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# Biodiesel and Renewable Diesel: It's All About the Policy

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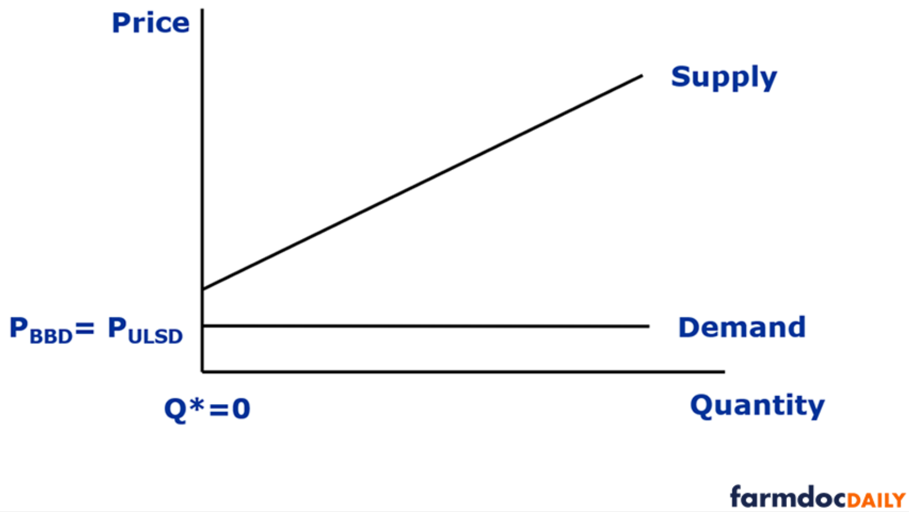
Consumption of biomass-based diesel (BBD) fuel has been rising rapidly in recent years. The two main types of biomass-based diesel are "FAME biodiesel" and "renewable diesel." Historically, FAME biodiesel production has substantially outpaced renewable diesel production, but this began to change in recent years due to a boom in building out renewable diesel production capacity. The boom in renewable diesel production in the U.S. has raised numerous questions about the impact on grain and oilseed markets. We began a series on the renewable diesel boom with an article last week (*farmdoc daily*, February 8, 2023) that compared the production processes and characteristics of FAME biodiesel and renewable diesel. In this article we examine the key role that policy plays in supporting the production of biodiesel and renewable diesel.

**Analysis**

In order to analyze the role of policy, we use a partial equilibrium economic model of the BBD market that has been used in one form or another in a number of earlier articles on the Renewable Fuel Standard (RFS) and RIN pricing (e.g., *farmdoc daily*, April 5, 2017; August 23, 2017). The model shown in Figure 1 represents the supply of BBD producers and demand from diesel blenders at the wholesale level in a competitive market. It is important to note that supply represents the total of domestic and imported production. The supply curve is upward sloping to reflect the increasing marginal cost of BBD as quantity supplied increases. Retail demand at the consumer level is implicitly represented by a simple percentage markup of the wholesale demand shown in Figure 1. This implies full pass through of wholesale price changes to the retail level.

