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# **Renewable Fuel Standard Waiver Options during the Drought of 2012**

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## Summary

The Environmental Protection Agency (EPA) has been asked to waive the biofuel use mandates, or Renewable Fuel Standard (RFS). This action could reduce demand for agricultural feedstocks to be used to make biofuels, potentially offsetting some of the impacts of the 2012/13 drought and reducing crop prices relative to what would occur without a waiver. There are many steps between the complicated biofuel use mandates that require at least minimum levels of use for four different biofuel categories and their effects on agricultural commodity markets. This report summarizes estimate of these impacts generated using the FAPRI-MU economic models.

The analysis is based on the FAPRI-MU model that includes biofuel and agricultural commodity markets. The point of comparison is an updated FAPRI-MU baseline that takes into account low yields for certain crops, including corn, due to the drought, and the assumption that current policy is continued into the future. The baseline assumes no waiver of the RFS in response to the drought. Analysis reported here estimates the effects of a waiver on agricultural and biofuel markets. There are **important uncertainties**:

- *Ethanol use* might respond more or less quickly to changes in ethanol price than we expect. It is not clear how quickly refiners and blenders would adjust the way they produce consumer-ready fuels in response to a waiver.
- The mismatch of *crop marketing years and calendar year mandates*. We represent the RFS on a crop marketing year basis, but this simplification could cause us to miss important nuances of how a waiver might affect markets.
- This mismatch is complicated by the *rate of ethanol use* in E10 blending. As the E10 market is largely saturated and represents the main use of ethanol, it is difficult for blenders to delay ethanol use from the tail end of the current, tight marketing year to the start of the next year after a new harvest might lead to lower corn prices.

Analysis compares the agricultural and biofuel market outcomes with the mandate waived against the baseline. **Key results** include the following:

- Reducing the overall RFS has a small negative effect on the corn price in 2012/13 relative to the baseline because overall ethanol use and production are projected to be motivated mostly by crop and fuel market conditions in the current marketing year, not the RFS. Waiving the mandate, a minimum use requirement, has limited market impact if people were going to use almost as much as the mandate anyway.
- A waiver in 2012/13 may have larger negative impacts on corn market prices in 2013/14 than in 2012/13. Extra biofuel use in one year typically can help to meet the next year's mandate. If this practice is permitted, a waiver in 2012/13 could make it far easier to satisfy the RFS in 2013/14, when limits on E10 blending make mandate compliance difficult. If the waiver also disallows counting biofuel use in 2012/13 against the mandate in the next year, then the mandate might be more difficult to meet in 2013/14. In this case, corn prices in the year after the waiver would be higher than in the baseline.
- Waiving the advanced mandate reduces sugar cane ethanol imports, leading to more corn starch ethanol production and a higher corn price in 2012/13.
- More generally, mandate changes can have partly offsetting ethanol trade impacts. Reducing domestic use of corn starch ethanol tends to cause more exports. Reducing imported advanced ethanol tends to cause less exports.

## Useful terms relating to biofuel mandates \*

We use the following technical terms about the mandates and how they work.

*Mandates or Renewable Fuel Standard (RFS):* the mandates are minimum levels of biofuel use. The mandates must be met by fuel blenders who buy fuel products, blend them into consumer fuels, and sell these final fuels to retailers. There are four mandates that are defined by the greenhouse gas (GHG) emission reduction threshold and the eligible feedstocks. The mandates have a hierarchy, with broader mandates and sub-mandates. Simplifying, the mandates are as follows.

The *cellulosic and agricultural waste* (“cellulosic”) mandate can be met by biofuels that achieve a high GHG target and are made from certain dedicated biomass feedstocks or crop co-products.

The *biodiesel* mandate can be met using biodiesel that achieves a high GHG target than the overall mandate target.

The *advanced* mandate can be met by any fuel that meets the biodiesel and cellulosic mandate thresholds, as well as other biofuels not made from corn starch and that still meet a certain GHG target. At present, sugar cane ethanol imported from Brazil is an example of a biofuel that helps to meet the advanced mandate.

The *overall or total* mandate can be met by any fuel that meets the advanced mandate threshold, as well as “conventional” ethanol made from corn starch.

*Conventional gap:* the difference between the overall and advanced mandates is the maximum amount of conventional (corn starch) ethanol that can be counted towards the mandate.

*Advanced gap:* the difference between the advanced mandate and its two sub-mandates (biodiesel and cellulosic) is the maximum contribution of other advanced biofuels, like sugar cane ethanol, towards the advanced mandate. (More advanced biofuel beyond the advanced gap would compete with conventional ethanol to fill the conventional gap.)

*Binding or non-binding mandate:* A binding mandate means that less of the corresponding biofuel would be used given market conditions if not for the mandate. A non-binding mandate means that people already choose to use more than the mandated amount because of market conditions.

*Renewable Identification Numbers (RINs)* are generated when biofuels are blended for domestic use, and are used by blenders to prove that they meet the mandates. A RIN indicates the biofuel type.

*RIN price:* RINs are traded. If the RIN price falls close to zero, then it is easy to meet the mandate (non-binding). If the RIN price is high, then the mandate is difficult to meet (binding). RIN prices can vary by biofuel type, but the RIN prices reflect the hierarchy of mandates.

*Rollover:* RINs can be stocked for later use. The implementing regulations allow up to 20% of the current year’s mandate to be met using RINs generated in the prior year.

\* For more information, see Thompson, Meyer, Westhoff, “The New Markets for Renewable Identification Numbers” *Applied Economic Perspectives and Policy*, 2010; or Thompson, Meyer, Westhoff, “Renewable Identification Numbers Are the Tracking Instrument and Bellwether of US Biofuel Mandates” *Eurochoices*, 2009.

## Baseline

The baseline is the FAPRI-MU August 2012 baseline update (<http://www.fapri.missouri.edu/>), with selected additional updates. Generally, projections are based on data available at start of August, 2012. However, the outlook for petroleum, gas, ethanol and corn prices and markets is further updated based on data available in mid-September 2012.

The baseline assumes a corn yield of 122.8 bushels per acre and projects a season average price of \$7.87 per bushel in 2012/13 (Table 1). The drought is also expected to reduce soybean and hay yields in 2012/13, leading to rises in the prices of these crops, as well. Assuming a return to normal weather in 2013/14, the corn production would recover and corn price is projected to fall to \$5.22.

The baseline projects less conventional ethanol production and less corn use for ethanol in 2012/13 than in the previous year, but this reduction is largely associated with lower conventional ethanol exports. Domestic use falls by 2 percent, while production declines by 10 percent, given a large change in net trade in ethanol and a draw-down of ethanol stocks.

