS

Item	2005/ 2006	2006/ 2007	2007/ 2008	2008/ 2009	2009/ 2010	2010/ 2011	2011/2012 Proj.
Area Planted (Mill. Ac.)	81.8	78.3	93.5	86.0	86.4	88.2	91.9
Area Harvested (Mill. Ac.)	75.1	70.6	86.5	78.6	79.5	81.4	84.0
Yield (Bu/Ac.)	148.0	149.1	150.7	153.9	164.7	152.8	147.2
Beg. Corn Stocks (Mill. Bu.)	2,114	1,967	1,304	1,624	1,740	1,775	1,308
Corn Production (Mill. Bu.)	11,114	10,535	13,038	12,092	13,092	12,447	12,358
Corn Imports (Mill. Bu.)	9	12	20	14	8	28	20
Total Corn Supply (Mill. Bu.)	13,237	12,514	14,362	13,729	14,841	14,250	13,686
Estimated Corn Feed Use (Mill. Bu.)	6,155	5,598	5,938	5,300	5,125	5,000	4,750
Estimated Corn+DDGS Feed Use	6,612	6,195	6,735	6,212	6,238	6,178	5,942
Estimated Food/Seed/Ind. Use (Mill. Bu.)	2,981	3,488	4,363	4,840	5,961	6,107	6,205
Estimated Fuel Ethanol Use (Mill. Bu.)	1,603	2,117	3,026	3,524	4,591	4,700	4,800
Estimated DDGS Prod. (Mill. Bu. Equiv.)	508	670	958	1,116	1,454	1,488	1,520
DDGS Exports (Mill. Bu. Equiv.)	50	73	161	204	340	311	328
Estimated DDGS Feed Use (Mill. Bu. Equiv.)	457	597	797	912	1,113	1,178	1,192
Other Food/Seed/Ind. Use (Mill. Bu.)	1,378	1,371	1,337	1,316	1,370	1,407	1,405
Corn Exports (Mill. Bu.)	2,134	2,125	2,436	1,849	1,980	1,835	1,700
Estimated Total Corn Use (Mill. Bu.)	11,270	11,210	12,737	11,989	13,066	12,942	12,655
Estimated Ending Corn Stocks (Mill. Bu.)	1,967	1,304	1,624	1,740	1,775	1,308	1,031
Estimated U.S. Average Farm Price, Corn, $/Bu.	$2.00	$3.04	$4.20	$4.00	$3.55	$4.25	$5.25
Estimated % Corn Production Used for Fuel Ethanol	14%	20%	23%	29%	35%	38%	39%
Estimated Corn Ending Stocks to Total Use Ratio	17.5%	11.6%	12.8%	14.5%	13.6%	10.1%	8.1%
November WASDE Corn Ending Stocks to Total Use Ratio	21.4%	7.9%	15.1%	9.0%	12.5%	6.2%	6.7%
Required RFS Reduction (%)	0%	10%	0%	10%	0%	15%	15%
Actual Corn-Based Ethanol RFS, Following Year	4.0	4.7	9.0	10.5	12.0	12.6	13.2
Adjusted Corn-Based Ethanol RFS, Following Year	4.0	4.2	9.0	9.5	12.0	10.7	11.2

The RFS, Fuel and Food Prices, and the Need for Statutory Flexibility

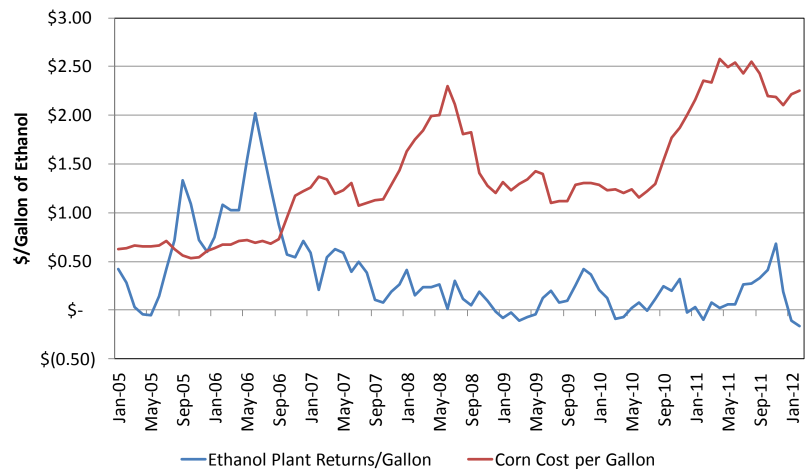
Summary: Even with a more flexible RFS, corn prices would have remained much higher than was the case in 2005/2006. Extremely small carryover stocks in 2010/2011 and 2011/2012 caused corn prices to increase to new record levels. Those higher prices severely rationed both feed use and exports, even with the more flexible RFS.

