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The Renewable Identification Number System and U.S. Biofuel Mandates

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Abstract

The Renewable Fuel Standard (RFS) sets annual mandates for renewable transportation fuels sold or introduced into commerce in the United States. The current RFS sets mandates through 2022. The Renewable Identification Number (RIN) system was created by the U.S. Environmental Protection Agency to facilitate compliance with the RFS. A RIN is a 38-character numeric code that corresponds to a volume of renewable fuel produced in or imported into the United States. RINs remain with the renewable fuel through the distribution system and ownership changes. Once the renewable fuel is blended into a motor vehicle fuel, the RIN is no longer required to remain with the renewable fuel. Instead, the RIN may then be separated from the renewable fuel and used for RFS compliance, held for future compliance, or traded. The RFS mandates are prorated down to "obligated parties"—individual gasoline and diesel producers and/or importers—based on their annual production and/or imports. Each year, obligated parties are required to meet their prorated share of the RFS mandates by accumulating RINs, either through fuel blending or by purchasing RINs from others. Understanding the RIN system and the prices for RINs when bought and sold can provide key insights into the impact of mandates on biofuel and feedstock markets. For 2011, conventional ethanol RIN prices have been low, implying low probability that the corresponding mandate has been binding and suggesting that other factors have contributed to expansion beyond the mandate. Conversely, biodiesel RIN prices have been high in 2011, implying a more binding biodiesel mandate with effects on soybean oil and other biodiesel feedstock markets.

Keywords: Renewable Fuel Standard, Renewable Identification Number, mandates, biofuels, feedstocks

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Contents

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Introduction

To reduce dependence on foreign oil and to address climate change concerns, U.S. policymakers have introduced a combination of policies to support the production and consumption of biofuels. An important element of U.S. biofuel policy is the Renewable Fuel Standard (RFS). The RFS originated with the Energy Policy Act of 2005 and was expanded and extended by the Energy Independence and Security Act of 2007 (EISA). The Renewable Identification Number (RIN) system was developed by the U.S. Environmental Protection Agency (EPA) to ensure compliance with RFS mandates. RINs are used by obligated parties to demonstrate compliance with their pro rata share of a particular year's mandate. Obligated parties are producers or importers of gasoline and diesel in the 48 contiguous States and Hawaii, including blenders that produce gasoline from nonrenewable blendstocks.[1] Understanding the RIN market is key to understanding the role of the RFS mandates in biofuel and feedstock markets.

[1]Noncontiguous States and territories are not specifically included, but Hawaii has chosen to opt in to the program. Also, some exceptions have been provided for small refineries.

Background

Over the years, policymakers have introduced different policies to support the production and consumption of biofuels (Duffield et al., 2008). The National Energy Act of 1978 gave ethanol blends of at least 10 percent in volume a 40-cent-per-gallon exemption from the Federal motor fuel tax.

The Clean Air Act Amendments of 1990 (CAAA 90) boosted demand for ethanol. Congress mandated the use of oxygenated fuels in specific U.S. regions during winter months to reduce carbon monoxide emissions. The two most common ways to increase the oxygen content of gasoline are to add methyl tertiary butyl ether (MTBE) or ethanol. As provided by the CAAA 90, cities with the worst smog pollution were required to use reformulated gasoline by 1995. Congress further specified that reformulated gasoline contain oxygen at 2 percent by weight. While many cities voluntarily adopted this program, environmental concerns about MTBE led many States to ban its use.

The 2005 Energy Policy Act and several of its provisions related to agriculture-based renewable energy production were critical factors driving the surge in ethanol supply and demand. This act maintained air quality standards, thereby continuing the need for reformulated gasoline. Furthermore, the act did not provide liability protection for MTBE, reducing its use and stimulating ethanol demand (Westcott, 2007). Consequently, ethanol became the oxygenate of choice for the reformulated gasoline program by spring 2006. Indirectly, other Federal programs supported ethanol production by providing incentives for research on renewable fuels. This act also created the RFS program, which initially mandated that 4.0 billion gallons of renewable fuel be blended into gasoline in 2006 and increased to 7.5 billion gallons by 2012.[2]

The scope of the RFS was expanded and extended in 2007 by the EISA. Provisions of the new mandate (or RFS2) go through 2022. RFS2 mandates inclusion of 15.2 billion gallons of renewable fuel in U.S. transportation fuel by 2012 and 36 billion gallons by 2022.[3] Specific RFS2 mandates were created for various subcategories of biofuels—advanced biofuels, cellulosic biofuels, and biomass-based diesel (biodiesel).[4] The sub-mandates are defined by eligible feedstock types and lifecycle greenhouse gas (GHG) emission reductions.[5]

The subcategory mandates also have a hierarchy within RFS2. For example, of the 15.2 billion gallons mandated for 2012, 2 billion gallons must come from advanced biofuel. RFS2 specifies the required volumes for biodiesel and cellulosic biofuels, while the rest can be met by other advanced biofuels that satisfy the feedstock and GHG-reduction requirement. RFS2 specifies 500 million gallons for cellulosic biofuel and 1 billion gallons for biomass-based diesel and leaves the remaining advanced mandate unspecified. Any excess in the cellulosic or biomass-based diesel categories can count toward the unspecified advanced mandate. The other 13.2 billion gallons are accounted for by the unrestricted portion of the mandate[6] (indicated by implicit nonadvanced biofuels, maximum, in fig. 1). Ethanol derived from corn starch and other biofuels that do not qualify as "advanced" would count

[2]Credits for biodiesel were provided for under the 2005 Act.

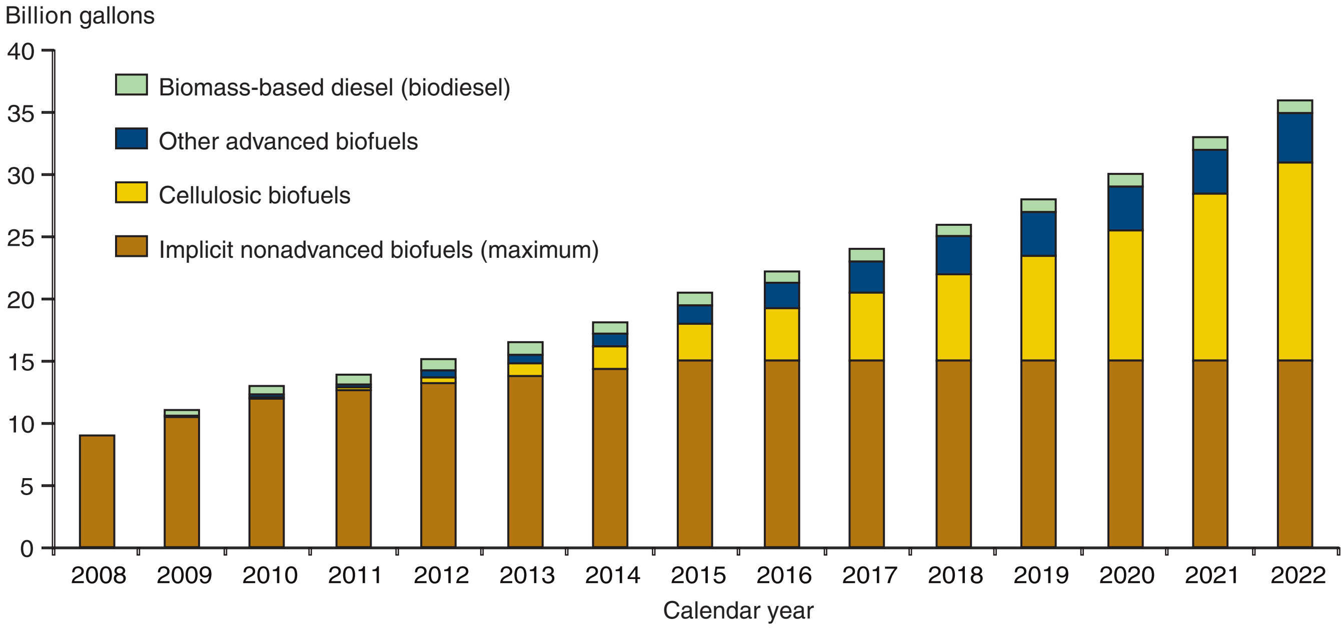
[3]Waivers, reductions, and modifications to the RFS2 are allowed if the EPA determines that the standard would serverely harm the economy or environment, or that there is an inadequate domestic supply. EPA must reduce the cellulosic biofuel mandate if projected cellulosic production is below the mandate. Additionally, authority for adjusting the biomass-based diesel fuel mandate based on price-based considerations is provided for in the EISA.

[4]Advanced biofuel is defined as any renewable fuel other than those derived from corn starch, which can apply to a variety of fuels, including biodiesel, cellulosic, and other alcohols.

[5]The EPA is required to apply lifecycle GHG performance threshold standards to ensure that each category of renewable fuel emits fewer GHGs than the petroleum fuel it replaces. Specifically, the lifecycle GHG emissions of qualifying renewable fuels must be at least 20 percent less than the lifecycle GHG emissions of the 2005 baseline average of petroleum fuel that it replaces. Similar rules apply to renewable fuels qualifying as advanced biofuel (50 percent), biomass-based diesel (50 percent) and cellulosic biofuel (60 percent).