The overall mandate is somewhat binding in the baseline, as the \$0.10 conventional RIN value shows, so the volume of corn starch (conventional) ethanol used in domestic markets is not greatly reduced in 2012/13 relative to 2011/12. In the baseline, the overall mandate is rising over time, and the conventional gap (see glossary on page 2) grows to 15 billion gallons in 2015. Its increase tends to make the mandate more binding over time. This is one reason why the conventional RIN price is expected to rise to over \$0.50 in 2013/14.

The domestic use of ethanol is assumed in the baseline to be slow to respond to price changes during the 2012/13 marketing year.<sup>1</sup> E10 use is nearly ubiquitous now. Because of changes in the fuel blending sector, E10 reductions might be small even if the ethanol price rises as projected in the baseline in 2012/13 relative to the gasoline price. The fuel industry has become very accustomed to making and selling 10 percent ethanol blends, and it appears that moderate changes in relative ethanol and petroleum product prices will have only small effects on ethanol use in the short run. Ethanol use is also expected to respond slowly if ethanol prices were to fall instead of rise. The potential increase in ethanol use in E10 is limited by the size of the overall market for gasoline. Very little E15 or E85 is available at this time, and costly infrastructure development would make it difficult to make these fuel widely available in a short period of time. This combination of considerations means that overall domestic ethanol use is expected to be relatively unresponsive to price changes in 2012/13.

The advanced mandate plays a role in determining the baseline projections for ethanol imports. This mandate is binding, as indicated by an average \$0.72 advanced RIN price in 2012/13. The advanced gap can be filled using sugar cane ethanol, so more ethanol is imported from Brazil in the current marketing year than in recent years to help fill meet the advanced mandate. Sugar cane ethanol imports increase further in 2013/14 as the advanced mandate continues to rise.

Summarizing baseline ethanol markets in 2012/13, the rate of ethanol inclusion in domestic fuel is steady at nearly 10% with little responsiveness to price, imports are brought in to meet the advanced biofuel

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<sup>1</sup> This understanding of slow response of ethanol use in E10, at least in a certain range of relative prices, is also reflected in other work. For example, see Tyner, Taheripour, Hurt, "Potential Impacts of a Partial Waiver of the Ethanol Blending Rules", Farm Foundation, 2012 ([www.farmfoundation.org](http://www.farmfoundation.org)).

mandate, and exports are reduced in response to rising domestic prices. In 2013/14, growing mandates in the baseline become increasingly binding, and are met with more imports and more domestic use.

**Table 1. Selected baseline indicators.**

	2011/12	2012/13	2013/14
<b>Effective RFS mandates</b>		(million gallons)	
Total	14,783	16,100	16,972
Advanced	1,783	2,500	2,772
Biodiesel	933	1,187	1,280
Cellulosic	4	46	85
Gaps			
Conventional	13,000	13,600	14,200
Advanced	380	674	766
<b>RIN core values</b>		(dollars per gallon)	
Conventional	0.01	0.10	0.54
Advanced	0.78	0.72	1.27
<b>Petroleum market prices</b>		(dollars per barrel)	
Petroleum, West Texas int.	94.88	94.88	94.88
		(dollars per gallon)	
Gasoline, unleaded retail	3.50	3.50	3.50
<b>Ethanol market indicators</b>		(million gallons)	
Production	13,777	12,458	14,908
Imports	227	662	714
Domestic use	12,891	12,689	14,690
Exports	1,097	591	779
Change in stocks	15	-160	153
Ethanol prices		(dollars per gallon)	
Conventional rack	2.45	2.70	2.27
Other advanced rack	3.05	3.31	3.00
<b>Corn market indicators</b>		(million bushels)	
Production	12,358	10,727	14,228
Domestic use	10,790	10,002	11,576
Ethanol and co-prod.	5,000	4,490	5,360
		(dollars per bushel)	
Corn price	6.25	7.87	5.22

*Note:* these data are updated relative to the FAPRI-MU August 2012 baseline based on information available in mid-September from CBOT futures for ethanol prices, NYMEX RBOB futures for gasoline price, NYMEX light crude futures for West Texas intermediate petroleum price, and the September World Agricultural Supply and Demand Projections for the corn market.

### **Do conventional RIN prices support the baseline projections?**

OPIS data indicate that the price for a conventional RIN generated from 2012 corn starch ethanol use rose above \$0.05 per gallon when the drought started, and then this price fell below \$0.05. Whereas our initial understanding of markets in August 2012 led to projections of an average conventional RIN price of \$0.19 for the 2012/13 marketing season, the baseline of this analysis revises this price to \$0.10, on average, for the current marketing year. There are at least three possible explanations for the turn-around in conventional RIN prices.

One is that the overall mandate is not expected to become very binding. In this case, a conventional RIN is not worth much, because blenders were going to use almost as much biofuel as the mandate requires anyway. However, the story is complicated by rollover provisions that allow up to 20% of next year's mandate to be met with RINs generated this year. Consequently, the conventional RIN price this year should also depend on how binding the mandate is expected to be next year. Given the rising mandate and serious concerns about the rising blend wall, our baseline projections include a sharply higher 2013/14 conventional RIN price relative to 2012/13, suggesting that rollover RINs from 2012/13 could be a cheaper way to meet the mandate in 2013/14 as compared to blending fuel in that marketing year.

A second possible explanation for the low conventional RIN price relative to our average price is the possibility of a waiver. A waiver could make conventional RINs unusable this year. Moreover, because rollover is limited, there is no reason to store more than 20% of next year's mandate if it is not waived, and none at all if next year's mandate is waived. If ethanol use in E10 blends is likely to remain fairly high, then more conventional RINs would be generated than wanted in this case, and the conventional RIN price would fall to no more than the transaction cost. Anyone buying or selling a conventional RIN in summer 2012 presumably builds in their assessment of this possible outcome.

A third possibility is the mismatch between marketing year, the basis of our representation, and calendar year. A \$0.10 conventional RIN price could be consistent with a period that begins in September 2012 even though the price in September is substantially lower, particularly if the rising mandate, which is unwaived in the baseline, becomes increasingly binding over time.