Higher corn prices also affected ethanol producer profit margins. If the demand guarantee of the RFS had been lower in the 2010/2011 and 2011/2012 corn marketing years, the incentives for ethanol production would also have been lower. With lower incentives and smaller margins, ethanol producers would have reduced production, easing the pressure on corn stocks and prices.

Iowa State Model Ethanol Plant Profit Margins and Corn Costs

Key Point:

Tighter corn stocks and higher corn prices since 2009 have reduced ethanol plant profitability. Lower margins have reduced the incentives to increase production. Had the RFS been adjusted in 2010 and 2011 ethanol production would have declined slightly due to a lower demand guarantee.

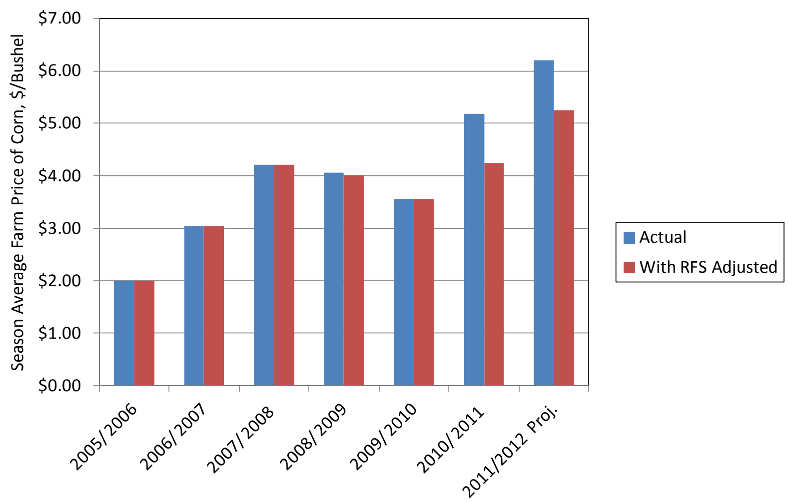


The next chart shows the estimated corn price effect with the RFS adjustment mechanism in effect.

Actual and Estimated Season Average Corn Prices with RFS Adjustment

Key Point:

Automatic RFS adjustments have little or no corn price effect until the extremely tight corn stocks of 2010/2011 and 2011/2012. In those two years the adjustment causes somewhat reduced ethanol production incentives which lead to higher corn stocks and lower corn prices. In both years corn prices are lowered by almost $1.00 per bushel.



Lower corn prices also allow more corn use for feed, and would have lowered food production cost/price pressures. Increased corn availability for livestock and poultry feeding would have enabled more domestic supply of meat and poultry, but consumption would still have fallen from 2007 to 2012.

Not only would corn prices have been lower in 2010/2011 and 2011/2012, price volatility would also have declined. The Babcock and McPhail article cited earlier concluded:

“We examine the marginal effect of ethanol policies such as the RFS mandates and the blending wall on price variability of corn and gasoline. Theoretical and empirical results both suggest that current ethanol policies decrease the price elasticity of demand for both commodities, and therefore increase price variability. An important implication has to do with the policy actions with respect to biofuels and particularly ethanol from corn. Policy actions that result in maintaining or changing the current mandates and/or the blend wall should account for their effect on the price elasticity of demand and price volatility for corn and gasoline markets.”

Using a statistical model of gasoline and corn prices the authors ran scenarios with historically low and high crude oil prices, and elimination of the RFS. Corn and gasoline price volatility would be reduced more with low crude oil prices because the incentives to continue ethanol production would be lower in a low energy price environment.

The authors also included elimination of the 10 percent ethanol blend limit (BW, or blend wall, in the table below) in their analysis. That elimination also lowered price volatility, but not by as much as eliminating the RFS in the case of low crude oil prices. “Low” and “High” crude oil prices refer not to a specific price, but the lower and upper ends of the historical range. Gasoline price volatility is also decreased. The results presented in the table below are not surprising. Artificially created, inflexible, demand should increase price volatility.

