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# Impact of Sales Constraints and Entry on E85 Demand


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## **Abstract**

In a recent paper, we estimated the potential demand for ethanol consumed in E85 using an estimated distribution of E85 acceptance by consumers and by calculating the average distance that owners of flex vehicles would have to drive to find an existing gas station that sells the fuel. Two issues that we did not address that will help determine how much E85 will actually be consumed in the future are: (a) the impact on demand from an increase in the number of gas stations that sell E85, and (b) sales capacity constraints at individual stations. It is reasonable to expect that owners of flex vehicles will seek out E85 if the cost per mile traveled with E85 is lower than with regular gasoline. However, there is a practical limit on how much fuel an individual station can sell in a given period. The quantities of ethanol use that we projected when E85 is discounted would exceed the volume that average gasoline stations can actually sell. Not taking these practical limits into account overstates the amount of ethanol that actually would be sold

## **Disciplines**

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**by Bruce A. Babcock and Sebastien Pouliot**

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# Impact of Sales Constraints and Entry on E85 Demand

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In a recent paper, we estimated the potential demand for ethanol consumed in E85 using an estimated distribution of E85 acceptance by consumers and by calculating the average distance that owners of flex vehicles would have to drive to find an existing gas station that sells the fuel.<sup>1</sup> Two issues that we did not address that will help determine how much E85 will actually be consumed in the future are: (a) the impact on demand from an increase in the number of gas stations that sell E85, and (b) sales capacity constraints at individual stations. It is reasonable to expect that owners of flex vehicles will seek out E85 if the cost per mile traveled with E85 is lower than with regular gasoline. However, there is a practical limit on how much fuel an individual station can sell in a given period. The quantities of ethanol use that we projected when E85 is discounted would exceed the volume that average gasoline stations can actually sell. Not taking these practical limits into account overstates the amount of ethanol that actually would be sold.

Of course, unmet demand for E85 gives a strong signal for other retailers to enter the market and start selling the fuel. Adding new stations in locations where E85 sales are strong at existing stations would reduce the importance of per-station sales constraints. Adding new stations in locations with lots of flex vehicles but no stations would boost E85 consumption overall.

This short report complements our previous work by showing the sensitivity of aggregate E85 demand to per-station capacity constraints and to strategic expansion of stations that offer E85. Thus, it provides a more complete picture of the practicality of significantly boosting ethanol consumption with E85. Our overall conclusion—that E85 offers a way through the E10 blend wall—is not altered by this sensitivity analysis; but, as we show here, new investments will be needed.

## Impact of Per-Station Sales Constraints

The average sales of gasoline per retail outlet is about 1.2 million gallons per year, or 100,000 gallons per month, with approximately 115,000 stations selling a total of 135 billion gallons of fuel annually. Most stations that sell E85 likely have a very low number of pumps that dispense the fuel. Thus, it does not seem likely that per-station sales of E85 could be more than 100,000 gallons per month.

Because E85 has not been competitively priced with gasoline on a widespread basis, we do not have lots of data to say with confidence how much E85 could be sold at a single station on a monthly basis if it were discounted. The data we do have suggest that per-station sales could be substantial. According to the monthly report on E85 sales published by Minnesota's Department of Commerce, in May of 2013, 49,546 gallons of E85 were sold by a single station.<sup>2</sup> The same report shows that the lowest price at which E85 was sold in that month was \$2.61 per gallon, whereas 87 octane gasoline sold for an average of \$3.94 per gallon. At this price ratio, E85 reduces fuel costs per mile by about 10 percent. If the station that sold almost 50,000 gallons of fuel was also the station that