An additional puzzle is to reconcile the 2012 conventional RIN price with our understanding of 2013 market conditions. The baseline projections suggest a strong increase in the conventional RIN price in calendar year 2013 if there is no waiver for these reasons:

- RFS mandates and conventional gap grow, so more RINs will be needed for compliance.
- Ethanol exports are running lower than they were a year ago, leaving more available for domestic use and 2012 compliance. Ethanol exports cannot decline forever, and rising sugar cane ethanol imports for the advanced gap might lead to more demand for US exports.
- Conventional RIN generation in 2013 might be constrained by a tight corn market. Stocks are low. Corn use for ethanol and co-products in 2012/13 is on track to be lower than in 2011/12.
- Most ethanol is used in E10, so the monthly rate of use is nearly constant. Blenders might not be able to ramp up use to meet the mandate even if corn prices fall after the 2013 corn harvest.
- The blend wall might make it hard to sell more ethanol. If more fuel with over 10% ethanol will have to be sold, then the prices of these fuels will have to be low relative to alternative options.
- The baseline projects that most 2012 RIN rollover stocks are used by summer 2013.

If these factors are accurate and no waiver is expected, then we would expect strong demand for rollover RINs to carry into 2013 and that would tend to drive current conventional RIN prices higher.

## Options that are analyzed

Scenarios are defined as follows. First, the overall mandate is reduced to *eliminate the conventional gap*. The part of the total mandate that can be filled using corn starch ethanol is reduced to zero. First, we assume that RIN rollover from a year with a waiver can be carried into the next year. To show the importance of this assumption, we test the impacts of disallowing conventional RIN rollover from the year with a waiver to the following year.

Second, the advanced mandate is reduced to eliminate the advanced gap. Advanced biofuel, such as imported sugar-cane ethanol, continues to count towards the overall mandate. Two separate scenarios are examined that differ in what they assume about the overall RFS and thus the conventional gap. In one, there is no offsetting reduction in the overall mandate, so the *conventional gap increases*. In the other scenario, the overall mandate is reduced by the same amount as the reduction in the advanced mandate, so that *the advanced gap is reduced and the conventional gap remains constant*.

In all four scenarios, the waivers are applied on *2012/13 marketing year*. The actual waiver options available to the EPA apply to calendar year mandates, however. This mismatch means that some of the results discussed here might not be directly applicable to an actual waiver of calendar year mandates.

These simulations test the extreme case of waivers that eliminate mandate components or gaps. More modest reductions seem likely to have the same directional impact on variables of interest, but partial waivers have not been tested.

A key point is that sufficiently large reductions in the mandate are likely to reduce RIN prices almost to zero. In this circumstance, we expect blenders to carry forward more RINs for the next year up to the limit permitted under rollover rules. We are not certain how rollover would be handled in the event a waiver, however, and this appears to be a key factor determining the impact on the year after the waiver.

In the all simulations, the cellulosic mandate is waived, as it is in the baseline. Cellulosic biofuel production continues to be below EISA mandated levels of use. So far, the EPA has not exercised its authority to reduce broader mandates, so the shortfall in cellulosic biofuel relative to the mandate must be offset by greater advanced biofuel use. However, the volumes so far have been small. We assume that the broader RFS mandates, overall and advanced, are reduced by as much as the cellulosic mandate from 2013/14 on, so there is no increase in the conventional or advanced gaps. For this reason, the total and advanced mandate of the baseline diverge from the targets of the EISA.

The biodiesel mandate is assumed to be set at 1.28 billion gallons from 2013 calendar year on.

## Conventional gap eliminated

In this scenario, the overall mandate is waived in 2012/13 to eliminate the conventional gap, so corn starch ethanol no longer counts towards the mandate (Table 2). There is no mandate for ethanol made from corn. Instead, the mandates are defined in the EISA such that corn ethanol helps to fill the conventional gap, which is the difference between the overall or total mandate and the advanced sub-mandate. We assume no change in any of the sub-mandates so the volumes required for each one, as well as for the advanced gap, are unchanged.

We do not match these assumptions for 2012/13 marketing year to 2012 and 2013 calendar year RFS requirements. While the mandated volume of each marketing year can be thought of as a weighted average of the two relevant calendar years, there might be constraints that discourage quick

generalization of these assumptions to calendar year data. For example, a key question is if the waiver reduction is enough to make the mandate non-binding, or not, so a smaller reduction might very well be sufficient to make the overall mandate non-binding.

**Table 2. Conventional gap scenario assumptions.**

	Baseline		Conventional gap		Absolute difference		Percent difference	
	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
<b>Effective RFS mandates</b>	(million gallons)							
Total	16,100	16,972	2,500	16,972	-13,600	0	-84.5%	0.0%
Advanced	2,500	2,772	2,500	2,772	0	0	0.0%	0.0%
Biodiesel	1,187	1,280	1,187	1,280	0	0	0.0%	0.0%
Cellulosic	46	85	46	85	0	0	0.0%	0.0%
Gaps								
Conventional	13,600	14,200	0	14,200	-13,600	0	-100.0%	0.0%
Advanced	674	766	674	766	0	0	0.0%	0.0%

The reduction in the overall mandate in 2012/13 means that fewer RINs need to be used for compliance in that year (Table 3). Instead of 16.1 billion RINs, only 2.5 billion are used. Moreover, all the RINs that are used for compliance are entirely for the purpose of complying with the sub-mandates, as shown by the advanced RIN compliance use at 2.5 billion gallons in that year. Most of the conventional RINs that are generated have no value because the conventional gap is eliminated and they cannot count against the advanced mandate, so they expire unused. The exception is RIN rollover, or stocks.

Rollover provisions allow up to 20% of the mandate in one year to be met using RINs generated in the previous year. We do not know if rollover provisions would be adjusted if there is a waiver, so we leave them unchanged. This raises a question about waiver implementation.<sup>2</sup> Can RINs be generated in the year of the waiver and carried over into the next year? Specifically, can conventional RINs be generated in 2012/13 and used in 2013/14, the year after the waiver, up to the 20% limit? Here, we assume that rollover is permitted, but we test the alternative assumption in a later section.

The scenario eliminates the conventional gap in 2012/13, so the conventional RIN price is driven to its minimum level in that year. If RINs are so cheap, then we expect blenders to make sure they have as many RINs as can be used for rollover. Thus, rollover stocks of conventional RINs at the end of 2012/13 are at the maximum if a waiver eliminates the conventional gap in that year.<sup>3</sup> In reality, the rollover limit applies to the amount carried over at the end of December, not the end of August as in our marketing year representation, but maximize RIN rollover seems a reasonable expectation.

<sup>2</sup> Another question is whether sub-mandate rollover coming into 2012/13 could be used for a broader mandate if that sub-mandate is waived? This question is not particularly relevant in the scenarios reported here, but could be important in the event that a waiver is applied to a sub-mandate with a great deal of carry-in rollover stocks.

