FarmEcon LLC
A source of information on global farming and food systems
Thomas E. Elam, PhD
President

FarmEcon LLC
3825 Constitution Dr.
Carmel, IN 46032
317-873-9949
www.farmecon.com
thomaselam@farmecon.com

The RFS, Fuel and Food Prices, and the Need for Reform

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Dr. Thomas E. Elam
President, FarmEcon LLC

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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.

Consumers have seen food prices increase faster than general inflation since the current RFS was enacted in 2007. Food affordability has stopped the long term trend of improving, and is deteriorating.

Job creation in the food sector has been substantially reduced by the diversion of corn to ethanol production. Almost 1 million potential food sector jobs that could have been created from 2007 to 2011 were not. Diversion of corn to ethanol production is one contributing factor to the prolonged recession in the U.S. labor market.

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. Domestic 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 market access in the event of a natural disaster, and a sharp reduction in corn production. Ethanol producers should fully share 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 and declines in food affordability 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 and 740 million in 2012.

- 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. The 2012 cost was reduced to $7.6 billion by the expiration of the conventional biofuel tax credit (VEETEC).
- Using measures of gasoline prices and oil refiner margins, from 2000 through 2012 there was no statistically significant effect of increased ethanol production on gasoline prices or oil refiner margins.
  - Both statistical models showed very weak, statistically insignificant, associations 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 and gasoline prices. That model used flawed methodology. Projected 2011 effects are unrealistic.
- In the U.S., the January 2007, through December 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 December 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 2012 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.
- Abandonment of the conventional biofuel RFS would not affect overall U.S. fuel supplies, but would tend to reduce the volatility and level of corn and other important agricultural commodity prices to the benefit of both food and fuel producers.
- Given the realities of cellulosic biofuels, the RFS program 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 a fuel 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):

"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)."

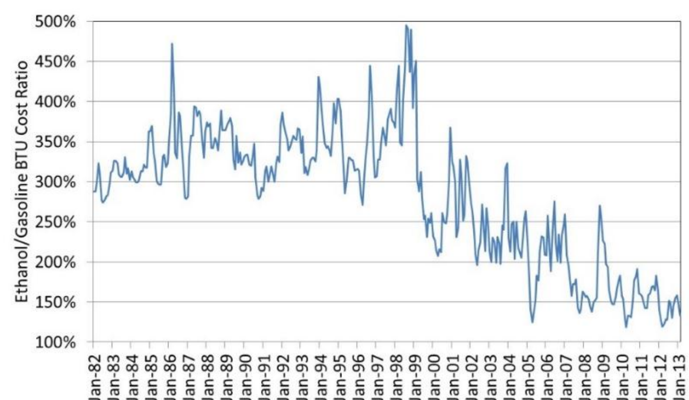
Ethanol must sell at a significant discount to gasoline to achieve equal fuel cost per mile. If ethanol blends higher than 10 percent are not competitively priced, the result will be failure of those fuels to achieve significant sales. That has been the fate of E85. According to recent Department of Energy statistics, ethanol blends of more than 55 percent account for only 1,000 barrels per week out of total gasoline production of about 8.8 million barrels per week. Ethanol blends under 55 percent, almost entirely E10, account for about 94 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 February 2013, 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 averaged a 60 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 February 2013



[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.
[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 4/17/2013.
[4] Nebraska Energy Office. Ethanol and Unleaded Gasoline Average Rack Prices. Found at http://www.neo.ne.gov/statshtml/66.html, Accessed 4/17/2013.

In 2011, the United States exported 1.2 billion gallons of ethanol, and 740 million gallons in 2012. 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 difference was $1.20 per gallon premium for ethanol energy versus gasoline energy. From January, 1982 until December 2007, the average was a $1.36 per gallon premium for ethanol energy. Again, ethanol energy has not been priced competitively with gasoline since 1982.

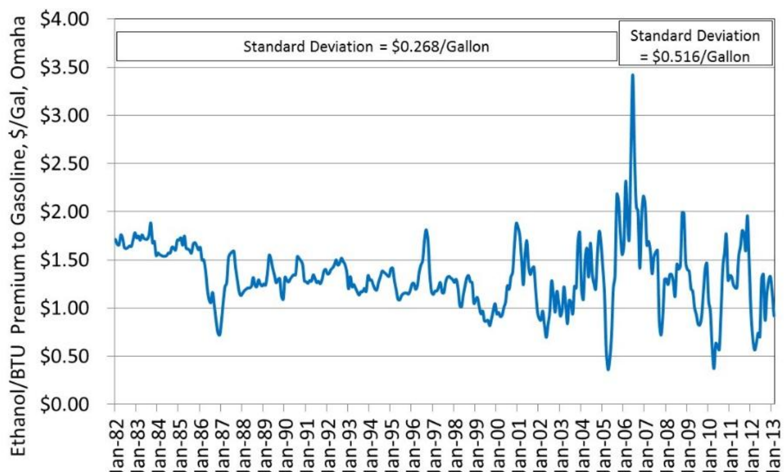
Not only has the ethanol energy price premium remained at high levels, the volatility of the premium has doubled. The standard deviation of the ethanol energy premium was $0.268 per gallon from 1982 to mid-2005, when the first RFS was enacted. Since then the standard deviation was $0.516 per gallon. 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 Equivalent

Omaha, Nebraska, January, 1982 to February, 2013



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.

[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.

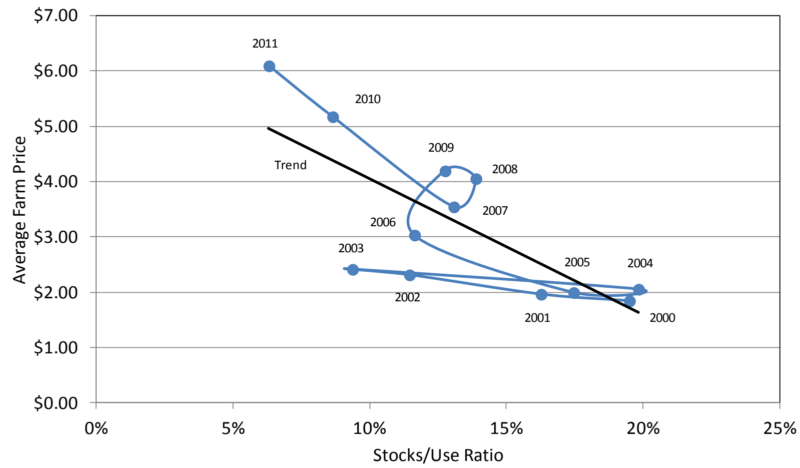
Increases in corn prices since 2005 are primarily the result of both higher mandates for corn-based ethanol production and higher energy prices. Each played a significant role, and they reinforced each other in their corn price effects. Absent the RFS mandates and higher oil prices, corn prices would 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.

