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EPA and RFS2: Market Impacts of Biofuel Mandate Waiver Options

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Summary

The EPA is required by law to implement biofuel use mandates and it has proposed to waive the cellulosic mandate again and to increase the biodiesel mandate. If there are no parallel decreases in the other mandates, then a reduction in the cellulosic mandate causes an increase in the requirement for advanced biofuels other than cellulosic biofuels. If other mandates are decreased, then that imperative to replace the shortfall in cellulosic biofuel with other biofuels is reduced or, in the extreme case, eliminated. A higher biodiesel mandate reduces the requirement for other advanced biofuels.

We use the FAPRI-MU stochastic model of biofuel and agricultural commodity markets to explore these alternatives in terms of the quantity and price impacts relative to an assumed baseline. Results are contingent on assumptions, such as those regarding the nature of U.S. ethanol demand, ethanol import supplies and particularly Brazilian market responses, and biodiesel costs. The analysis is partial, as we do not include such critical considerations as greenhouse gas and welfare impacts. The starting point of analysis is the FAPRI-MU stochastic baseline of March 2012, which predates current concerns about weather conditions in the U.S.

Biodiesel mandate at 1 billion gallons (b.g.), not 1.28 b.g., results through 2015/16 suggest:

- A lower biodiesel mandate is less binding, but the advanced mandate (of which biodiesel is a submandate) must be met by increased use of other advanced biofuels.
- Because more sugarcane ethanol is imported to fill the advanced mandate, retail ethanol price falls and corn-starch ethanol exports rise, making the overall mandate more binding.
- The net impact on total mandate compliance cost can be positive or negative, but the average is small and positive in the simulations explored here.

Mandate waiver option results through 2015/16 lead to these conclusions:

- The choice affects the combination of domestically produced conventional ethanol and advanced sugarcane ethanol imports in domestic use. It can also affect the combination of sugarcane ethanol and biodiesel used to meet the advanced mandate.
- Increasing the advanced biofuel requirement can make the total mandate more difficult to meet for two reasons. First, greater sugarcane ethanol imports increases the competitiveness of conventional ethanol exports, so the conventional ethanol price rises. Second, more ethanol use domestically lowers the retail ethanol price.
- Mandate compliance costs are sensitive to waiver options. A higher advanced mandate is more difficult to meet. A higher advanced mandate has second-round effects through the competition of conventional and advanced ethanol in domestic and foreign markets that can lead to even greater changes in compliance costs.
- Crop market effects tend to be modest, with one exception in soybean oil markets.
- Biofuel and crop market effects vary with circumstances, particularly the potential for extra biodiesel use to help fill a high advanced biofuel mandate.

Table 1. Summary of impacts from waived and unwaived total and advanced biofuel mandates, with 1.00 or 1.28 billion gallon biodiesel mandates

Averages, 2013/14 to 2015/16	Baseline	Unwaived		Biodiesel mandate at one billion gallons			
		Scenario	Change	Waived	Change	Unwaived	Change
Mandate assumptions			(billion gallons)				
Total	17.95	19.67	1.72	18.02	0.07	19.67	1.72
Advanced	3.28	5.00	1.72	3.35	0.07	5.00	1.72
Biodiesel	1.28	1.28	0.00	1.00	-0.28	1.00	-0.28
Cellulosic	0.32	0.52	0.19	0.39	0.07	0.60	0.28
Selected biofuel quantities			(billion gallons)				
Ethanol production	15.39	15.66	0.27	15.51	0.12	15.78	0.39
Ethanol imports	0.97	2.44	1.47	1.34	0.37	2.66	1.69
Biodiesel production	1.33	1.35	0.01	1.09	-0.24	1.15	-0.19
Conventional ethanol use	14.27	14.22	-0.05	14.30	0.04	14.26	0.00
Advanced ethanol use	1.07	2.54	1.47	1.44	0.37	2.77	1.70
Biodiesel use	1.29	1.30	0.02	1.04	-0.25	1.09	-0.19
Biofuel prices, wholesale			(dollars per gallon)				
Conventional ethanol	2.23	2.30	0.06	2.27	0.04	2.33	0.10
Advanced ethanol	2.60	2.82	0.22	2.66	0.06	2.86	0.26
Biodiesel	5.21	5.24	0.03	4.77	-0.44	4.88	-0.33
RIN values			(dollars per RIN-gallon)				
Conventional	0.62	0.77	0.16	0.69	0.07	0.82	0.20
Advanced	0.99	1.30	0.32	1.07	0.09	1.35	0.37
Biodiesel	1.88	1.91	0.02	1.49	-0.39	1.58	-0.30
			(billion dollars)				
Mandate compliance cost	14.07	19.29	5.22	14.38	0.31	19.48	5.41
Crop prices			(billion gallons)				
Corn	4.78	4.80	0.02	4.78	-0.01	4.79	0.01
Soybeans	11.34	11.37	0.03	11.16	-0.18	11.23	-0.11

Notes: (1) Data are on a marketing year basis. (2) Mandate compliance costs are the costs of meeting the requirements of the RFS2. (3) The baseline assumes the biodiesel mandate rises to 1.28 billion gallons (b.g.) from 2013, and that the EPA chooses to waive the cellulosic mandate and waives broader total and advanced mandates by the same amount ("Waived"). (4) The alternatives explored include a lower biodiesel mandate of 1 b.g. and leaving broader mandates unchanged at legislated levels ("Unwaived").

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Introduction

The Energy Independence and Security Act (EISA) of 2007 extended and expanded U.S. biofuel use mandates. The mandates, as defined by the Renewable Fuel Standard (RFS2, to distinguish it from an earlier version), require fuel blenders to include at least minimum volumes of different fuels in domestic fuel use. The mandates are hierarchical, not independent, and are distinguished by criteria relating to feedstocks and greenhouse gas reductions. The four mandates include a total, or overall, requirement for all qualifying biofuels, a submandate for advanced biofuels, and biodiesel and cellulosic mandates that are two submandates of advanced biofuels. A biofuel that meets a submandate also helps to meet the broader mandate, but the reverse is not true.

The hierarchy leads to gaps between broad mandate and submandate. The "conventional gap" is defined as the part of the total mandate that can be met by conventional biofuels (e.g. corn starch ethanol) and need not be met using advanced biofuels. The "advanced gap" is defined as the volume by which the advanced mandate exceeds the sum of biodiesel and cellulosic mandates. The advanced gap calculation is complicated by equivalence values that are used to render biofuels comparable, and which we assume to count a gallon of biodiesel as equivalent to 1.5 gallons of ethanol.

