Impact on Corn Prices from Reduced Biofuel Mandates

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Abstract

Press reports indicate that the Environmental Protection Agency may significantly reduce ethanol mandates to levels that can easily be met. To gain insight into what this decision implies about the price of corn we use a new model of the corn and RIN markets to project corn and ethanol prices and quantities through the 2019 marketing year under two ethanol mandate scenarios. The first scenario is the status quo where mandates that can be met with corn ethanol increase to 14.4 billion gallons in 2014 and 15 billion gallons in 2015 and thereafter. Mandates at this level can only be met using E85 so also included in this scenario is 5,000 new locations where E85 can be purchased. The second scenario holds mandates at 13 billion gallons, a level that can be met with E10. The price of corn is higher by between 5 and 6 percent—about 25 cents per bushel—in the higher mandate scenario. RIN prices are close to zero most of the time in the lower mandate scenario and average between 50 and 60 cents in the higher mandate scenario. Though the corn price difference is economically meaningful to corn farmers and livestock feeders, it is small compared to the price swings that the market has experienced since 2006. This modest change in corn prices from alternative mandate levels suggests that the level of mandate should be determined more by consideration of broad policy objectives rather than the impact on the price of corn. Of key importance to the advanced biofuel industry is whether policy will support the expansion of biofuels consumption by creating incentives to invest in flex cars and fueling stations that will facilitate expanded consumption of low-carbon ethanol. Consideration of the costs and benefits of creating these incentives as part of a national energy policy is of greater long-run importance than the impact of mandates on the price of corn.

Impact on Corn Prices from Reduced Biofuel Mandates

According to press reports the Environmental Protection Agency may reduce biofuel mandates in 2014 from 14.4 billion gallons to 13 billion gallons.[1] The likely justification for such a reduction is the belief that ethanol consumption cannot easily exceed the quantity that can be consumed in E10—gasoline that contains 10 percent ethanol. Many groups would applaud such a decision. Oil refiners would face practically no costs of complying with Renewable Fuel Standard mandates because they would be easy to meet. Livestock organizations and anti-hunger advocates are both against the use of corn to produce transportation fuel. Corn is the chief feed ingredient in livestock rations so diversion of corn from feed to fuel increases feed costs. Most anti-hunger groups simply oppose corn ethanol on the moral grounds that a crop that could produce food should not be used to produce fuel.

That expansion of corn ethanol has increased corn prices is not surprising: after all why else would corn farmers be the ethanol industry's biggest supporter? What causes more disagreement is whether government policy or market forces determine the level of corn ethanol production. Carter, Rausser and Smith (2010) estimate that the expansion in corn ethanol production between 2005 and 2010 increased corn prices by about 30 percent. They evidently attribute all the increase in investment and production in the ethanol industry to mandates, so this 30 percent estimate is the impact of ethanol mandates. Babcock and Fabiosa estimate that corn ethanol mandates and subsidies together caused corn prices to be only 8 percent greater than they would have been from 2006 to 2009. But they estimate that actual corn prices were 36 percent higher than they would have been over this period if ethanol production had remained constant at 2005 levels. Thus the major disagreement between these two studies is the extent to which government intervention caused the dramatic expansion in the industry beginning in 2005.

Looking forward, the role of government policy in determining the size of the corn ethanol industry is a less relevant question because existing corn ethanol plants could produce more than 15 billion gallons, which is the maximum amount of corn

[1] For example, see http://www.reuters.com/article/2013/10/10/epa-ethanol-idUSL1N0I023620131010

ethanol that can be used to meet RFS mandates.[2] Of more relevance to the level of future corn prices is the impact of government policy in determining the proportion of industry capacity that operates. The objective of this paper is to provide insight into this question with a focus on the imminent EPA decision about what mandate levels will be in 2014, and what that decision likely signals about mandates in future years.