<sup>3</sup> Based on our reading of the regulations and informal discussions with officials, we apply the 20% rollover limit to the RFS mandates, not to the gaps. This is a technical point, but the analysis requires that the limit is calculated correctly. With the mandate waiver in 2012/13 and low advanced RIN rollover projected, the conventional RIN carried over for 2013/14 can rise up to 20% of the total RFS – not the 20% of the conventional gap – less any advanced RINs before hitting the rollover limit. Because the rollover limit applies to a larger quantity, the second year effects larger than they would be if the limit applied only to the conventional gap.

The advanced mandate is not waived, so advanced RINs are generated to be used along with RINs rolled in from the previous year for compliance in 2012/13. Some additional advanced RINs are used for rollover into 2013/14. (Although not shown here, the biodiesel mandate is also unchanged, so biodiesel RINs are still useful for compliance and are also carried forward in the form of rollover.) Because of ethanol market impacts, discussed later, the waiver makes the advanced mandate a bit less binding in 2012/13, so advanced RIN rollover is somewhat higher. At the lower 2012/13 advanced RIN price, more advanced RINs are held at the end of the year to help to meet the mandate in the next year.

In the analysis, greater RIN rollover at the end of 2012/13 is one key reason for the 2013/14 impacts. Three billion more conventional RINs and additional advanced RINs available in 2013/14 make the mandates less binding in that year relative to the baseline, even though the waiver applies only to 2012/13.

RIN core values estimate the price of RINs, excluding transaction costs, based on the assumptions of these simulations. RIN values indicate how binding mandates are, but also take into account RIN rollover demand, not just RIN use for compliance. The baseline conventional RIN value, without any mandate, is \$0.10. This value drops to zero if the overall mandate is waived to eliminate the conventional gap. The \$0.50 reduction in the conventional RIN value in 2013/14 is far larger than in the year of the waiver.

**Table 3. Renewable Identification (RIN) markets in the conventional gap scenario.**

	Baseline		Conventional gap		Absolute difference		Percent difference	
	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
<b>Overall RFS</b>								
	(million gallons)							
Rollover of prior year	2,252	362	2,252	3,352	0	2,990	0.0%	825.2%
RINs Generated	14,211	16,609	14,051	15,477	-159	-1,132	-1.1%	-6.8%
RINs used for RFS	16,100	16,972	2,500	16,972	-13,600	0	-84.5%	0.0%
Rollover for next year	362	0	3,352	1,858	2,990	1,858	825.2%	n.a.
Expire unused	0	0	10,451	0	10,451	0	n.a.	n.a.
<b>Advanced RFS</b>								
Rollover of prior year	324	53	324	81	0	27	0.0%	51.6%
RINs Generated	2,230	2,718	2,257	2,691	27	-27	1.2%	-1.0%
RINs used for RFS	2,500	2,772	2,500	2,772	0	0	0.0%	0.0%
Rollover for next year	53	0	81	0	27	0	51.6%	n.a.
Expire unused	0	0	0	0	0	0	n.a.	n.a.
<b>RIN core values</b>								
	(dollars per RIN-gallon)							
Conventional	0.10	0.54	0.00	0.03	-0.10	-0.50	-100.0%	-94.0%
Advanced	0.72	1.27	0.64	0.88	-0.08	-0.39	-11.1%	-31.0%
Biodiesel	1.17	1.30	1.17	1.29	0.00	-0.02	-0.1%	-1.3%

One reason for larger second-year impacts is rollover, as the extra RINs carried forward mean that more RINs are available in 2013/14 than in the baseline. A second reason is that the overall mandate is growing and becoming more binding. The conventional RIN value in the baseline increases substantially from 2012/13 to 2013/14 based on a rising conventional gap, petroleum price level, blend wall obstacles, and other factors. As the mandate is more binding in 2013/14 with a higher conventional RIN value, the extra rollover RINs available in the scenario cause the RIN value to fall, and the RIN value has farther to fall than in 2012/13.

Total RINs generation is lower than the baseline level in both years because there are fewer conventional RINs if the overall mandate is reduced in one year. Rollover spreads the effect out. However, the effect is not dramatic in these projections. This is partly a result of our understanding of the unresponsiveness of ethanol demand in the short run, as discussed below, which leads to many billions of gallons of conventional ethanol used even though the associated RINs have no value, as indicated by the scenario result that more than 10 billion gallons of conventional RINs expire unused in 2012/13.

The reduction in overall RINs generated in 2012/13 is approximately equal to the reduction in corn ethanol production (Table 4). Waiving the overall mandate to eliminate the conventional gap means that blenders are no longer required to blend corn starch ethanol. Part of the reason is that the overall mandate is not very binding in the baseline. For example, the \$0.10 baseline conventional RIN value in 2012/13 is much less than the advanced RIN value, indicating that the advanced mandate is more binding.

Another reason is the expectation that blenders have limited ability to respond to price in the short run – a key source of uncertainty. The retail ethanol price rises and the price of conventional ethanol in wholesale markets falls, but the effects on the quantity used are not very pronounced. At present, it is not clear how quickly blenders would discontinue blending ethanol and petroleum products in E10.

**Table 4. Biofuel markets in the conventional gap scenario.**

	Baseline		Conventional gap		Absolute difference		Percent difference	
	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
<b>Ethanol market indicators</b>			(million gallons)					
Production	12,458	14,908	12,295	13,927	-163	-981	-1.3%	-6.6%
From corn	12,171	14,564	12,010	13,598	-161	-966	-1.3%	-6.6%
From other feedstocks	287	343	286	328	-2	-15	-0.6%	-4.3%
Imports	662	714	689	687	27	-27	4.1%	-3.8%
Domestic use	12,689	14,690	12,529	13,558	-159	-1,132	-1.3%	-7.7%
Exports	591	779	622	934	30	155	5.1%	20.0%
<b>Ethanol prices</b>			(dollars per gallon)					
Conventional rack	2.70	2.27	2.67	2.11	-0.02	-0.16	-0.9%	-7.1%
Other advanced rack	3.31	3.00	3.31	2.95	0.00	-0.05	0.0%	-1.7%
Effective retail	3.46	2.56	3.54	2.84	0.07	0.29	2.0%	11.3%
<b>Biodiesel</b>			(million gallons)					
Production	1,060	1,300	1,061	1,303	0	3	0.0%	0.3%
Domestic use	1,005	1,246	1,005	1,247	0	0	0.0%	0.0%
Net exports	56	54	56	57	0	3	0.4%	6.0%
<b>Biodiesel rack price</b>			(dollars per gallon)					
Biodiesel rack price	4.91	5.06	4.91	5.04	0.00	-0.03	0.0%	-0.5%

In this analysis, the ability to switch back from E10 to fuels without ethanol is limited in the short run. This is an assumption that is likely to have an impact on results. If ethanol blending were more responsive to price, then conventional ethanol use would fall more if the conventional gap is eliminated, so RIN generation would also fall farther. The 2012/13 impacts on crop markets could be larger if the decrease in corn used to make ethanol and co-products were more pronounced.