Figure 1. Economic Model of the Biomass-Based Diesel (BBD) Market

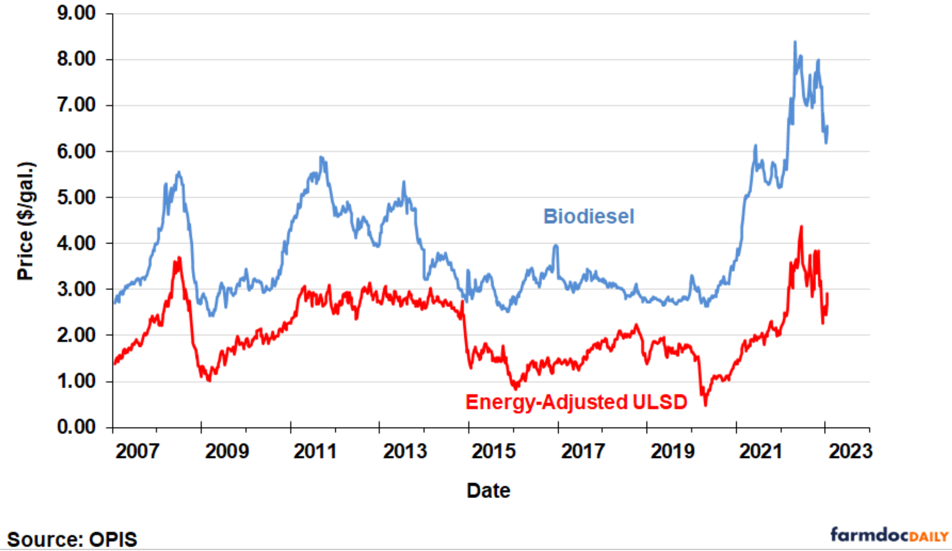



The model in Figure 1 also assumes that BBD demand is perfectly elastic (horizontal) at the level of ultra-low sulfur diesel (ULSD) prices. This reflects an assumption that BBD and diesel are perfect substitutes (after adjusting for the lower energy value of BBD) and that BBD is a small enough part of the diesel market that changes in the BBD price do not impact the overall demand for diesel fuel, including any "rebound" effects (e.g., Lewis, 2016). The implication is that the BBD price must be the same as the ULSD price in order for there to be a positive BBD demand. If the BBD price is above the ULSD price, then no BBD will be demanded. While the model is obviously a simplification of the factors that influence the individual supply and demand of FAME biodiesel and renewable diesel, it has proven to be a useful representation of the basic economics of the BBD market.

The most notable feature of the BBD market in Figure 1 is that the equilibrium market quantity (Q*) of BBD is zero. In other words, there is no intersection of the supply and demand curves in the positive quadrant of price and quantity. This unusual outcome reflects the fact that the production cost of BBD is almost always substantially higher than that of ULSD. This in turn causes the price of BBD to generally exceed that of ULSD by a wide margin. It should be noted that this does not mean there can never be a positive equilibrium quantity of BBD without policy incentives. For example, this could happen when diesel prices are very high and BBD feedstock prices (e.g., soybean oil) are very low. The equilibrium portrayed in Figure 1 assumes this is not the norm.

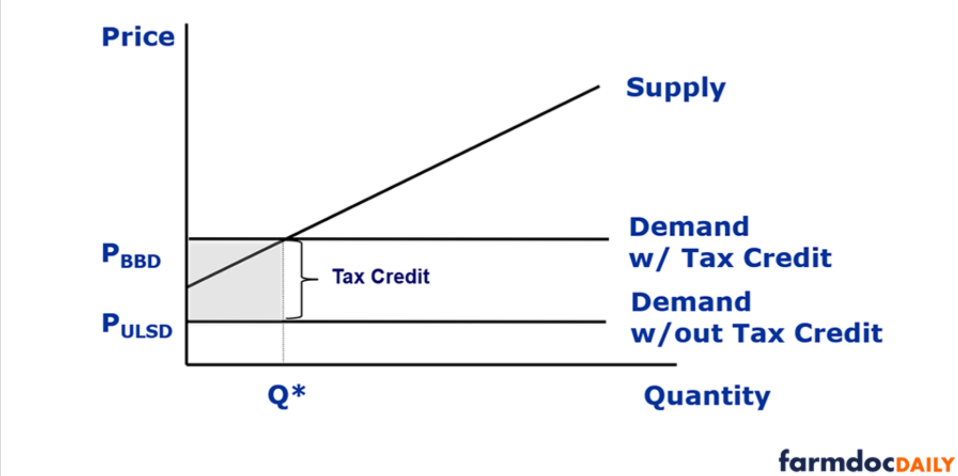
Historical evidence on BBD and diesel prices is presented in Figure 2. It shows weekly wholesale prices of FAME biodiesel and energy-adjusted prices of ULSD at Chicago over January 25, 2007 through January 19, 2023. Although there are a few times when the biodiesel and ULSD prices are close, there is not a single week where the biodiesel price is below the ULSD price. The difference in prices is normally $1 to $3 per gallon, and recently has ballooned to as large as $5. On average, the biodiesel price over this time period is $2.12 per gallon above the ULSD price. This difference is 110 percent of the ULSD price, so biodiesel is on average more than twice as expensive as ULSD. The bottom-line is that little or no BBD would be produced and consumed without some kind of policy incentive.