Mandates and the Demand for Ethanol

If EPA decides to follow the mandate schedule in the Energy Independence and Security—the law that governs the Renewable Fuels Standard—then the biofuel mandate that can be met by corn ethanol is scheduled to increase from 13.8 billion gallons in 2013 to 14.4 billion gallons in 2014 and reach its maximum level of 15 billion gallons ion 2015, where it is scheduled to stay until 2022. The American Petroleum Institute and the American Fuel and Petrochemicals Manufacturers have petitioned EPA to reduce 2014 mandates to levels that can be easily met with 10 percent blends, or about 12.9 billion gallons.[3] The reason why oil industry groups want to limit mandates to this level is easy to understand: they have configured their refineries to produce low octane gasoline that needs to be blended with 10 percent ethanol to produce 87-octane regular gasoline.

The key factor determining the impact on corn prices from ethanol mandates is the level of ethanol production that would occur without mandates. To estimate this production level requires estimation of the market demand for ethanol. The current configuration of refineries has created a short-run inelastic demand for ethanol at a quantity about equal to 10 percent of blended gasoline sales. Press reports indicate that EPA may reduce ethanol mandates to less than needed to meet this 10 percent blending level. If this occurs then ethanol mandates will impose no costs on owners of refineries, at least in the short run.

It is difficult to determine if the current refinery configuration is long-run optimal. If it is, then the long-run demand for ethanol is also quite inelastic at an ethanol quantity equal to10 percent of gasoline sales. If this configuration is optimal only under the

[2] The Renewable Fuels Association estimates that as of January, 2013 the capacity of the US ethanol industry stood at 14.7 billion gallons. Existing ethanol plants would only have to have to exceed their nameplate capacity by two percent to achieve 15 billion gallons.
[3] The petition can be found at: http://www.api.org/news-and-media/news?page=3

constraint that a 10 percent ethanol blend is required by biofuel mandates, then the long-run demand for ethanol is more elastic than the current demand elasticity would suggest. In this report we assume that using a 10 percent ethanol blend in gasoline increases oil refinery profits so that they will keep refineries configured as they are currently unless the price of ethanol exceeds the price of gasoline.

Babcock and Pouliot (2013) estimate the demand for E85, which is a blend of up to 85 percent ethanol and 15 percent gasoline. The demand for E85 is quite limited when the cost per mile driving on E85 is higher than E10. But demand becomes quite elastic when E85 prices become competitive with E10. Eventually demand becomes quite inelastic due to limits on the number of stations that sell E85. The range of E85 quantities where demand is elastic increases if additional E85 fueling stations become available because the bottleneck limiting demand for E85 is access to fueling stations not the number of flex vehicles. The Babcock and Pouliot (2013) demand curve for E85 will be used in this analysis to determine the level of market-driven demand for ethanol beyond E10 levels.

Projecting Future Corn Prices

It is important for groups with an interest in corn prices to better understand the impact of the imminent EPA mandate decision on those prices. If EPA decides to reduce mandates, will the price of corn in 2014 decrease significantly? If not, why not? What would happen to corn prices in 2015 and beyond if EPA kept mandates at levels that could easily be met with 10 percent blends? Answering these questions is inherently difficult because nobody can predict the future levels of key factors that will influence the market demand for ethanol and the supply of corn. The principle driver of potential ethanol demand will be oil prices. If they stay high or move higher, then demand for corn ethanol will be high. The principle driver of corn supply is planted acreage and growing-season weather. If Corn Belt summers return to more normal conditions, then corn yields will increase, supplies will be abundant, and planted acreage will move lower because of lower expected future corn prices.

Although we cannot predict what oil prices and summer weather will be in the future, we do have knowledge about the amount of likely variability in both and can account for this variability when projecting future corn prices. That is, future projections of corn prices can be made conditional on what oil prices and growing conditions turn out to be.

An economic model of the corn market is needed to solve for the corn prices that will occur given a level of oil prices and growing season weather. This model needs to be forward looking because corn farmers have shown that their planting decisions depend on what price they expect to receive at harvest for their crop. The model should account for the demand for ethanol by consumers and the demand for corn by both ethanol producers and others. The model needs to account for how corn and RIN buffer stocks grow or shrink in response to large or small crops. And finally, the model should provide projections of corn prices for at least several years into the future because the Renewable Fuels Standard runs until 2022. A new model that includes all of these attributes is now available for corn price projections. Its first results are reported here in terms of providing estimates of the impact on corn prices, corn plantings, and ethanol production under two ethanol mandate scenarios.