[6]Corn ethanol qualifies for the unrestricted portion of the mandate, but there is no specific mandated volume for corn-based ethanol in RFS2. Thus, corn-based ethanol use beyond the unrestricted portion of the mandate would not count toward meeting total RFS2.

Figure 1
Renewable fuel standard (RFS) mandate, by type, 2008-22



Note: Biodiesel RFS specified through 2012; subsequent years "shall not be less than the applicable volume. . .for calendar year 2012."
Source: U.S. Environmental Protection Agency, Energy Independence and Security Act of 2007.

toward this category's mandate. Again, the hierarchy of the submandates means that any excess from the advanced mandate can count toward this unrestricted portion, but not vice versa.

The Renewable Identification Number (RIN) system was developed by the EPA to ensure compliance with RFS2 mandates. A RIN is a 38-character numeric code (table 1) that corresponds to a volume of renewable fuel produced in or imported to the United States. RINs are generated by the producer or importer of the renewable fuel. RINs must remain with the renewable fuel as the renewable fuel moves through the distribution system and as ownership changes. Once the renewable fuel is blended into motor vehicle fuel, the RIN is no longer required to remain with the renewable fuel. Instead, the RIN may be separated from the renewable fuel and then can be used for compliance, held for future compliance, or traded.

RINs are the basic units for RFS2 compliance. The EPA has developed a system called the EPA Moderated Transaction System (EMTS) to manage RIN transactions.[7] EMTS screens RINs and provides a structured environment for conducting RIN transactions.[8] To participate, users must:

1. Register with EPA;
2. Create an individual account via EPA's Central Data Exchange (CDX); and
3. Submit transactions.

For example, a renewable fuel producer can electronically submit a volume of renewable fuel produced, as well as the number of RINs generated and assigned. EMTS will automatically screen each batch and either reject the information or allow the RINs created by the generator's account. RINs must

[7]Under the initial RFS, parties made various errors generating and using RINs.

[8]As of July 1, 2010, renewable fuel producers and importers, gasoline and diesel refiners, renewable fuel exporters, RIN owners, and any other RFS2 regulated party must use EMTS.

Table 1
Renewable Identification Number (RIN) code definitions

38-character code: KYYYYCCCCFFFFFBBBBBRRDSSSSSSSSEEEEEEEE	
K	RIN assignment code (1=Assigned; 2=Separated)
YYYY	Year batch is produced/imported
CCCC	Company registration ID
FFFFF	Facility registration ID
BBBBB	Producer-assigned batch number
RR	Equivalence value for the renewable fuel
D	Renewable type code[1]
SSSSSSSS	RIN block starting number
EEEEEEEE	RIN block ending number

[1]Five separate RIN categories: D=3 for cellulosic biofuel; D=4 for biomass-based diesel; D=5 for advanced biofuel; D=6 for other renewable fuel; and D =7 for cellulosic diesel.
Source: U.S. Environmental Protection Agency.

remain with the biofuel until it has been blended; then it may be traded. The seller posts the sale of their RINs at a certain price. The buyer logs into EMTS and accepts the transaction, assuming all information is correct. Upon acceptance, the buyer's RIN account is automatically increased by the number of RINs purchased. RIN transactions must be verified and certified quarterly by the EPA. The RIN price is one of the new pieces of information required by the EPA to be reported to the EMTS (EPA, March 2010).

The RIN Market Is Key To Implementing the Renewable Fuel Standard

The RIN market plays a critical role in successfully implementing the RFS2. By the end of November each year, the EPA calculates an annual percentage RFS2 by dividing the volume of renewable fuel required by EISA to be blended into gasoline and diesel for the following year by the volume of gasoline and diesel projected to be consumed in that year according to the U.S. Energy Information Administration (EIA). For example, EISA set a total RFS2 of 13.95 billion gallons of total renewable fuel for 2011, and the EPA calculated the final percentage standard for renewable fuel at 8.01 percent.[9] The renewable volume obligation (RVO) (table 2) for each obligated party is equal to this percentage standard times the annual volume of gasoline and diesel produced or imported.

Each calendar year, obligated parties must meet their RVOs by accumulating RINs that represent an amount of renewable fuel used as transportation fuel sold or introduced into commerce in the United States. If an obligated party has not acquired enough RINs to meet its RVOs then, under certain conditions, the party can carry a deficit into the next calendar year so long as the full deficit and that following year's obligation are covered in the next year. If an obligated party acquires more RINs than it needs to meet its RVOs, it can transfer the excess to another party or retain them for compliance with its RVOs in the following year (subject to a 20 percent rollover cap). The rollover cap ensures that no more than 20 percent of a current-year obligation can be satisfied using RINs from the previous year. These options reduce costs to obligated parties of meeting their RVOs. Some nonobligated parties[10] (when registered with the EPA) are also allowed to trade RINs. RINs are valid for compliance in the calendar year for which they are generated or for the following calendar year (within the rollover limit), so a RIN expires if unused after 2 years.

With the expanded RFS2 provisions, each obligated party now has four RVOs to meet—total renewable fuel, advanced biofuel, biomass-based diesel, and cellulosic biofuel—to demonstrate compliance. Previously, the

[9]Separate percentage standards were also specified for cellulosic biofuel, biomass-based diesel, and advanced biofuel. For details, see http://www.epa.gov/otaq/fuels/renewablefuels/420f10056.htm.

[10]For example, small refineries.

Table 2
Renewable volume obligation (RVO) formula and definitions

$RVO_i = (RFStd_i \times GV_i) + D_{i-1}$

where

RVO_i = The RVO for an obligated party for calendar year i (gallons of renewable fuel).

$RFStd_i$ = The renewable fuel standard for calendar year i, determined by EPA (percent).

GV_i = The nonrenewable gasoline and diesel volume, which is produced or imported by the obligated party in calendar year i (gallons).

D_{i-1} = Renewable fuel deficit or carryover from the previous year (gallons).

Source: U.S. Environmental Protection Agency.

initial RFS established one RVO (total renewable fuel) through 2012 and two RVOs (total renewable fuel and cellulosic biofuel) to be met in 2013. RFS2 requires that RVOs be calculated based on production or importation of both gasoline and diesel fuels. Every physical gallon of renewable fuel produced or imported into the United States must be assigned a unique RIN for compliance. Equivalence values for every physical gallon of renewable fuel represent the number of gallons that can be claimed for compliance purposes, based on its energy content compared with ethanol, and adjusted for renewable content (see EPA, May 2007 for more information on equivalence values). For example, a gallon of conventional ethanol counts as 1 RIN, a gallon of biobutanol counts as 1.3 RINs, a gallon of biodiesel (mono alkyl ester) counts as 1.5 RINs, and a gallon of nonester renewable diesel counts as 1.7 RINs.[11]

[11]The EPA has interpreted the biomass-based diesel volume mandate as diesel volume rather than as ethanol-equivalent volume. Thus, although 1 gallon of biodiesel (mono alkyl ester) counts as 1.5 RINs for the advanced biofuel and the total renewable fuel standards, it counts as 1 gallon for the biomass-based diesel mandate.

The Core Value of RINs

The actual RIN price includes the core value of RINs, transaction costs, and/or a speculative component. The core value of a RIN is the gap, if positive, between the supply price (P_s) and the demand price (P_d) for biofuels at any given quantity (Thompson et al., 2009b) (fig. 2). The supply price, corresponding to any point on the supply curve, is the price that allows biofuel producers to cover the cost of producing at that output level. Similarly, the demand price corresponds to any point on the demand curve that consumers (blenders) would be willing to pay for that volume of biofuels without the mandates. If the market equilibrium quantity exceeds the mandate, then the RIN core value is zero. If the mandate (represented by the vertical RFS2 line) exceeds the market equilibrium quantity (Q_e), then the RIN core value is positive (fig. 2). Note that the supply price (the price producers receive) is equal to the demand price (the price consumers are willing to pay with no mandate) plus the core value of the RIN. This calculation assumes that costs are covered and mandated levels are produced. In aggregate, the total cost of meeting the RFS2 is equal to the mandated quantity times this per-unit cost (RIN price). The RIN price, or the gap between supply price and demand price, represents the per-unit cost of meeting the mandate. Therefore, a high RIN price indicates a high overall cost of meeting the RFS2.