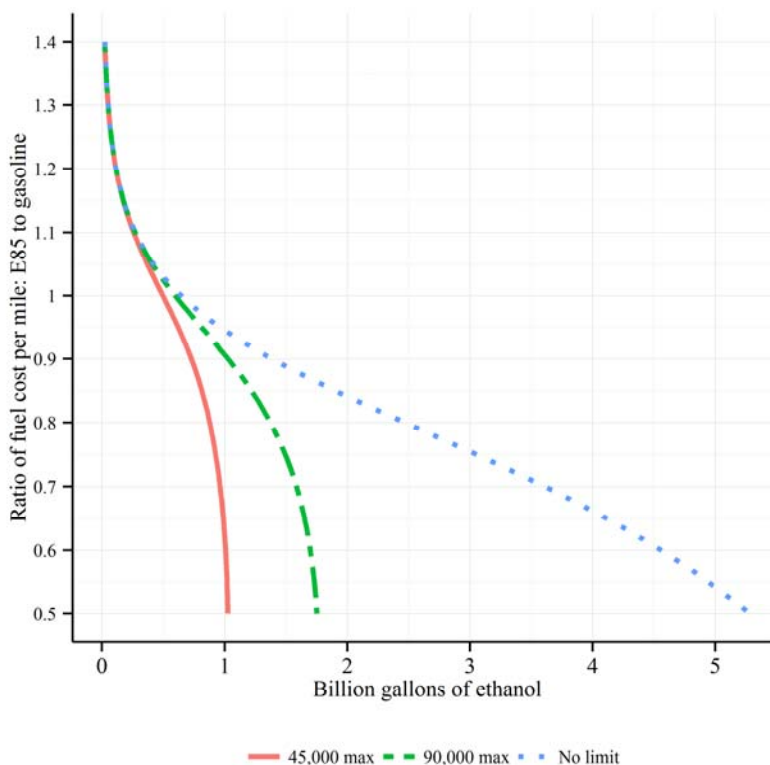
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<sup>1</sup> Babcock, B.A., and S. Pouliot. "Price It and They Will Buy: How E85 Can Break the Blend Wall." Policy Briefing Paper 13 PB-11. Center for Agricultural and Rural Development, Iowa State University.

<sup>2</sup> The monthly report is available at <http://mn.gov/commerce/energy/images/E-85-Fuel-Use-Data.pdf>

discounted the price of E85, then this suggests that even heavier discounts would have led to even greater sales.

In our original analysis, we used the location of existing stations that sell E85 and the number of flex vehicles that were close to the station to determine potential demand for E85 at different prices. Because we did not place an upper limit on per-station sales of E85, we implicitly assumed that sales volumes at existing stations could expand without limit to meet demand. Figure 1 shows the impact on aggregate demand if instead we limit per-station sales to either 45,000 gallons per month or to 90,000 gallons per month. For comparison purposes, the demand curve with no per-station limit on sales is also shown.



**Figure 1. Impact on demand from per-station maximum sales limits**

What Figure 1 shows is that once E85 is priced below parity with gasoline, then owners of flex vehicles will respond by wanting to buy more of E85. However, it is apparent that once the price of E85 is discounted at 10 percent or more, many stations will hit a limit on per-station sales. If no one station could sell more than 45,000 gallons per month of E85, then aggregate consumption of ethanol as E85 is constrained at about one billion gallons. If the per-station limit is 90,000 gallons per month, then total consumption cannot exceed about 1.8 billion gallons.<sup>3</sup> In contrast, if no constraints exist, as in our original analysis, then potential consumption exceeds 5 billion gallons.

Figure 1 indicates that congestion and lines at stations that sell E85 will be a limiting factor on sales if E85 is priced to save drivers money. The obvious cure for this

<sup>3</sup> In making these calculations we hold constant the number of flex vehicles that were registered as of January 1, 2013.

congestion will be for fuel stations to increase the price of E85 as much as possible while selling as much as their capacity limit allows. This will, of course, not help obligated parties meet their blending requirement. It will, however, create incentives for competing fuel stations to install E85 pumps.

### **Impact on Demand from Increasing Retail Outlets that Sell E85**

Excess demand for E85 can exist either because stations that currently sell the fuel cannot physically sell more of it, or because owners of flex vehicles in a region live too far away from a station to make it worth their while to buy the fuel. Either situation creates a profit opportunity for a station owner to invest in the equipment needed to sell E85. In 2008, the US Department of Energy reviewed cost data and estimated that it would cost a gasoline station owner about \$60,000 to install a new tank and replace or retrofit pumps, hoses, and dispensers to make them compatible with E85.<sup>4</sup> If this station sells 200,000 gallons of E85 per year, and if the station owner receives 10 cents per gallon more than selling an alternative fuel, then this would generate \$20,000 per year in additional income that could justify investing in E85. For larger sales of E85, a proportionally smaller profit margin on E85 will generate \$20,000 per year in additional income. Lowering the price of E85 by 10 cents per gallon requires lowering the price of ethanol by approximately 13 cents per gallon if E85 contains 75 percent ethanol. If 10 cents per gallon is the discount needed to incentivize new E85 equipment, then RIN prices on conventional biofuels would rise by 13 cents per gallon to create this incentive.<sup>5</sup> An example at the end of this report shows that this increase in RIN prices would be above the RIN price that reflects the discount needed to incentivize drivers to buy E85.