The first scenario is one in which EPA holds to scheduled increases in biofuel mandates and corn ethanol production expands to meet mandates that increase to 14.4 billion gallons in 2014, and 15 billion gallons thereafter. This scenario also includes investment in additional E85 stations that allows for compliance with higher mandates. The second scenario is one in which investment does not occur because EPA holds mandates at 13 billion gallons, which is just below the maximum level that can be consumed in 10 percent blends. A comparison of corn prices under these two scenarios will indicate the impact of higher mandates and facilitation of E85 consumption through investment.

Model Assumptions

The model was solved for the 2014/15 marketing year through the 2019/20 marketing year. The 2013/14 marketing year was treated as known. Some key assumptions that drive results are as follows:

US Corn Yields

We set 2014 expected corn yield per harvested acre to 158.5 bushels per acre in 2014. Mean yield was increased by two bushels per acre per year. The amount of yield variability was estimated using historical deviations from trend yield. Yield was assumed to be beta-distributed and the standard deviation of yield was kept constant from 2014 through 2019.

Wholesale Gasoline Prices

Mean wholesale gasoline prices were fixed at $2.60 per gallon. The standard deviation of gasoline prices was fixed at $0.52 per gallon. Gasoline prices were assumed to be log-normally distributed.

Ethanol Yields and Costs

Ethanol yield was fixed at 2.76 gallons per bushel of corn processed. To facilitate calculations, approximately 30 percent of each bushel processed was returned to the corn market as feed. Thus the net yield of ethanol per bushel of corn processed is 3.81 gallons per bushel. The non-corn cost of producing ethanol was fixed at 0.5 per gallon.

Non-Ethanol Demand

The elasticity of non-ethanol, non-storage demand for corn was fixed at -0.44, Adjemian and Smith (2012). The position of the demand curve for each year of the projection period was based on USDA (2013) long term agriculture projections

Corn Supply

The elasticity of US harvested corn acreage was fixed at 0.2.

Corn Storage Cost

The physical cost of storing corn from one harvest to the next marketing year is fixed at $0.36 per bushel. A function relating marginal convenience yield to stocks to use ratios was estimated using data from 1989 to 2012.

Ethanol Trade

To focus solely on domestic production and consumption, we assume that both exports and imports of ethanol are zero. This assumption results in lower demand for corn ethanol in the scenario where mandates are fixed at 13 billion gallons. Thus the results for this scenario underestimate ethanol production and corn prices. The impact of assuming no ethanol imports is more difficult to assess without expanding the scope of the model because imports are used to meet advanced RFS mandates and low carbon intensity targets in California.

Solving the Model

This new model of the corn market is solved by finding the level of planted acreage and ethanol production such that corn and RIN prices in a year are consistent with future corn and RIN prices through corn and RIN storage. That is, the model finds planted acreage and ethanol production levels that lead to corn prices where there is no incentive to store another bushel of corn to the next marketing year and RIN prices where there is no incentive to either borrow or bank an additional RIN to the next year, unless RIN banking or borrowing limits have been reached.

For corn, in normal years, this means that corn price this year plus the cost of storage equals the expected corn price next year. If marginal convenience yield is high because of a short crop, then expected price next year equals this year's price plus storage costs minus the value of the convenience of having a bushel of corn on hand because of supply shortages. Thus in corn-short years, next year's expected corn price can be less than this year's corn price.

For RINs, the solution condition means that the expected price of RINs must rise at the rate of interest except when borrowing and banking limits are reached. The RIN price drops to zero when the banking constraint binds. Next year's expected RIN price may be less than this year's price plus interest costs when the borrowing constraint binds. This will occur when high RIN prices this year create an incentive to borrow RINs from the following year but statutory limits on borrowing have been reached.

The model was solved using collocation methods developed by Judd (1992,1998). Others who have applied these methods to agricultural commodity markets with storage

include Miranda (1997), Peterson and Tomek (2005), and Gouel (2013). To our knowledge this is the first time this method has been applied to the corn market accounting for both corn and RIN storage.