The EISA gives the Environmental Protection Agency (EPA) the responsibility to waive the mandates if conditions warrant. The EPA has waived the cellulosic mandate every year it has been in place so far, resetting the volume to a lower level, and the EPA proposes to waive it in the near future. Because it is a submandate, the choice to waive the cellulosic mandate causes an increase in the advanced gap (the part of the advanced mandate that need not be filled by submandated biodiesel and cellulosic biofuels) if there are no other changes to the mandates. The EPA has the option to waive the broader mandates, so the advanced gap increase could be reduced or eliminated.

The EPA has not reduced the other mandates so far. This decision leads to an increase in the advanced gap equal to the shortfall in cellulosic biofuel production relative to the EISA mandate. Because of the exact legislated volumes, this decision has had little or no impact so far. However, as the RFS2 establishes a cellulosic biofuel mandate that will be half a billion gallons (b.g.) out of the overall 15.2 b.g. mandated in 2012, and 3 b.g. out of 20.5 b. g. in 2015, EPA decisions may have greater consequences in the future.

This paper explores the impact of EPA decisions about whether or not to waive the broader mandates when the cellulosic mandate is waived. This paper also simulates the impacts of EPA options to set the biodiesel mandate at 1 b.g or 1.28 b.g. after 2012.

Methods and assumptions

FAPRI-MU uses economic models that focus on U.S. biofuel and agricultural commodity markets to estimate the impacts of EPA options in implementing biofuel mandates. These are structural dynamic models that represent supplies, demands, and stocks of commodities, land allocation, and other key behavioral decisions in each year of a ten-year projection period. These models are documented elsewhere, and have served as the basis for numerous FAPRI-MU reports and journal publications (listed at the end of this report). The model is simulated stochastically, meaning for many hundreds of different market contexts for each scenario, as discussed later, but mean values are usually presented.

For example, the baseline value of the corn price in 2013/14 presented in the following tables is the average of 500 outcomes for the corn price in that marketing year, each based on its own particular sequence of corn and other crop yield shocks, petroleum price, and other factors. The corn price in 2013/14 reported in the table representing results of the first scenario is also an average of 500 simulations. In the scenario, the same set of 500 random shocks is used as in the baseline, but the assumption about how the mandate is waived is changed. The difference between the corn price in the baseline and scenario is determined solely by this one change in policy assumption, taking into account the agricultural and biofuel market interactions. By construction, this difference in average corn prices is the average of the estimated 2013/14 corn price impacts from this policy change over all 500 market conditions simulated stochastically.

The mandates are varied in the scenarios explored here (Table 2, page 9). The EISA sets out a total mandate that rises from 15.2 b.g. in 2012 to 20.5 b.g. in 2015. The advanced mandate is 2.0 b.g. in 2012 and increases to 5.5 b.g. in 2015. The EISA does not set out specific values for the biodiesel mandate after 2012, when it is 1 b.g. The cellulosic mandate is 0.5 b.g. in 2012 and expands rapidly to 3 b.g. in 2015 in the EISA. If these mandated volumes were not waived and biodiesel remained at 1 billion gallons, then there would be no advanced gap (the portion of the advanced mandate not met by submandated biodiesel and cellulosic biofuels) until 2013. The conventional gap would rise from 12.6 b.g. in 2012 to its 15 b.g. peak in 2015. (The mandates are converted into marketing years later for integration with crops models.)

The **baseline** does not use the volumes set out in the EISA. The EPA has waived the cellulosic mandate in the past, and we assume that production technology advances quickly, but not so quickly that the EPA leaves the cellulosic mandate unwaived. In 2012/13 marketing year, we follow the example set by the EPA in its actions so far and we do not reduce the broader advanced and total mandates at all. This means the advanced gap increases by the amount of the reduction in cellulosic biofuel. The baseline deviates from this pattern from 2013/14 on, reducing advanced and total mandates by the same amount as the cellulosic mandate to eliminate any impact on the advanced gap and the conventional gap. We assume the biodiesel mandate is set at 1.28 b.g. from 2013 on, leading to a reduction in the advanced gap relative to a continuation at 1 b.g. We explore three alternative scenarios relative to the baseline:

Scenario 1: Unwaived

Broader mandates are not reduced at all. The lower cellulosic biofuel mandate without broader mandate waivers increases the advanced gap relative to the baseline.

Scenario 2: **Waived, 1 b.g. biodiesel**

Broader mandates are reduced and the biodiesel mandate is 1 b.g. The reduction in the biodiesel mandate increases the advanced gap relative to the baseline.

Scenario 3: **Unwaived, 1 b.g. biodiesel**

Broader mandates are unchanged and the biodiesel mandate is 1 b.g. Combining the previous two scenarios leads to the largest increase in the advanced gap explored here.

Other policies are left unchanged at announced levels. This means that the blender tax credits and ethanol specific duty are not continued, having expired at the end of 2011, and the cellulosic biofuel producer tax credit expires at the end of 2012.

Table 2. Legislated and alternative assumptions for mandates

Calendar or marketing year	2012	2013	2014	2015	2012/13	2013/14	2014/15	2015/16
EISA unwaived mandates								
Total	15.2	16.6	18.2	20.5	16.1	17.6	19.7	21.7
Advanced	2.0	2.8	3.8	5.5	2.5	3.4	4.9	6.7
Biodiesel	1.0	(not specified)				(not specified)		
Cellulosic	0.5	1.0	1.8	3.0	0.8	1.5	2.6	3.8
Advanced gap *	0.0	0.3	0.5	1.0	0.2	0.4	0.8	1.3
Conventional gap	13.2	13.8	14.4	15.0	13.6	14.2	14.8	15.0
Baseline								
Total	15.2	16.5	17.4	18.5	16.1	17.1	18.2	18.5
Advanced	2.0	2.7	3.0	3.5	2.5	2.9	3.4	3.5
Biodiesel	1.0	1.3	1.3	1.3	1.2	1.3	1.3	1.3
Cellulosic	0.0	0.1	0.3	0.4	0.0	0.2	0.4	0.4
Advanced gap	0.5	0.8	0.8	1.2	0.7	0.8	1.1	1.2
Conventional gap	13.2	13.8	14.4	15.0	13.6	14.2	14.8	15.0
Broader mandates unwaived								
Total	15.2	16.6	18.2	20.5	16.1	17.6	19.7	21.7
Advanced	2.0	2.8	3.8	5.5	2.5	3.4	4.9	6.7
Biodiesel	1.0	1.3	1.3	1.3	1.2	1.3	1.3	1.3
Cellulosic	0.0	0.1	0.3	0.6	0.0	0.2	0.5	0.8
Advanced gap	0.5	0.8	1.5	3.0	0.7	1.3	2.5	3.9
Conventional gap	13.2	13.8	14.4	15.0	13.6	14.2	14.8	15.0
Biodiesel at one billion gallons, waived mandates								
Total	15.2	16.5	17.4	18.6	16.1	17.2	18.3	18.6
Advanced	2.0	2.7	3.0	3.6	2.5	3.0	3.5	3.6
Biodiesel	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Cellulosic	0.0	0.1	0.4	0.5	0.0	0.3	0.4	0.5
Advanced gap	0.5	1.1	1.2	1.6	1.0	1.2	1.5	1.6
Conventional gap	13.2	13.8	14.4	15.0	13.6	14.2	14.8	15.0
Biodiesel at one billion gallons, unwaived mandates								
Total	15.2	16.6	18.2	20.5	16.1	17.6	19.7	21.7
Advanced	2.0	2.8	3.8	5.5	2.5	3.4	4.9	6.7
Biodiesel	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Cellulosic	0.0	0.1	0.4	0.7	0.0	0.3	0.6	0.9
Advanced gap	0.5	1.2	1.9	3.3	1.0	1.6	2.8	4.3
Conventional gap	13.2	13.8	14.4	15.0	13.6	14.2	14.8	15.0

