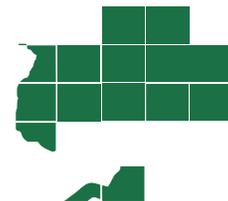


# Agricultural and Resource Economics UPDATE



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## Do Gasoline Prices Account for Ethanol's Lower Energy Content?

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U.S. law effectively mandates that retail gasoline must contain at least 10% ethanol. This artificial demand for ethanol drives up the price of corn, harming livestock operations and global food consumers. Recently, the U.S. government determined that short-term removal of the mandate would have no measurable impact on ethanol demand and, therefore, no impact on corn prices. If true, this ruling suggests motorists may be paying the same retail price for ethanol as gasoline, even though ethanol lowers fuel economy.

In 2011 the United States consumed about 134 billion gallons of gasoline. An additional 13 billion gallons of ethanol was blended into that gasoline, as required by U.S. energy policy. At \$3.50 per gallon, total consumer spending at the gas pump was approximately \$515 billion in 2011.

Unlike in Brazil or Canada, where motorists are free to choose whether they burn ethanol in their engines, motorists in the United States are required to use gasoline that is blended with ethanol. The blending reduces fuel economy because ethanol produces about one-third less energy per gallon than gasoline.

One main reason the U.S. government requires ethanol blending is the strong political lobby of the corn farmers who now sell about one-third of their harvest into the fuel market instead of the food market. They also receive political backing from the renewable fuels industry.

The acute 2012 drought in the Midwest lowered the U.S. corn harvest by about 28% from levels expected in June 2012, a supply shock of historical proportions. The drought had an unprecedented impact on corn prices because a large share of the harvest was already taken off the market by the ethanol program irrespective of the overall supply situation.

There is some scope to reduce ethanol production below mandated levels

in a particular year by using credits accumulated by above-mandate production in the previous year. However, uncertainty about future ethanol policy, the desire to save these credits for future years, and the value of ethanol in a gasoline blend means that most of the demand rationing for the 2012–13 corn harvest was placed onto non-ethanol uses. This is the portion of the corn market that allows for supply and demand to work and, accordingly, the drought severely impacted the livestock industry and food consumers—especially those in less-developed countries.

The U.S. government could have potentially mitigated some of the effects of the 2012 drought by issuing a one-year waiver on the ethanol mandate, effective January 1, 2013, and then extended for one additional year in 2014. It was for this reason that several state governors petitioned the U.S. Environmental Protection Agency (EPA) to temporarily relax biofuel volume requirements under the renewable fuels standard—RFS. The governors, several members of Congress, and many firms and associations in the agricultural sector were asking the EPA to give the food markets some relief from record-high grain prices brought on by the drought.

But the EPA rejected the waiver request because it found the mandate is not causing severe economic harm. The EPA decision, announced

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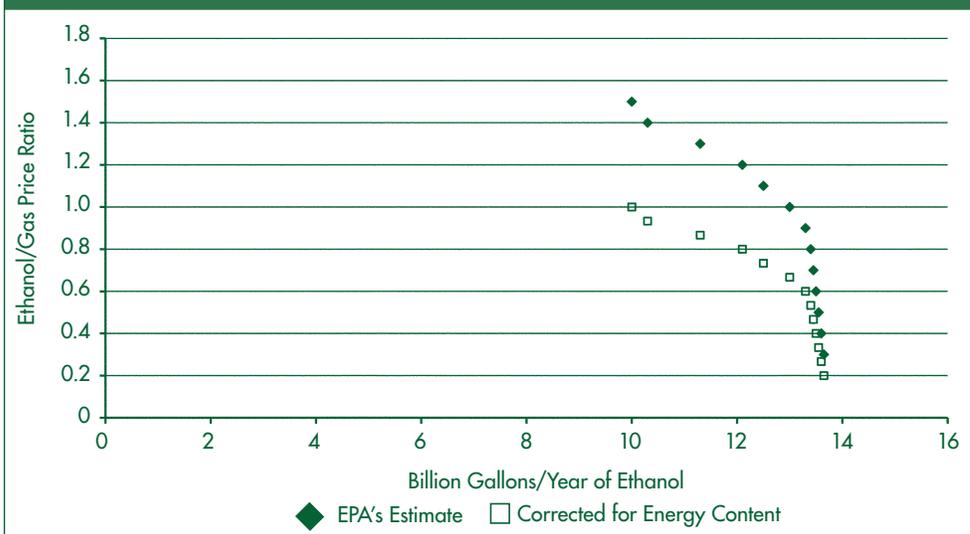
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Figure 1. Estimated Ethanol Annual Demand Curve for 2012 and 2013



in November 2012, is not surprising because of the politics of ethanol. By law, the agency determined that it could only grant a relatively short-term waiver (one year) and the criterion for doing so was very stringent. It would have required the EPA to find that the RFS created “severe” economic harm in the short-run.