Model Solutions

Table 1 shows the average model solution for the scenario in which EPA lets the ethanol mandate increase to 14.4 billion gallons in 2014 and 15 billion gallons in 2015. There is not a single model solution because the model is solved for a wide range of corn yields and gasoline prices. Because this model is solved on a marketing year basis, the mandates that are imposed on the model solutions are 14.2 billion gallons for the 2013/14 marketing year and 14.8 billion gallons for the 2014/15 marketing year, and 15 billion gallons thereafter. To allow these mandates to be met, 5,000 additional stations that sell E85 are installed in the 2014/15 marketing year.

The results show that the increased ethanol mandates can be met with the 5,000 additional stations through a combination of expanded ethanol consumption and production and a drawdown in the number of banked RINs. The first-year drawdown of banked RINs is about 500 million RINs to meet the 14.2 billion gallon mandate. Thus about 13.7 billion gallons of ethanol are actually consumed. Thereafter, ethanol production and consumption are much more closely aligned, with the average size of the RIN bank slightly below zero in the last period. Average corn prices rise modestly through the projection period. This modest rise hides the actual volatility in the model solutions caused by yield variability. Harvested corn acreage falls from its high mark of 89.1 million acres in 2013, stabilizing at an average level of 86 million acres. Average RIN prices are between 50 and 60 cents per gallon which implies that ethanol mandates push average ethanol consumption higher than what market demand would dictate in the absence of mandates. This level of RIN prices would likely incentivize additional investment in stations beyond the 5,000 stations that are considered in this scenario that sell E85 (or E15) which would then results in lower RIN prices.

Average model solutions with reduced mandates and no investment in E85 stations are shown in Table 2. Corn prices and production are modestly lower due to decreased demand for ethanol. Average RIN prices are close to zero which implies that

the 13 billion gallon ethanol mandate is largely irrelevant to ethanol production and consumption levels. Because the average price of RINs is so low, the bank of RINs grows and is used to buffer the effects of short corn crops. At the end of the projection period the bank of RINs grows to about 2 billion on average.

Table 1. Average Model Solutions with Increased Mandates*

	Marketing Year						
	13/14	14/15	15/16	16/17	17/18	18/19	19/20
Ethanol Mandate	14.2	14.8	15.0	15.0	15.0	15.0	15.0
New E85 Stations	0	5,000	0	0	0	0	0
Harvested Acreage	89.10	85.82	85.87	86.01	86.23	86.38	86.53
Corn Production	13.84	13.60	13.78	13.97	14.18	14.38	14.58
Corn Price	4.54	4.65	4.64	4.69	4.74	4.81	4.84
Ending Corn Stocks	1.563	1.744	1.858	1.890	1.908	1.885	1.866
Ethanol Demand Price	1.16	1.18	1.18	1.18	1.19	1.20	1.20
Ethanol Production	13.71	14.86	14.86	14.84	14.86	14.85	14.85
RIN Price	0.53	0.54	0.54	0.55	0.56	0.56	0.57
Beginning RIN Stock	1.00	0.514	0.572	0.429	0.273	0.130	-0.025

Notes: Units are billion gallons for ethanol mandate, ethanol production, and beginning RIN stock; million acres for harvested acreage $ per bushel for corn prices, $ per gallon for ethanol price and RIN price; and billion bushels for ending corn stocks and corn production.

Table 2. Average Model Solutions with Reduced Mandates*

	Marketing Year						
	13/14	14/15	15/16	16/17	17/18	18/19	19/20
Ethanol Mandate	13.0	13.0	13.0	13.0	13.0	13.0	13.0
New E85 Stations	0	0	0	0	0	0	0
Harvested Acreage	89.1	84.91	84.89	85.02	85.22	85.42	85.55
Corn Production	13.84	13.45	13.62	13.81	14.01	14.22	14.41
Corn Price	4.35	4.41	4.38	4.42	4.49	4.55	4.57
Ending Corn Stocks	1.446	1.677	1.807	1.857	1.848	1.838	1.813
Ethanol Demand Price	1.61	1.64	1.64	1.65	1.67	1.68	1.69
Ethanol Production	13.48	13.22	13.21	13.20	13.19	13.16	13.15
RIN Price	0.0253	0.0177	0.0142	0.0127	0.0116	0.011	0.0115
Beginning RIN Stock	1.0	1.476	1.691	1.878	1.963	1.995	1.980

*Units are billion gallons for ethanol mandate, ethanol production, and beginning RIN stock; million acres for harvested acreage $ per bushel for corn prices, $ per gallon for ethanol price and RIN price; and billion bushels for ending corn stocks and corn production.

