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The Competitiveness of Ethanol in E10 Gasoline Blends during the Coronavirus Crisis

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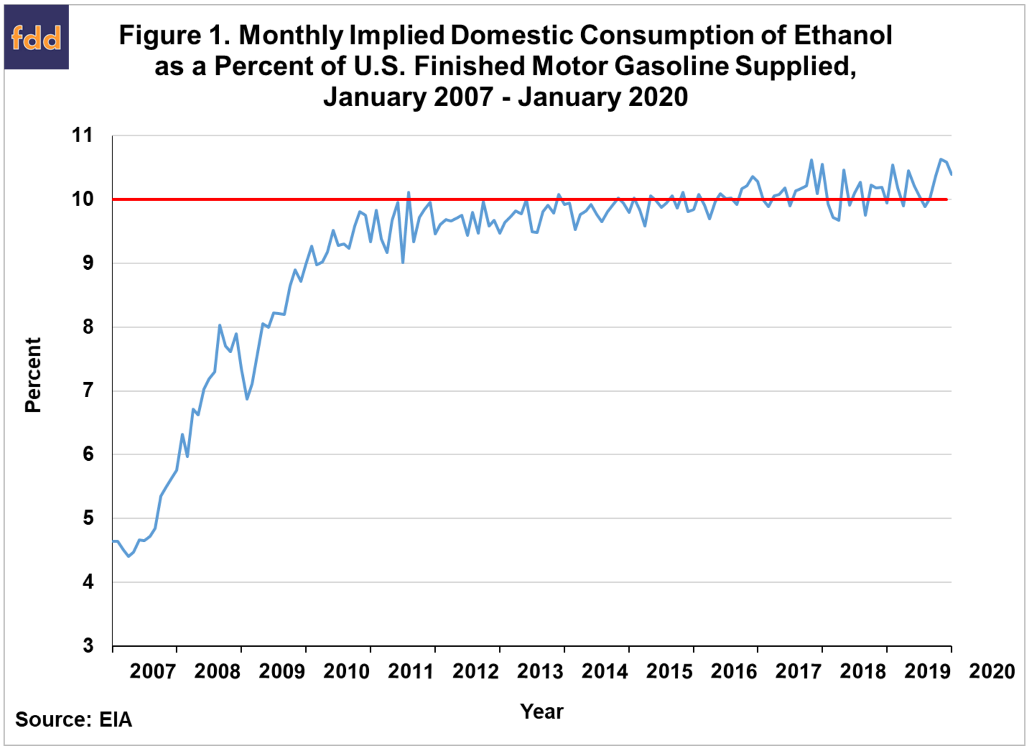
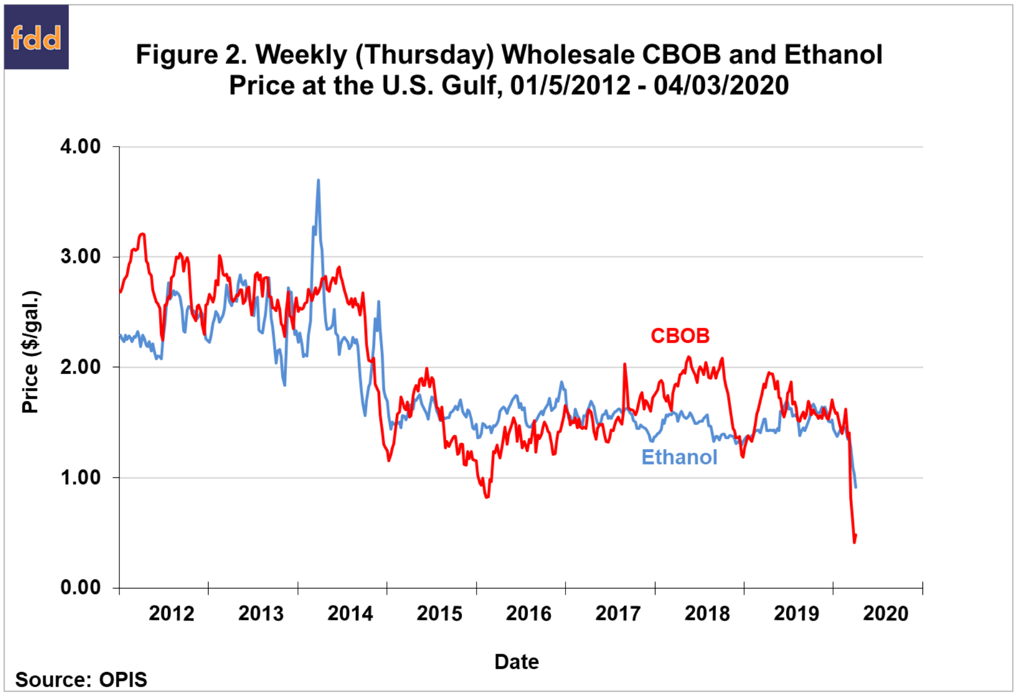
The restrictions put in place to "flatten the curve" in the fight against the coronavirus pandemic have had enormous and historically unprecedented impacts on U.S. gasoline consumption. The latest weekly data from the EIA indicates that gasoline use is now off by about 46 percent from the level prevailing in early March. A parallel decline in domestic ethanol consumption is underway because virtually every gallon of gasoline in the U.S. contains 10 percent ethanol (*farmdoc daily*, March 26, 2020). New reports of ethanol plants closing down are published almost daily, with a general expectation that at least half of all plants in the U.S. will eventually be taken off-line for as long as the coronavirus pandemic continues. An additional concern in the ethanol industry is that the effects of the crisis have been so severe that the competitiveness of ethanol in the E10 gasoline blend may be being threatened. Figure 1 shows that the aggregate (implied) blend rate for ethanol has been around 10 percent since 2011 and has actually tended to increase slightly in recent years. In fact, the average aggregate blend rate for ethanol in 2019 set a new high of 10.23 percent. The current misery in the ethanol industry would undoubtedly become even more severe if the aggregate blend rate were to start falling. The purpose of this article is to analyze recent data to determine whether the competitiveness of ethanol in E10 gasoline blends is being impacted by the coronavirus pandemic.