### Demand for Ethanol by Refiners and Blenders

If the RFS had been waived, then refiners and blenders would have been free to choose how much ethanol to blend into gasoline. The decision would be driven by economics and motorist demand for ethanol, unlike the current situation in which they are forced to blend a certain annual volume.

Implicit in the EPA’s recent ruling was a determination that the ethanol mandate is not binding in the short-run, which means the gasoline industry would continue to blend 10% corn ethanol into gasoline even if no longer required to do so. In other words, the EPA found that the demand curve for ethanol is relatively steep because refiners and blenders like to use ethanol even if they are paying more than its true market value. One reason they might like ethanol so much is that they can blend it into gasoline without dropping the

price to allow for the fact that ethanol dilutes the energy value of the fuel.

Figure 1 reproduces the ethanol demand curve used by the EPA in arriving at their finding. The vertical axis in Figure 1 is the price ratio of ethanol to gasoline. Historically, the ratio of ethanol to gasoline prices has been around 90%, but it fluctuates with the prices of corn and crude oil. Until 2011 there was a tax credit for blending ethanol, which affected the ethanol to gasoline price ratio.

The demand curve used by the EPA is traced out by the solid diamonds in Figure 1. This curve assumes that, even if the price of ethanol were 40% more than gasoline, refiners and blenders would choose to blend 10 billion gallons of ethanol; at 20% higher prices, they would still blend about 12 billion gallons, which is close to 90% of the 2013 mandate. Therefore, as part of its ruling, the EPA decided that ethanol will be blended even if it is substantially more expensive than gasoline and there is no mandate. This is unlikely.

In Figure 1 we draw an alternative demand curve that adjusts for energy content, which is traced out by the hollow squares in Figure 1. This demand curve starts to bend to the left once the ethanol/gasoline price ratio rises above 0.7 because ethanol has only two-thirds

the energy content of gasoline.

We believe the finding that a RFS waiver would have a relatively small impact on the demand for ethanol for blending was partly due to the EPA’s assumption that gasoline is sold on a volume (and not on an energy) basis. This implies it is profitable for the industry to “cut” gasoline with ethanol as long as ethanol is cheaper than the gasoline blendstock (BOB)

The EPA apparently assumed that once ethanol is blended into gasoline, then consumers get no discount for the reduced energy content. In other words, they assumed that motorists are being fooled because they do not realize that it takes 1.53 gallons of ethanol to equal a gallon of gasoline, based on BTUs of energy in a gallon.

We submitted a comment to EPA while they were reviewing the waiver request. In that submission, we argued that a waiver would have an impact if finished gasoline is priced lower when it contains ethanol compared to when it has zero ethanol. One of the EPA’s published comments on our submission was: “we did not see evidence presented in this study to change our reasoning with respect to how ethanol is priced.” (Fed. Register, 77, No. 228, Nov 27, 2012, p. 70767).

If true, this EPA assumption has stunning consequences as it suggests there is a large hidden cost associated with the ethanol mandate. Most consumers and businesses pay close attention to the amount of money they spend on transportation. If the cost of driving were to increase due to lower energy content in gasoline, then some motorists would reduce their demand for fuel and the price would decline.

This assertion holds for E85, which is a motor fuel that contains up to 85% ethanol. The fact that E85 usually sells at a discount to regular gasoline reveals that consumers determine their fuel demand based partially on energy content. It is also the case that

E85 is not popular with motorists.

But consumers do not have a choice today because aside from E85, which has a very small market share, the volumetric mandate effectively requires refiners and obligated parties to produce and market only motor fuel with 10% ethanol (known as E10). In ongoing research, we are presently analyzing market data to test whether the price of E10 reflects energy content.

What if the EPA is right and consumers do not get a discount to reflect the lower mileage of fuel with 10% ethanol compared to gasoline with zero ethanol? In that case, the RFS conventional biofuels mandate is severely harming consumers by enabling gasoline producers/distributors to sell an inferior product (blended gasoline) at the same price as uncut gasoline. And motorists are required by law to purchase the blended fuel even if it is not priced competitively.