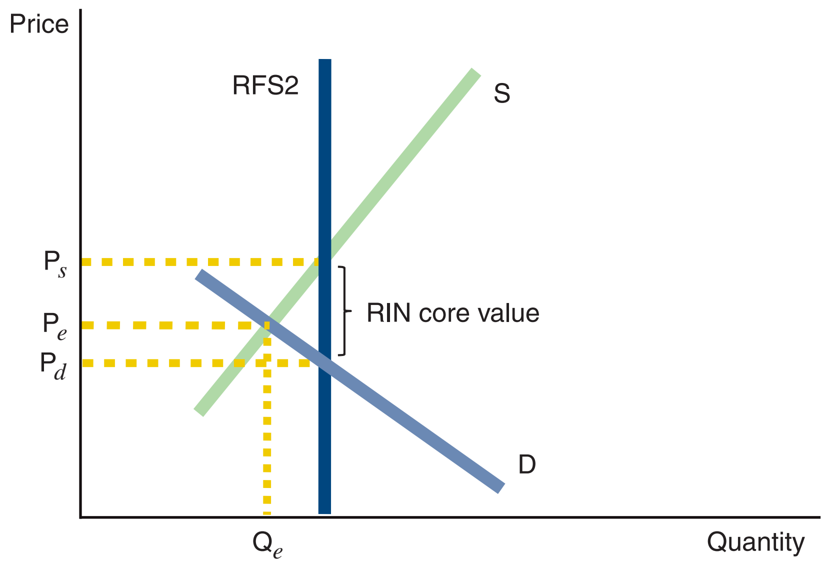
The RIN Market Ensures that the Mandate Is Met

The RFS2 mandate could be met by each obligated party blending their required volume of biofuel and reporting those RINs to the EPA. However, a market for RINs has been established to facilitate the trading of the RINs. RIN demand comes from obligated parties who find it less expensive to buy separated RINs[12] than to obtain RINs from purchasing and blending biofuels. RIN supply can come from obligated parties who blend more biofuels than required, and thus have more RINs than needed for compliance, or from nonobligated parties. With an excess supply of RINs, the price of RINs becomes negligible.[13] If there is a shortage of RINs in the marketplace and blenders want to buy more separated RINs than are available, RIN prices will increase. RIN prices will rise to bridge the gap between the willingness to pay for biofuels and the cost of producing biofuels at the mandated quantity. In theory, the RIN market ensures that mandated demand will generate high enough biofuel prices to allow biofuel producers to cover their production costs up to the RFS2.

[12]RINs separated from biofuel after the biofuel has been blended.

[13]RIN prices might still be positive, reflecting transaction costs and/or speculative components.

Figure 2
Biofuels market with a binding mandate



S=Supply curve.
D=Demand curve.
RFS2=The mandated quantity.
Q_e=The equilibrium quantity without the mandate.
P_e=The equilibrium price without the mandate.
P_s=The supply price for biofuels at mandated quantity.
P_d=The demand price for biofuels at mandated quantity.
RIN=Renewable Identification Number.
Source: USDA, Economic Research Service, based on Thompson et al., 2009b.

What Affects RIN Prices?

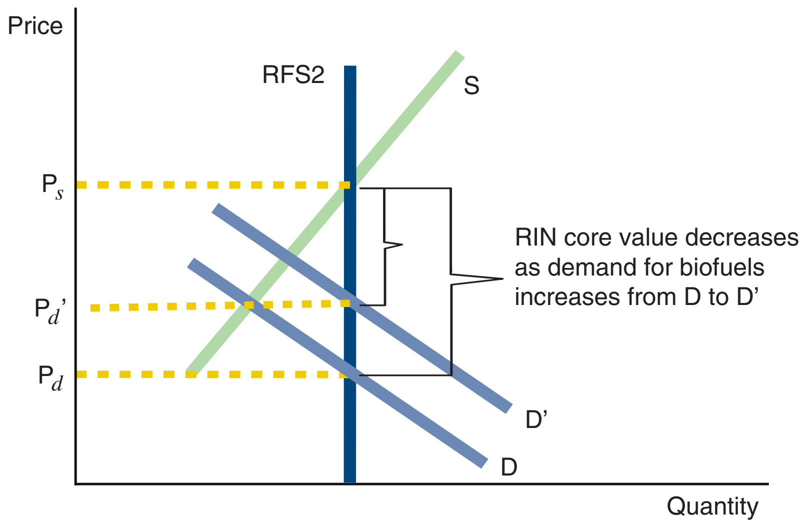
As with the overall RFS2 and its submandates, there is also a hierarchy for the prices of different types of RINs. For example, advanced biofuel RINs will be worth at least as much as conventional ethanol RINs, because advanced biofuels count toward both the advanced RFS2 and total RFS2, while conventional ethanol only counts toward the total RFS2.

Tax Credits

Tax credits make blenders more willing to blend biofuels. The demand curve for biofuels shifts upward from D to D’ and the price of RINs drops as represented by the reduction in the “RIN core value” (fig. 3). Note that if blending already exceeded the mandate (D intersected S at a quantity above RFS2), RIN prices would be zero. The demand shift to D’ would increase blending further but RIN prices would not change, remaining at zero.

In this case, the tax credit would not contribute to meeting the mandate. In contrast, eliminating the Volumetric Ethanol Excise Tax Credit (VEETC) would make blenders less willing to blend ethanol. In this case, the demand curve for ethanol shifts downward from D’ to D, and conventional ethanol RIN prices increase. The VEETC is set to expire after December 31, 2011, and conventional ethanol RIN prices are expected to rise if this tax credit is not renewed unless equilibrium blending remains above the mandate.

Figure 3
Biofuel market with a demand shift



S=Supply curve.
D=Demand curve.
D'=The shifted demand curve.
RFS2=The mandated quantity.
P_s=The supply price for biofuels at mandated quantity.
P_d=The demand price for biofuels at mandated quantity.
P_d' =The new demand price responding to the shifting demand curve.
RIN=Renewable Identification Number.
Source: USDA, Economic Research Service, based on Thompson et al., 2009b.

The biodiesel blenders' tax credit expired at the end of 2009; however, at the end of 2010, the Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010 (H.R. 4853) retroactively reinstated and extended the biodiesel tax credit through 2011. Extending biodiesel tax credits makes blenders more willing to blend biodiesel, thus shifting up the demand curve for biodiesel and decreasing the price of biodiesel RINs. As for the VEETC, if the biodiesel tax credit is not extended, biodiesel RIN prices would be expected to rise.

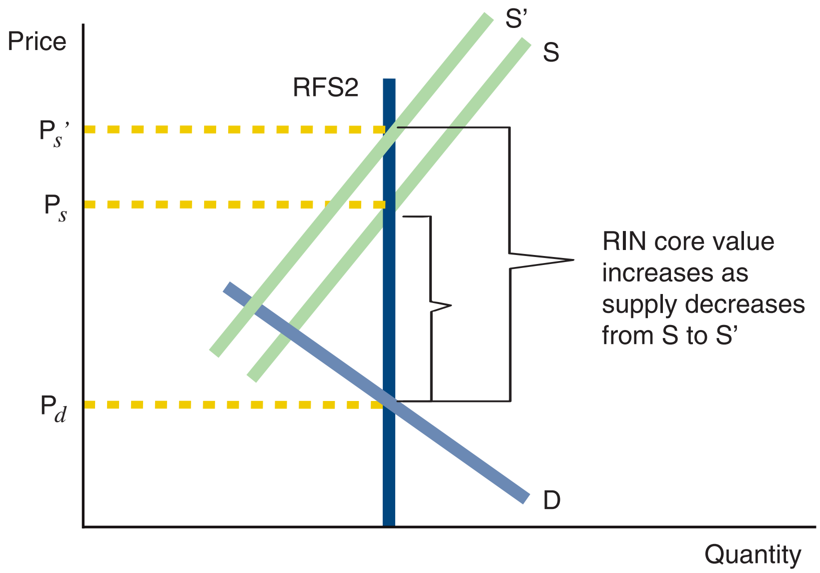
Crude Oil Prices

Crude oil prices help shape RIN prices, unless blending already exceeds the mandate. In most cases, higher crude oil prices lead to an increased willingness to pay for substitute biofuels and shift up the demand curve for biofuels (D shifts to D' as in fig. 3), thus lowering the price for RINs (RIN core value declines in fig. 3). When crude oil prices drop, consumers' willingness to pay for biofuels decreases. The demand curve for biofuels shifts downward, and prices for RINs increase.

Feedstock Prices

Feedstock prices account for a large share of biofuel production costs. A surge in feedstock prices will increase biofuel production costs. When feedstocks become more expensive, the supply curve for biofuels shifts upward

Figure 4
Biofuel market with a supply shift



S=Supply curve.
S'=Shifted supply curve.
D=Demand curve.
RFS2=The mandated quantity.
P_s=The supply price for biofuels at mandated quantity.
P_s'=The new supply price responding to the shifted supply curve.
P_d=The demand price for biofuels at mandated quantity.
RIN=Renewable Identification Number.
Source: USDA, Economic Research Service, based on Thompson et al., 2009b.

(S to S' as in fig. 4) and the prices of RINs increase (larger RIN core value). In contrast, lower feedstock prices will reduce production costs, the supply curve for biofuels shifts downward, and the prices of RINs decrease. Feedstock production affects the price of the feedstock in the short run. Thus, feedstock production also has implications for RIN values. For example, when corn production is high, corn prices and production costs of conventional ethanol decrease. Thus, the prices of conventional ethanol RINs decrease. The opposite is true when corn production is relatively low.

Speculative Component

Speculators who register with the EPA are allowed to buy and sell RINs. For example, if they anticipate a widening gap between market supply and demand prices of biofuel at the following year's mandate, they can buy RINs this calendar year to hold and sell the following year. This process could potentially reduce the number of RINs available for the current year's compliance and increase RIN prices.