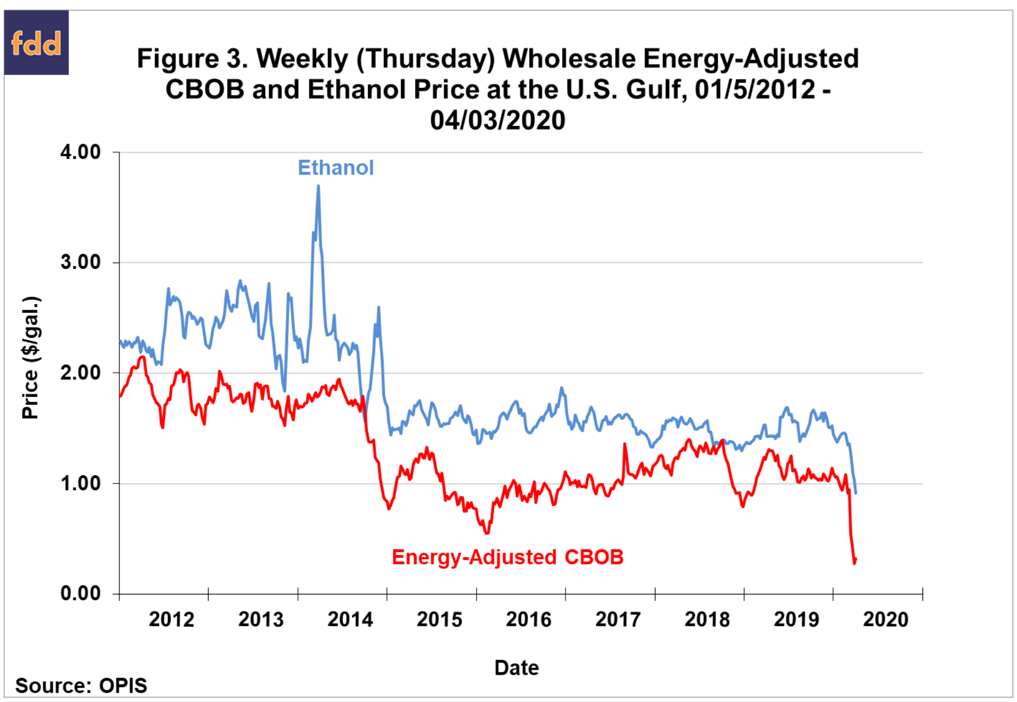
Analysis

Several previous *farmdoc daily* articles (e.g., April 4, 2019) examine the blending economics of ethanol in gasoline blends. The basic idea is that a tradeoff exist between the energy penalty of adding ethanol to the gasoline blend and the benefit of the octane-enhancing qualities of ethanol. Since ethanol has about two-thirds of the energy value of petroleum gasoline blendstock there is an energy penalty for adding ethanol to the blend. However, ethanol also has a high octane rating and substitutes for other octane enhancers in the gasoline blend. The value of ethanol as an octane enhancer then is dependent on the price of ethanol versus the price of alternative octane enhancers adjusted by relative octane value. In the *farmdoc daily* article of April 4, 2019 the energy penalty, octane premium, and net value of ethanol were computed based on weekly prices of ethanol, CBOB, and aromatics at the U.S. Gulf over the period January 25, 2007 through March 14, 2019. The price of ethanol was consistently below the average price of aromatics, the assumed alternative octane enhancers, such that the ethanol octane premium more than offset the ethanol energy penalty.

As in previous articles, we start with a comparison of the wholesale price of ethanol relative to the price of CBOB at the U.S. Gulf. We use the Gulf because this is the location for which we were able to obtain price data for the aromatics. While price relationships may differ somewhat by location, the Gulf should be reasonably representative of price relationships nationally. Data before 2012 are excluded from the analysis here in order to avoid complications arising due to the ethanol blenders tax credit (VEETC), which expired at the end of 2011. Figure 2 shows the weekly Gulf prices for ethanol and CBOB for the period January 5, 2012 through April 3, 2020. The price of ethanol has varied above and below the price of CBOB, but general slightly below CBOB. The recent steep drop in the price of CBOB is obvious, falling $0.93 per gallon since the first week in March. Over the same time period, the price of ethanol at the Gulf has fallen $0.43, about half as much as CBOB. This has driven the ratio of ethanol to CBOB prices to very high levels, in the range of two-to-one, and this is the main reason that concerns have arisen about the competitiveness of ethanol.