Price Variability of Corn and Gasoline Under Different Crude Oil Price Scenarios

Scenario	Corn CV	Gasoline CV
High crude oil prices		
RFS, BW, and tax credits	0.2654	0.2365
Elimination of BW	0.2008	0.2180
Elimination of RFS	0.2441	0.2295
Low crude oil prices		
RFS, BW, and tax credits	0.3043	0.2703
Elimination of BW	0.2952	0.2661
Elimination of RFS	0.2497	0.2518

The “CV” is the coefficient of variation. It is the standard deviation of the corn or gasoline price divided by the average of the respective price. As such, it is a measure of the volatility of the prices relative to their averages.

The annual RFS adjustment mechanism contained in the Goodlatte bill would, in agreement with this model, also reduce the incentives to produce ethanol when corn prices are high due to corn production shortages. While corn prices would still increase with poor weather, corn price volatility would be lowered if the ethanol demand guarantee was lowered for a year. When crude oil prices are at the low end of their historic range the effect would be more than when they are at the high end.

In the current situation the 2012 corn crop under severe drought stress across much of the Corn Belt, and ending stocks are critically low. An RFS formula-based adjustment mechanism is more important now than ever.

Summary: RFS Flexibility Needed for Corn-Based Ethanol

The current, inflexible, corn-based ethanol RFS coupled with the inability of farmers to produce enough corn to satisfy all potential users has led to sharp increases in corn costs and price volatility for all users. The RFS should be reformed to allow for automatic adjustments to the RFS to reduce incentives for ethanol production in years when corn stocks are forecast to reach critically low levels.

Even with a lower and more flexible RFS, market conditions may justify no change, or higher, ethanol production. In this case a lower RFS would have little or no effect on ethanol producers or production. However, in the event of poor ethanol production margins, a lower RFS would be an added incentive for ethanol producers to reduce production, making more corn available for other users, and potentially higher stocks. Price and cost pressures would be lowered for all corn users, including ethanol producers.

An automatic adjustment to the corn-based ethanol RFS offers potential benefits for all corn users, with no significant downside for ethanol production or profitability. In fact, the long term viability of corn-based ethanol production would be improved by a more flexible RFS that encourages lower corn demand in years when corn crop shortfalls occur.

RFS Adjustments for Cellulosic Ethanol

An ambitious RFS schedule and generous tax credits for cellulosic ethanol have completely failed to produce any meaningful amount of fuel. The first commercial scale plant (Poet/DSM) is under construction, It is scheduled to come online in 2013. However, it will cost about $250 million to build, and have only 20 million gallons-per-year initial capacity, but only if it operates as designed.

The 2013 cellulosic ethanol RFS calls for 1.0 billion gallons of cellulosic ethanol. The 2013 cellulosic RFS, and all years beyond 2013, is grossly unrealistic.

The 2007 cellulosic RFS was recently examined in great detail by the National Research Council[16]. A broad-based, multi-disciplinary, group of experts concluded that meeting the current cellulosic RFS schedule is highly unlikely. Extraordinary technical barriers to successful commercialization of cellulosic ethanol were described in detail. In addition, the report found significant issues with increased greenhouse gas emission goals, cost-efficient feedstock production, increased competition for food crop land, increased federal subsidy costs, increased water use, and potential air quality degradation.

In light of these recent findings, the EPA should reexamine the 2007 RFS schedule for cellulosic ethanol. Any cellulosic ethanol RFS should reflect the realities of technical barriers, fuel costs, food production, and environmental impact.

In addition to the technical issues with increased cellulosic ethanol production, there is also a major price and competitiveness problem. Corn-based ethanol has already saturated the E10 market. Unless cellulosic ethanol is fully price competitive with gasoline, it will be very difficult to move beyond the current E10 volume ceiling. Simply put, while there is a blending mandate, motorists will not voluntarily buy higher blend levels unless the cost per mile is at least as good as E10. Mandating purchase of a product for which there is no purchase incentive will prove to be very difficult.

[16] National Research Council. Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy. Washington DC. 2011.