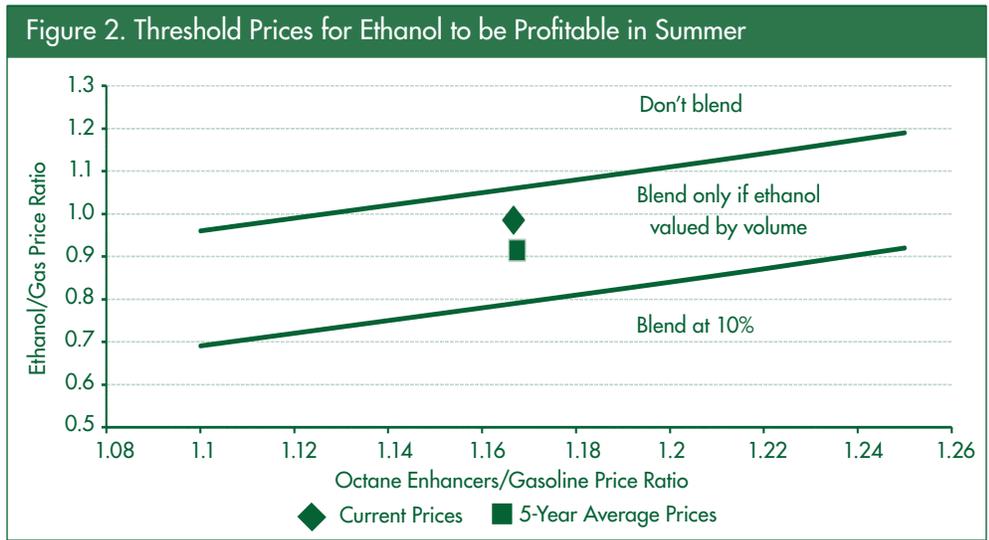
### The True Value of Ethanol

Estimating the true value of blended gasoline will help establish the true demand curve for ethanol for purposes of determining the economic welfare effects of the mandate.

To estimate the value of ethanol, we constructed a linear programming model of gasoline blending.

As a blending component, ethanol's main advantages lie in its relatively high octane rating and its lower price per volume. On the other hand, ethanol has high volatility, lower energy content, and higher distribution costs because it cannot be transported by pipeline.

Our model minimizes the total cost of producing a gallon of gasoline equivalent (GGE) subject to achieving a minimum octane rating and a maximum Reid vapor pressure level (RVP), which is a common measure of a fuel's volatility. We restrict ethanol content to be no more than 10% of gasoline volume, which is the maximum amount of ethanol that most of the U.S.



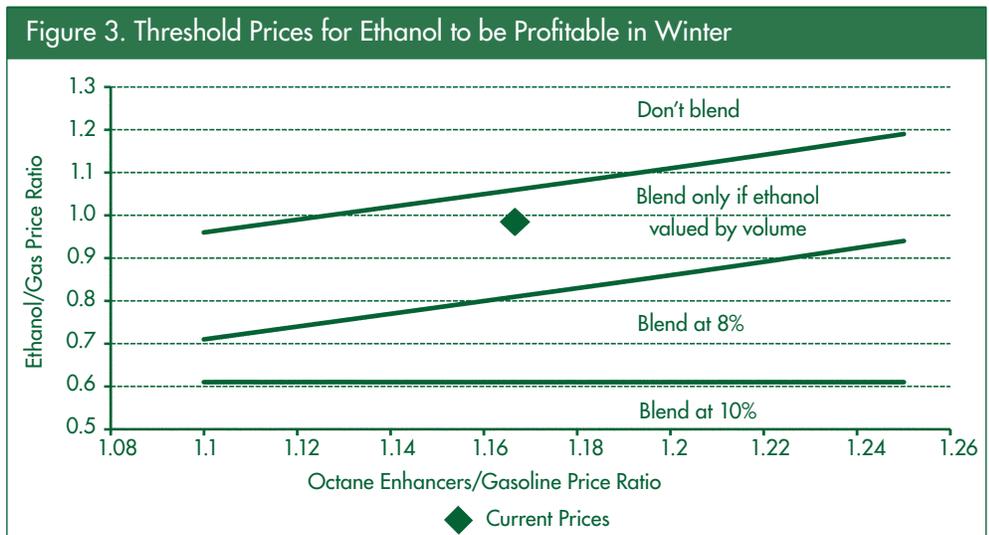
vehicle fleet can handle without causing serious damage to the engine due to the corrosive nature of ethanol. To account for the possibility that gasoline is priced by volume rather than energy content, we also use our model to find the minimum cost formula for producing a gallon of fuel by volume without regard for energy content.