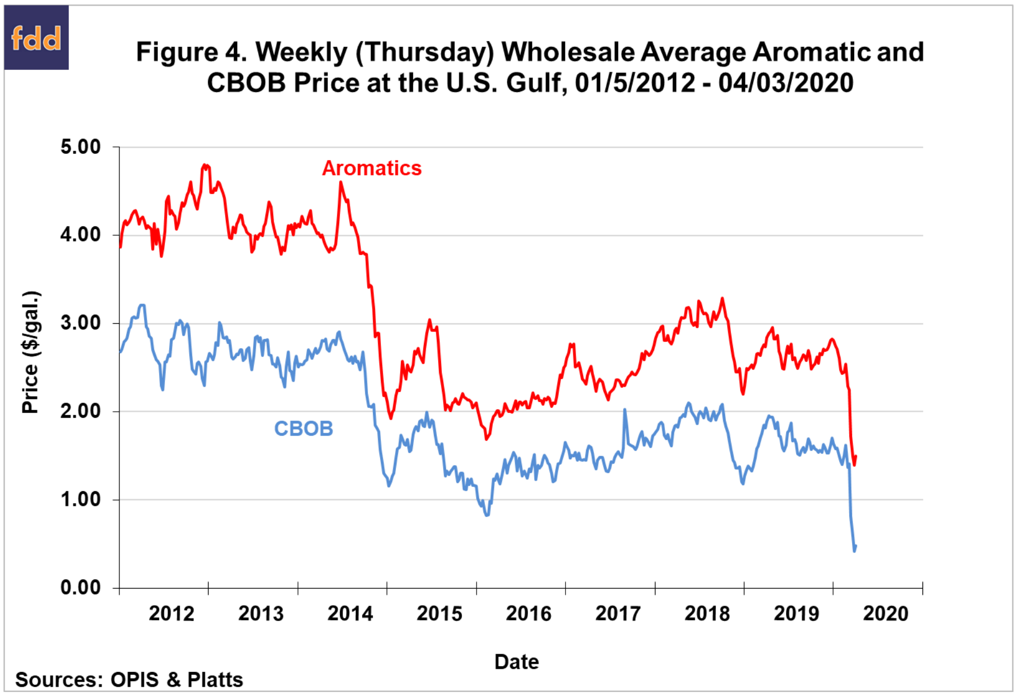


We next adjust the price of gasoline in Figure 2 order to express its price on an energy-equivalent basis relative to ethanol. In particular, we assume that ethanol has approximately two-thirds the energy value of CBOB (ethanol: 80,340 BTU per gallon, CBOB 120,215 BTU per gallon), so that the price of CBOB is multiplied by approximately two-thirds. As shown in Figure 3, the energy-adjusted price of CBOB has been below the price of ethanol except for very brief periods in 2014 and 2018. The energy adjustment not only flips the average direction of the relationship between ethanol and CBOB prices, but it also makes ethanol much more expensive than CBOB. Recent price movements have driven the energy-adjusted price of CBOB very low in relation to ethanol. The gap is now about $0.60 per gallon.



Turning to the octane benefit of ethanol, the magnitude depends on the price of ethanol relative to other octane enhancers. The alternative octane enhancers we consider are known as the "aromatic" compounds: benzene, toluene, and xylene. These compounds have octane ratings that are generally similar to ethanol and have a long history as octane enhancers in gasoline blends. Aromatics are typically produced via high-pressure catalytic reformers in the same refineries that produce other petroleum feedstock for gasoline blending.

Following our previous analyses, the average price for the three aromatics at the Gulf is computed in order to simplify the analysis. Due to the expense of updating the aromatics price data, we estimate the average weekly aromatic prices the last several years using a regression model of aromatic prices regressed on the nearby WTI crude oil futures price. Specifically, we regress the average weekly aromatic price on the weekly WTI futures price over January 5, 2012 through February 2, 2017, which has an R-squared 0.90. For the following period of February 9, 2017 through April 3, 2020, we use the regression coefficients to project the average aromatic price based on observed WTI crude oil futures prices. Finally, we continue to assume that ethanol and the aromatics substitute approximately one-for-one in gasoline blends in terms of octane. As shown in Figure 4, the average price of the aromatics tends to follow the price of CBOB, but at a premium.



As presented in Figure 5, the average price of the three aromatic octane enhancers has been above or well-above the price of ethanol since January 2012. The price difference was especially large from the beginning of 2012 through the first half of 2014. After the crash in crude oil prices during the second half of 2014, the price difference narrowed substantially, and then increased again in 2018. This difference represents the estimated value of ethanol as an octane enhancer in the E10 gasoline blend, assuming that the price of the aromatics would not have been different if ethanol had not been available as an octane enhancer. Despite the steep estimated price drop in aromatics in recent weeks, ethanol prices remain below the aromatics, by about $0.60 per gallon.