**Figure 2. Weekly (Thursday) FAME Biodiesel and Wholesale Ultra Low Sulfur Diesel (ULSD) Prices at Chicago, 01/25/2007 - 1/19/2023**



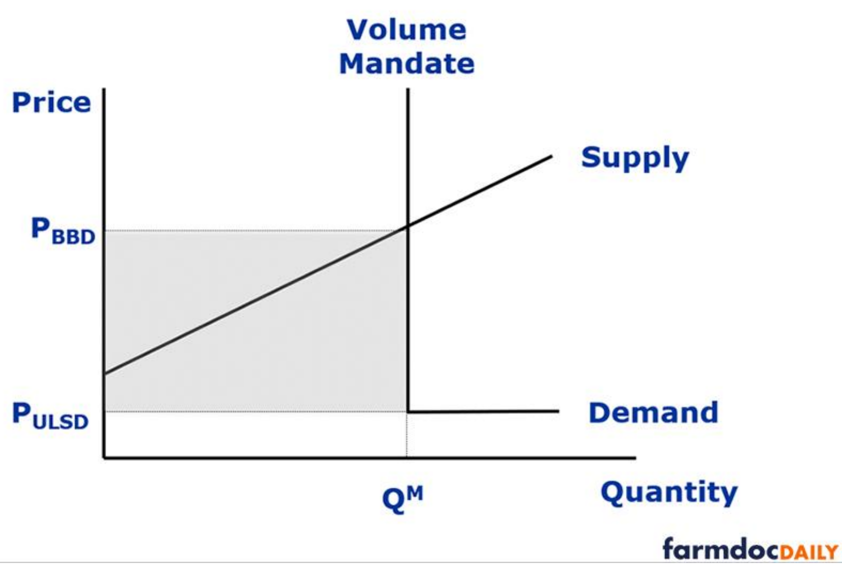

Given the basic model setup, we can analyze a variety of policy scenarios. The first scenario, presented in Figure 3, is a blenders tax credit. The impact of the tax credit is to shift the BBD demand curve up by the amount of the credit, which in reality has long been $1 per gallon in the U.S. (e.g., *farmdoc daily*, April 5, 2017). The effective selling price for biodiesel producers at any given quantity of biodiesel is increased by the amount of the credit. The upward shift in the demand curve results in a positive quantity of BBD being produced and consumed as producers respond to the higher effective selling price of BBD. In the new equilibrium, the total wholesale cost of BBD is the area given by $P_{BBD}$ X Q*, which is split between blenders [$P_{ULSD}$ X Q*] and taxpayers [($P_{BBD}$ – $P_{ULSD}$) X Q*]. The taxpayer cost is represented by the shaded rectangle in Figure 3. The cost to diesel consumers at the pump is the blender cost plus a percentage wholesale-retail markup.