The impact of reduced mandates can be measured by comparing the Table 2 results with the Table 1 results. Both the absolute difference in average results and the percent difference are shown in Table 3. Corn prices drop about 5 percent from reduced

mandates or about 25 cents per bushel. Corn production drops by about 100 million bushels which is between 1.1 and 1.2 percent. Ethanol production drops by about 11 percent from reduce mandates. Corn prices would decrease even more from this drop in demand except that the decrease in corn supply from lower planted acreage boosts average prices.

There are two ways of viewing these results. The rather modest decrease in corn prices from relaxing the mandates could be viewed as evidence that the agricultural crop sector would not be too badly hurt from a reduction in mandates. An alternative view is that a reduction in mandates would not be a panacea for livestock organizations or anti-hunger groups who want to see corn prices decrease by even more than they have in the last six months. The very low RIN prices in Table 2 also suggest that corn prices would not move any lower even if mandates were eliminated, because the mandate is not increasing the production of ethanol. This result hinges on the assumption that oil companies would continue to find it profitable to blend inexpensive ethanol with low-octane gasoline to create 87 regular gasoline. In either case, it is difficult to argue that a change in corn prices provides an over-riding justification for either reducing mandates or letting them grow because the impacts of a reduction are modest.

Table 3. Impact of Reduced Ethanol Mandates*

	Marketing Year						
	13/14	14/15	15/16	16/17	17/18	18/19	19/20
Corn Production	0	-0.91	-0.98	-0.99	-1.01	-0.96	-0.98
	0.0%	-1.1%	-1.1%	-1.2%	-1.2%	-1.1%	-1.1%
Corn Price	-0.19	-0.24	-0.26	-0.27	-0.25	-0.26	-0.27
	-4.2%	-5.2%	-5.6%	-5.8%	-5.3%	-5.4%	-5.6%
Ending Corn Stocks	-0.117	-0.067	-0.051	-0.033	-0.06	-0.047	-0.053
	-7.5%	-3.8%	-2.7%	-1.7%	-3.1%	-2.5%	-2.8%
Ethanol Demand Price	0.45	0.46	0.46	0.47	0.48	0.48	0.49
	38.8%	39.0%	39.0%	39.8%	40.3%	40.0%	40.8%
Ethanol Production	-0.23	-1.64	-1.65	-1.64	-1.67	-1.69	-1.7
	-1.7%	-11.0%	-11.1%	-11.1%	-11.2%	-11.4%	-11.4%
RIN Price	-0.50	-0.52	-0.53	-0.54	-0.55	-0.55	-0.56
	-95.2%	-96.7%	-97.4%	-97.7%	-97.9%	-98.0%	-98.0%
Beginning RIN Stock	0	0.962	1.119	1.449	1.69	1.865	2.005

*Units are billion gallons for ethanol production and beginning RIN stock; million acres for harvested acreage $ per bushel for corn prices, $ per gallon for ethanol price and RIN price; and billion bushels for ending corn stocks and corn production.

Before concluding it is useful to consider how a reduction in mandates would affect the distribution of corn prices and RIN prices. One justification for lower mandates is that mandates can exacerbate corn price spikes caused by short crops. Figure 1 shows the distribution of corn prices for the 2015/16 marketing year for the two scenarios considered. The distribution with the increased mandate is shifted to the right, which represents a higher average corn price, and it is slightly flatter, which indicates a bit more price variability. The increase in price variability is not greater because of the role that RIN and corn stocks play in buffering the effects of low corn yields. Corn stocks are drawn down in low yield years as are RIN buffer stocks. Due to the ability to borrow RINs from future years, the RIN stock can actually turn negative, further buffering the effects of low corn yields.