Appendix: Gasoline Price Models

Model 1, Monthly Gasoline Prices, Crude Oil Prices, Ethanol Production and Other Related Factors:

January, 2000 to February, 2012 monthly average New York harbor conventional gasoline regular spot price FOB (Cents per Gallon) is a function of:

Explanatory Variable	Estimated Coefficient	T Statistic
Intercept	-60.273	-1.60
Crude oil composite acquisition cost by refiners ($/barrel)	2.582	46.03
Production of fuel ethanol (000 barrels)	0.000589	1.65
Percent utilization of refinery operable capacity	1.499	4.23
Month end crude oil stocks (excluding strategic petroleum reserve) (000 barrels)	0.0000818	3.25
Motor gasoline ending stocks (000 Barrels)	-0.000726	-4.96
Net gasoline exports (000 Barrels)	-0.000351	-1.53
Katrina effect, Sept-Oct 2005 = 1, otherwise 0	30.585	4.27
MTBE withdrawal effect, Apr-Aug 2006 = 1, otherwise 0	23.138	5.27
2007 refinery outages, Mar-Jul 2007 = 1, otherwise 0	26.967	6.05
If month is January = 1, otherwise 0	14.391	3.61
If month is February = 1, otherwise 0	16.699	4.08
If month is March = 1, otherwise 0	9.371	2.51
If month is April = 1, otherwise 0	4.886	1.31
If month is May = 1, otherwise 0	3.443	0.88
If month is June = 1, otherwise 0	-2.770	-0.69
If month is July = 1, otherwise 0	-7.739	-1.85
If month is August = 1, otherwise 0	-9.117	-1.97
If month is September = 1, otherwise 0	-1.928	-0.48
If month is October = 1, otherwise 0	-7.511	-1.81
If month is November = 1, otherwise 0	-5.835	-1.54
If month is December = 0 (base price for seasonal variation)	NA	NA

n = 146, Degrees of Freedom = 124, R^2 = 0.988

A “T Statistic” of ±1.98 is required to be statistically significant from zero at the 95 percent level.

Discussion: Except for ethanol production all of the variables are statistically significant and have the expected direction of influence. Ethanol production and net gasoline exports were not statistically significant.

Model 2, Monthly 3:2:1 Crack Spread, Crude Oil Prices, Ethanol Production and Other Related Factors:

January 2000 to February 2012 monthly average New York gasoline and heating oil prices and the crude oil composite acquisition cost by refiners were used to compute the 3:2:1 crack spread ($/barrel). The crack spread is modeled as a function of:

Explanatory Variable	Estimated Coefficient	T Statistic
Intercept	-20.246	-1.633
Crude oil composite acquisition cost by refiners ($/barrel)	0.152	8.237
Production of fuel ethanol (000 barrels)	0.000156	1.328
Percent utilization of refinery operable capacity	0.540	4.625
Month end crude oil stocks (excluding strategic petroleum reserve) (000 barrels)	0.0000249	3.011
Motor gasoline ending stocks (000 Barrels)	-0.000249	-5.164
Net gasoline exports (000 Barrels)	-0.000170	-2.248
Katrina effect, Sept-Oct 2005 = 1, otherwise 0	10.808	4.581
MTBE withdrawal effect, Apr-Aug 2006 = 1, otherwise 0	6.764	4.685
2007 refinery outages, Mar-Jul 2007 = 1, otherwise 0	7.997	5.451
If month is January = 1, otherwise 0	4.774	3.638
If month is February = 1, otherwise 0	5.246	3.896
If month is March = 1, otherwise 0	2.169	1.762
If month is April = 1, otherwise 0	0.098	0.080
If month is May = 1, otherwise 0	-0.863	-0.674
If month is June = 1, otherwise 0	-2.774	-2.098
If month is July = 1, otherwise 0	-4.713	-3.432
If month is August = 1, otherwise 0	-5.093	-3.343
If month is September = 1, otherwise 0	-2.199	-1.647
If month is October = 1, otherwise 0	-3.266	-2.395
If month is November = 1, otherwise 0	-2.172	-1.742
If month is December = 0 (base price for seasonal variation)	NA	NA

n = 146, Degrees of Freedom = 124, R^2 = 0.740

A “T Statistic” of ±1.98 is required to be statistically significant from zero at the 95 percent level.

Discussion: Except for ethanol production all of the variables have the expected direction of influence. Ethanol production was not statistically significant. Net gasoline exports had a negative, and weakly significant, effect on the 3:2:1 crack spread.

The magnitude of the ethanol production and net gasoline export effects are is almost the same, but with opposite sign. As was shown earlier, since 2007 increased ethanol production (gasoline energy equivalent) has been very near to the increase in gasoline net exports. To any extent that these two effects are real, they tend to cancel each other out during that period of time.