* Advanced gap calculations assume a 1.5 equivalence value for biodiesel and, in the EISA row, that the biodiesel mandate is constant at one billion gallons after 2012.

Baseline

The baseline used here is developed from the March 2012 FAPRI-MU stochastic baseline. We summarize only a subset of the FAPRI-MU model data that are directly relevant to this study (Table 3 and Table 4). However, these simulations are based on the FAPRI-MU model system that focuses on U.S. crop, livestock, dairy, and biofuel markets. Moreover, even for the commodities reported here, only incomplete data about supply and demand are presented in order to save space.

Baseline biofuel data suggest growing volumes of domestic production and use, with greater ethanol exports and imports. To some extent, this is driven by mandated use volumes. Over this period, the conventional gap grows, so the rising total mandate can be met, in part, using corn starch ethanol, leading to greater domestic use and production of this type of biofuel. Even taking into account the low volumes of cellulosic biofuel permitted due to the assumed waiver, as well as the assumption that broader mandates are also reduced from 2012/13 on, more imported sugarcane ethanol is used to fill out the advanced gap and to help meet the advanced mandate – assuming that no significant domestic sources of such advanced biofuels comes on-line during this period. Rising sugarcane ethanol imports into the U.S. put upward pressure on the Brazilian ethanol price, helping to make U.S. conventional ethanol more competitive in foreign markets so U.S. conventional ethanol exports remain strong.

Biodiesel use is driven by the rising biodiesel mandate through 2014/15 in most simulations. In some stochastic simulations, biodiesel use is drawn higher by the rising advanced mandate, which it also helps to fill, but these instances are rare in the baseline because the costs of biodiesel feedstocks tend to make it less attractive than imported sugarcane ethanol. These mandate effects, plus a small amount of net exports, sustain biodiesel production.

Renewable Identification Number (RIN) prices reflect the degree to which different mandates are binding. (A "binding" mandate forces blenders to use more biofuel relative to what they would use if not for the mandate.) Here, the prices do not include transaction costs, but do reflect this core value that depends on the degree to which mandates are binding and drives the RIN prices overall. The non-zero average conventional RIN price indicates that the total mandate tends to be binding during this period in many of the stochastic simulations. The rising conventional RIN price suggests that it is becoming more difficult to meet, particularly during the period to 2015/16 when the conventional gap expands to its peak of 15 b.g.

The advanced RIN price is also greater than zero in most of the stochastic simulations, averaging about $1.00 per gallon in this period, indicating that it is difficult to meet the advanced mandate given the baseline assumptions.

The biodiesel RIN price averages nearly $2.00 per RIN-gallon (e.g. after conversion to a common basis using a 1.5 equivalence value). Partly because the EPA is assumed to hold the

biodiesel mandate constant after 2012 at 1.28 b.g. in the baseline, this mandate does not become more binding during this period. Because of the mandate hierarchy, additional biodiesel RINs can be used beyond the mandated volume to help meet the advanced mandate, displacing sugarcane ethanol. In this case, the submandate for biodiesel would be less binding on its own than the broader advanced mandate, so biodiesel would be used beyond the biodiesel mandate in order to help to meet the advanced mandate. This result depends on the costs of domestic production of biodiesel and imported sugarcane ethanol at volumes that have not yet been seen, but is an infrequent occurrence in baseline stochastic simulations.

Biofuel prices at wholesale reflect the buyers' value of these fuels, which includes the price of the underlying fuel for blending, ethanol or biodiesel, and the value generated from the biofuel by blenders tax credits (which expire at end 2011) and RINs. The value of the biofuel in blending is driven by supply and demand conditions in fuel markets, which are not explored here but have been found elsewhere to be particularly sensitive to the petroleum price. In stochastic simulations, the average petroleum price tends to be flat this period, leading to flat average biofuel prices as shown by the retail ethanol price.

Biofuel prices at the wholesale level are the prices that link supply and demand for each type of biofuel. These prices drive returns to bio-refineries which, in turn, purchase feedstocks. Rising use of corn and other commodities for biofuel production tends to put some upward pressure on prices. Other biodiesel feedstocks tend to replace soybean oil in the baseline simulations. Corn and soybean prices during the period tend to be below recent price levels, but remain above historical averages.

Baseline – tables

Table 3. Baseline biofuel markets summary

Marketing year	2013/14	2014/15	2015/16	Average
Ethanol market quantities		(billion gallons)		
Production	14.7	15.5	16.0	15.4
Imports	0.7	1.0	1.1	1.0
Domestic use	14.4	15.8	16.5	15.6
Conventional	13.5	14.4	14.9	14.3
Advanced	0.8	1.1	1.3	1.1
Cellulosic	0.2	0.4	0.4	0.3
Exports	0.9	0.7	0.6	0.8
Ethanol prices		(dollars per gallon)		
Advanced ethanol	2.62	2.64	2.54	2.60
Conventional ethanol	2.09	2.31	2.30	2.23
Retail	2.34	2.26	2.34	2.31
Biodiesel market quantities		(billion gallons)		
Production	1.33	1.34	1.33	1.33
Domestic use	1.28	1.29	1.29	1.29
Biodiesel net exports	0.05	0.05	0.05	0.05
Biodiesel price		(dollars per gallon)		
Wholesale	5.38	5.19	5.06	5.21
RIN values		(dollars per RIN-gallon)		
Biodiesel RIN	1.99	1.87	1.79	1.88
Advanced RIN	0.95	1.10	0.91	0.99
Conventional RIN	0.42	0.76	0.67	0.62
		(billion dollars)		
Mandate compliance cost	10.52	16.50	15.19	14.07