Given that the baseline conventional RIN value is \$0.10, the mandate is not seen as extremely binding in the baseline so the potential impacts even if ethanol demand is more responsive should not be overstated. It might be argued that a more responsive demand would imply a larger baseline conventional RIN value, in the event that there is no waiver. However, observed conventional RIN prices are well below \$0.05 at the time of writing, suggesting that the mandate is not very binding and conventional ethanol use would not be much lower without the mandate (see the related text box on page 5).

The reduction in corn ethanol used in the market means a higher retail price, as noted above, and that encourages advanced ethanol use. With the assumed low responsiveness of demand, less corn starch ethanol is available, and this translates into somewhat more imported sugar-cane ethanol used domestically. The slight increase in import demand relaxes the degree to which the advanced mandate is binding in 2012/13, as shown by the reduction in the advanced RIN value in that year (Table 3). The extra advanced RINs in 2012/13 are rolled over to 2013/14, leading to an exactly offsetting impact on imports in the second year when those rollover RINs are used up.

The lower conventional ethanol wholesale price and rising imports both argue for greater ethanol exports (Table 4). The increase in ethanol imports puts upward pressure on the price for sugar cane ethanol in Brazil. The higher price in a competing market encourages conventional ethanol exports. At the same time, the reduction in domestic blending increases supplies available from the US, as shown by the lower conventional rack price, also encouraging conventional ethanol exports

The biodiesel market impacts are small. The indirect cross-effects through feedstock and fuel markets are small, and do not all work in the same direction.

Eliminating the conventional gap leads to less corn ethanol use and production, and consequently less corn used to make ethanol and co-products (Table 5). This category of corn use falls by 1% in 2012/13 and 7% in 2013/14 as the impacts of the waiver work through RIN and ethanol markets, subject to our representation of RIN rollover and slow ethanol demand response.

**Table 5. Corn market impacts in the conventional gap scenario.**

	Baseline		Conventional gap		Absolute difference		Percent difference	
	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
<b>Corn market indicators</b>								
			(million acres)					
Area planted	96.41	94.99	96.41	93.92	0.00	-1.07	0.0%	-1.1%
			(million bushels)					
Production	10,727	14,228	10,727	14,074	0	-154	0.0%	-1.1%
Domestic use	10,002	11,576	9,970	11,340	-33	-236	-0.3%	-2.0%
Ethanol and co-prod.	4,490	5,360	4,431	5,006	-59	-354	-1.3%	-6.6%
Feed and residual	4,158	4,782	4,183	4,894	26	112	0.6%	2.3%
Other	1,355	1,434	1,356	1,440	1	6	0.1%	0.4%
Exports	1,251	1,879	1,261	1,933	10	54	0.8%	2.9%
Ending stocks	729	1,527	752	1,578	23	51	3.1%	3.3%
			(dollars per bushel)					
Corn price	7.87	5.22	7.83	5.05	-0.04	-0.17	-0.5%	-3.2%

Less corn demand leads to a \$0.04 reduction in the corn price in 2012/13 and a \$0.17 reduction in corn price in 2013/14. Other uses of corn increase somewhat as the price falls. In 2013/14, the baseline projections are for a similar level of corn planting relative to 2012/13 but greater production, assuming a return to trend yields. In the scenario with the conventional gap waived, a bit less area is planted to corn in 2013/14 because of the lower prices, relative to the baseline, and this reduction in supply partly offsets the lower demand for corn use for ethanol and co-products.

The broader impacts on crop and crop product prices are driven primarily through the impacts on corn markets (Table 6). The initial impact in 2012/13 is most pronounced for feed grains that compete directly with corn in feed use. Cross impacts through land use play a role in 2013/14 effects, as some land is reallocated from corn to other crops, such as soybeans and wheat, so the prices of other crops fall in this year relative to the baseline even as the corn price change becomes less pronounced. For distillers grains, the co-product of corn ethanol, the net effect of reduced supplies and changing prices of competing feeds is only small changes relative to the baseline. Soybean meal prices are pushed up marginally because of less competition with distillers grain.

**Table 6. Crop and crop product prices in the conventional gap scenario.**

	Baseline		Conventional gap		Absolute difference		Percent difference	
	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
<b>Crop and crop product prices</b>								
Corn (\$/bu.)	7.87	5.22	7.83	5.05	-0.04	-0.17	-0.5%	-3.2%
Wheat (\$/bu.)	8.33	6.96	8.31	6.88	-0.01	-0.08	-0.2%	-1.1%
Sorghum (\$/bu.)	7.40	4.82	7.37	4.70	-0.03	-0.12	-0.4%	-2.4%
Soybeans (\$/bu.)	16.17	11.18	16.17	11.12	0.00	-0.07	0.0%	-0.6%
Soybean meal (\$/ton)	485.08	293.57	485.49	294.41	0.42	0.84	0.1%	0.3%
Soybean oil (cents/lb.)	55.32	56.13	55.29	55.69	-0.03	-0.44	-0.1%	-0.8%
Upland cotton (cents/lb.)	70.11	70.77	70.09	70.56	-0.02	-0.22	0.0%	-0.3%
Rice (\$/cwt)	14.60	14.37	14.60	14.33	0.00	-0.04	0.0%	-0.3%
Ethanol (\$/gallon)	2.70	2.27	2.67	2.11	-0.02	-0.16	-0.9%	-7.1%
Biodiesel (\$/gallon)	4.91	5.06	4.91	5.04	0.00	-0.03	0.0%	-0.5%
Distillers grains (\$/ton)	276.05	170.01	276.25	170.62	0.20	0.61	0.1%	0.4%

Lower corn price means lower feed costs for livestock producers, unless offset by slightly higher soybean meal and distillers grain prices. Generally, these feed price changes lead to an increase in net returns to meat production relative to the baseline (Table 7). The lower feed costs persist into the second year of the scenario, as noted earlier, but meat producers respond to the lower costs by increasing quantities supplies somewhat so meat prices fall.