**Figure 3. Economic Model of the Biomass-Based Diesel (BBD) Market with a Blenders Tax Credit**



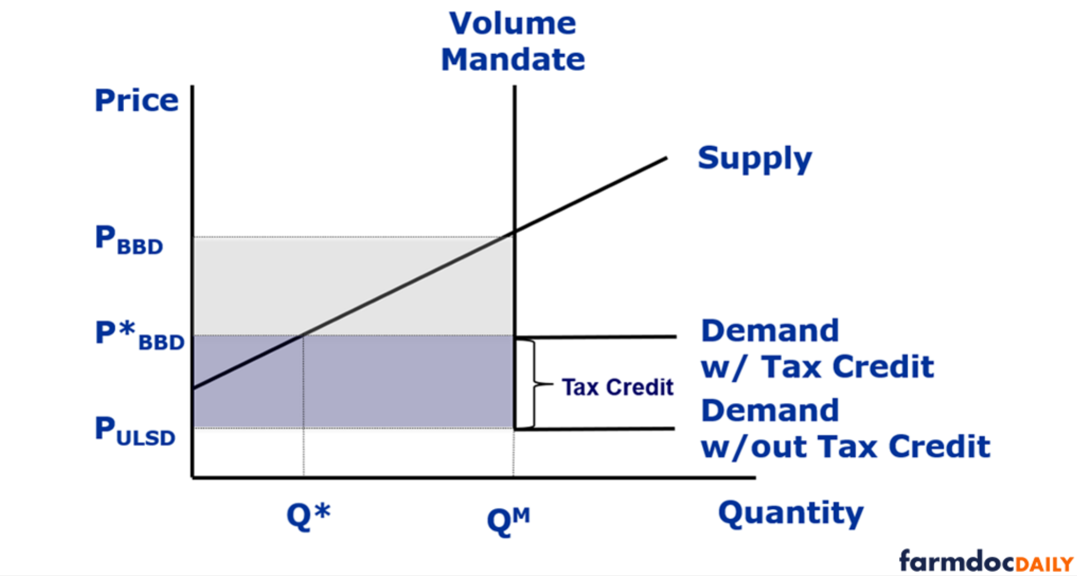

The second policy scenario, shown in Figure 4, is a volume mandate. Like the U.S. Renewable Fuel Standard (RFS), the mandate is assumed to be a minimum and higher quantities of BBD are possible if market conditions dictate (e.g., *farmdoc daily*, September 10, 2019). Since the mandated BBD quantity ($Q^M$) exceeds the amount of BBD that would be produced in a market equilibrium (zero), the mandate is said to be “binding.” To incentivize the higher production, BBD producers must be paid a price that is higher than the ULSD price. This means that the demand for BBD effectively becomes perfectly inelastic at the mandated quantity. The entire demand curve becomes L-shaped, with the vertical and perfectly inelastic portion equal to the volume mandate and the horizontal perfectly elastic portion above the mandate equal to the ULSD price. In the new equilibrium, the total wholesale cost of BBD is the area given by $P_{BBD}$ X $Q^M$, which is split between blenders [$P_{ULSD}$ X $Q^M$] and consumers [($P_{BBD}$ – $P_{ULSD}$) X Q*]. The consumer cost is represented by the shaded rectangle in Figure 4. The cost to diesel consumers at the pump is the total wholesale cost plus a percentage wholesale-retail markup. In this policy scenario, there is no cost to taxpayers.