Table 4. Baseline crops markets summary

Marketing year	2013/14	2014/15	2015/16	Average
Corn market		(billion bushels)		
Production	13.791	13.974	14.261	14.009
Domestic use	11.642	11.877	12.090	11.870
Fuel alcohol	5.201	5.437	5.590	5.409
Exports	2.029	2.101	2.160	2.097
		(dollars per bushel)		
Farm price	4.71	4.80	4.83	4.78
Soybean market		(billion bushels)		
Production	3.285	3.311	3.320	3.305
Domestic use	1.808	1.822	1.833	1.821
Exports	1.495	1.496	1.501	1.497
		(dollars per bushel)		
Farm price	11.37	11.30	11.35	11.34
Soybean oil market		(billion pounds)		
Production	19.036	19.184	19.293	19.171
Domestic use	17.930	17.780	17.768	17.826
Biodiesel	4.165	3.897	3.643	3.902
Exports	1.342	1.428	1.619	1.463
		(cents per pound)		
Market price	57.98	55.91	54.53	56.14

Scenario 1: Advanced and overall mandates not waived at all

The only change in assumptions in this "unwaived" case relative to the baseline is that advanced and overall mandates are not waived. The **baseline** assumption is that the EPA opts to reduce advanced and total mandates by an amount equal to the reduction in the cellulosic biofuel use mandate from 2013/14 on. In the **unwaived scenario**, the EPA continues not to reduce advanced or total mandates. There is no reduction in the volume of advanced fuel use required in this scenario, so any reduction in the cellulosic biofuel mandate causes an equal increase in the advanced gap.

The advanced mandate is harder to meet because the other advanced gap increases by the full amount of the short-fall in cellulosic biofuel, in this scenario. This is reflected in the higher advanced RIN price. Domestic use of advanced ethanol rises to meet the higher mandate. More sugarcane ethanol is imported for this purpose, assuming still that domestic advanced biofuel supplies remain small.

Greater sugarcane ethanol imports into the U.S. drives the Brazilian ethanol price higher, as suggested by the higher price of advanced ethanol in the U.S. To the extent that the Brazilian ethanol price rises, conventional ethanol exports from the U.S. become more competitive. While the increase in the advanced ethanol price is not very large based on the underlying assumptions, it is enough to explain greater conventional ethanol exports than in the baseline. Because blenders bid against exporters for conventional ethanol, greater exports make it more difficult for blenders to include enough of this fuel to meet the total mandate. More conventional ethanol exports tend to cause the conventional RIN price to increase relative to the baseline.

There is more ethanol overall because of greater imported sugarcane ethanol to meet the advanced mandate and because the mostly binding overall mandate prevents conventional ethanol use from falling. To coax consumers to buy more ethanol, there is downward pressure on the price of fuels with ethanol included, and the more ethanol in the fuel the greater the pressure. The implied retail ethanol price falls, but the magnitude of this decrease is sensitive to the nature of ethanol-blended fuel demand. The falling retail price makes it even harder for blenders to meet total and advanced mandates, further increasing corresponding conventional and advanced RIN prices.

The need for more advanced biofuels has only minimal effects on the biodiesel markets given the assumptions used here. Apart from indirect effects through agricultural and fuel markets, a higher advanced mandate can affect biodiesel RIN prices directly. Because biodiesel is a submandate of the advanced mandate, it is permitted for extra biodiesel beyond the mandated amount to be used in order to help to fill the advanced gap. In this case, the extra biodiesel would mean less need to use other advanced biofuels, like sugarcane ethanol. Although this is a possible outcome, it does not occur frequently in these stochastic simulations. In this scenario,

the biodiesel RIN exceeds the advanced RIN price by an average of $0.61 per RIN-gallon (after putting them on a comparable basis). The differences average $0.90 in 2012/13 and $0.43 in 2015/16. The difference suggests that the biodiesel mandate tends to be much more strongly binding than the advanced mandate in 2012/13, in particular. In this context the rising advanced RIN price is less likely to rise as high as the biodiesel RIN price, so the change in the biodiesel RIN prices relative to the baseline is about zero in the first year of the simulations. In contrast, by 2015/16 there are some simulations with a big enough increase in the advanced RIN price that some extra biodiesel is sold to help to meet the advanced mandate. In these cases, the biodiesel RIN price increases relative to the baseline level. These results are sensitive to expectations about biodiesel feedstock costs and sugarcane ethanol supplies, as well as assumptions about the potential for greater ethanol use in E15 or E85 as the ethanol price falls relative to the gasoline price.

Mandate compliance costs are sharply higher. As our estimates of compliance costs (excluding transaction costs) are driven by the product of RIN price and RINs used for compliance, the higher advanced RIN price and higher advanced mandate cause a sharp increase in compliance costs. Moreover, the higher conventional RIN price more than offsets the small reduction in conventional ethanol use, further increasing the overall compliance costs.

Crop market effects are modest. At first, there is somewhat less demand for corn to make into conventional ethanol, but conventional ethanol production turns around – owing to conventional ethanol exports – relative to the baseline. Consequently, corn use for ethanol production initially decreases relative to the baseline, then exceeds the baseline.

Scenario 1: Unwaived mandates (so greater advanced gap) – tables

Table 5. Unwaived mandates biofuel markets summary

Marketing year	2013/14	2014/15	2015/16	Average
Ethanol market quantities		(billion gallons)		
Production	14.6	15.8	16.6	15.7
Imports	1.2	2.4	3.7	2.4
Domestic use	14.8	17.3	19.5	17.2
Conventional	13.3	14.4	14.9	14.2
Advanced	1.3	2.5	3.9	2.5
Cellulosic	0.2	0.5	0.8	0.5
Exports	1.0	0.8	0.8	0.9
Ethanol prices		(dollars per gallon)		
Advanced ethanol	2.68	2.85	2.94	2.82
Conventional ethanol	2.07	2.40	2.42	2.30
Retail	2.27	2.21	2.29	2.26
Biodiesel market quantities		(billion gallons)		
Production	1.33	1.35	1.36	1.35
Domestic use	1.28	1.30	1.32	1.30
Biodiesel net exports	0.05	0.05	0.05	0.05
Biodiesel price		(dollars per gallon)		
Wholesale	5.38	5.21	5.12	5.24
RIN values		(dollars per RIN-gallon)		
Biodiesel RIN	1.99	1.89	1.85	1.91
Advanced RIN	1.09	1.39	1.42	1.30
Conventional RIN	0.48	0.94	0.90	0.77
		(billion dollars)		
Mandate compliance cost	11.86	21.82	24.19	19.29