**Table 7. Livestock market impacts of the conventional gap scenario.**

	Baseline		Conventional gap		Absolute difference		Percent difference	
	2012	2013	2012	2013	2012	2013	2012	2013
<b>Beef prices and returns</b>								
	(dollars per hundredweight)							
5-Area steer price	121.78	130.00	121.76	129.83	-0.02	-0.17	0.0%	-0.1%
	(dollars per cow)							
Cow-Calf net returns	83.23	122.58	83.66	124.43	0.42	1.86	0.5%	1.5%
	(dollars per pound)							
Retail price	5.08	5.30	5.08	5.30	0.000	-0.002	0.00%	-0.04%
<b>Pork prices and returns</b>								
	(dollars per hundredweight)							
Barrows & gilts price	65.83	70.44	65.82	70.30	-0.02	-0.14	0.0%	-0.2%
Farrow to finish net ret.	-6.97	-6.76	-6.89	-6.35	0.08	0.40	-1.1%	-6.0%
	(dollars per pound)							
Pork retail price	3.44	3.59	3.44	3.58	0.000	-0.004	-0.01%	-0.11%
<b>Poultry prices and ratios</b>								
	(dollars per pound)							
Chicken 12-city price	0.855	0.908	0.855	0.907	0.000	-0.002	0.0%	-0.2%
Turkey hen price	1.073	1.070	1.072	1.069	0.000	-0.001	0.0%	-0.1%
	(ratio)							
Broiler to feed ratio	3.23	3.66	3.23	3.67	0.00	0.01	0.0%	0.2%
Turkey to feed ratio	4.70	4.82	4.70	4.84	0.00	0.02	0.1%	0.4%

## Conventional RIN rollover not carried forward

The 2013/14 effects are determined in large part by RIN rollover. Existing rules state that up to 20% of the mandate in any given year can be met using RIN rollover from the preceding year. It is our assumption in the preceding analysis that conventional RINs would be generated during a waiver that eliminates the conventional gap in 2012/13 and then used as rollover RINs to be carried into 2013/14. The implication of a waiver that eliminates the conventional gap and not being able to store conventional RINs is compared to the baseline and to the effects of a conventional gap elimination if rollover is permitted. This scenario also highlights the part rollover plays in determining second-year effects of the previous analysis.

In the tables in this section, the baseline results are compared to both the results of the previous scenario (waiver with rollover) and an alternative case (waiver without rollover). The 2012/13 results are almost the same in either case. The main difference is that rollover RINs at the end of the year for the overall mandate are reduced to the level of advanced rollover RINs because, assuming no conventional RIN rollover, only sub-mandate RINs are permitted to be carried forward.

If no conventional RIN rollover is permitted from 2012/13, then the 2013/14 overall mandate is more binding than in the baseline or in the case of the waiver with rollover (Table 8). In contrast either to the baseline or to the case with rollover, the case without rollover has less supply of conventional RINs in 2013/14, so more conventional RINs must be generated in that year and the conventional RIN price is higher than in the baseline, not lower as in the previous scenario. In terms of the conventional RIN prices, the direction of second-year impacts are reversed if there is no rollover.

Through the impacts on ethanol markets, discussed below, the advanced mandate is also more binding in 2013/14 if conventional RIN rollover is not permitted during the waiver.

**Table 8. RIN markets with and without rollover in the conventional gap scenario.**

	Baseline		Waiver with rollover		Waiver without rollover	
	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
<b>Overall RFS</b>	(million gallons)		(difference from baseline, million gallons)			
Rollover of prior year	2,252	362	0	2,990	0	-284
RINs Generated	14,211	16,609	-159	-1,132	-149	284
RINs used for RFS	16,100	16,972	-13,600	0	-13,600	0
Rollover for next year	362	0	2,990	1,858	-284	0
Expire unused	0	0	10,451	0	13,735	0
<b>Advanced RFS</b>						
Rollover of prior year	324	53	0	27	0	25
RINs Generated	2,230	2,718	27	-27	25	-25
RINs used for RFS	2,500	2,772	0	0	0	0
Rollover for next year	53	0	27	0	25	0
Expire unused	0	0	0	0	0	0
<b>RIN core values</b>	(dollars per RIN-gallon)		(difference from baseline, dollars per RIN-gallon)			
Conventional	0.10	0.54	-0.10	-0.50	-0.10	0.14
Advanced	0.72	1.27	-0.08	-0.39	-0.08	0.08
Biodiesel	1.17	1.30	0.00	-0.02	0.00	0.04

Greater need to generate conventional RINs in 2013/14 relative to the baseline means greater corn ethanol production and domestic use (Table 9). Rather than falling relative to the baseline, as in the case with rollover, more ethanol is used in the US in 2013/14. This drives the conventional ethanol price at wholesale higher in this scenario as compared to the baseline, so exports are lower. More conventional ethanol blended means greater overall use of ethanol than in the baseline projection, pushing the retail price lower.

Both of these price changes contribute to the higher advanced RIN value. Lower ethanol exports from the US leads to a higher Brazilian ethanol price, so it costs more to import sugar cane ethanol that helps to meet the gap. At the same time, a lower retail price of ethanol makes it more difficult to sell the imported ethanol domestically. With higher cost to acquiring advanced ethanol and a lower resale value, the advanced mandate is more difficult to meet, so the advanced RIN value is bid higher in 2013/14 relative to the baseline.

There is more demand for corn to make ethanol and co-products in 2013/14 because of the need for conventional ethanol to meet the more stringently binding overall mandate. Whereas the case with rollover leads to less corn use for this purpose than in the baseline in 2013/14, in the case without rollover this use rises above the baseline level. Greater corn demand leads to a corn price that is higher than the baseline price, not less, in the year after the waiver if there is no rollover.