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.

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.

Season-Average Corn Price vs. Stocks-to-Use Ratio
(Year is Year of Harvest, Black Line is Trend))

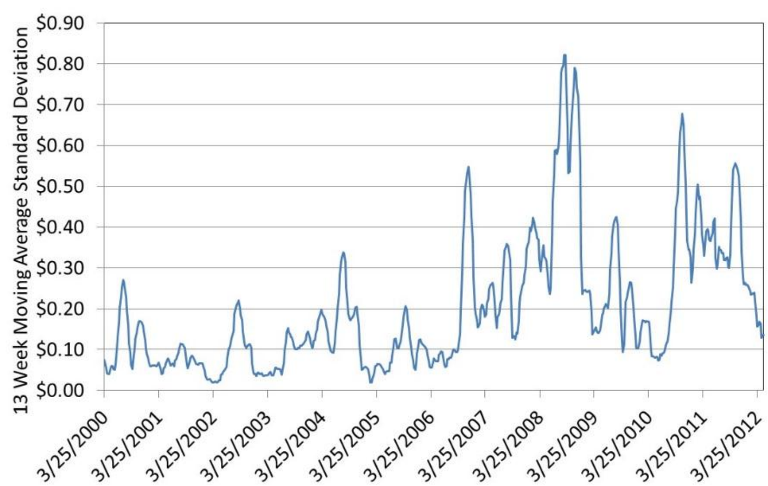


Less obvious than the increase in corn prices has been in the increase in their volatility. The next graph shows the 13 week standard deviation of weekly Central Illinois elevator corn bids. The volatility obviously increases markedly after the 2007 RFS. This higher volatility has increased business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

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.

13 Week Standard Deviation of Central IL Elevator Corn Bids

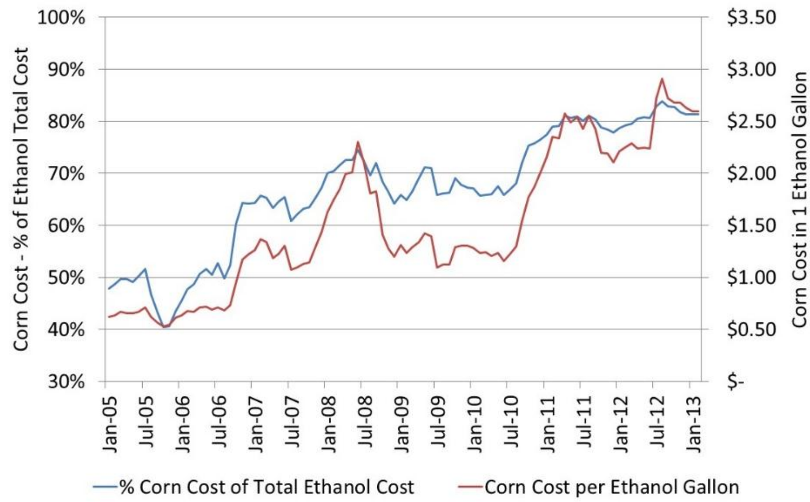


The impact of higher corn prices on ethanol production costs is shown in the following chart. Prior to the RFS, corn accounted for about a $0.60 cost per gallon of ethanol. The corn cost per gallon is now in the $2.50 to $2.75 range. Looking at the cost of just the corn used in ethanol for per gasoline-equivalent fuel energy produced, that cost is currently in the $3.75 to $4.10 range. This cost alone is well above recent wholesale prices for 87 octane unleaded gasoline.

Key Point:

Higher corn prices have increased the cost of ethanol production. Corn now represents over 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, 2012/2013 Crop Year[7]

Commodity	Units	Domestic Food Production Use	Price	Value/Cost, $ Million
Corn				
Corn as Grain	Bushels	5,787	$6.90	$39,930
DGs from Corn	Tons	33.7	$270	$9,099
Total Corn				$49,029
Soybeans				
Soybean Meal	Tons	29,900	$425	$12,708
Soybean Oil	Million Pounds	13,200	$0.49	$6,468
Total Soybeans				$19,176
Wheat	Bushels	1,386	$7.80	$10,811

[6] Source: Iowa State Ethanol Plant Profitability Model. Found at http://www.extension.iastate.edu/agdm/energy/xls/d1-10ethanolprofitability.xls. Accessed 4/17/2013

[7] USDA. World Agricultural Supply and Demand Estimates. April, 2013. DGs statistics are estimated based on ethanol production, exports and year-to-date prices.

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 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]

Crop Years 2005-2012

Commodity	2005	2006	2007	2008	2009	2010	2011	2012	% Increase 2005-2012
Corn									
Corn as Grain	$12,310	$21,177	$30,454	$26,382	$23,057	$32,126	$37,152	$39,930	224%
DDGS from Corn	$946	$1,782	$3,333	$3,118	$3,478	$6,884	$8,266	$9,099	861%
Total Corn	$13,256	$22,959	$33,787	$29,500	$26,536	$39,011	$45,418	$49,029	270%
Soybeans									
Soybean Meal	$5,782	$7,059	$11,138	$10,181	$9,537	$10,470	$12,708	$12,708	120%
Soybean Oil	$3,845	$4,947	$7,985	$4,656	$5,081	$7,479	$6,468	$6,468	68%
Total Soybeans	$9,626	$12,006	$19,123	$14,837	$14,618	$17,948	$19,176	$19,176	99%
Wheat	$3,677	$4,507	$6,234	$8,034	$5,206	$6,430	$10,811	$10,811	194%
Total Cost	**$26,559**	**$39,472**	**$59,143**	**$52,371**	**$46,360**	**$63,389**	**$75,404**	**$79,016**	**198%**
Cumulative Increase		**$12,912**	**$45,496**	**$71,308**	**$91,109**	**$127,939**	**$176,783**	**$229,240**	

By 2012, the annual farm level cost of the three commodities had risen from $26.6 billion in 2005 to $79.0 billion, more than tripled. The cumulative cost increase over the 2005-2012 was $229.2 billion.