Table 6. Unwaived mandates crops markets summary

Marketing year	2013/14	2014/15	2015/16	Average
Corn market		(billion bushels)		
Production	13.794	13.954	14.288	14.012
Domestic use	11.632	11.886	12.125	11.881
Fuel alcohol	5.179	5.473	5.648	5.433
Exports	2.034	2.092	2.147	2.091
		(dollars per bushel)		
Farm price	4.70	4.83	4.87	4.80
Soybean market		(billion bushels)		
Production	3.284	3.315	3.313	3.304
Domestic use	1.808	1.823	1.831	1.820
Exports	1.495	1.497	1.498	1.497
		(dollars per bushel)		
Farm price	11.38	11.30	11.44	11.37
Soybean oil market		(billion pounds)		
Production	19.037	19.194	19.283	19.171
Domestic use	17.939	17.826	17.836	17.867
Biodiesel	4.177	3.960	3.769	3.969
Exports	1.335	1.396	1.557	1.429
		(cents per pound)		
Market price	58.02	56.11	55.24	56.46

Table 7. Unwaived mandates biofuel markets summary - changes relative to baseline

Marketing year	2013/14	2014/15	2015/16	Average
Ethanol market quantities		(billion gallons)		
Production	-0.04	0.25	0.59	0.27
Imports	0.47	1.34	2.59	1.47
Domestic use	0.33	1.50	2.99	1.61
Conventional	-0.15	0.02	-0.01	-0.05
Advanced	0.47	1.34	2.61	1.47
Cellulosic	0.02	0.15	0.41	0.19
Exports	0.09	0.08	0.17	0.11
Ethanol prices		(dollars per gallon)		
Advanced ethanol	0.06	0.21	0.40	0.22
Conventional ethanol	-0.02	0.09	0.12	0.06
Retail	-0.07	-0.05	-0.05	-0.05
Biodiesel market quantities		(billion gallons)		
Production	0.00	0.01	0.03	0.01
Domestic use	0.00	0.01	0.03	0.02
Biodiesel net exports	0.00	0.00	0.00	0.00
Biodiesel price		(dollars per gallon)		
Wholesale	0.00	0.02	0.06	0.03
RIN values		(dollars per RIN-gallon)		
Biodiesel RIN	0.00	0.02	0.05	0.02
Advanced RIN	0.14	0.30	0.51	0.32
Conventional RIN	0.05	0.18	0.23	0.16
		(billion dollars)		
Mandate compliance cost	1.33	5.32	9.00	5.22

Table 8. Unwaived mandates crops markets summary - changes relative to baseline

Marketing year	2013/14	2014/15	2015/16	Average
Corn market		(billion bushels)		
Production	0.002	-0.020	0.026	0.003
Domestic use	-0.010	0.009	0.035	0.011
Fuel alcohol	-0.022	0.036	0.058	0.024
Exports	0.005	-0.010	-0.012	-0.006
		(dollars per bushel)		
Farm price	-0.02	0.03	0.04	0.02
Soybean market		(billion bushels)		
Production	-0.001	0.004	-0.007	-0.001
Domestic use	0.000	0.001	-0.002	0.000
Exports	0.000	0.002	-0.003	0.000
		(dollars per bushel)		
Farm price	0.01	-0.01	0.09	0.03
Soybean oil market		(billion pounds)		
Production	0.001	0.009	-0.010	0.000
Domestic use	0.009	0.046	0.067	0.041
Biodiesel	0.012	0.063	0.126	0.067
Exports	-0.007	-0.032	-0.062	-0.034
		(cents per pound)		
Market price	0.04	0.20	0.71	0.32

Scenario 2: Waived mandates and 1 billion gallon biodiesel mandate

The **baseline** assumption that the EPA will set the biodiesel mandate at 1.28 b.g. after 2012 is replaced in this **1 b.g. biodiesel mandate scenario** with the assumption that the biodiesel mandate will be set at 1 b.g. after 2012.

It is easier to meet a lower mandate. Reducing the biodiesel mandate results in lower biodiesel RIN prices with less domestic biodiesel use as compared to the baseline.

The reduction in the biodiesel mandate results in an increase in the advanced gap, assuming no other change in the mandates. A gallon of biodiesel counts as 1.5 gallons of ethanol after taking the equivalence value into account so that the units are comparable. The reduction in the biodiesel mandate by 0.28 b.g. implies an increase in the advanced gap of 0.42 b.g. in terms of ethanol. To meet the higher advanced gap, more advanced ethanol is used domestically. This increase is supplied by greater sugarcane ethanol imports relative to the baseline.

More ethanol use leads to a lower implied retail ethanol price compared to the baseline as fuels with more ethanol must be sold to consumers. The size of this effect is sensitive to assumptions about how cheaply ethanol must be priced in order for ethanol consumption to expand, particularly in high-blend fuels. The lower ethanol price makes it more difficult to meet advanced and total mandates.

Greater sugarcane ethanol imports into the U.S. drives the price of ethanol in Brazil higher, sustaining ethanol exports from the U.S. Continued exports compete with domestic use, helping to hold the conventional ethanol price higher and making it more costly for blenders to buy conventional ethanol for compliance with the total mandate. This result is sensitive to the modeled responses in Brazilian and other ethanol and feedstock markets to the price changes.

In the baseline, the biodiesel mandate is almost always more binding than the advanced mandate. This is also true in the scenario, but there are at least a few more of the simulation outcomes where the advanced mandate is at least as binding. In those instances, the advanced and biodiesel RIN prices would be the same and biodiesel use could exceed the biodiesel mandate to help to fill the advanced gap, competing with Brazilian ethanol. However, this possibility depends on biodiesel feedstock and sugarcane ethanol markets.