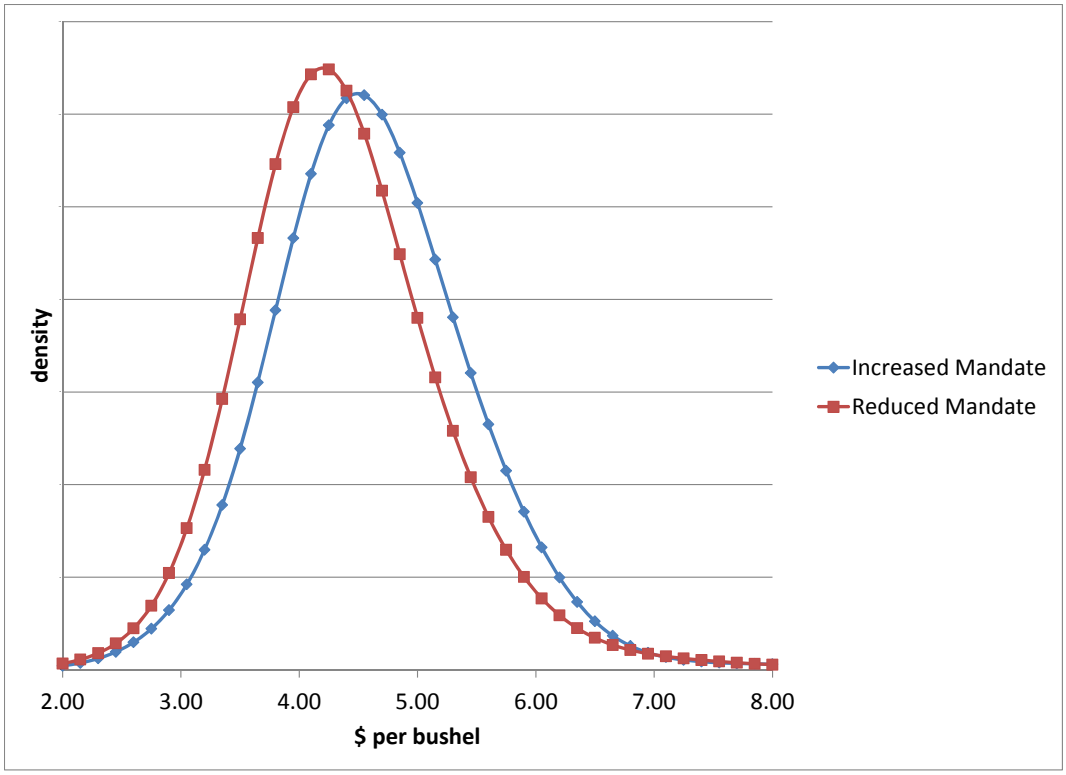

Figure 1. Distributions of Corn Prices in 2015/16

Figure 2 shows the two distributions of RIN price solutions in 2015/16. The distribution with reduced mandates shows that 60 percent of the RIN price solutions are less than one cent. This represents a return to the situation that mostly prevailed between 2008 and 2011 when RIN prices were quite low. If mandates are increased and if 5,000

new E85 stations are built, then about 95 percent of RIN price solutions are between 50 and 70 cents.