It should 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 2012. 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 increased 9.6 percent, slower than the all items other than food increase of 10.5 percent. From 2008 to 2012 food prices increased 13.3 percent, all other items increased only 8.3 percent. Total inflation for all items other than food slowed by 21.2 percent from the period before the RFS compared to the period after. Food inflation increased 37.8 percent faster. Food categories that depend heavily on grains any edible oils saw even more rapid inflation increases after the RFS.

U.S. Price Inflation, Food, All Items Other than Food and Selected Food Categories[9]

Before and After the 2007 RFS

CPI Category and Ratio	From: January-2005 To: December-2007	From: January-2008 To: December-2012	Change in Inflation
All CPI Items Other Than Food (Includes Energy)	10.5%	8.3%	-21.2%
All Food	9.6%	13.3%	37.8%
Cereals and Bakery Products	9.4%	16.6%	76.6%
Meats, Poultry, Fish, and Eggs	8.3%	16.3%	96.7%
Fats and Oils	5.0%	29.6%	493.1%

[8] USDA. World Agricultural Supply and Demand Estimates. Various issues, 2005-2013. 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 4-17-2013.

The rapid increase in the last three categories should come as no surprise. They all make heavy use of the three basic commodities shown in a 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.

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 rates 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.

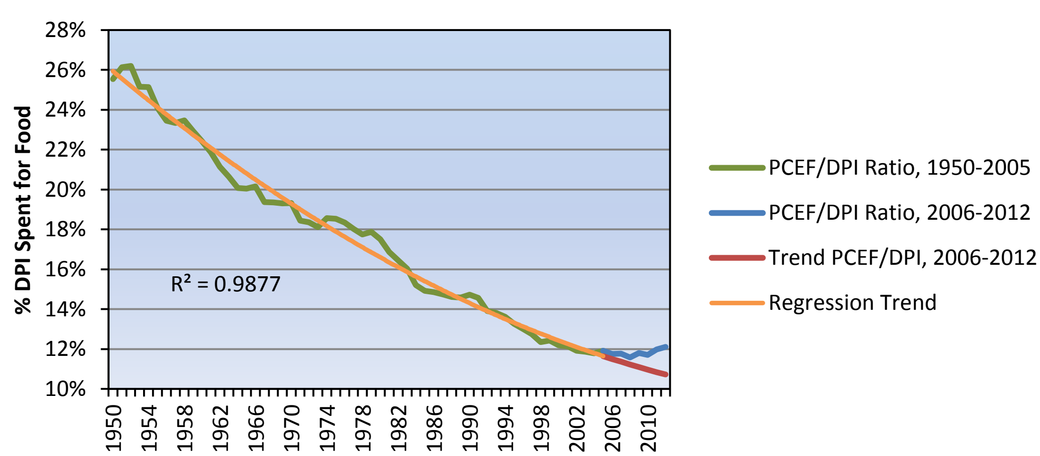
In addition, ethanol production costs and ethanol prices were also increased by the 2007 RFS. The result was that ethanol has been priced out of all blends except E10. Thus, the United Sates is producing surplus ethanol that cannot be sold here, and was having to export significant surplus ethanol until the 2012 crop disaster forced reductions in ethanol production!

Food Affordability Has Been Profoundly Affected

A major U.S. long term economic trend has been increasingly affordable food. Affordability has been commonly measured as the percent of disposable income spend for food. The trend is not a straight line; affordability improvement has been slowing over time, but was still trending down until 2006. Since 2006 this trend has reversed, and that reversal is the largest since 1950. Increasing food affordability has freed up income for spending on all other consumer goods and services, helping the economy grow and add jobs.

Since 2007, food prices are increasing compared to all other prices, and consumers' food costs are now increasing relative to the long term trend. The last time the gap grew in a manner similar to the current experience was during the 1970s when farm commodity prices boomed as a result of growing grain and soybean exports. The current gap is much larger than that one.

Personal Consumption Expenditures for Food (PCEF): Percent of Disposable Personal Income (DPI)

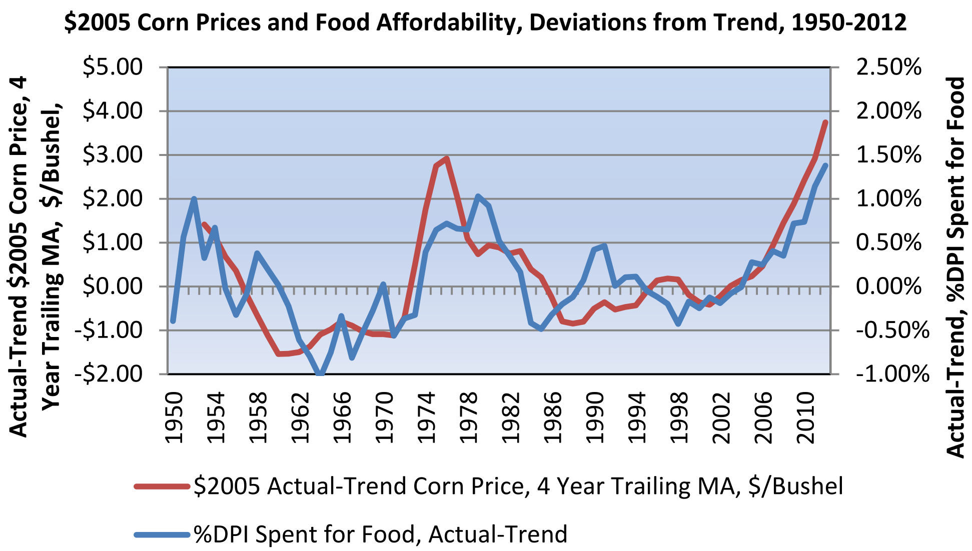


The graph above shows this departure from the long term affordability trend. Food spending is shown as a percent of disposable (after tax) personal income.