**Figure 4. Economic Model of the Biomass-Based Diesel Market (BBD) with a Binding Volume Mandate**



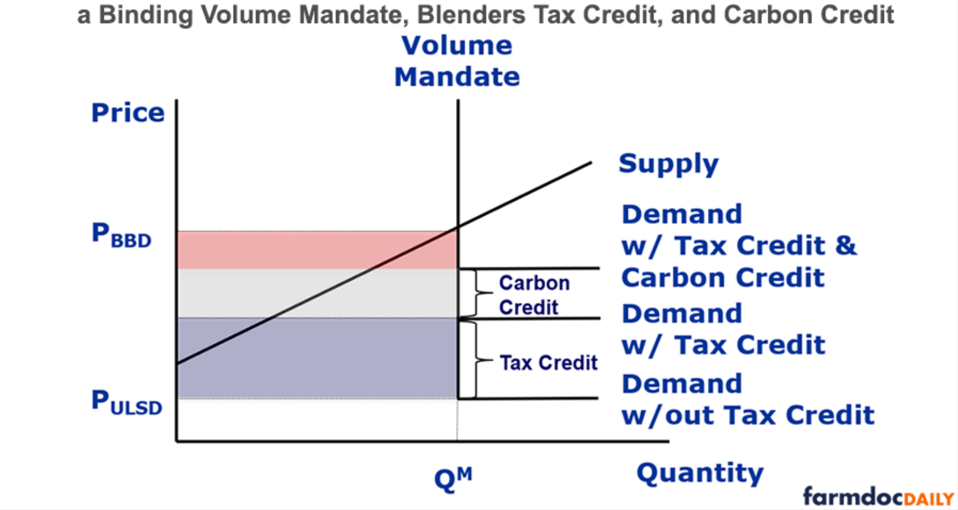

The third policy scenario we consider, shown in Figure 5, is both a tax credit and a volume mandate. This scenario reflects the situation for most of the last 15 years when both the RFS mandate and the $1 per gallon blenders tax credit have been in place in the U.S. The mandate is assumed to be binding because it requires a higher level of production than under a tax credit alone ($Q^M$>Q*). The effect of the tax credit under this scenario is purely distributive because the BBD price and quantity are unaffected by the tax credit. Notice also that the demand curve for BBD is kinked as in the previous scenario except the horizontal portion is increased by the amount of the tax credit. Hence, the total wholesale cost of BBD is the area given by $P_{BBD}$ X $Q^M$, which is split between blenders [$P_{ULSD}$ X $Q^M$], taxpayers [($P^*_{BBD}$ – $P_{ULSD}$) X $Q^M$], and consumers [($P_{BBD}$ – $P^*_{BBD}$) X $Q^M$]. The taxpayer cost is represented by the blue shaded rectangle in Figure 5 and the consumer cost is represented by the grey shaded rectangle. In this policy scenario, the size of the tax credit only affects the split in the costs between taxpayers and consumers. A larger tax credit offsets more of the costs borne by consumers and *vice versa*.

**Figure 5. Economic Model of the Biomass-based Diesel Market (BBD) with a Binding Volume Mandate and Blenders Tax Credit**




The fourth policy scenario we consider, shown in Figure 6, is a binding volume mandate, blenders tax credit, and a carbon credit. The additional credit reflects the incentives available to BBD producers through California's Low Carbon Fuel Standard (LCFS), which penalizes fossil transportation fuels and incentivizes lower carbon renewable fuels, like BBD, to meet reduced carbon emission targets. The analysis is the largely same as it was in Figure 5, with the effect of the blender tax credit and the carbon credit being entirely distributive. The total wholesale cost of BBD is now split between blenders, taxpayers (blue rectangle), consumers in California (grey rectangle), and consumers in general (pink rectangle).

**Figure 6. Economic Model of the Biomass-based Diesel Market (BBD) with a Binding Volume Mandate, Blenders Tax Credit, and Carbon Credit**




The fifth policy scenario we consider, shown in Figure 7, again considers a volume mandate, blenders tax credit, and a carbon credit. The change in this scenario is that the carbon credit is assumed to be large enough to unbind the volume mandate. With the volume mandate no longer binding, the analysis is similar to that in Figure 3 with only the blenders tax credit. The nuance is that the two credits are effectively stacked one on top of the other. The effect of the blender and carbon credits is no longer purely distributive, with the sum of the two credits incentivizing BBD production of Q**, which exceeds the volume mandate of $Q^M$. The total wholesale cost of BBD is the area given by $P_{BBD}$ X Q**, which is split between blenders [$P_{ULSD}$ X Q**], taxpayers [($P^*_{BBD}$ – $P_{ULSD}$) X Q**], and consumers in states with LCFS-type policies [($P_{BBD}$ – $P^*_{BBD}$) X $Q^{**}$]. The taxpayer cost is represented by the blue shaded rectangle in Figure 7 and the California consumer cost is represented by the grey shaded rectangle.

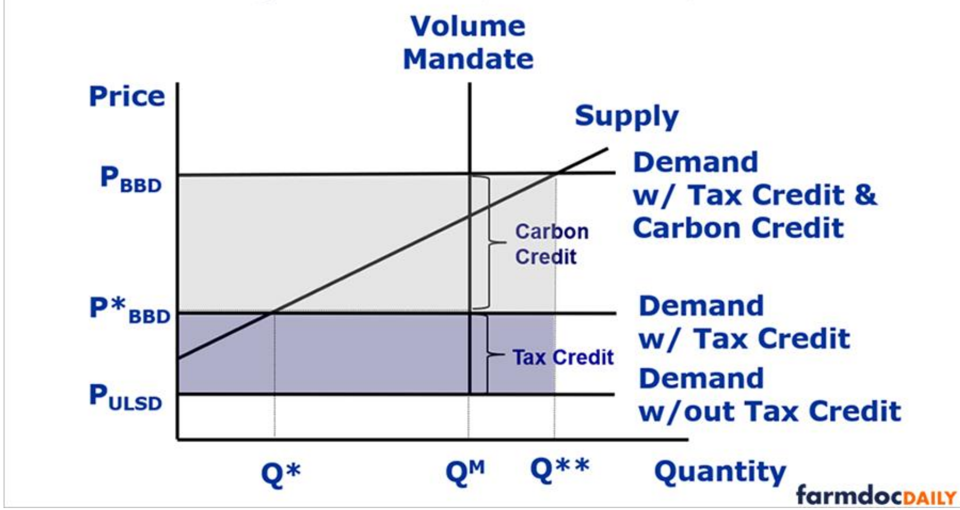


**Figure 7. Economic Model of the Biomass-Based Diesel Market with a Non-Binding Volume Mandate, Blenders Credit, and Carbon Credit**