Historical RIN Prices

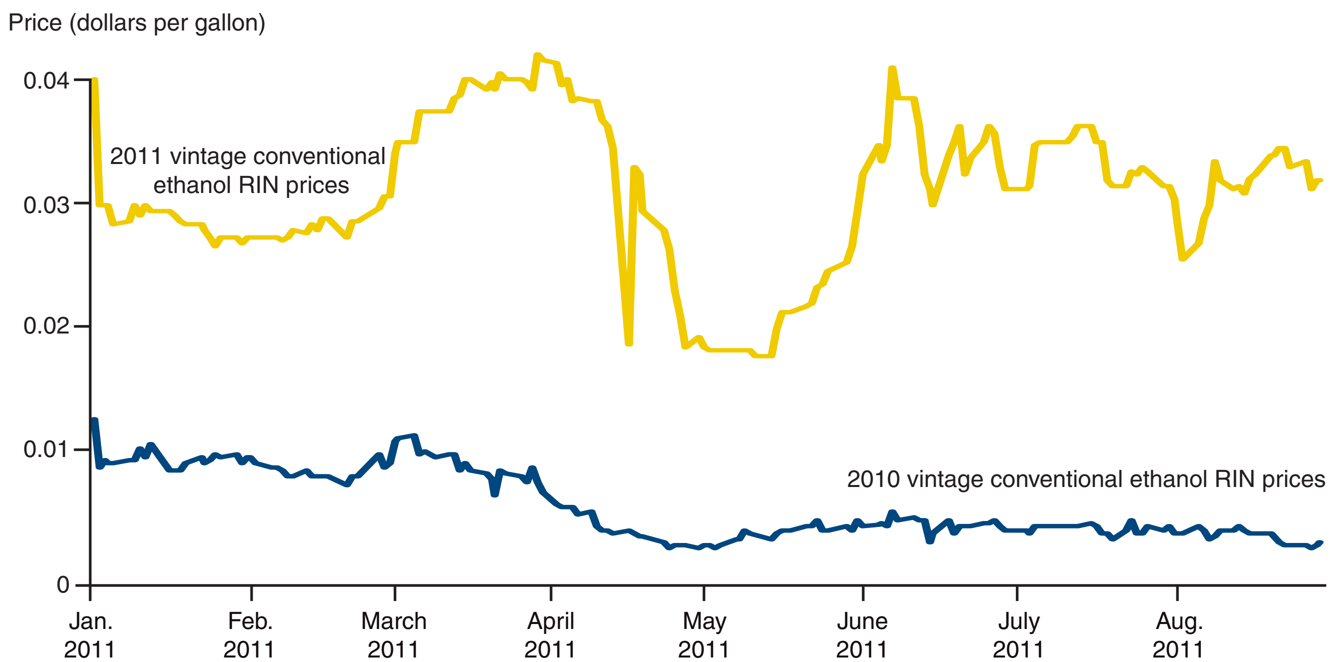
The EPA permits RINs from a calendar year to be rolled over for next year's compliance, so extra RINs from 2010 could be used toward meeting the 2011 RFS2. This rollover provision is subject to a 20 percent cap on the amount of an obligated party's 2011 RVO that can be met using 2010 RINs (EPA, March 2010). RIN prices for both 2010 and 2011 vintages are available during 2011. Historical prices indicate that there is a hierarchy of RIN prices and that the vintage of the RIN matters. Given the vintage, a biodiesel RIN is worth at least the value of a conventional ethanol RIN because a biodiesel RIN can meet both noncellulosic advanced and overall mandates.

For January-August 2011, conventional ethanol RIN prices averaged about 3 cents (fig. 5), implying a low probability that the implicit nonadvanced mandate is binding for 2011. While the mandates remain important to the market, particularly for long-term incentives to develop industry production capacity and supporting infrastructures, low RIN prices suggest that other factors, such as crude oil prices, have provided incentives to produce more than the corresponding mandate.

During this same period, however, 2011 biodiesel RIN prices averaged about $1.24 (fig. 6). By mid-August 2011, biodiesel RIN prices hit more than $1.60. The high biodiesel RIN price implies a more binding biodiesel mandate and a significant impact on biodiesel demand. If biodiesel producers buy more soybean oil for production, soybean oil prices increase, leading to higher demand and prices for competing vegetable oils and fats, as well.

It is not clear how much of the biodiesel RIN price is attributable to the core RIN value, transaction costs, and the speculative component. Nonetheless, a high RIN price suggests that a large gap exists between the supply price that biodiesel producers need to cover the cost of producing the required amount and the demand price that fuel blenders would be willing to pay for the

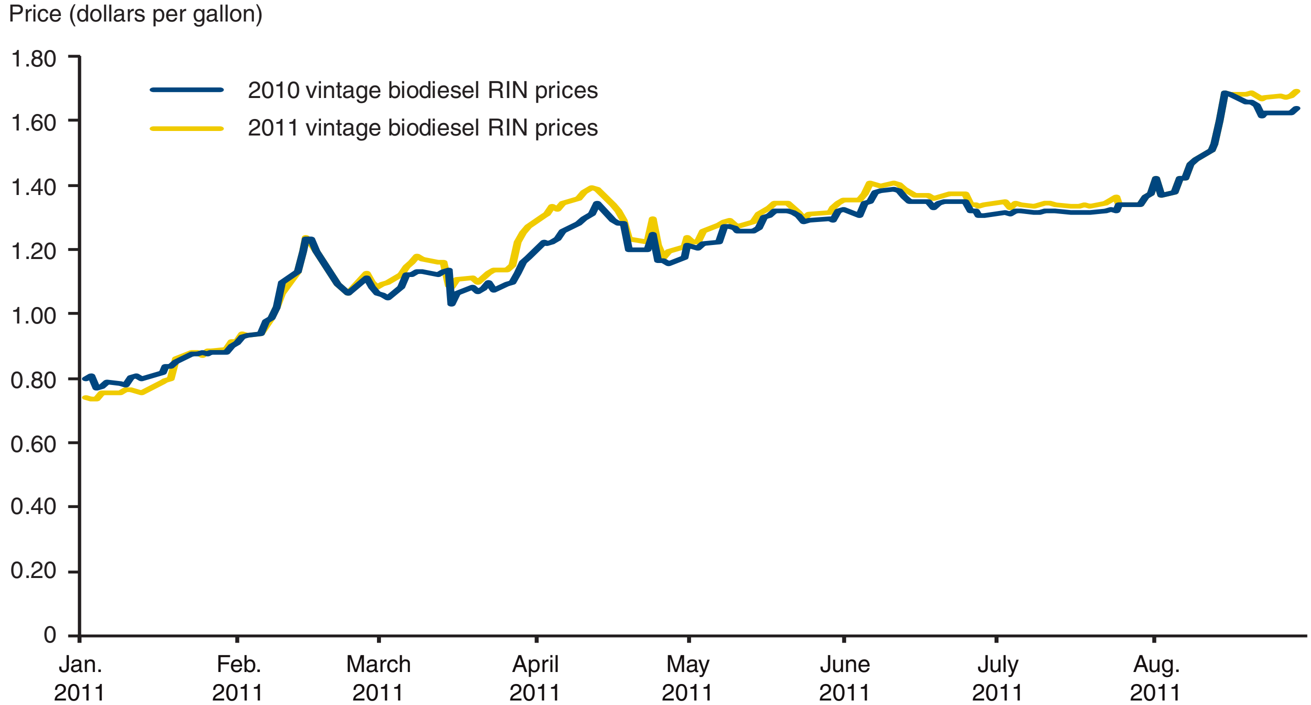
Figure 5
Conventional ethanol RIN prices, 2010 and 2011 vintages



RIN=Renewable Identification Number.

Source: Oil Price Information Service (OPIS), *Ethanol & Biodiesel Information Service*.

Figure 6
Biodiesel RIN prices, 2010 and 2011 vintages



RIN=Renewable Identification Number.

Source: Oil Price Information Service (OPIS), *Ethanol & Biodiesel Information Service*.

quantity without the mandate. In contrast, the positive but low RIN price for conventional ethanol may reflect the speculative component and/or transaction cost.[14]

Cellulosic Mandate Waivers, Credits, and RIN Prices

For 2010, the EPA reduced the required volume of cellulosic biofuels from 100 million gallons, as specified by EISA, to 5 million gallons, due to the limited production of cellulosic biofuel. In addition, to compensate for low cellulosic volume, the EPA made cellulosic biofuel waiver credits available to obligated parties for end-of-year compliance at $1.56 per gallon-RIN (EPA, March 2010). The number of waiver credits offered could not exceed the amount of the cellulosic biofuel standard. For 2011, the EPA reduced the required volume of cellulosic biofuels from 250 million gallons, as specified by EISA, to 6.6 million gallons. The EPA also made cellulosic biofuel waiver credits available to obligated parties for end-of-year compliance at $1.13 per credit (EPA, December 2010). These waiver credits cannot be traded or rolled forward and can only be used to meet the cellulosic biofuel standard for the calendar year offered. Unlike cellulosic biofuel RINs, waiver credits cannot be used to meet either the advanced biofuel standard or the total renewable fuel standard. Currently, cellulosic biofuel RINs are not available.[15]

[14]The average 2010-vintage conventional ethanol RIN price in 2011 has been less than 1 cent, suggesting that transaction costs for a conventional ethanol RIN may be no higher than this amount.

[15]For additional information, see http://www.epa.gov/otaq/fuels/renewablefuels/compliancehelp/rfsdata.htm.