**Table 9. Ethanol and corn markets with and without rollover in the conventional gap scenario.**

	Baseline		Waiver with rollover		Waiver without rollover	
	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
<b>Ethanol market indicators</b>	(million gallons)		(difference from baseline, million gallons)			
Production	12,458	14,908	-163	-981	-145	244
From corn	12,171	14,565	-161	-966	-143	240
From other feedstocks	287	343	-2	-15	-2	4
Imports	662	714	27	-27	25	-70
Domestic use	12,689	14,690	-159	-1,132	-149	239
Exports	591	779	30	155	35	-79
<b>Ethanol prices</b>	(dollars per gallon)		(difference from baseline, dollars per gallon)			
Conventional rack	2.70	2.27	-0.02	-0.16	-0.03	0.06
Other advanced rack	3.31	3.00	0.00	-0.05	0.00	0.00
Effective retail	3.46	2.56	0.07	0.29	0.07	-0.06
<b>Corn market indicators</b>	(million acres)		(difference from baseline, million acres)			
Area planted	96.41	94.99	0.00	-1.07	0.00	0.03
	(million bushels)		(difference from baseline, million bushels)			
Production	10,727	14,228	0	-154	0	4
Domestic use	10,002	11,576	-33	-236	-20	44
Ethanol and co-prod.	4,490	5,360	-59	-354	-52	88
Feed and residual	4,158	4,782	26	112	31	-42
Other	1,355	1,434	1	6	2	-2
Exports	1,251	1,879	10	54	14	-19
Ending stocks	729	1,527	23	51	6	-15
<b>Corn price</b>	(dollars per bushel)		(difference from baseline, dollars per bushel)			
	7.87	5.22	-0.04	-0.17	-0.06	0.06

## Advanced gap eliminated

The waiver option explored here is to reduce the advanced mandate in order to eliminate the advanced gap. This change means advanced biofuels, mostly sugar-cane ethanol imports, no longer help to fill the advanced mandate. However, advanced ethanol still competes with conventional, corn starch ethanol to fill the conventional gap, as well as in domestic and foreign ethanol markets.

This scenario is conducted with two alternative cases regarding the treatment of the overall mandate (Table 10). In the first case, “advanced only”, the overall mandate is not changed, so the reduction in the advanced mandate makes the conventional gap expand by an offsetting amount.<sup>4</sup> In the second case,

<sup>4</sup> Waiving a sub-mandate will affect a gap unless the broader mandate is also reduced. This consequence of waivers in the nested hierarchy of the RFS mandates has been observed each year that the cellulosic mandate has been waived, but the implications have been small in the past. For forward-looking analysis of cellulosic waiver options, see FAPRI-MU #04-12.

“advanced and overall”, the overall mandate is reduced by the same amount, so the conventional gap is not changed from the baseline level.

Reducing the advanced mandate to eliminate the advanced gap means that no advanced RINs are required for compliance beyond what is already produced to meet biodiesel and cellulosic mandates. However, there remains the potential that the advanced RIN value will not drop to zero, as might be expected if the advanced gap is eliminated. First, because the advanced mandate is a sub-mandate of the overall mandate, advanced RINs can substitute for conventional RINs in helping to meet the overall mandate. Because of this potential for substitution, the advanced RIN value will not fall below the conventional RIN value. Second, assuming blenders can generate advanced RINs in 2012/13 to rollover for use in 2013/14, up to the 20% limit, they are assumed to put a value on advanced RINs even though they cannot be used in the current marketing year because of the waiver. In both cases for this scenario, the advanced RIN value remains above the conventional RIN value as advanced RINs are generated to build up rollover.

Eliminating the advanced gap in 2012/13 greatly reduces the incentive to import sugar-cane ethanol, which is almost 70% lower than the baseline level. Less advanced ethanol imports means lower foreign ethanol prices, so less 2012/13 conventional ethanol is exported than in the baseline in either case.

The conventional RIN value effects vary by case. If the reduced advanced mandate is not offset with a reduction in the overall mandate, then the conventional gap rises in 2012/13 and the conventional RIN value also increases relative to the baseline. However, if the overall mandate is reduced by the same amount as the advanced mandate, then there is no change in the conventional gap. In this case, the conventional RIN value falls in 2012/13 because of ethanol market impacts discussed below.

There is also a distinction between the two cases in terms of the size of the impact on the conventional ethanol market and retail ethanol price. In the first case, the shortfall in advanced biofuel must be offset by greater conventional RIN generation or drawing down conventional RIN rollover stocks carried into 2012/13. Total domestic use is a bit lower than in the baseline if the conventional gap increases because there is some scope to draw down conventional RIN rollover stocks, so a small part of the reduction in actual use of advanced ethanol in the baseline is replaced in the first case by using conventional RIN rollover. This means a small decrease in overall ethanol use and slightly higher retail price than in the baseline.

The conventional ethanol and retail ethanol price impacts are different in the second case. The overall mandate is reduced by the same amount as the advanced mandate in this case, so the conventional gap is the same as in the baseline. Without the offsetting increase in the conventional gap, the reduction in advanced ethanol use translates more directly into a reduction in total domestic ethanol use as compared to the baseline, so the retail price rises a bit more in this case than it did in the first case.

The 2013/14 ethanol market effects are explained mostly by rollover RINs. Advanced RIN rollover that is pushed to its maximum level in the year of the waiver. More advanced RIN rollover carried from 2012/13 means a lower advanced RIN value and less need for imported advanced ethanol in 2013/14 relative to the baseline.

Conventional RIN rollover is a key difference between these two cases. In the first case, the increase in the conventional gap and higher conventional RIN value of 2012/13 makes it more attractive for blenders to use RINs for immediate compliance rather than to save them for 2013/14. Less conventional RIN rollover from 2012/13 means less conventional RIN supply in 2013/14 compared to the baseline, so somewhat

more conventional ethanol must be blended – and more corn used to make ethanol in that year – in order to meet the mandate. The net effect is greater total domestic sales of ethanol than in the baseline and a slightly lower retail price in 2013/14 in this case.

**Table 10. RFS, RIN, and biofuel market indicators for advanced gap scenarios.**

	Baseline		Advanced only		Advanced and overall	
	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
<b>Effective RFS mandates</b>	(million gallons)					
Total	16,100	16,972	16,100	16,972	15,426	16,972
Advanced	2,500	2,772	1,826	2,772	1,826	2,772
Biodiesel	1,187	1,280	1,187	1,280	1,187	1,280
Cellulosic	46	85	46	85	46	85
Gaps						
Conventional	13,600	14,200	14,274	14,200	13,600	14,200
Advanced	674	766	0	766	0	766
<b>RIN rollover</b>	(million gallons)					
Total	362	0	293	0	862	0
Advanced	53	0	271	0	277	0
<b>RIN core values</b>	(dollars per RIN-gallon)					
Conventional	0.10	0.54	0.11	0.59	0.05	0.31
Advanced	0.72	1.27	0.39	1.23	0.38	1.02
Biodiesel	1.17	1.30	1.17	1.31	1.17	1.30
<b>Ethanol market indicators</b>	(million gallons)					
Production	12,458	14,908	12,706	15,086	12,607	14,603
From corn	12,171	14,564	12,416	14,738	12,318	14,264
From other feedstocks	287	343	290	348	289	339
Imports	662	714	205	497	211	491
Domestic use	12,689	14,690	12,620	14,759	12,514	14,191
Exports	591	779	442	672	459	766
<b>Ethanol prices</b>	(dollars per gallon)					
Conventional rack	2.70	2.27	2.74	2.30	2.73	2.20
Other advanced rack	3.31	3.00	3.01	2.94	3.06	2.91
Effective retail	3.46	2.56	3.50	2.54	3.54	2.69