The sixth and final policy scenario we consider, shown in Figure 8, is a binding volume mandate and an import tariff (duty). As an example, the U.S. won a case before the International Trade Commission in 2017 and imposed substantial import duties on Argentinian and Indonesian FAME biodiesel (*farmdoc daily*, March 28, 2018). In this scenario, the import tariff is assumed to be a fixed amount per gallon of BBD to simplify the analysis. The effect is to shift the BBD supply curve up and the left by the amount of the tariff. Since the volume mandate is binding this does not change the quantity of BBD but does raise the price of BBD. The total wholesale cost of BBD is now split between blenders and consumers (blue + grey rectangles).

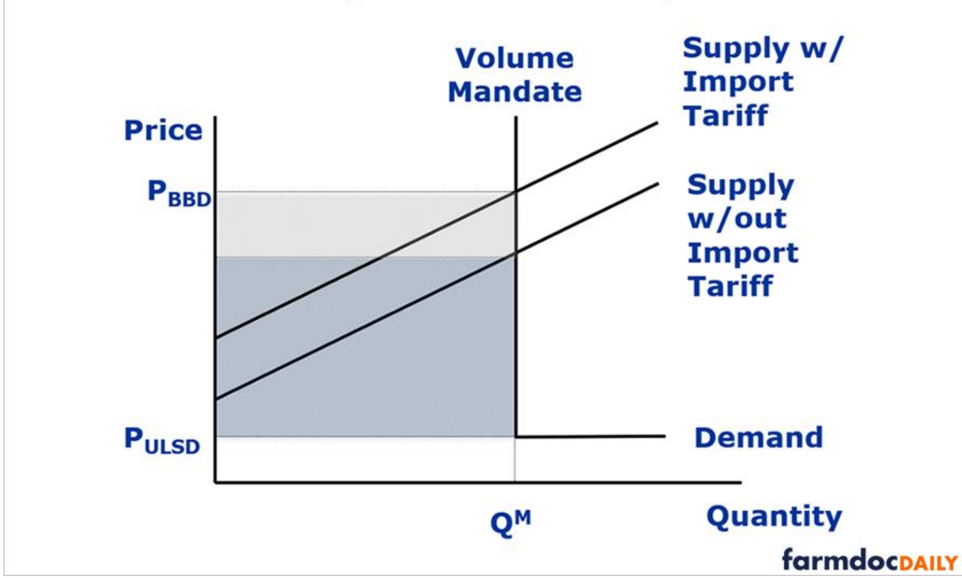


**Figure 8. Economic Model of the Biomass-Based Diesel (BBD) Market with a Binding Volume Mandate and Import Tariff**

## Implications

Biomass-based diesel (BBD) production in the form of renewable diesel is undergoing a major boom. What is not well understood is that the boom is entirely policy driven. This is most directly evident in the fact that the price of BBD (as represented by FAME biodiesel) is about twice as expensive as petroleum diesel. The implication is that little or no BBD would be produced and consumed in the U.S. without substantial policy incentives. A further implication is that the renewable diesel boom cannot be understood without understanding the policies driving the boom. In this article, we use a simple model of the BBD market to illustrate the impact of a variety of policy scenarios. When considered in isolation, the market impact of the policies considered are fairly straightforward. The analysis becomes much more complicated when multiple policies are in effect at the same time. In particular, the impact of a given policy may be heavily dependent on which other policies are in place at the same time. In the U.S., all four of the following policies are presently in place and interact to determine the price and quantity of BBD: i) blenders tax credit; ii) RFS mandates; iii) carbon credits in California; and iv) import duties (tariffs). The interactions between these policies can produce surprising and poorly understood economic outcomes.

The next article in this series on the renewable diesel boom will examine the production capacity for FAME biodiesel in the U.S. FAME is the other major type of BBD besides renewable diesel.

[1] *The findings and conclusions in this publication are those of the authors and should not be construed to represent any official USDA or U.S. Government determination or policy. This work was supported in part by the U.S. Department of Agriculture, Economic Research Service.*

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