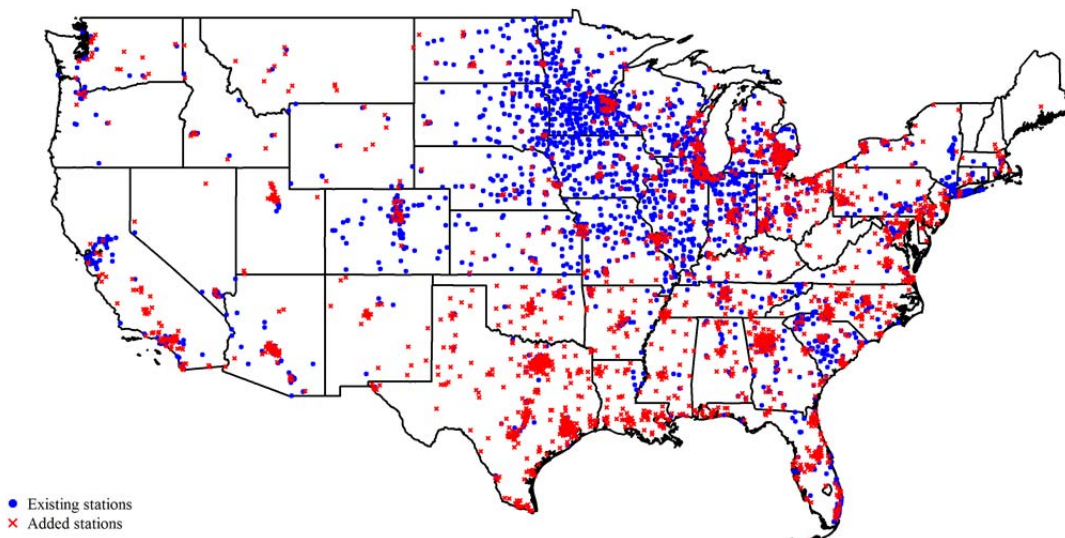
The most profitable place to invest in E85 would be where owners could generate the highest margin on sales. Assuming that the wholesale price of E85 would be approximately the same to all retailers, the highest margin could be obtained where demand for E85 is highest. Demand is highest in locations that have the highest concentrations of flex vehicles and the lowest number of stations that sell E85. That is, the current unmet demand for E85 is in locations where there are large numbers of flex vehicles that do not fuel on E85.

The red dots in Figure 2 show 2,500 of the most profitable locations for E85 pumps, assuming that E85 is priced to generate fuel-cost savings for owners of flex vehicles. The blue dots show the locations of existing stations. It is apparent that E85 stations should be located where flex vehicles are located, namely in urban areas. Thus, Figure 2 shows clusters of red dots in major metropolitan areas. It is also apparent that many of the existing stations that sell E85 were not located with the purpose of selling a lot of fuel to owners of flex vehicles. This can be explained by the fact that E85 has been priced not to generate large sales, but rather to meet the relatively small market demand of drivers who like the idea of using a renewable fuel.

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<sup>4</sup> See “Clean Cities Fact Sheet: Business Case for Installing E85 at Retail Stations.” US Department of Energy: Energy Efficiency and Renewable Energy. January 2008. [www.afdc.energy.gov/pdfs/42061.pdf](http://www.afdc.energy.gov/pdfs/42061.pdf). These costs did not include any tax incentives available to stations for installing E85 equipment.

<sup>5</sup>This example assumes that expanding E85 use is the least cost way of meeting biofuel mandates. If this is not correct, then RIN prices would not decrease by the amount needed to incentivize investment in E85 tanks and pumps, and as such, investment will not occur.