The reduction in the biodiesel mandate causes small average changes in compliance costs as compared to the baseline. The average effect in the first three years is a small increase. The explanation for why greater flexibility in meeting the mandate can cause a higher price reflects how market-wide impacts can play a role. The biodiesel mandate cost falls, but other changes also affect mandate compliance costs. First, advanced RIN price rises with the increase in the advanced gap, so the increase in imported ethanol that is used in place of biodiesel tends to offset some of the cost reduction. Second, greater U.S. imports of sugarcane ethanol from Brazil

leads to more U.S. exports of conventional ethanol and a higher conventional ethanol price. Blenders must pay that price for ethanol they use for compliance with the total mandate, so if exports cause the conventional ethanol price to rise, the conventional RIN price will also rise. Third, as the sum of conventional and advanced ethanol use increases, the retail ethanol price is pushed lower. A low retail price represents another obstacle for blenders using ethanol domestically, also driving advanced and conventional RINs prices higher. The total effect on the conventional RIN price is not large, but it applies to 13-15 billion gallons, so it constitutes a large share of the total compliance cost in this period.

The finding that a lower biodiesel mandate that increases market flexibility causes a small increase in costs, averaged over all simulations, is contingent on many assumptions. The cost of importing ethanol from Brazil on this scale, biodiesel supply costs, and the responsiveness of U.S. demand to prices in the near-term future, particularly the potential for expansion in the E85 market, all play a part in determining the compliance cost impacts.

For crop markets, the reduction in the binding biodiesel mandate use causes less biodiesel production, so biodiesel feedstock use falls relative to the baseline. The initial impact is on soybean oil price, as well as other biodiesel feedstocks. Taking into account other links to biofuel markets and interactions among agricultural commodities, crop prices are lower than in the baseline.

Scenario 2: Waived mandates and 1 billion gallon biodiesel mandate – tables

Table 9. Waived mandates and 1 b.g. biodiesel biofuel markets summary

Marketing year	2013/14	2014/15	2015/16	Average
Ethanol market quantities		(billion gallons)		
Production	14.7	15.7	16.1	15.5
Imports	1.1	1.4	1.5	1.3
Domestic use	14.8	16.3	16.9	16.0
Conventional	13.4	14.5	15.0	14.3
Advanced	1.2	1.5	1.6	1.4
Cellulosic	0.3	0.4	0.5	0.4
Exports	1.0	0.7	0.6	0.8
Ethanol prices		(dollars per gallon)		
Advanced ethanol	2.68	2.70	2.60	2.66
Conventional ethanol	2.11	2.38	2.33	2.27
Retail	2.28	2.28	2.34	2.30
Biodiesel market quantities		(billion gallons)		
Production	1.08	1.10	1.09	1.09
Domestic use	1.03	1.05	1.03	1.04
Biodiesel net exports	0.06	0.06	0.06	0.06
Biodiesel price		(dollars per gallon)		
Wholesale	4.90	4.78	4.63	4.77
RIN values		(dollars per RIN-gallon)		
Biodiesel RIN	1.56	1.50	1.41	1.49
Advanced RIN	1.08	1.15	0.98	1.07
Conventional RIN	0.51	0.84	0.71	0.69
		(billion dollars)		
Mandate compliance cost	10.91	17.06	15.17	14.38

Table 10. Waived mandates and 1 b.g. biodiesel crops markets summary

Marketing year	2013/14	2014/15	2015/16	Average
Corn market		(billion bushels)		
Production	13.812	14.039	14.305	14.052
Domestic use	11.670	11.931	12.130	11.910
Fuel alcohol	5.209	5.463	5.602	5.425
Exports	2.028	2.101	2.162	2.097
		(dollars per bushel)		
Farm price	4.72	4.79	4.82	4.78
Soybean market		(billion bushels)		
Production	3.267	3.273	3.293	3.278
Domestic use	1.799	1.809	1.821	1.810
Exports	1.483	1.475	1.484	1.481
		(dollars per bushel)		
Farm price	11.13	11.18	11.17	11.16
Soybean oil market		(billion pounds)		
Production	18.939	19.054	19.169	19.054
Domestic use	17.128	17.014	16.979	17.040
Biodiesel	2.959	2.790	2.500	2.749
Exports	2.016	2.074	2.272	2.121
		(cents per pound)		
Market price	53.29	52.00	50.43	51.91

Table 11. Waived mandates and 1 b.g. biodiesel biofuel markets summary - changes relative to baseline

Marketing year	2013/14	2014/15	2015/16	Average
Ethanol market quantities		(billion gallons)		
Production	0.06	0.17	0.12	0.12
Imports	0.38	0.36	0.36	0.37
Domestic use	0.40	0.54	0.47	0.47
Conventional	-0.02	0.10	0.03	0.04
Advanced	0.38	0.36	0.36	0.37
Cellulosic	0.04	0.09	0.08	0.07
Exports	0.04	-0.02	0.01	0.01
Ethanol prices		(dollars per gallon)		
Advanced ethanol	0.06	0.06	0.06	0.06
Conventional ethanol	0.01	0.08	0.03	0.04
Retail	-0.06	0.02	0.00	-0.02
Biodiesel market quantities		(billion gallons)		
Production	-0.25	-0.23	-0.24	-0.24
Domestic use	-0.26	-0.24	-0.25	-0.25
Biodiesel net exports	0.01	0.01	0.01	0.01
Biodiesel price		(dollars per gallon)		
Wholesale	-0.48	-0.41	-0.43	-0.44
RIN values		(dollars per RIN-gallon)		
Biodiesel RIN	-0.42	-0.37	-0.39	-0.39
Advanced RIN	0.13	0.06	0.07	0.09
Conventional RIN	0.09	0.07	0.04	0.07
		(billion dollars)		
Mandate compliance cost	0.39	0.55	-0.02	0.31

Table 12. Waived mandates and 1 b.g. biodiesel crops markets summary - changes relative to baseline

Marketing year	2013/14	2014/15	2015/16	Average
Corn market		(billion bushels)		
Production	0.020	0.065	0.043	0.043
Domestic use	0.028	0.054	0.040	0.041
Fuel alcohol	0.008	0.026	0.012	0.015
Exports	-0.001	0.000	0.002	0.000
		(dollars per bushel)		
Farm price	0.00	-0.01	-0.01	-0.01
Soybean market		(billion bushels)		
Production	-0.018	-0.037	-0.027	-0.027
Domestic use	-0.009	-0.013	-0.011	-0.011
Exports	-0.012	-0.021	-0.017	-0.017
		(dollars per bushel)		
Farm price	-0.25	-0.12	-0.18	-0.18
Soybean oil market		(billion pounds)		
Production	-0.096	-0.131	-0.124	-0.117
Domestic use	-0.802	-0.766	-0.789	-0.786
Biodiesel	-1.206	-1.108	-1.143	-1.152
Exports	0.675	0.646	0.653	0.658
		(cents per pound)		
Market price	-4.69	-3.92	-4.09	-4.23

Scenario 3: Unwaived mandates and 1 billion gallon biodiesel mandate

In this scenario, **unwaived mandates and 1 b.g. biodiesel**, both the baseline mandate assumptions are changed. The broader mandates are not waived at all as the cellulosic mandate is reset to a lower level. The biodiesel mandate is set at 1 b.g. rather than 1.28 b.g. Both of these two options would increase the advanced gap, leading to results similar to those of the previous two scenarios but more pronounced.