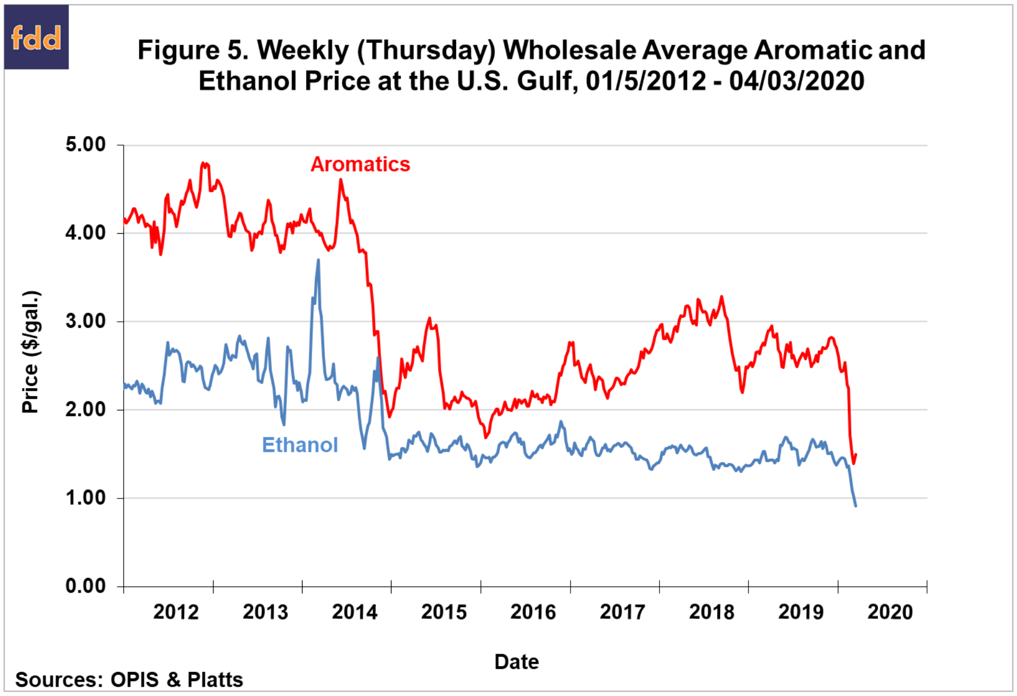
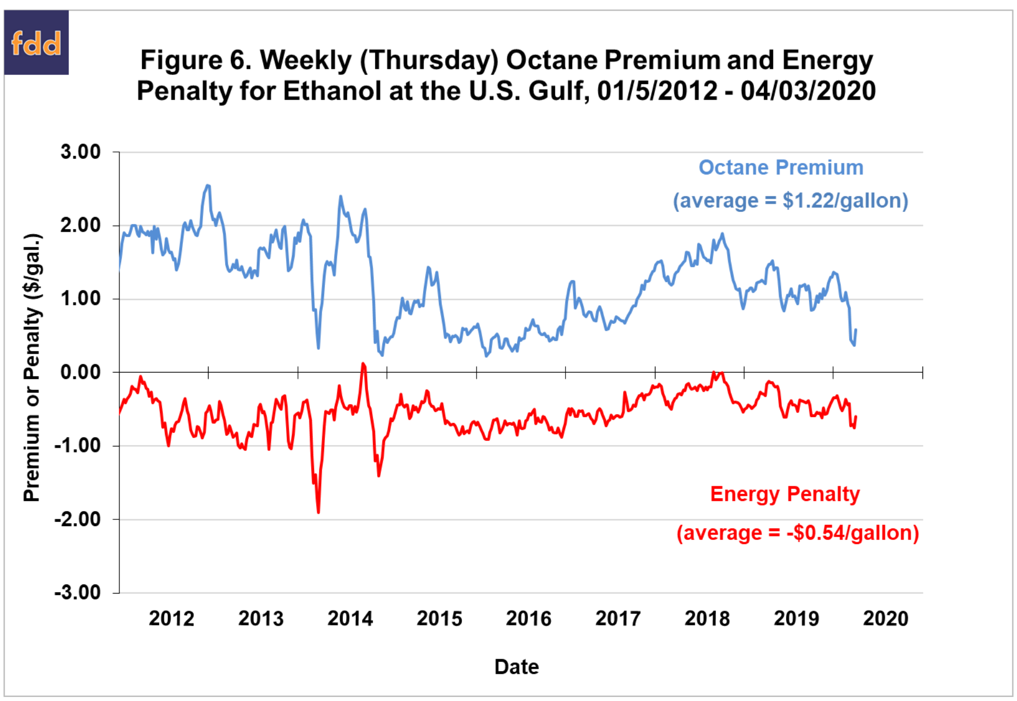