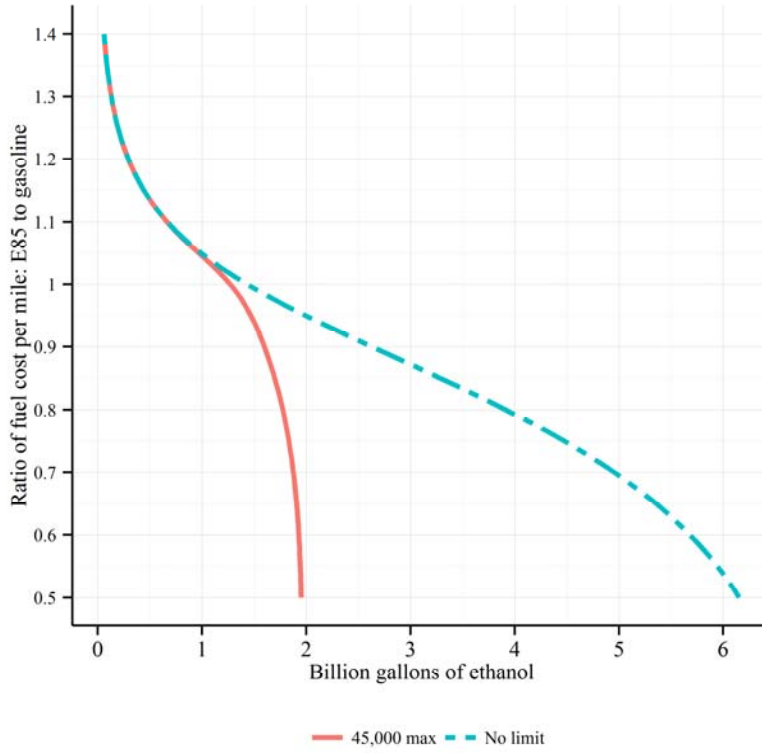


**Figure 2. Profitable locations to invest in E85**

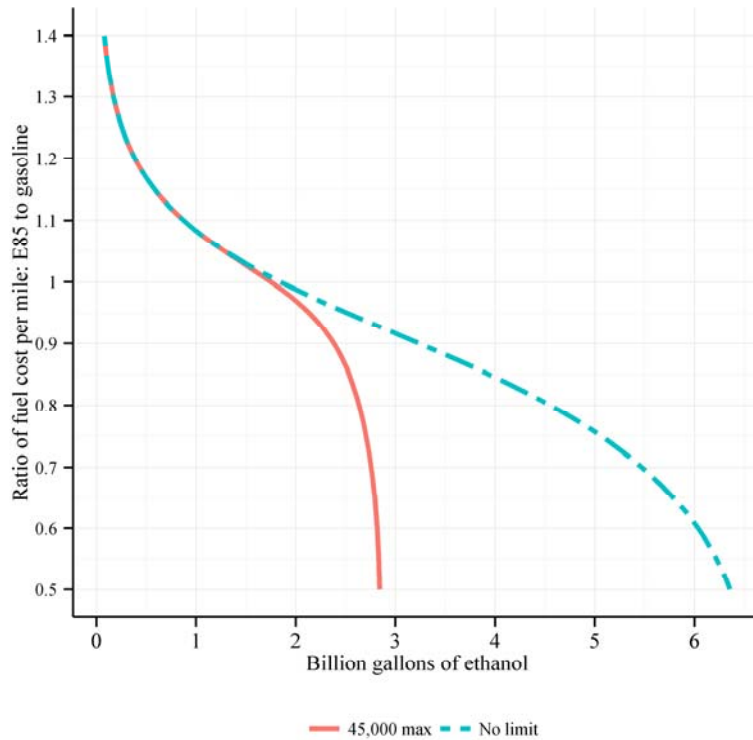
Figure 3 shows what aggregate ethanol demand would be after adding the 2,500 new stations shown in Figure 2. The red demand curve is the quantity of ethanol consumed in E85 if no station can sell more than 45,000 gallons per month. Comparing this demand curve to the Figure 1 demand curve shows that adding 2,500 stations and imposing the limit on per-station sales doubles potential demand to about two billion gallons. It is also apparent from the demand curve in Figure 3 that with no per-station limits excess demand for E85 would still exist. Figures 4 and 5 show aggregate demand curves if 5,000 and 7,500 stations, respectively, choose to sell E85. Each increment of 2,500 stations results in decreasing increments of consumption. This is expected because the first 2,500 stations are located in areas where demand is highest, and the next 2,500 locations are located where potential demand is not as high.

As shown in Figure 5, if 7,500 stations install E85 tanks and pumps in profitable locations, which would mean that about 10 percent of all fuel stations offer E85, and if sales per station are limited to 45,000 gallons per month, then ethanol consumption in E85 would be approximately three billion gallons if E85 is priced to generate 10 percent fuel cost savings to consumers.<sup>6</sup>

<sup>6</sup>These calculations assume that E85 contains 75 percent ethanol. The ethanol content of ethanol blend fuel varies across states and months, and will also depend on the price of ethanol relative to gasoline.