Model 3, Monthly Gasoline Crude Oil Price Ratio, Ethanol Production and Other Related Factors:

January 2000 to February 2012 monthly average New York gasoline price and the crude oil composite acquisition cost by refiners ratio were used to compute a price ratio of gasoline to crude oil. That ratio is modeled as a function of:

Explanatory Variable	Estimated Coefficient	T Statistic
Intercept	0.803	2.676
Crude oil composite acquisition cost by refiners ($/barrel)	-0.00142	-3.177
Production of fuel ethanol (000 barrels)	0.00000201	0.706
Percent utilization of refinery operable capacity	0.0133	4.723
Month end crude oil stocks (excluding strategic petroleum reserve) (000 barrels)	0.000000428	2.134
Motor gasoline ending stocks (000 Barrels)	-0.00000556	-4.775
Net gasoline exports (000 Barrels)	-0.000000627	-0.342
Katrina effect, Sept-Oct 2005 = 1, otherwise 0	0.214	3.751
MTBE withdrawal effect, Apr-Aug 2006 = 1, otherwise 0	0.100	2.866
2007 refinery outages, Mar-Jul 2007 = 1, otherwise 0	0.138	3.886
If month is January = 1, otherwise 0	0.1262	3.971
If month is February = 1, otherwise 0	0.1347	4.131
If month is March = 1, otherwise 0	0.0970	3.254
If month is April = 1, otherwise 0	0.0711	2.391
If month is May = 1, otherwise 0	0.0591	1.905
If month is June = 1, otherwise 0	-0.0049	-0.152
If month is July = 1, otherwise 0	-0.0395	-1.187
If month is August = 1, otherwise 0	-0.0544	-1.474
If month is September = 1, otherwise 0	-0.0034	-0.106
If month is October = 1, otherwise 0	-0.0432	-1.309
If month is November = 1, otherwise 0	-0.0296	-0.980
If month is December = 0 (base price for seasonal variation)	NA	NA

n = 146, Degrees of Freedom = 124, R^2 = 0.675

A “T Statistic” of ±1.98 is required to be statistically significant from zero at the 95 percent level.

Discussion: Except for ethanol production all of the variables have the expected direction of influence. Ethanol production was not statistically significant. Net gasoline exports had a negative, but statistically insignificant, effect on the price ratio.

Interestingly, as crude oil prices increase, the ratio of gasoline to crude oil price declines. This is likely due to the dilution of fixed refining costs as crude oil prices rise.

Model 4, Monthly Gasoline Crude Oil Price Spread versus Crude Oil, Ethanol Production and Other Related Factors:

January 2000 to February 2012 monthly average New York gasoline price and the crude oil composite acquisition cost by refiners were used to compute a cents per gallon price spread of gasoline to crude oil. That spread is modeled as a function of:

Explanatory Variable	Estimated Coefficient	T Statistic
Intercept	-60.273	-1.599
Crude oil composite acquisition cost by refiners ($/barrel)	0.201	3.576
Production of fuel ethanol (000 barrels)	0.000589	1.647
Percent utilization of refinery operable capacity	1.499	4.228
Month end crude oil stocks (excluding strategic petroleum reserve) (000 barrels)	0.0000818	3.252
Motor gasoline ending stocks (000 Barrels)	-0.000726	-4.960
Net gasoline exports (000 Barrels)	-0.000351	-1.525
Katrina effect, Sept-Oct 2005 = 1, otherwise 0	30.585	4.265
MTBE withdrawal effect, Apr-Aug 2006 = 1, otherwise 0	23.138	5.274
2007 refinery outages, Mar-Jul 2007 = 1, otherwise 0	26.967	6.048
If month is January = 1, otherwise 0	14.391	3.608
If month is February = 1, otherwise 0	16.699	4.080
If month is March = 1, otherwise 0	9.371	2.505
If month is April = 1, otherwise 0	4.886	1.310
If month is May = 1, otherwise 0	3.443	0.884
If month is June = 1, otherwise 0	-2.770	-0.689
If month is July = 1, otherwise 0	-7.739	-1.855
If month is August = 1, otherwise 0	-9.117	-1.969
If month is September = 1, otherwise 0	-1.928	-0.475
If month is October = 1, otherwise 0	-7.511	-1.813
If month is November = 1, otherwise 0	-5.835	-1.540
If month is December = 0 (base price for seasonal variation)	NA	NA

n = 146, Degrees of Freedom = 124, R^2 = 0.675

A “T Statistic” of ±1.98 is required to be statistically significant from zero at the 95 percent level.

Discussion: Except for ethanol production all of the variables have the expected direction of influence. Ethanol production was not statistically significant. Net gasoline exports had a negative, but statistically insignificant, effect on the margin.

Interestingly, as crude oil prices increase, the gross margin between the gasoline and crude oil prices increases. This is likely due to increasing refining costs as crude oil prices rise.