Figures 2 and 3 show the key results from our model for summer and winter gasoline blends (accounting for different RVP maximum levels). The vertical axis in Figures 2 and 3 is the price ratio of ethanol to gasoline, and the horizontal axis is the price ratio of octane enhancers to gasoline. In each figure there are two upward sloping lines. In the area below the lower upward sloping line, it would be profitable to blend ethanol at the

maximum 10% (8%) in the summer (winter). Currently, both the winter and summer fuels are blended at the 10% ethanol level (i.e., E10) because the federal mandate requires the nation to use a fixed volume of ethanol.

In the absence of the mandate, winter fuel would most likely have less ethanol than summer fuel because the allowed RVP maximum is higher in the winter. This would permit the addition of more butane, which has high octane and is attractively priced, but cannot be used extensively in the summer due to its high RVP.

The area between the two upward sloping lines represents a region in the price grid where blending makes economic sense only if the blend is sold on a volume basis rather than on its energy content. Finally, above the top



Where available	
<b>Bronze</b>	<b>May contain up to 10% Ethanol</b>
<b>Silver</b>	<b>May contain up to 5% Ethanol</b>
<b>V-Power</b>	<b>Contains no Ethanol</b>
For more information please contact Customer Service at 1-800-661-1600	
Gas pump in Canada where unlike in the United States, motorists have a choice regarding ethanol percentage. V-Power is the premium high-octane gasoline.	

line, blending ethanol is not optimal.

In Figures 2 and 3, the diamond represents the approximate point where the market is now—with wholesale gasoline at \$2.41, the price of octane enhancers around \$2.81, and ethanol at \$2.38. It is clear that if retail (blended) gasoline were valued on energy content, it wouldn't be optimal to blend at the present time because the diamond lies above the bottom upward sloping line in each figure.

On the other hand, if we don't account for the energy content of ethanol, which means that blenders are able to "cut" gasoline with ethanol and, in essence, "fool" consumers, then it would be optimal to blend. In this situation, consumers lose because they do not receive a discount for the blended fuel, even though it gives them lower mileage.

How unusual is the current environment? Ethanol prices currently are high due to high corn prices, but crude oil prices are also relatively high at about \$90 bbl. for WTI crude and \$110 bbl. for Brent crude.

What if ethanol and gasoline prices return to their 5-year average values of \$2.02 and \$2.21 per gallon, respectively? Then we will have a situation similar to that shown by the solid square in Figure 2, which represents 5-year average prices. We see that the square lies between the two threshold lines, indicating blending would not be profitable if gasoline

was priced on an energy basis.

If the EPA is correct and there would be no market response to a temporary reduction in the mandate, then gasoline consumers are effectively absorbing the economic cost associated with lesser fuel economy. This is a hidden cost of the ethanol program and a wasteful, inefficient tax on motorists.

Our model shows that E10 is priced above its minimum-cost GGE by approximately 0.9% in the summer and 0.6% in the winter. This mispricing comes at a direct cost to consumers, which we estimate costs them \$3.5 billion per year, or 2.63 cents per gallon.

Who reaps the benefits from ethanol being overvalued in this way? Because ethanol is usually blended at the terminal level, refiners may or may not see this benefit. The blenders may collect some of this profit, or possibly it is bid away into the price of ethanol, further benefitting the ethanol industry.

If refiners do not receive the blending profit then ethanol provides them with less economic benefit and it imposes an opportunity cost in the form of lower utilization of existing refinery capital. In this scenario, refiners would have a greater incentive to respond to a waiver by reducing ethanol use.

## Conclusion

Implicit in a recent decision by the U.S. Environmental Protection Agency (EPA) is the conclusion that the ethanol mandate costs U.S. motorists

about \$3.5 billion per year by allowing refiners/blenders to cut gasoline with lower-valued ethanol without adjusting the price of the blended product. Ideally, motorists should be free to choose between no ethanol or some blend of ethanol in their gasoline. This would reduce costs to motorists, allow refiners and blenders to choose to blend less ethanol when the corn harvest is low, and blend more ethanol when the harvest is abundant.

### Suggested Citation:

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### For additional information, the authors recommend:

Energy Policy Research Foundation Inc. (EPRINC) "Ethanol's Lost Promise" Washington DC. Sept. 2012. <http://eprinc.org/pdf/EPRINC-ETHANOL-LOSTPROMISE-2012.pdf>

"Notice of Decision Regarding Requests for a Waiver of the Renewable Fuel Standard." *Federal Register* 77:228 (November 27, 2012):70752-70776.

USDOE "Analyses in Support of the EPA Evaluation of Waivers of the Renewable Fuel Standard (Ethanol Demand)" Nov. 2012. [www.regulations.gov/#!documentDetail;D=EPA-HQ-OAR-2012-0632-2544](http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OAR-2012-0632-2544).