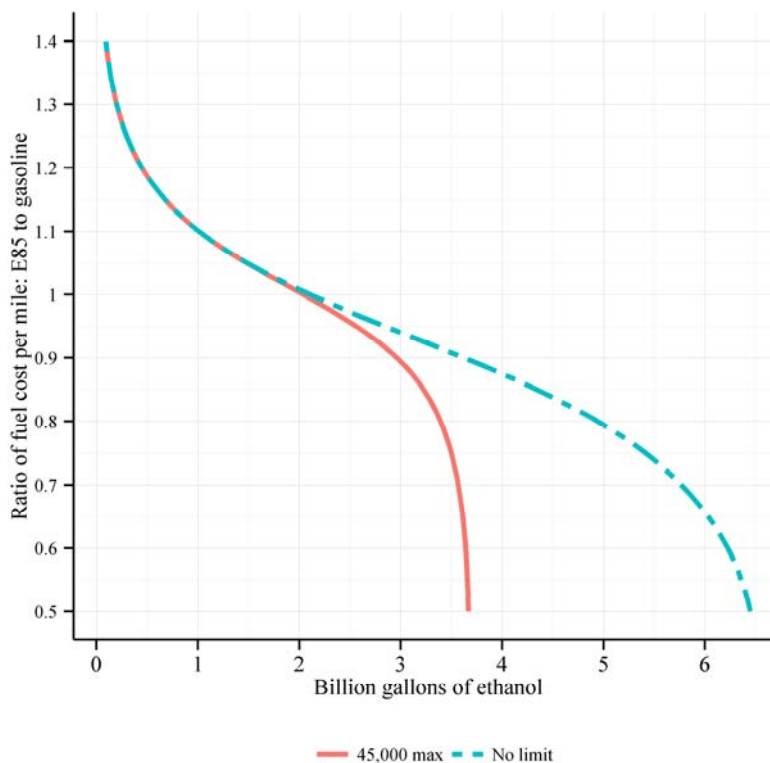


**Figure 3. Ethanol Demand in E85 with 2,500 New Retail Outlets**



**Figure 4. Ethanol demand in E85 with 5,000 new retail outlets**



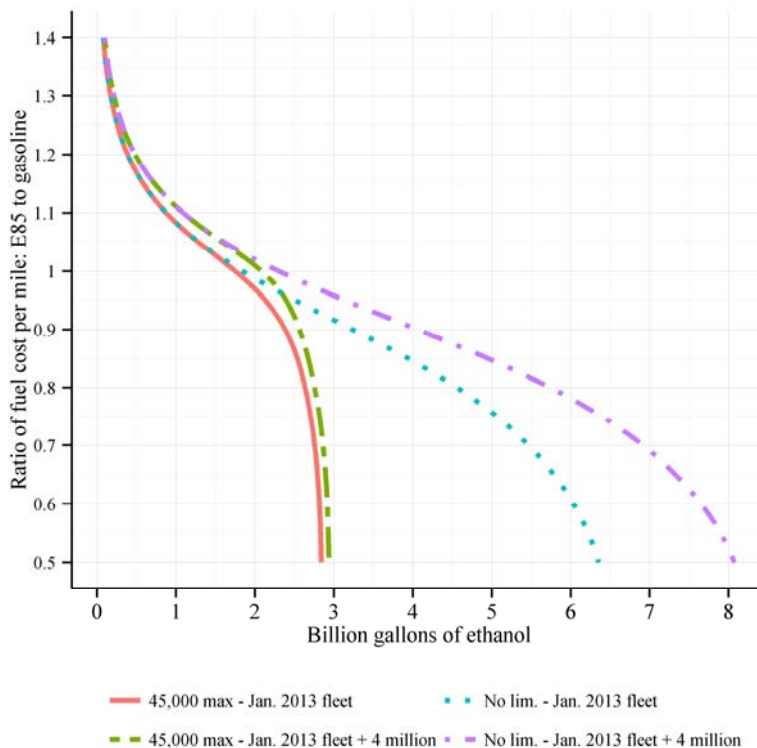


**Figure 5. Ethanol demand in E85 with 7,500 new retail outlets**

A comparison of the “No limit” demand curves in Figures 1, 3, 4, and 5 shows that adding stations has a quite small impact on potential demand for E85. The reason for this lack of impact is that potential demand is limited by the number of flex vehicles that exist. According to Verleger, who cites data from the Renewable Fuels Association, the number of new flex vehicles registered in the United States in 2012 increased by almost 2.5 million.<sup>7</sup> We make an estimate of the 2015 demand for ethanol in E85 by assuming that two million new flex vehicles are added to the US vehicle fleet in 2013 and in 2014. For simplicity, we assume that these flex vehicles are located proportionately in the same locations as existing flex vehicles. Combining this assumed growth in flex vehicles with 5,000 new stations that sell E85 by 2015 results in the demand curve shown in Figure 6.