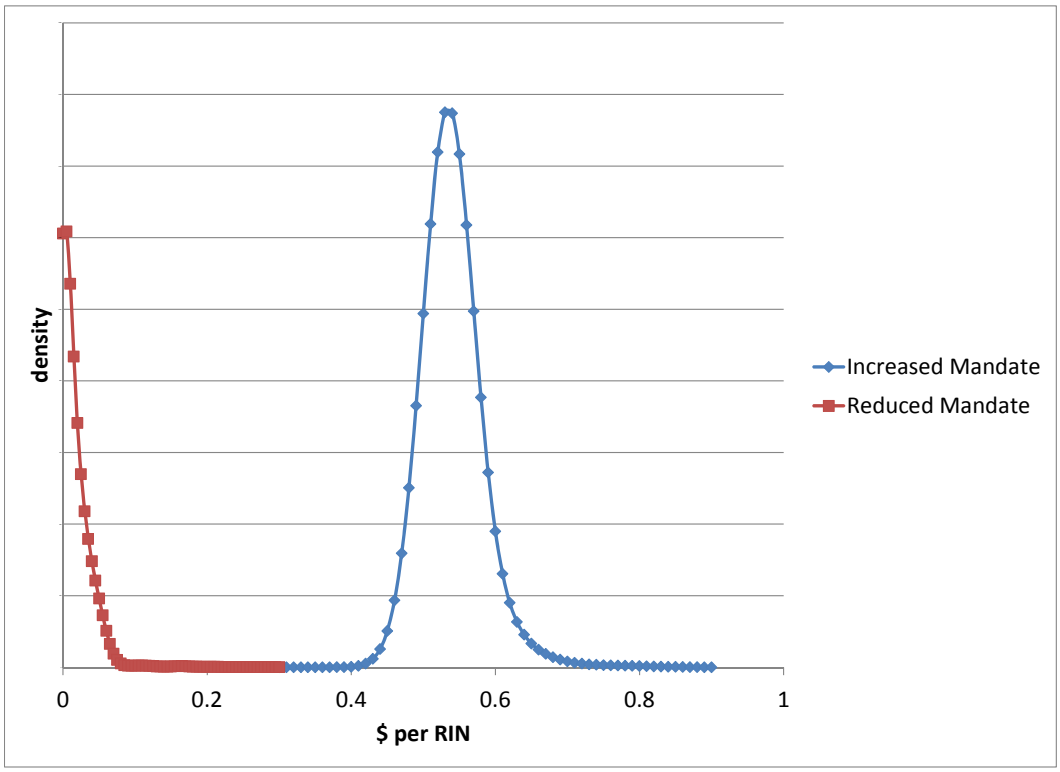

Figure 2. Distributions of RIN Prices in 2015/16

Policy Implications

The price of corn has fallen dramatically in 2013. For example, the average price received by corn farmers in March was $7.13 per bushel. The average price received in October was $4.49 per bushel, a drop of 37 percent. Corn prices have not been this low since October of 2010. Barring another short crop in 2014, corn prices are unlikely to return to recent high levels and could drop further if growing season weather is favorable. In contrast to the large swings we have seen in corn prices, the results presented here indicate that EPA's mandate decisions for 2014 and beyond will impact corn prices by about 25 cents per bushel, or by between 5 and 6 percent. This relatively modest impact suggests that whether ethanol mandates should be reduced to levels that can be easily met with 10 percent blends or increased above those levels should be determined by factors other than the impact on corn prices.

A decision by EPA to reduce ethanol mandates in 2014 and 2015 would send a strong signal to car companies to reduce their production of flex vehicles, and to

investors to not invest in high-ethanol-blend fueling stations or in next-generation plants that convert cellulosic material to ethanol. It likely also sends a negative signal to investors in biofuel plants that can convert cellulosic material to non-ethanol biofuels, such as synthetic diesel or gasoline. It might not seem that an EPA decision to decrease support for ethanol would imply a decrease in support for these "drop-in" fuels because they can be easily integrated into existing fuel channels. But the cost of constructing plants that can produce drop in fuels is high. High investment costs imply high risk. A reduction in public policy support for ethanol would only increase the perceived risk that in the future EPA would also reduce its support for other biofuels.

Two stated objectives of the RFS are to reduce greenhouse gas emissions and to reduce petroleum imports. Economists are nearly unanimous that the best way to cut emissions is with a widely-applied carbon tax because the cost of reducing emissions is minimized when a tax is applied equally to all emission sources. Similarly, the most efficient way or reducing oil imports is to tax imports. But politicians rarely agree with economists' prescriptions so second-best policy instruments such as the RFS that only apply to liquid transportation fuels to meet policy objectives are utilized.

RFS mandates stimulate biofuel production which substitutes for petroleum, a large part of which is imported. And almost all the growth in future mandates are for advanced biofuels which lower greenhouse gas emissions much more than conventional biofuels. Thus the RFS, however inefficiently, will meet its stated objectives.

The question facing EPA and Congress is whether the costs of maintaining support for biofuels through the RFS are too high for the benefits that are obtained. If the costs are too great or if a more efficient policy is available, then this should be communicated as quickly as possible. The sooner that a decision to withdraw support for biofuels is made, the better, as this will allow investment dollars to be redirected to more profitable enterprises. However, if a withdrawal of support for biofuels is not forthcoming, then a decision to set mandates at levels that can be easily met sends exactly the wrong signal to investors because without investment, increased consumption of biofuels will never occur. This policy consideration should be of upmost importance, not the price of corn, which will increase marginally with scheduled increases in ethanol mandates.

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