U.S. Conventional Ethanol Market

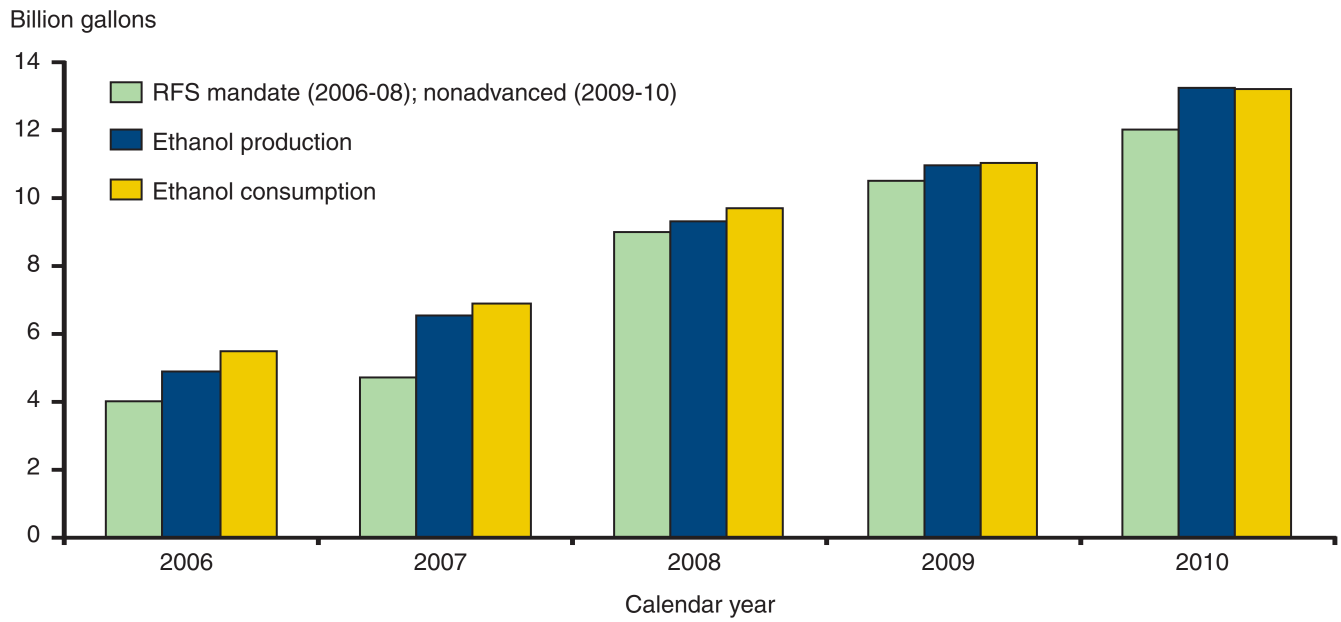
The development of the conventional ethanol market has depended mainly on the interaction of Government policies; the prices of corn, petroleum, and coproducts from ethanol production; and technology. Responding to strong Government support and high petroleum prices, actual conventional ethanol production and consumption exceeded the RFS in 2006, 2007, and 2008, and the implicit maximum nonadvanced mandated level in 2009 and 2010 (fig. 7). Ethanol's share (by volume) in the motor gasoline market increased significantly from 3.5 percent in 2006 to about 9.5 percent in 2010 (fig. 8).

While ethanol can be produced from a variety of crops, corn serves as the predominant feedstock for U.S. domestic biofuel production. During the last 3 marketing years, corn used for ethanol production as a share of total corn use has increased from 24 percent to 37 percent (fig. 9). Increased use of corn for ethanol production has raised corn prices, which has reduced other domestic usage and exports. The decrease in corn for livestock feeding is partially offset by the increase in distillers' grains in livestock rations.[16]

[16]Distillers' grains are the primary coproduct from dry-mill corn ethanol production and can best be used as a feed for ruminant animals, such as beef cattle and dairy cows. Monogastric animals, such as hogs and poultry, are more limited in their ability digest the distillers' grains in their rations.

Greater U.S. demand for corn has contributed to higher corn prices (Trostle, 2008; OECD/FAO, 2008; Abbott et al., 2008; Westhoff, 2010). Corn prices rose from $2.00 per bushel in 2005/06 to an estimated $5.20 per bushel for 2010/11 (fig. 10). Higher corn prices have also encouraged producers to increase their corn acreage. U.S. cropland planted to corn increased to 93.5 million acres in 2007, the highest level since 1944. Some of the increase in land planted to corn has come from other crops, affecting the markets of all field crops. Despite increased corn plantings, corn usage has outpaced production growth, reducing carryover stocks (fig. 11).

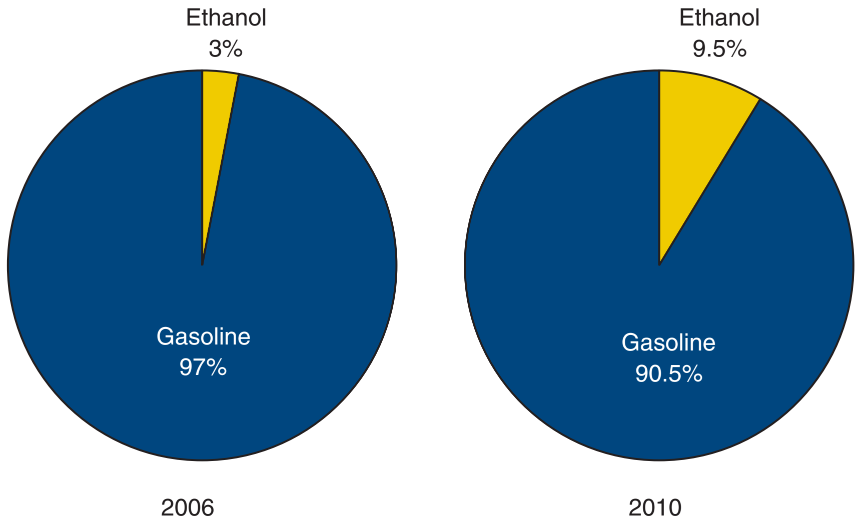
Figure 7
U.S. ethanol production, consumption, and RFS mandate levels



RFS=Renewable fuel standard.

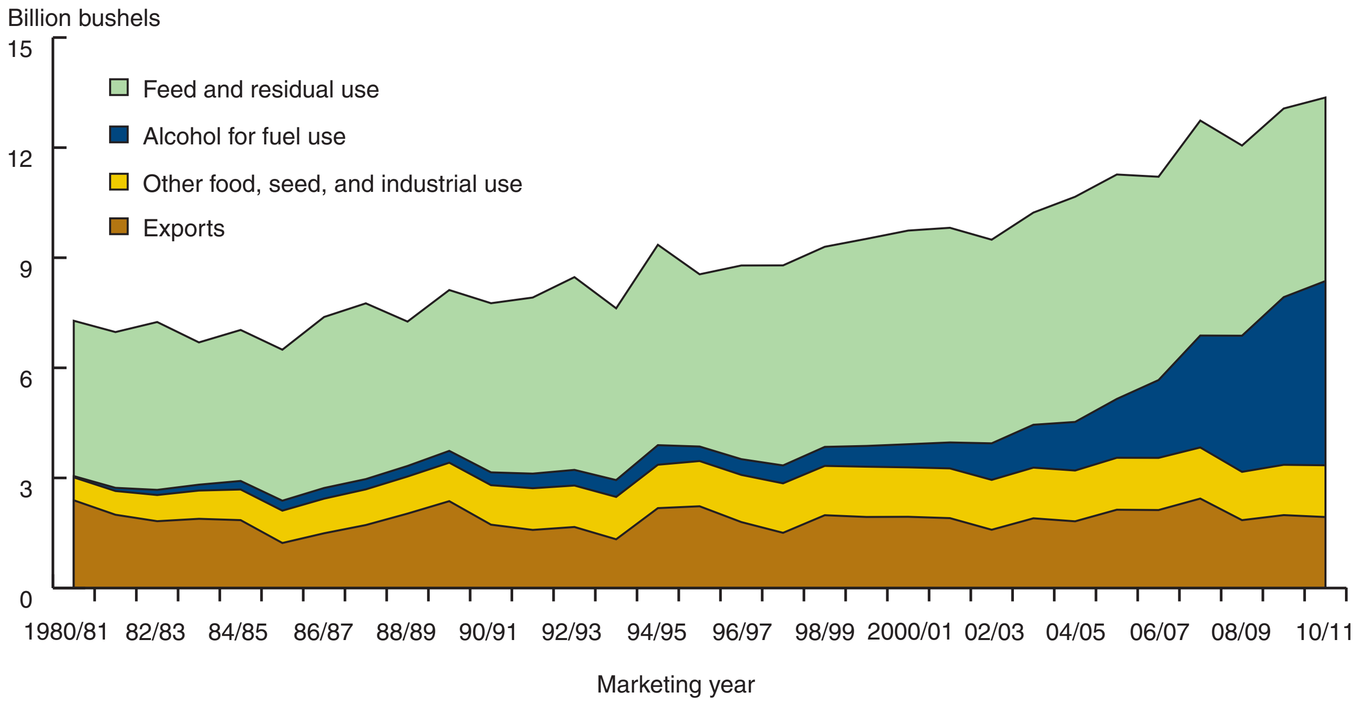
Source: U.S. Energy Information Administration, *Monthly Energy Review*, table 10.3, March 2011.