The greater advanced gap leads to a more binding advanced mandate, as shown by the higher advanced RIN price, and to more imports of sugarcane ethanol to meet the advanced mandate. Greater ethanol imports lead both to lower retail ethanol price and more potential for exports, making the overall mandate more binding and raising the conventional RIN price.

Biodiesel use falls as less is mandated. Biodiesel RIN prices are lower, as well, and the narrow gap between average prices of biodiesel RINs and advanced RINs indicate that the advanced mandate is more binding than the biodiesel mandate in a large share of the outcomes. In those cases, the two RIN prices are the same (on a RIN-gallon basis) and extra biodiesel is blended to help meet the advanced mandate. This result, which is contingent on relative costs of biodiesel and sugarcane ethanol, as well as any other advanced biofuels, leads to somewhat lower advanced RIN prices than would occur if extra biodiesel was not available to help meet the expanded mandate.

The mandate compliance costs tend to be substantially higher. Clearly, bigger mandates that cause an expansion in the advanced gap lead to more use relative to the baseline. In addition, the shift from biodiesel to ethanol has implications for RIN prices related to conventional as well as advanced ethanol. In addition to more sugarcane ethanol imports at a rising price, as noted earlier, one further effect is that downward pressure on retail ethanol prices as more ethanol must be sold and another added effect is the strength of conventional ethanol exports as U.S. ethanol imports drive up foreign prices.

This scenario has the largest biofuel and crop market impacts relative to the baseline, but the price impacts remain mostly modest. The soybean oil price is most affected as biodiesel feedstock demand falls, meaning a lower soybean price as well. However, these are exceptions, as other impacts, such as the effects on area planted to different crops, tend to be less than 1% on average relative to the baseline.

Scenario 3: Unwaived mandates and 1 billion gallon biodiesel mandate – tables

Table 13. Unwaived mandates and 1 b.g. biodiesel biofuel markets summary

Marketing year	2013/14	2014/15	2015/16	Average
Ethanol market quantities		(billion gallons)		
Production	14.7	15.9	16.7	15.8
Imports	1.5	2.6	3.9	2.7
Domestic use	15.2	17.7	19.7	17.5
Conventional	13.3	14.5	15.0	14.3
Advanced	1.6	2.7	4.0	2.8
Cellulosic	0.3	0.6	0.9	0.6
Exports	1.1	0.8	0.8	0.9
Ethanol prices		(dollars per gallon)		
Advanced ethanol	2.74	2.88	2.96	2.86
Conventional ethanol	2.09	2.46	2.44	2.33
Retail	2.23	2.24	2.29	2.25
Biodiesel market quantities		(billion gallons)		
Production	1.09	1.15	1.20	1.15
Domestic use	1.04	1.09	1.14	1.09
Biodiesel net exports	0.06	0.05	0.05	0.05
Biodiesel price		(dollars per gallon)		
Wholesale	4.92	4.87	4.84	4.88
RIN values		(dollars per RIN-gallon)		
Biodiesel RIN	1.58	1.58	1.59	1.58
Advanced RIN	1.19	1.41	1.46	1.35
Conventional RIN	0.55	0.98	0.94	0.82
		(billion dollars)		
Mandate compliance cost	12.10	21.85	24.50	19.48

Table 14. Unwaived mandates and 1 b.g. biodiesel crops markets summary

Marketing year	2013/14	2014/15	2015/16	Average
Corn market		(billion bushels)		
Production	13.814	14.028	14.313	14.052
Domestic use	11.666	11.937	12.150	11.918
Fuel alcohol	5.200	5.489	5.651	5.447
Exports	2.030	2.095	2.151	2.092
		(dollars per bushel)		
Farm price	4.71	4.82	4.85	4.79
Soybean market		(billion bushels)		
Production	3.266	3.276	3.293	3.278
Domestic use	1.799	1.811	1.822	1.811
Exports	1.483	1.477	1.485	1.482
		(dollars per bushel)		
Farm price	11.14	11.22	11.32	11.23
Soybean oil market		(billion pounds)		
Production	18.942	19.070	19.193	19.068
Domestic use	17.161	17.171	17.311	17.215
Biodiesel	3.009	3.020	3.004	3.011
Exports	1.991	1.950	2.001	1.980
		(cents per pound)		
Market price	53.48	52.85	52.49	52.94

Table 15. Unwaived mandates and 1 b.g. biodiesel biofuel markets summary - changes relative to baseline

Marketing year	2013/14	2014/15	2015/16	Average
Ethanol market quantities		(billion gallons)		
Production	0.06	0.41	0.72	0.39
Imports	0.80	1.55	2.74	1.69
Domestic use	0.74	1.89	3.27	1.97
Conventional	-0.12	0.10	0.01	0.00
Advanced	0.80	1.55	2.75	1.70
Cellulosic	0.06	0.25	0.53	0.28
Exports	0.11	0.05	0.17	0.11
Ethanol prices		(dollars per gallon)		
Advanced ethanol	0.12	0.24	0.42	0.26
Conventional ethanol	0.00	0.15	0.14	0.10
Retail	-0.11	-0.02	-0.06	-0.06
Biodiesel market quantities		(billion gallons)		
Production	-0.24	-0.19	-0.14	-0.19
Domestic use	-0.25	-0.19	-0.14	-0.19
Biodiesel net exports	0.01	0.01	0.01	0.01
Biodiesel price		(dollars per gallon)		
Wholesale	-0.46	-0.32	-0.22	-0.33
RIN values		(dollars per RIN-gallon)		
Biodiesel RIN	-0.41	-0.29	-0.20	-0.30
Advanced RIN	0.24	0.31	0.55	0.37
Conventional RIN	0.13	0.22	0.27	0.20
		(billion dollars)		
Mandate compliance cost	1.57	5.35	9.32	5.41

Table 16. Unwaived mandates and 1 b.g. biodiesel crops markets summary - changes relative to baseline