With a R^2 of 0.988, the 1950-2005 affordability trend line (orange) is a near perfect fit to the actual data (green). The blue line is 2006-2012 actual data, the red line is the 1950-2005 trend projected from 2006 to 2012. A declining trend shows improving food affordability. The blue line trends up, and indicates declining affordability. The gap between the 2012 actual and trend food affordability is about $160 billion in food spending.

The increasing food affordability gap is related to the sharp increase in post-2007 commodity prices. With a very long and involved chain of production and supply of all the items that use major crops, increases in their prices do not immediately show up at the supermarket or restaurant. In fact, short term volatility in major crop prices rarely show up at the consumer level. But, with the sustained price increases since 2005, we are now seeing major impacts on food production costs, retail food prices, and restaurant menu prices.

Looking at the record of corn prices and food affordability (measured as percent of disposable income spent for food, see next chart) there is a clear relationship between changes in corn prices and food affordability. As already mentioned, corn prices affect markets and prices for other farm products, so when corn prices rise as they have since 2005, other farm product prices will go up too, adding pressure to increase retail prices of a broad range of food prices.



The graph above shows the relationship between constant dollar (using the 2005 base year Personal Consumption Expenditures (PCE) price deflator) corn price deviations from trend versus food affordability deviation from trend. Due to the high year-to-year volatility of corn prices, a 4 year moving average of the corn price trend deviations is used. The data are, again, 1950 to 2012. An increase in food spending as a percent of DPI is a reduction in food affordability.

Costs to the Average Food Consumer, Family of Four and the U.S. Economy: The post-2005 increase in food costs relative to trend has had added significant expense to family food bills and the nation's food expense. The table below details these food cost increases versus the long term affordability trend.

In current 2012 dollars, the average person saw a 2012 food bill that was $514 higher than trend. For a family of four, the increased cost above the trend was $2,055.

For the country's food spending, the actual above-trend 2012 food bill was $162 billion. In perspective, the increase in food spending is about the same as annual consumer spending on either vehicle repairs, college education, or telecommunications. Given the outlook for sustained high major crop prices through mid-2013, we are likely to see another very large 2013 food bill increase.

Food Cost Increases Versus 1950-2005 Trend

Year	Per Capita Actual-Trend Cost, $2005	Per Capita Actual-Trend Cost, $Actual	Family of 4 Food Cost, $Actual	Family of 4 Actual-Trend Cost, $Actual	Total Economy Actual-Trend Cost, Billion $2005	Total Economy Actual-Trend Cost, Billion $Actual
2006	$79	$82	$15,589	$326	$24	$24
2007	$132	$139	$16,255	$557	$40	$42
2008	$116	$126	$16,754	$504	$35	$38
2009	$230	$250	$16,484	$1,002	$71	$77
2010	$238	$264	$16,807	$1,057	$74	$82
2011	$371	$423	$17,736	$1,690	$116	$132
2012	$440	$514	$18,017	$2,055	$139	$162

Of the $162 billion above-trend total food cost increase for the 2012 U.S. food bill, about $70 billion, or 44%, is due to 2005-2012 price increases for grains, soybean products, DDGS and hay. These are the major commodities used to produce our meats, eggs, dairy products, bread, bakery products, cereal, and are also included in a wide range of other supermarket and restaurant food items. In addition, costs for a wide variety of other related minor agricultural commodities have also increased.

The RFS was a major factor behind the increased corn demand that led to higher food prices and increased family spending. Nowhere in the world has there been any major biofuel production sector created without similar mandates or heavy subsidies. Absent the RFS and its blending mandates, the industry would not have the market power to create these disruptions to the nation's economic fabric and food production sector.

Has Increased Ethanol Production Created or Destroyed Jobs?

Direct versus Indirect and Induced Jobs: Economic activity in any sector will create activity in other sectors. Indirect jobs are created when, for example, a construction project in the meat processing sector creates jobs for the construction sector. For meat and poultry, indirect jobs are also created in the very large food wholesaling, retailing and foodservice sectors. Induced jobs are created when direct employees in a sector spend their income for goods and services in other sectors. For example, when an ethanol plant employee visits a doctor, jobs are supported in the medical care sector.

Drawing the line on what to count and not to count in indirect and induced jobs is always arbitrary. Direct jobs are the only ones we can count with a high degree of precision.

Impact on Direct Post-Farm Processing Jobs: If we examine corn use numbers in the context of post-farm processing sector direct jobs that are part of food versus fuel value-added chains, there is a dramatic difference. Each million tons of corn plus DDG used to produce meat and poultry supports 3,602.3 direct jobs in processing alone (524,500 ÷ 145.6). The same number for ethanol processing is

159.8 direct jobs (11,971 ÷ 74.9), only 4.4% as many per ton of corn used as meat and poultry processing. Clearly, diverting corn from meat and poultry production to ethanol reduces the net employment opportunities.

Direct Jobs per Million Tons of Corn/DDG Use and Indirect/Induced Jobs Multipliers
Ethanol versus Meat and Poultry Processing

Item	Value
Direct Jobs in Ethanol Processing Sector	11,971
Direct Jobs in Meat and Poultry Processing Sector	524,500
Million Tons of Corn Used in Ethanol Production Net of DDG Production	74.9
Million Tons of Corn and DDG Used in Meat and Poultry Production	145.6
Direct Jobs per Million Tons of Corn and DDG Used in Ethanol Processing Sector	159.8
Direct Jobs per Million Tons of Corn and DDG Used in Meat and Poultry Processing Sector	3,602.3
Claimed Indirect and Induced Jobs in Ethanol Processing	383,260
Assumed Ethanol Processing Jobs Multiplier	**32.5**
Claimed Indirect and Induced Jobs in Meat and Poultry Processing	1,269,500
Assumed Meat and Poultry Processing Jobs Multiplier	**2.4**

Direct employment in meat and poultry processing is over 32 times the number directly employed by ethanol processors. Put another way, for every direct job at risk in the ethanol industry, there are more than 32 direct jobs at risk in meat and poultry value-added sectors. Or, put another way, corn used in meat and poultry production creates more than 32 times the number of direct jobs than the same amount of corn used in ethanol production. Unintended consequences of the RFS are putting large numbers of current and potential food sector jobs at risk in exchange for minimal job gains in ethanol production and value.