Figure 8
Share of ethanol in U.S. finished gasoline blends



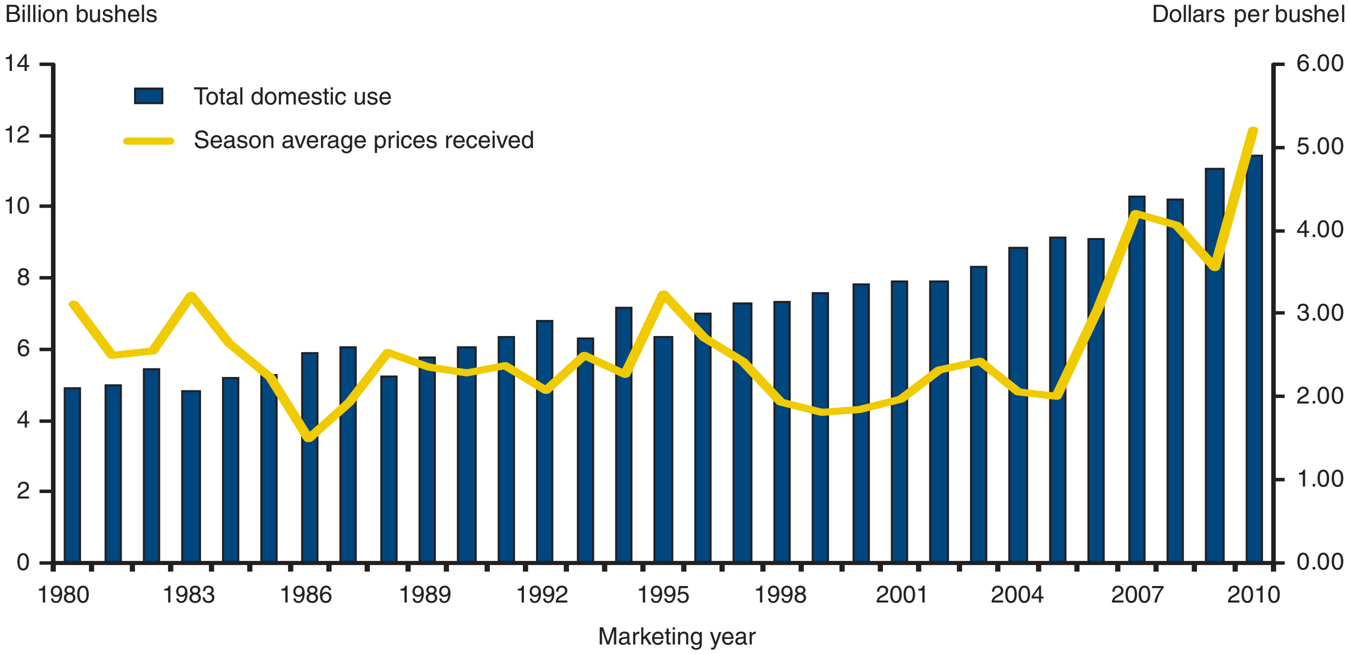
Source: U.S. Energy Information Administration.

Figure 9
U.S. corn use



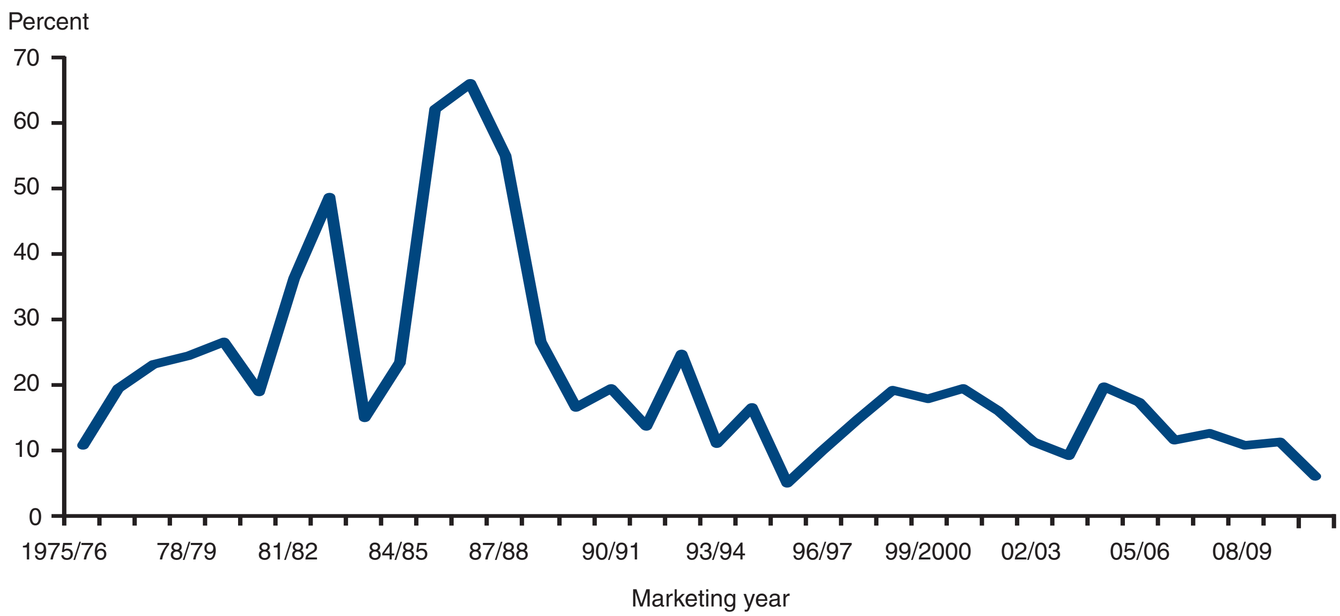
Source: USDA, Economic Research Service.

Figure 10
Season average farm price of corn and total domestic use of corn, 1980-2010



Note: Latest data may be subject to revision.
Source: USDA, Economic Research Service and National Agricultural Statistics Service.

Figure 11
Stocks-to-use ratio for corn



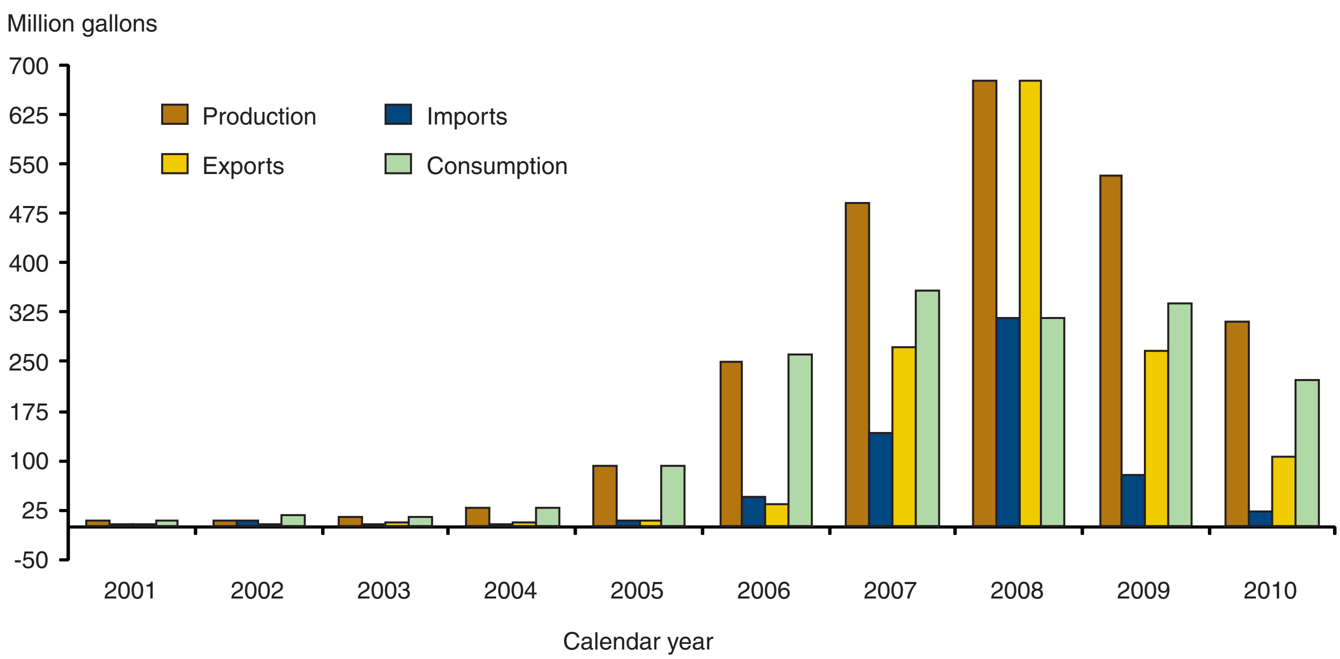
Note: Latest data may be subject to revision.
Source: USDA, Economic Research Service, *Feed Grains Database*.