In the second case, conventional rollover from 2012/13 is greater than in the baseline, not less. The 2012/13 conventional gap is unchanged relative to the baseline, but the higher retail price and lower exports induce an increase in conventional ethanol blending. As more conventional RINs are generated and the conventional RIN value falls, more RINs are stored as 2012/13 rollover and available for use in 2013/14. The greater conventional rollover in 2013/14 relative to the baseline means that less conventional ethanol needs to be used to meet the mandate, so corn ethanol use is lower in 2013/14 in the second case.

Biodiesel market impacts are small in either case. In principle, because biodiesel is a sub-mandate to the advanced mandate, changes in the advanced mandate could affect biodiesel. However, because baseline projections – and recent RIN price data – suggest that the biodiesel mandate is much more binding than the advanced mandate, there is no direct impact of waiver options on biodiesel markets in these scenarios.

The crop market impacts of the advanced waiver scenario are driven primarily by the demand for corn to be used for making ethanol and co-products. In both cases, more conventional ethanol is used in 2012/13 if the advanced mandate is reduced, so corn price rises relative to the baseline. Because of the RIN rollover effects discussed above, conventional ethanol use in 2013/14 is higher than the baseline level in the first case and lower in the second case, and this impact leads to a higher corn price relative to the baseline in 2013/14 if the conventional gap increases and a lower corn price if the conventional gap is unchanged.

**Table 11. Crop and crop product prices in the advanced gap scenarios.**

	Baseline		Advanced only		Advanced and overall	
	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
<b>Crop and crop product prices</b>						
Corn (\$/bu.)	7.87	5.22	7.96	5.23	7.93	5.14
Wheat (\$/bu.)	8.33	6.96	8.36	6.99	8.35	6.94
Sorghum (\$/bu.)	7.40	4.82	7.46	4.84	7.44	4.77
Soybeans (\$/bu.)	16.17	11.18	16.17	11.23	16.17	11.19
Soybean meal (\$/ton)	485.08	293.57	484.58	294.17	484.83	294.36
Soybean oil (cents/lb.)	55.32	56.13	55.34	56.31	55.32	56.09
Upland cotton (cents/lb.)	70.11	70.77	70.12	70.85	70.10	70.74
Rice (\$/cwt)	14.60	14.37	14.61	14.39	14.61	14.37
Ethanol (\$/gallon)	2.70	2.27	2.74	2.30	2.73	2.20
Biodiesel (\$/gallon)	4.91	5.06	4.91	5.08	4.91	5.06
Distillers grains (\$/ton)	276.05	170.01	276.48	169.68	276.57	169.83

## Key lessons and caveats

This analysis suggests that effects of a 2012/13 mandate waiver might be greater in 2013/14 than in the year of the waiver. Rising mandates, combined with blend wall limitations on ethanol expansion, suggest that the mandates will tend to become increasingly binding over time. The rollover provisions mean that RINs generated in 2012/13 that are not used because of a waiver can be applied in 2013/14. In the results reported here, a waiver in 2012/13 causes the already low conventional RIN price in 2012 to drop to zero and has a larger absolute impact on the 2013/14 conventional RIN price, and correspondingly larger second-year effects on other markets.

A concern is the lack of information on which to base our representation of RIN rollover behavior. We believe that RIN rollover depends on current RIN values and next year's mandate, but our data about actual rollover in the few years since the RFS was started is implied by other data, not necessarily what was actually held, and it remains to be seen how much RIN rollover would be carried under different market conditions. The example of reconciling current conventional RIN prices with baseline expectations is illustrated earlier in this report (see text box on page 5).

Trade can offset some impacts of various waiver options. Waiving the overall mandate, only, leads to a reduction in the volume of conventional ethanol made from corn starch in domestic markets in 2012/13, and some of this reduction is offset by greater exports. Waiving the advanced mandate can affect the advanced gap, leading to changes in imports of sugar cane ethanol that help to meet this requirement. If US imports less ethanol, then world price is lower and the US is likely to export less conventional ethanol. These complications are a consequence of the two-way trade that has been observed in recent years and

that we project to continue during the baseline period as long as the advanced mandate is more binding than the overall mandate.

There are key assumptions and important limitations to the study.

Marketing year simulations are not entirely satisfactory representations of calendar year mandates and, for that matter, some of the other underlying factors. Our results suggest that rollover is a key element, but our rollover is a constraint at the end of August, whereas the actual rollover limit applies at the end of December, which is in between corn harvests. The effect of rollover seems intuitively to remain important even considering it on a calendar year basis: easily carrying extra RINs from a year when a mandate is waived to a year with the mandate more binding can lead to larger effects after the waiver. However, we do not model the rollover on a calendar year basis so we approach this extrapolation with some caution.

Fuel use seems to continue to be dominated by E10 even though the drought caused a higher ethanol feedstock prices. The analysis presented here is based on the assumption that fuel blenders would be slow to shift back to making gasoline without ethanol. This assumption means that there is limited scope for rising ethanol wholesale prices to lead to lower ethanol use during a one-year waiver – at least for ethanol price changes that are not very large.

Taking this understanding of fuel markets further, it also means that rate of ethanol use during the year might be inflexible. If ethanol use is almost all E10 in 2012/13 and if blenders are not quick to adjust, then the rate of ethanol use each month is approximately 10% of total gasoline and ethanol motor fuel use. Absent large ethanol stocks, this implies that the rate of corn use for ethanol production might also be based primarily on the monthly rate of fuel use. This seemingly inflexible rate of use might be difficult to reconcile with both the rollover limits and rising mandates that must be met at the end of each calendar year, if there is no waiver. Moreover, if corn yields are below trend in autumn 2013, then there could be additional challenges.

The results stress the importance of the mandate hierarchy, delayed impacts that take place after a waiver, trade, and the interactions among biofuel and crop markets more generally. However, there are important uncertainties about market behavior in the future, particularly about ethanol use, RIN rollover, and reconciling marketing year and calendar year information.