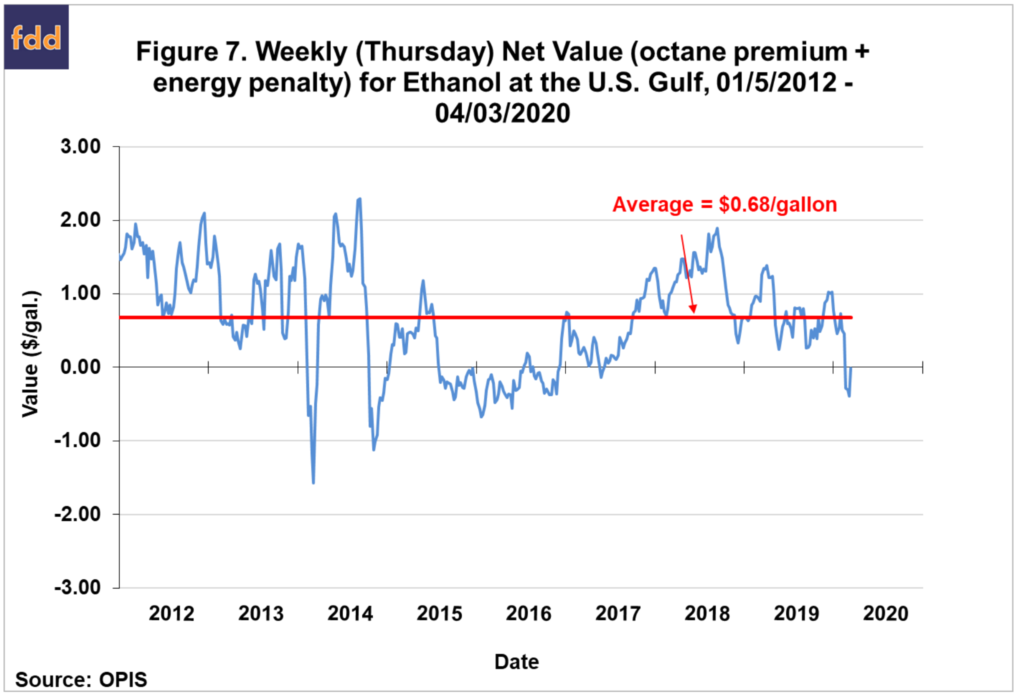