A recent Renewable Fuels Association employment study claimed an added 32.5 indirect and induced jobs per direct employment job in the ethanol industry. The meat and poultry study claimed a more modest 2.4 jobs. Given the vastly lower post-processing value added to ethanol versus meat and poultry, the higher jobs impact multiplier for ethanol is extremely dubious.

Impact on Indirect and Induced Post-Farm Jobs: As shown in the table above, both meat and poultry and ethanol production affect many jobs outside their direct value chains. Indirect jobs are those that support the activities of the value adding process, but are defined as belonging to other economic sectors. These jobs include equipment and services suppliers, construction, hired transportation, travel, government employees, and a myriad of other occupations that support the direct employment sector. Induced jobs are those supported by the income earned by direct and indirect jobs holders. Induced jobs span the entire economy.

The methodology used to estimate the number of indirect and induced jobs is, by its nature, somewhat arbitrary. In theory, all economic activity has some degree of impact on all other economic activity. Some of those impacts are major, and easily observable. Construction work on a meat processing or ethanol plant obviously causes meaningful impact on the local construction sector, and its suppliers. A million gallons of ethanol produced in the U.S. has a theoretical, but not meaningful or measurable, impact on European grain production and associated jobs. Drawing the line between meaningful and negligible impacts will always involve judgment on where to stop counting. However, these impacts are very real.

Both meat and poultry groups and the ethanol industry have published recent indirect and induced job impact estimates. A 2011 study sponsored by the Renewable Fuels Association claimed 401,600 direct, indirect and induced jobs are associated with ethanol production[10]. The Renewable Fuels Association estimate implies that a million tons of corn used in ethanol production affects 5,359 jobs (401,400 ÷ 74.9).

According the 2009 American Meat Institute (AMI) study, 1,794,000 direct, indirect and induced jobs are involved in meat and poultry production and processing[11]. Meat and poultry production and processing system touches 10,749 jobs per million tons (1,794,000 ÷ 166.9), or 2.0 times the number of ethanol jobs. Even accepting very dubious ethanol industry indirect and induced jobs claims, corn used to produce meat and poultry creates significantly more employment.

A 2012 study for the U.S. poultry (broilers, turkeys and eggs) industry, using the same model employed by Renewable Fuels, estimated 327,400 direct jobs and a total of 1,337,030 direct and indirect jobs.[12] The total number of jobs affected is similar to the AMI study. Many of those jobs are in the processing, retailing and foodservice sectors that overlap both poultry and other meats.

Evidence of Economic Damage and job Losses from Employment Statistics: One symptom of reduced meat and poultry consumption shows up in recent declines in indirect food sector jobs. From 2002 to 2007 direct employment, on a full time equivalent (FTE) basis, in food production, processing, retailing and foodservice increased by 751,000. From 2007 to 2011 (2012 data are not available as of this time), employment in the same area declined by 195,000 FTE jobs. The net swing in job creation was 941,000 jobs. This change in job creation is partially attributable to the declines in meat and poultry consumption in 2007-2011 versus 2002-2007.

Full Time Equivalent Direct Employment in Food-Related Sectors (000s)[13]

Industry	2002	2007	2011
Agriculture, Farming	747	643	643
Food processing	1,689	1,622	1,575
Food stores	2,558	2,527	2,454
Food Service	6,718	7,671	7,596
Total Food Related FTE Employees	11,712	12,463	12,268
Net Change		**751**	**(195)**

Has Increased Ethanol Production Reduced Gasoline Prices?

A recent Iowa State working paper[14] 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,

[10] Data Source: Renewable Fuels Association, Contribution of the Ethanol Industry to the Economy of the United States, 2011.
[11] Data Source: American Meat Institute, The Meat and Poultry Industry Economic Contribution Study: 2009
[12] Data Source: The Poultry and Egg Industry Economic Contribution Study: 2012
[13] Data Source: Bureau of Economic Analysis: National Income and Product Accounts Tables

convoluted, calculation based on a highly dubious statistical model, since refuted by both this study and a more complete analysis from MIT and UC Davis[15].

With a more direct approach using actual (not the arbitrarily 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 shifted U.S. gasoline from domestic use to exports.

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. Two models were used. Both of the models are based on monthly data for January 2000 through December 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 small positive, but statistically meaningless, effect on gasoline prices. The estimated equation explained 98.7 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 both models are in the appendix to this study.

[14] 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.
[15] Christopher R. Knittel and Aaron Smith. Ethanol Production and Gasoline Prices: A Spurious Correlation. Giannini Foundation for Agricultural Economics. University of California Davis. July 12, 2012

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 small negative, but statistically meaningless, effect on the crack spread. Net gasoline exports were also statistically insignificant. All statistically significant variables had the expected direction of influence on the crack spread.

The model explained 73.6 percent of the variation in the crack spread.

Conclusions

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 December 2012. In the models increasing ethanol production was statistically insignificant in explaining wholesale gasoline prices or refiner margins.

The overall conclusion is that increasing ethanol production over the 2000-2012 period had no significant effect on wholesale gasoline pricing or refiner margins.

In both models net gasoline exports were also statistically insignificant. Increased ethanol production has caused gasoline exports to increase, but those increased exports have not depressed gasoline prices or refining 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 both 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.

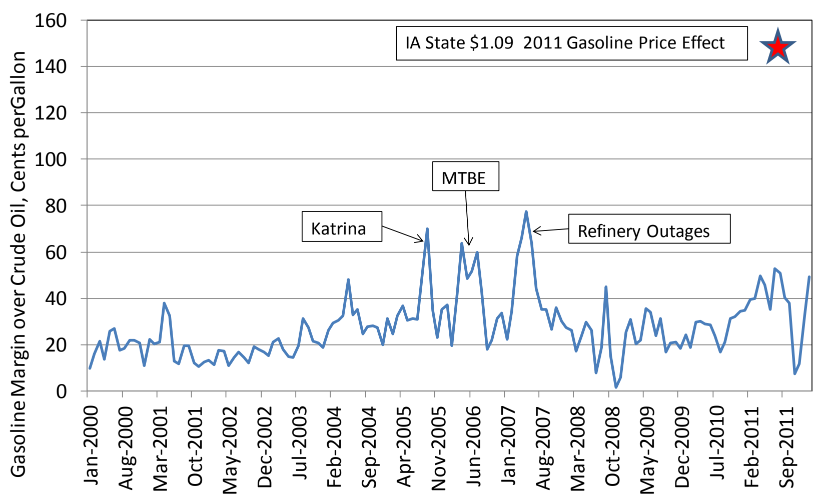
Other Iowa State Paper Issues

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.