Marketing year	2013/14	2014/15	2015/16	Average
Corn market		(billion bushels)		
Production	0.023	0.054	0.051	0.043
Domestic use	0.024	0.060	0.060	0.048
Fuel alcohol	-0.001	0.052	0.061	0.037
Exports	0.001	-0.007	-0.009	-0.005
		(dollars per bushel)		
Farm price	-0.01	0.02	0.02	0.01
Soybean market		(billion bushels)		
Production	-0.018	-0.034	-0.027	-0.027
Domestic use	-0.009	-0.011	-0.010	-0.010
Exports	-0.012	-0.018	-0.016	-0.015
		(dollars per bushel)		
Farm price	-0.23	-0.08	-0.03	-0.11
Soybean oil market		(billion pounds)		
Production	-0.094	-0.115	-0.100	-0.103
Domestic use	-0.769	-0.608	-0.457	-0.611
Biodiesel	-1.156	-0.878	-0.638	-0.891
Exports	0.649	0.522	0.382	0.518
		(cents per pound)		
Market price	-4.50	-3.06	-2.03	-3.20

Stochastic results

All the baseline and scenario data shown above are averages of 500 simulations. Each simulation reflects a different combination of randomly determined shocks to petroleum prices, yields, key demands, and selected other factors. Here, the ranges of market outcomes in the baseline and mandate scenarios are summarized for a selection of key variables (Table 17, page 33).

Two percentiles and the average are shown for marketing year 2015/16. The 10th percentile marks the boundary of the lowest 10% of outcomes. The 90th percentile marks the boundary of the highest 10% of outcomes. These percentiles are calculated independently. There is no reason to expect that the same simulation gives the 10th percentile result for each variable shown, for example.

The range of the advanced RIN price in the baseline suggests that the advanced mandate is binding in all the simulations given the assumptions used here. If the mandates are not waived and the advanced gap expands, then the entire range of advanced RIN prices rises substantially as an already binding mandate becomes more binding. The impact of reducing the biodiesel mandate from 1.28 b.g. to 1 b.g., but waiving the broader mandates, also suggests a broad increase in the range of advanced RIN prices, but a smaller impact in all instances. The range of advanced RIN prices shifts up the most if both the mandates are left unwaived and the biodiesel mandate is lower relative to the baseline.

The baseline biodiesel RIN price range also suggests that this mandate is binding in all stochastic simulations. If the advanced gap is allowed to increase by leaving broader mandates unwaived, then there might seem to be no direct impact on biodiesel mandate or markets. The 10th percentile results show otherwise. The advanced RIN prices are higher in this scenario and biodiesel is a submandate of advanced –biodiesel RINs can be used to help meet the advanced mandate – so the rising advanced RIN price sets a higher floor on biodiesel RIN prices. This rising floor pulls up the lower end of the biodiesel RIN price range. This effect only occurs at the low end of the biodiesel RIN price range because the average and 90th percentile prices are too high relative to the advanced RIN price for blenders to use biodiesel in place of imported ethanol, at least under the assumptions used here.

The scenarios with a lower biodiesel mandate of 1 b.g. instead of 1.28 b.g. tend to have lower biodiesel RIN prices. If the broader mandates are waived, then the pattern is one of a generally less binding mandate. If broader mandates are not waived, then the advanced gap grows and advanced RIN prices tend to be higher. Because biodiesel is a submandate of advanced, the advanced RIN price puts a floor on the biodiesel RIN price. In the context of both a lower biodiesel mandate and unwaived broader mandates, there is a greater possibility that the advanced mandate will be more binding than the biodiesel mandate, with the advanced RIN

price determining the biodiesel price. This outcome is indicated by the higher 10th percentile biodiesel price in this scenario relative to the baseline.

Compliance cost ranges are quite wide in the baseline and in all scenarios. Unwaived mandates cause both more biofuel use and more binding mandates, so these options lead to large increases in compliance costs. Compliance cost estimates can be lower in the scenario with waived mandates and a reduced biodiesel mandate. Whereas simulations of this scenario can result in greater compliance costs for the same reasons as described in the text – replacing biodiesel with advanced gap, lower ethanol retail price, and higher conventional export demand -- this outcome is no certainty. In some simulations, these impacts on advanced and overall mandate compliance costs do not outweigh the reduction in biodiesel mandate compliance cost, leading to lower overall costs, as represented by the 10th percentile effect shown here.

The soybean farm price is shown to demonstrate the ranges of impacts on crop market prices in these scenarios. Just like the average impacts shown in preceding tables, the broader effects on the range of soybean prices remains fairly limited in comparison to the larger shifts in biofuel markets. The soybean price impacts also reflect the potential for ambiguity even in terms of the direction of impact. The 10th percentile soybean price effects show instances when increasing biodiesel feedstock demand and higher soybean prices in the third scenario, even though the average and 90th percentile results have lower soybean prices than in the baseline.

Stochastic simulation results do not reflect the full range of uncertainty in these estimates. Only a subset of key drivers is drawn randomly, albeit including many important sources of market variation, whereas others are left unchanged. Structural relationships are also not altered. There is additional uncertainty about how cheaply ethanol-blended fuels must be priced, and for how long, in order for more ethanol to be used in this market. Scenarios involving rapidly rising sugarcane ethanol imports to the U.S. raise questions about how strongly Brazilian markets would respond. These and other sources of uncertainty are not included in the stochastic analysis presented here.

Table 17. Stochastic simulation results in 2015/16

	Baseline	**Unwaived, 1.28 b.g.**		**Waived, 1 b.g.**		**Unwaived, 1 b.g.**	
	level	level	difference	level	difference	level	difference
Advanced RIN value, dollars per RIN-gallon							
10	0.61	1.12	0.50	0.67	0.06	1.15	0.53
average	0.91	1.42	0.51	0.98	0.07	1.46	0.55
90	1.22	1.67	0.46	1.29	0.07	1.72	0.50
Biodiesel RIN value, dollars per RIN-gallon							
10	1.00	1.19	0.19	0.76	-0.24	1.15	0.15
average	1.79	1.85	0.05	1.41	-0.39	1.59	-0.20
90	2.57	2.56	0.00	2.13	-0.44	2.13	-0.43
Mandate compliance costs, billion dollars							
10	7.5	13.7	6.2	7.2	-0.2	13.9	6.4
average	15.2	24.2	9.0	15.2	0.0	24.5	9.3
90	25.0	34.1	9.1	25.4	0.4	34.1	9.1
Soybean farm price, dollars per bushel							
10	8.07	8.25	0.18	7.97	-0.10	8.23	0.15
average	11.35	11.44	0.09	11.17	-0.18	11.32	-0.03
90	14.77	14.85	0.09	14.58	-0.19	14.64	-0.13

Related FAPRI-MU publications, 2008-2011

(See http://www.fapri.missouri.edu/.)

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