Figure 6 presents our calculations of the value of the energy penalty and octane premium associated with ethanol in E10 gasoline blends over the period January 5, 2012 through April 3, 2020. The energy penalty is calculated as the energy-adjusted CBOB price minus the ethanol price and the octane premium is calculated as the aromatics price minus the ethanol price. The octane premium had a positive value for the entire period and the energy penalty had a negative value except for very brief periods in 2014 and 2018. The average octane premium for the entire period is estimated to be $1.22 per gallon and the average energy penalty is estimated to be -$0.54 per gallon.



We sum the calculated energy penalty and octane premium in Figure 7 to compute the net value of ethanol in E10 gasoline blends. Given the underlying volatility of the prices involved in the calculation it should come as no surprise that the pattern of net value showed a great deal of weekly variation. The net value has been generally positive but there have been sustained periods of negative values, particularly in 2015 and 2016. The average net value of $0.68 per gallon is highly statistically significant. The combined impact of lower CBOB prices relative to ethanol prices and lower aromatic prices relative to ethanol prices has driven the net value of ethanol into negative territory in the last month. However, the net value for the most recent week, April 3rd, is only -$0.01 per gallon, near breakeven. It is also noteworthy that even the lowest reading for net value in the last month, -$0.39 per gallon, does not exceed the lows established in 2016. These results suggest that a sustained period of negative net values even larger than those of recent weeks will be required before ethanol loses its competitive position in the E10 gasoline blend.



It is important to keep in mind the limitations of the analysis. We only considered the energy and octane characteristics of ethanol relative to petroleum CBOB blendstock. Other characteristics, such as Reid vapor pressure (RVP) almost certainly affect the value of ethanol in gasoline blends. We also did not take into account the lower energy value of aromatics relative to other petroleum blendstocks. This could potentially decrease the energy penalty of ethanol when it replaces aromatics in the blend. The bottom-line is that a refinery optimization model is needed to conduct a complete analysis of value of ethanol in the E10 gasoline blend and the results presented here should only be viewed as rough estimates of the true value.

Implications

Driving in the U.S. has literally fallen off a cliff as a result of restrictions brought on by the coronavirus pandemic. This has resulted in crashing gasoline use and prices. Ethanol use and prices have followed suit. The dramatic changes in prices have raised the specter of ethanol losing its competitive place in the E10 gasoline blend. The value of ethanol in the gasoline blend is based on two components: i) an energy penalty relative to gasoline based on the lower energy value of ethanol; and ii) an octane premium based on the lower price of ethanol relative to petroleum sources of octane. We calculated the energy penalty, octane premium, and net value of ethanol based on weekly prices of ethanol, CBOB gasoline, and aromatics at the U.S. Gulf and found that the net value of ethanol has dropped precipitously in the last month. However, the net value for the most recent week, April 3rd, is once again very near breakeven. It is also noteworthy that even the lowest reading for net value in the last month, -$0.39 per gallon, does not exceed the lows established in 2016. These results suggest that a sustained period of negative net values even larger than those of recent weeks will be required before ethanol loses its competitive position in the E10 gasoline blend. This conclusion is reinforced by the safety net provided by the RFS conventional ethanol mandate. Whatever the level of gasoline use turns out to be in 2020, it is most likely to still contain at least 10 percent ethanol.

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