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

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.



More significantly, the Iowa State authors do not seem to realize that their extrapolated $1.09 per gallon increase in 2011 gasoline price relative to the crude oil price would cause major changes in supply-side market behavior (preceding graph). 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.

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.

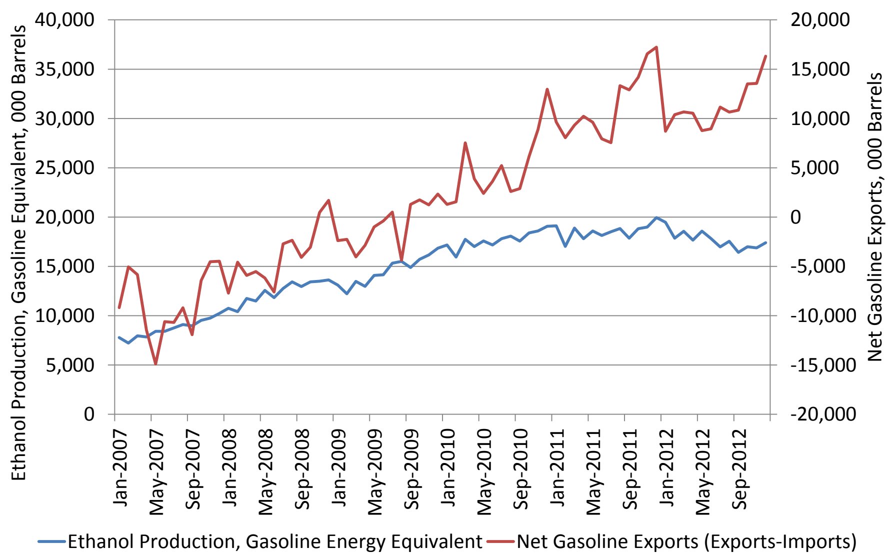
Has Increased Ethanol Production Increased U.S. Energy Supplies?

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 2012 was exported (next chart).

Monthly Ethanol Production (Gasoline Energy Equivalent) and Gasoline Exports

Key Point:

The increase in ethanol production since 2007 has displaced U.S. gasoline consumption, not added to the domestic energy supply. All of the energy produced by the added ethanol, and more, has left the country in the form of higher gasoline exports and reduced gasoline imports. As of the end of 2012, net gasoline exports are almost equal to the gasoline equivalent of all ethanol production.



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 production has had no significant effect on gasoline production?

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

In 2012, about 94 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, 2012 U.S. total liquid fuel consumption was about 5.199 billion barrels. Gasoline-equivalent ethanol consumption was about 203 million barrels (table below). U.S. ethanol energy consumption was only 3.9 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	2012, 000 Barrels
U.S. Ethanol Consumption, Gasoline Equivalent	202,549
Total U.S. Liquid Fuels Consumption	5,199,910
Ethanol Percent of U.S. Liquid Fuels	3.9%
U.S. Ethanol Production, Gasoline Equivalent	212,166
Global Liquid Fuels Consumption	32,499,600
U.S. Ethanol Percent of Global Liquid Fuels	0.65%

Does Ethanol Save Motorists Money?

The ethanol industry claims that increased use of ethanol fuel 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.

2011 Wholesale Level Cost of U.S. Ethanol Consumption[16]

Item	2012
Gasoline Average Price per Gallon	$2.95
Ethanol Average Price per Gallon, Gasoline Equivalent	$3.54
Ethanol Price Premium per Gallon	$0.59
Billion Gallons of Ethanol Consumed	12.95
Ethanol Cost to Motorists, $Billion	$7.61
Actual Ethanol Average Price per Gallon	$2.37

The table above shows that the 2012 ethanol price premium added about $7.6 billion to motorists' fuel bills. That cost was about half of 2011. Elimination of the conventional ethanol tax credit on January 1, 2012 saved $5.7 billion in federal outlays, and reduced the wholesale ethanol price by about $0.40 cents per gallon. The lower ethanol price reduced the cost of ethanol in the E10 blend that was 94% of sales.

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

[16] Sources: Ethanol and gasoline prices are from the Nebraska Energy Office. Ethanol consumption is from the Department of Energy, Energy Information Administration.

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[17]. However, on an energy basis the U.S. consumed only 188 million barrels of ethanol in 2011. How can 188 million barrels replace 485 million barrels?

The claim is apparently based on the theory that for every barrel of ethanol production there is no need to import all of the crude oil used to produce that 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 imports. The first problem with this theory is that if the U.S. did reduce crude oil imports, there would less production of all crude oil-based fuels, and other products other than gasoline. The U.S. would then need to import those other 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 2012 was about 281 million barrels. That is the energy of 188 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 will 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 2012 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, gasoline net 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, not refined product supply reductions.

U.S. Gasoline and Ethanol, Production, Trade and Consumption, 2007-2012[18]

[17] http://ethanolrfa.org/pages/ethanol-facts-energy-security, Accessed April 17, 2013
[18] These estimates use definitions that are different from the U.S. Department of Energy

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	3,008,762	136,539	2,872,223	199,168	3,071,391	1,637,771	5,404,347
2012 Actual	2,947,293	134,069	2,813,224	202,549	3,015,773	1,639,606	5,492,025
2007-12 Change	**33,282**	**238,317**	**(205,035)**	**111,025**	**(94,010)**	**131,076**	**(40,072)**

From 2007 to 2012, 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. On balance, all the gasoline displaced by ethanol, plus a significant amount of ethanol, was exported. Net gasoline exports increased by more than twice the increase in ethanol blending use. Net gasoline exports of 134,069,000 barrels in 2012 were more than the 2007-2012 111,025,000 barrel increase in ethanol blending (gasoline energy equivalent). Crude use declined, but not due to refined fuel product production reductions.