U.S. Biodiesel Market

A variety of potential fuel types can qualify as biomass-based diesel, however, biodiesel is the predominant type. In 2008, biodiesel production reached 677 million gallons (fig. 12). Domestic consumption reached its highest level at 358 million gallons in 2007. Biodiesel exports surged in 2007 and 2008, largely to the European Union (EU), as producers sought to benefit from U.S. and EU tax credits. During that time, a $1 per gallon U.S. biodiesel tax credit was in place. Any gallon of biodiesel—domestic or imported—that was blended with diesel was eligible for this tax credit regardless of the blend amount. For the export market, a typical blend is 0.1 percent diesel and 99.9 percent biodiesel. The resulting blend was then exported to the EU, where it was eligible for additional fuel tax credits (Carriquiry and Babcock, 2008). Much of the U.S. export surge reflected imported biodiesel that was blended in the United States, and then shipped to its final destination, often in the EU. This loophole for foreign biodiesel pass-through was closed in October 2008 when eligibility for the U.S. tax credit for foreign-produced biodiesel used outside the United States was eliminated. Moreover, the EU initiated anti-dumping laws because U.S. biodiesel accounted for 90 percent of the volume of biodiesel imported to the EU market. Since then, both U.S. imports and exports of biodiesel have dropped significantly.

One important characteristic of the U.S. biodiesel industry is its large excess capacity. The National Biodiesel Board reported that, as of June 2009, the United States supported 173 biodiesel plants with total annual production capacity of 2.69 billion gallons. For 2010, however, actual production was only 311 million gallons, implying a capacity utilization rate of about

Figure 12
U.S. biodiesel production, trade, and consumption, 2001-10



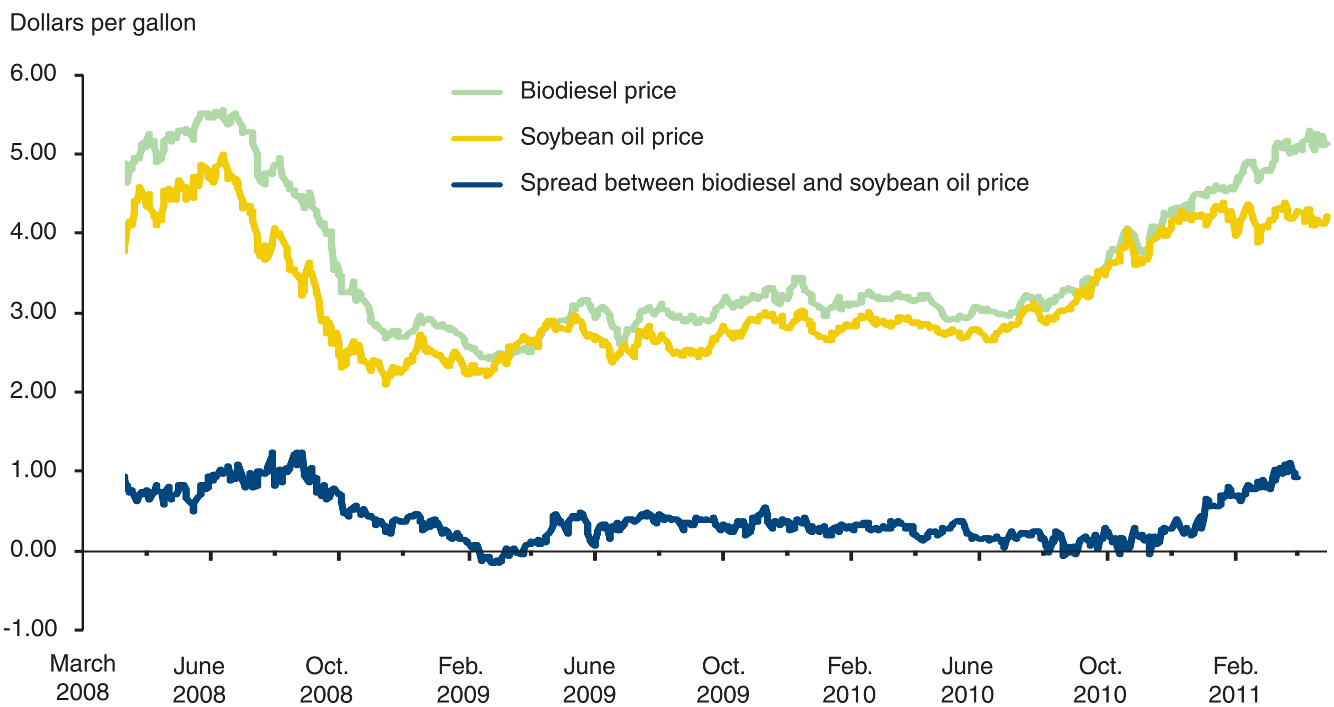
Source: U.S. Energy Information Administration, *Monthly Energy Review*, table 10.4, August 2011, http://www.eia.doe.gov/totalenergy/data/monthly/index.cfm.

11.6 percent. The low utilization rate of biodiesel capacity was due to the low profitability of producing biodiesel. The spread between biodiesel and soybean oil prices is one general indicator of the profitability of biodiesel production (fig. 13). Economic returns of producing biodiesel from soybean oil were low between March 2009 and December 2010, as indicated by the small price spread between biodiesel and soybean oil (fig. 14). In early 2011, the profitability of biodiesel production improved due to strong biodiesel prices. The uncertainty of the biodiesel tax credit extension played an important role in the 2010 biodiesel RIN market. The $1-per-gallon tax credit for blending biodiesel expired at the end of 2009, but it was not until the end of 2010 that the tax credit was retroactively reinstated and extended through 2011. Without biodiesel tax credits, biodiesel RIN prices would be higher. The uncertainty regarding the tax credit extension, however, increased the risk of biodiesel RIN value declining.

Although the biodiesel mandate is not defined after 2012, the RFS2 of EISA requires that at least 1 billion gallons of biodiesel be blended from 2012 on. Biodiesel can also be used to meet the advanced mandate, so biodiesel use could extend beyond its mandated volume to help meet the advanced mandate. Thus, the utilization rate of the industry capacity is expected to increase. If high biodiesel RIN prices are expected, the profitability of producing biodiesel and its supply will increase because the price biodiesel producers receive is equal to the price consumers pay plus the core value of biodiesel RINs. Increased production will lead to higher demand for biodiesel feedstocks.

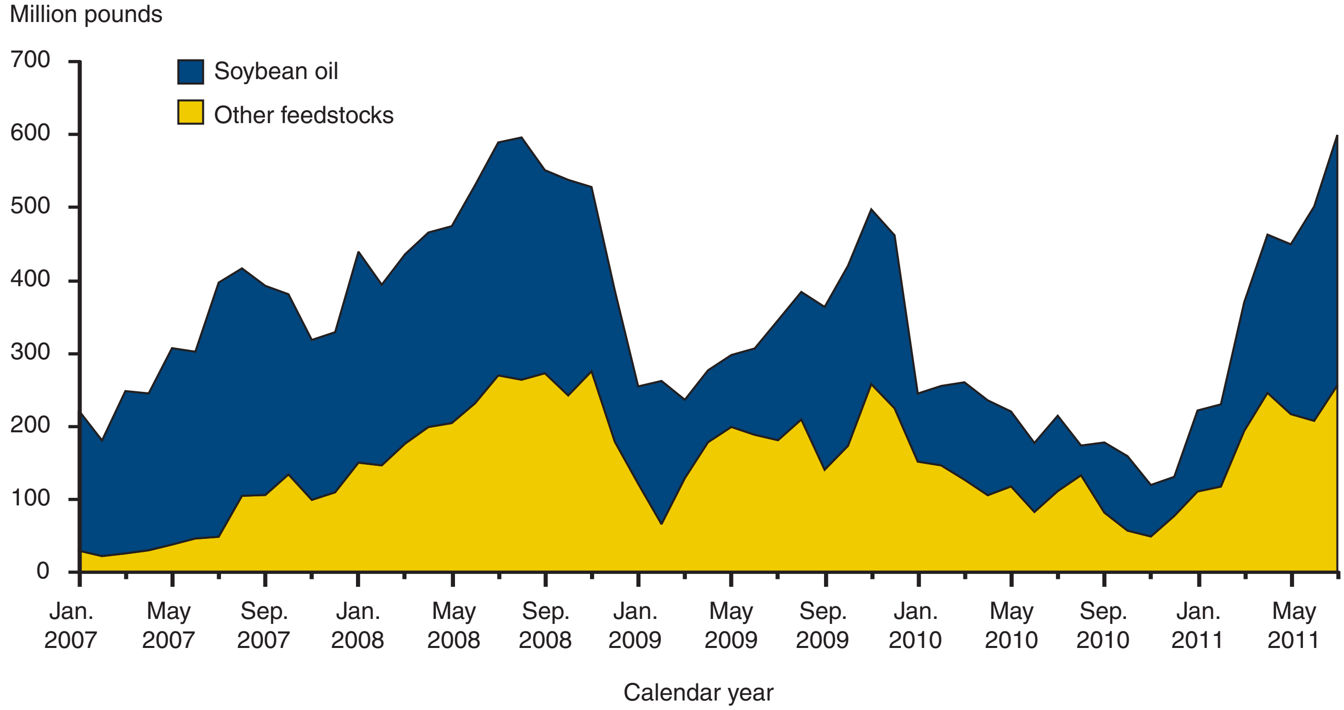
Figure 13

U.S. soybean oil and biodiesel prices, 2008-11



Source: Soybean oil prices calculated based on the contract closing prices from the Chicago Board of Trade; Chicago biodiesel B100 prices cacluated based on Oil Price Information Service.