One way to look at what happened as a result of increased ethanol production is that the RFS has forced almost all of the 2007-2012 ethanol production increase to be used in the U.S. In a very real sense, all of the energy contained in the 2007-2012 ethanol production increase was actually exported in the form of gasoline because there was no market for it here! We could have exported all of that 111,025,000 barrels of 2007-2012 increased ethanol production (gasoline energy equivalent) and still been a net gasoline exporter in 2012!

In other words, the 2007-2012 increase in ethanol production increased the global energy supply, but that energy was exported from the U.S. in the form of gasoline. Increased ethanol production since 2007 has not increased U.S. motor fuel consumption, or reduced crude oil use, or crude oil imports. That fact helps make sense out of the statistical model results that show no impact of increasing ethanol production in gasoline prices.

A major factor in reduced crude oil imports and use was increased total refiner fuel yield. As shown in the next table, the total gasoline and fuel oil yield increased from 71.6 percent in 2007 to 74.3 percent in 2012. Refiners reduced gasoline yields slightly due to its declining consumption. Versus 2007 yields, the yield increase saved 149 million barrels of 2012 crude oil use.

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 2012. Ethanol cannot replace any of those other refinery products.

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	44.9%	28.9%	73.8%
2012	45.2%	29.1%	74.3%

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 supplies grew and gasoline sales fell. With U.S. gasoline consumption on the decline, and ethanol adding to the gasoline supply, refiners simply started to produce slightly less per barrel of oil, and export more, gasoline to balance their total fuels supply and demand.

RFS Impact on Corn and Meat 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, and their impact on food spending, have acted as a drag on post-2007 economic growth, and recovery from the 2008-2009 recession. Job creation has also been slowed.

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 in 2011/2012 before the 2012 crop disaster forced use down to 4.55 billion in 2012/2013. 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 4.4 billion in 2012/2013. 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 18 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 5.7 billion bushels in 2012/2013.

Corn exports declined from about 2.1 billion bushels in 2005/2006 to an estimated 0.8 billion bushels in 2012/2013.

Both of these declines in use are the result of farm level corn prices increasing from $2.00 for the 2005/2006 crop year to almost $7.00 in 2012/2013. Higher corn prices (and associated increases in wheat and soybean product prices) have dramatically raised the costs of producing meat and poultry. Our former export customers have turn largely to South America for their corn needs.

April 10, 2013 USDA Corn Production, Supply and Demand Estimates[19]

Item	2005/ 2006	2006/ 2007	2007/ 2008	2008/ 2009	2009/ 2010	2010/ 2011	2011/ 2012	2012/2013 USDA Fcst.
Area Planted (Mill. Ac.)	81.8	78.3	93.5	86.0	86.4	88.2	91.9	97.2
Area Harvested (Mill. Ac.)	75.1	70.6	86.5	78.6	79.5	81.4	84.0	87.4
Yield (Bu/Ac.)	148.0	149.1	150.7	153.9	164.7	152.8	147.2	123.4
Beg. Corn Stocks (Mill. Bu.)	2,114	1,967	1,304	1,624	1,673	1,707	1,128	990
Corn Production (Mill. Bu.)	11,114	10,535	13,038	12,092	13,092	12,447	12,360	10,780
Corn Imports (Mill. Bu.)	9	12	20	14	8	28	29	125
Total Corn Supply (Mill. Bu.)	13,237	12,514	14,362	13,729	14,773	14,182	13,517	11,895
Corn Feed Use (Mill. Bu.)	6,155	5,598	5,938	5,182	5,125	4,793	4,545	4,400
Food/Seed/Ind. Use (Mill. Bu.)	2,981	3,488	4,363	5,025	5,961	6,426	6,439	5,937
Fuel Ethanol Use (Mill. Bu.)	1,603	2,117	3,026	3,709	4,591	5,021	5,011	4,550
Est. DDGS Prod. @18 lbs (Mill. Bu. Equiv.)	563	744	1,064	1,304	1,614	1,765	1,762	1,599
DDGS Exports (Mill. Bu. Equiv.)	50	73	161	204	340	340	309	267
Est. DDGS Feed Use (Mill. Bu. Equiv.)	513	671	903	1,100	1,274	1,425	1,452	1,333
Corn + DDGS Feed Use (Mill. Bu. Equiv.)	6,668	6,269	6,841	6,282	6,399	6,218	5,997	5,733
Other Food/Seed/Ind. Use (Mill. Bu.)	1,378	1,371	1,337	1,316	1,370	1,405	1,428	1,387
Corn Exports (Mill. Bu.)	2,134	2,125	2,436	1,849	1,980	1,835	1,543	800
Corn Net Exports (Mill. Bu.)	2,125	2,113	2,416	1,835	1,972	1,807	1,514	675
Total Corn Use (Mill. Bu.)	11,270	11,210	12,737	12,056	13,066	13,054	12,527	11,137
Ending Corn Stocks (Mill. Bu.)	1,967	1,304	1,624	1,673	1,707	1,128	990	758
U.S. Average Farm Price, Corn, $/Bu.	$2.00	$3.04	$4.20	$4.06	$3.55	$5.18	$6.22	$6.90
% Corn Production Used for Fuel Ethanol	14%	20%	23%	31%	35%	40%	41%	42%

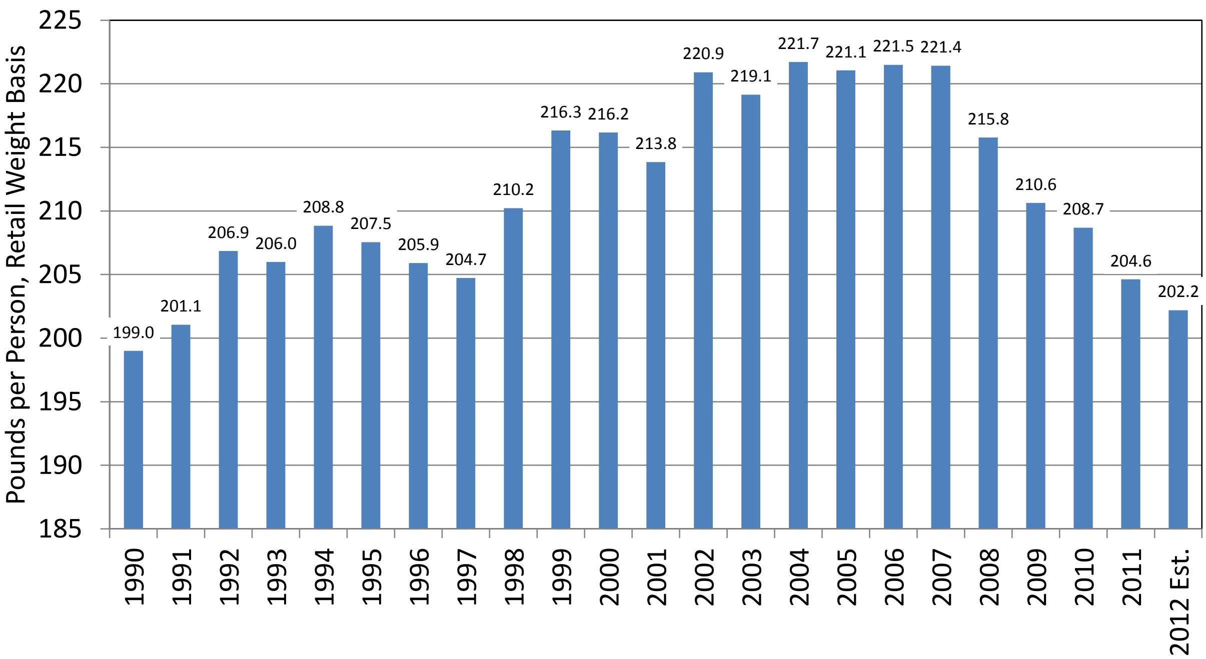
In the domestic market, the sharp increases in corn prices after 2007 have led to higher prices for foods that make heavy use of corn. Meat and poultry production has been heavily affected. Higher prices for these commodities have forced price rationing among consumers, and per capita consumption has declined to levels not seen since 1991 (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 production and 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.

USDA Estimates of Per Capita Total Meat and Poultry Consumption, 1990-2012[20]

[19] USDA, World Agricultural Supply and Demand Estimates, April 10, 2013. Years are September 1 crop years. DDGS statistics estimated by FarmEcon.

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



Summary: An inflexible RFS has caused high and volatile corn prices. Extremely small carryover stocks in 2010/2011 to 2012/2013 caused corn prices to increase to new record levels. Those higher prices severely rationed both feed use, resulting meat consumption, and exports.

The inflexible RFS impact on corn prices and price volatility was studied by Iowa State University. Not only would corn prices have been lower, 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.

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 plants (Poet/DSM and DuPont) are under construction. They are scheduled to come online in 2014. However, they will cost about $500 million to build, and have only 55 million gallons-per-year initial capacity, but only if they operates as designed.

The 2014 cellulosic ethanol RFS calls for 1.75 billion gallons of cellulosic ethanol. The 2014 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[21]. 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.

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

The Bottom Line

Despite overwhelming evidence that the inflexible RFS is causing significant economic harm, and few benefits, the EPA refused to grant a RFS waiver in the wake of the 2012 corn crop disaster. The current waiver system that relies on the judgment of a single political appointee is broken. The conventional biofuel RFS needs to be substantially reformed, or entirely removed.

Appendix: Gasoline Price Models

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

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

Variable	Coefficient	T
Constant	-92.33935775	-2.326185877
U.S. Crude Oil Composite Acquisition Cost by Refiners (Dollars per Barrel)	2.661642753	45.55229375
U.S. Oxygenate Plant Production of Fuel Ethanol (Million Barrels)	0.075380391	0.20072791
U.S. Percent Utilization of Refinery Operable Capacity (Percent)	1.727789506	4.802931302
U.S. Ending Stocks excluding SPR of Crude Oil and Petroleum Products (Million Barrels)	0.11918305	4.725172965
U.S. Motor Gasoline Ending Stocks (Million Barrels)	-0.824142742	-5.767141876
Net gasoline exports (Million Barrels)	0.04983226	0.210245441
Jan	16.03112208	3.860174213
Feb	17.75201631	4.158569722
Mar	10.5352715	2.686626276
Apr	5.162261127	1.301101864
May	0.958144504	0.229422696
Jun	-5.694714684	-1.330484275
Jul	-9.651037834	-2.192225171
Aug	-10.3360385	-2.133427155
Sep	-1.862283641	-0.430238169
Oct	-8.462763507	-1.926738424
Nov	-6.681878724	-1.671766198
Katrina Effect Sept-Oct 2005	33.33642842	4.296622099
MTBE Effect Apr-Aug 2006	21.5025586	4.493252383
2007 Refinery Outages Mar-Jul 2007	27.25898261	5.653795163

n = 156, Degrees of Freedom = 134, R^2 = 0.987

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. The monthly price level seasonal estimates use December as the base month.

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

January 2000 to December 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:

Constant	-33.17838042	-2.435228108
U.S. Crude Oil Composite Acquisition Cost by Refiners (Dollars per Barrel)	0.18145835	9.048244859
U.S. Oxygenate Plant Production of Fuel Ethanol (Thousand Barrels)	-4.08342E-05	-0.316811101
U.S. Percent Utilization of Refinery Operable Capacity (Percent)	0.631397725	5.11382022
U.S. Ending Stocks excluding SPR of Crude Oil and Petroleum Products (Thousand Barrels)	3.89383E-05	4.497876255
U.S. Motor Gasoline Ending Stocks (Thousand Barrels)	-0.000282767	-5.765201869
Net gasoline exports (Thousand Barrels)	-1.10472E-05	-0.135798319
Jan	5.30267672	3.720189262
Feb	5.554682218	3.791249947
Mar	2.44603812	1.817404701
Apr	-0.012523	-0.009196162
May	-1.876730705	-1.309285103
Jun	-3.964723245	-2.69884258
Jul	-5.418660026	-3.586162342
Aug	-5.526645823	-3.323626663
Sep	-2.318905977	-1.560893056
Oct	-3.5890465	-2.380765055
Nov	-2.517690736	-1.835296485
Katrina Effect Sept-Oct 2005	12.00910082	4.509677446
MTBE Effect Apr-Aug 2006	6.170663751	3.756898444
2007 Refinery Outages Mar-Jul 2007	8.212864375	4.963088033

n = 156, Degrees of Freedom = 134, R^2 = 0.736

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

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