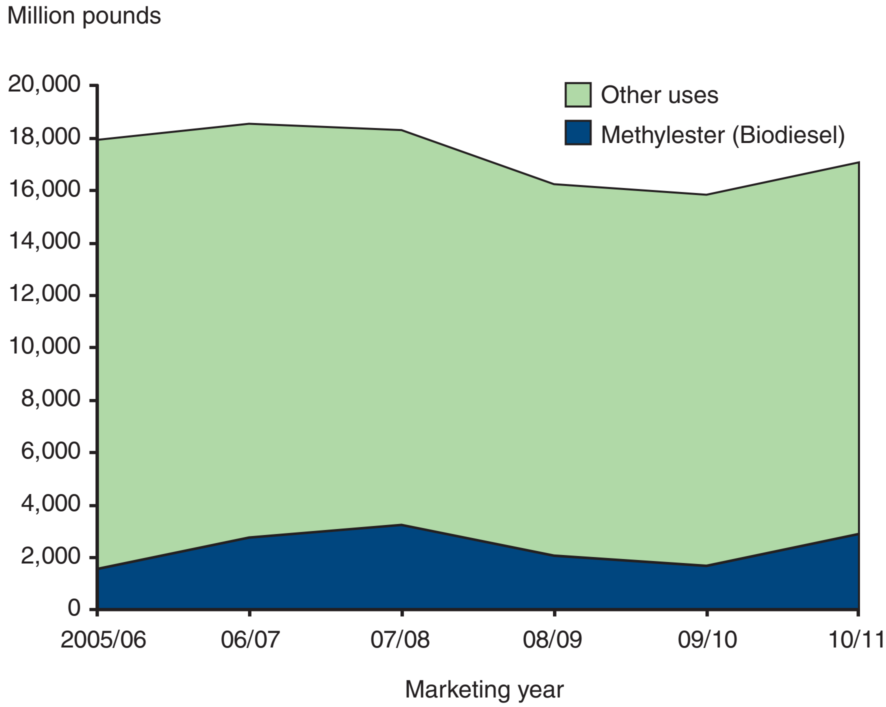
Figure 14
Total U.S. biodiesel production, by feedstock type, 2007-10



Source: Department of Commerce, U.S. Census Bureau, "M311K-Fats and Oils: Production, Consumption, and Stocks," *Current Industrial Report*, tables 2 and 2a, January 2007–July 2011.

The feedstocks available for U.S. biodiesel production have become more diversified. Prior to 2007, soybean oil was the primary feedstock of biodiesel production. Since then, its prominence has decreased as the share of soybean oil for biodiesel feedstock dropped to 80 percent in 2007, to 56 percent in 2008, and to 49.2 percent in 2009 (fig. 15). Other feedstocks for biodiesel production include other vegetable oils, such as canola oil and corn oil, and animal fat, such as poultry fat, tallow, white grease, and yellow grease. The changing trend in biofuel feedstocks reflected a policy change that increased the tax credit to $1 per gallon for biodiesel made from recycled vegetable oil and animal fats. Future market shares will depend on differences in the per-unit cost of production between soybean oil and other feedstocks. Increased biodiesel production raises demand for vegetable oils and animal fats, pushing up their prices. Adjustments occur throughout the vegetable oil and animal fats complex as market participants respond to changing price signals. In equilibrium, the profitability of producing biodiesel from soybean oil and other feedstocks would be expected to be equal.

Figure 15
Total U.S. soybean oil use



Source: Historical data based on USDA, Economic Research Service, *Oil Crops Yearbook 2010*, table 8; 2009/10 and 2010/11 data based on estimates and forecasts from *Oil Crops Yearbook 2010*, table 3.

Outlook and Implications

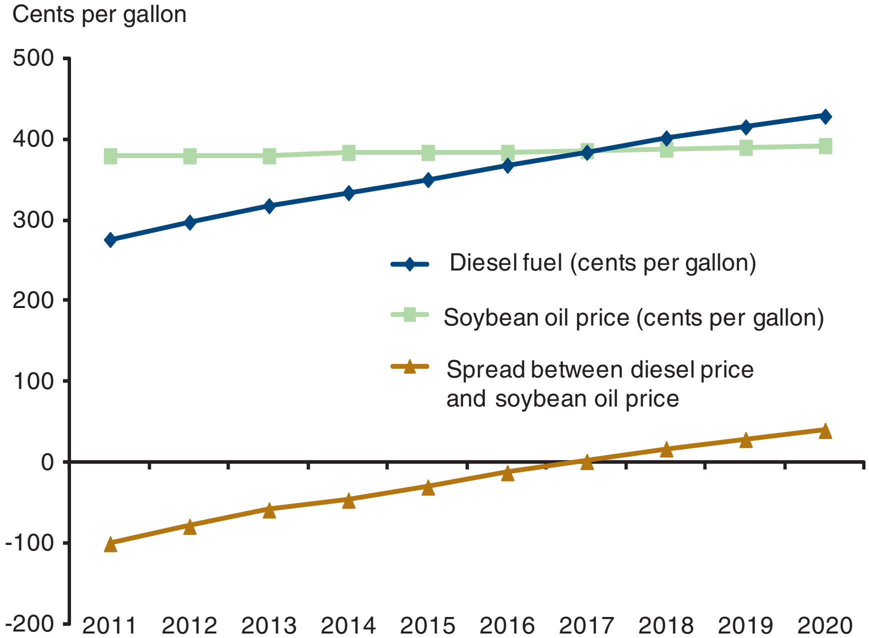
This study examines the market for RINs and the system established by the EPA to monitor and enforce provisions of the RFS. As RFS2-mandated levels for biofuel use increase, biofuel production will increase along with the demand for feedstocks. The total RFS2 for 2011 is 13.95 billion gallons, and 12.6 billion gallons make up the unrestricted portion of the mandate for which corn ethanol is eligible. Conventional ethanol RIN prices have been low in 2011, implying that the implicit nonadvanced ethanol mandate has not been binding. Low conventional ethanol RIN prices also suggest that factors other than the mandated level have provided economic incentives for increased ethanol production. Biodiesel RIN prices have been high in 2011, implying a more binding biodiesel mandate with mandate-driven effects on markets for soybean oil and other biodiesel feedstocks.

USDA's 2011 baseline projections suggest that conventional ethanol RIN prices could experience some variation in the next 10 years, as the impact of the RFS2 on corn markets varies from year to year. Assuming that the 45-cents-per-gallon tax credit for ethanol blenders and the 54-cents-per-gallon tariff on imported fuel ethanol remain in effect, the USDA baseline projects that U.S. grain-based ethanol consumption will be above the implicit nonadvanced mandated level for 2011 and 2012, but below the implicit nonadvanced mandated level for 2013-19, and then above the implicit nonadvanced mandated level again in 2020. When consumption rises above the implicit nonadvanced mandate, conventional ethanol RIN prices will be low. For other years, the projections suggest that market constraints will limit the ability to meet the mandate, thus implying reductions of the RFS2. Alternatively, if the RFS2 were not reduced for those years, conventional ethanol RIN prices would likely be higher, further impacting the corn market.

Alternative projections for ethanol and corn would result if tax credits and the import tariff expire at the end of 2011. Tax credits increase a blenders' willingness to pay for ethanol. Without tax credits, blenders have less incentive to use ethanol, making the mandate more binding or subject to reduction. Conversely, import tariffs make foreign ethanol more expensive, so removing the import tariff would increase ethanol imports. If more sugarcane ethanol from Brazil is available for import to meet the noncellulosic and nonbiodiesel portion of the advanced mandate, it might become less binding. If the advanced mandate is not binding, excess sugarcane ethanol could be used to meet the implicit nonadvanced mandate, making it less binding or subject to reduction.

The 2011 USDA baseline assumes that the biodiesel mandate will be held constant at 1 billion gallons starting in 2012. The baseline projects that the biodiesel mandate will be binding for the next 5-6 years, but that biodiesel production and use will exceed the 1 billion gallon mandate later in the decade. Use of soybean oil is projected to account for about 50 percent of the biodiesel output. To estimate potential biodiesel RIN prices, we calculated a simple biodiesel production profitability indicator—the spread between diesel prices and soybean oil prices for the next 10 years—based on USDA baseline projections of soybean oil prices and the EIA's 2010 Annual Energy Outlook projections of diesel prices (fig. 16). The negative price spread initially is

Figure 16
Projected U.S. soybean oil price and diesel fuel price, 2011-20



Source: U.S. Energy Information Administration, *2010 Annual Energy Outlook*, table 12; USDA *Agricultural Projections to 2020*, February 2011.

consistent with a binding mandate and suggests that biodiesel RIN prices will need to be high in the early years. High biodiesel RIN prices will increase the profitability of producing biodiesel, and thus its supply, because the price producers receive should be equal to the price consumers are willing to pay plus the core value of RINs. The increased production will lead to higher demand for biodiesel feedstocks. High biodiesel RIN prices suggest that the biodiesel RFS might have a significant impact on its feedstock markets, including the soybean oil market. In the later years of the USDA baseline (when the price spread in fig. 16 is positive), projected soybean oil used to produce methyl ester rises, suggesting that biodiesel output rises above the assumed 1 billion gallon mandate. Here, biodiesel RIN prices are likely to be lower since the biodiesel mandate is not binding and market forces (higher diesel fuel prices) provide sufficient economic incentives to meet and exceed the mandate.

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