As shown, the impact of four million new vehicles is substantial in terms of increasing potential demand for ethanol; but the impact on actual demand is limited if stations are already at their limit of E85 sales. A low proportion of the newly added flex vehicles will actually run on E85 if per-station limits of 45,000 gallons per month exist. At 45,000 gallons per month and a 10 percent cost discount, consumption of ethanol increases by approximately 250 million gallons from the addition of new flex vehicles. Potential consumption, if there is no limit on stations’ capacities, increases by approximately 700 million gallons at this discount level from the addition of four million flex vehicles.

<sup>7</sup> Verleger, P. “Renewable Identification Numbers.” Presented to the Agricultural Advisory Committee, Commodity Futures Trading Commission, Washington, D.C., July 25, 2013.



**Figure 6. Ethanol demand in E85 with 5,000 new E85 stations and four million new flex vehicles**

**RIN Prices to Incentivize E85 Investments**

Given farm prices for corn and retail gasoline prices, it is relatively straightforward to calculate the RIN price that will reflect the incentive needed to invest in E85. Babcock calculates that under normal growing conditions in the Corn Belt, corn prices will likely return to the \$4.00 per bushel range in the next two years.<sup>8</sup> If distiller grains are priced off \$4.00 corn and the plant price received for ethanol is \$1.60 per gallon, then per-bushel revenue to a dry mill ethanol plant would be approximately \$5.45.<sup>9</sup> Subtracting the \$4.00 cost of corn leaves \$1.45 per bushel to cover all other costs. Non-corn variable costs of producing ethanol are currently about \$0.37 per gallon.<sup>10</sup> At 2.75 gallons per bushel, this amounts to variable costs of \$1.02 per bushel. This implies that an ethanol price of \$1.60 per gallon generates \$0.43 per bushel of corn to pay fixed costs with any left-over for profits. Thus, with \$4.00 per bushel corn and \$1.60 per gallon ethanol, most, if not all of the corn ethanol industry would be producing ethanol.

Current gasoline futures prices indicate a 2015 retail gasoline price of about \$3.40 per gallon. To generate a fuel cost savings of 10 percent from E85 would require an E85 retail price of \$2.38 per gallon assuming that E85 contains 75 percent ethanol. With a wholesale-to-retail markup of \$0.75 per gallon, this implies a wholesale price of E85 equal to \$1.63 per gallon. With wholesale gasoline prices at \$2.65 per gallon, this requires that ethanol be priced at \$1.28 per gallon. A RIN price for conventional biofuel

<sup>8</sup> Babcock, B. "Biofuels Policy Impact on Agricultural Profitability: Outlook for 2013 and 2014." Presented at "The Shifting Nexus of Global Agriculture" Federal Reserve Bank of Kansas City, July 16, 2013.

<sup>9</sup> This does not account for the additional revenue being generated by ethanol plants from extraction of corn oil.

<sup>10</sup> Iowa State University Extension keeps track of costs for a representative dry mill ethanol plant. The data can be accessed at [http://www.agmrc.org/renewable\\_energy/](http://www.agmrc.org/renewable_energy/).

of \$0.32 would reflect the difference between the \$1.60 plant price of ethanol and the \$1.28 required ethanol price at the blender.

Now if an additional markup of 10 cents per gallon on E85 is needed to incentive investment in pumps and tanks, as discussed in an example earlier in this text, then ethanol would need to be priced at the blender at \$1.15 per gallon rather than \$1.28 per gallon. Thus, this supports a RIN price of \$0.45 per gallon rather than \$0.32 per gallon. Current RIN prices for conventional biofuels are running at approximately \$0.70 per gallon, which suggests plenty of incentives for the installation of new E85 pumps.

### **Conclusions**

The expectation that ethanol consumption would increase in the United States by almost a billion gallons in 2014 is reasonable if E85 were priced to save owners of flex vehicles money. Another one or two billion gallons of ethanol would be consumed if the number of stations that sell E85 increases substantially. Further increases in sales will take place as the number of flex vehicles continues to increase. Current RIN prices reflect enough of an incentive to both price E85 to save drivers money and to support investment in E85 tanks and pumps.

While three billion gallons of ethanol consumption may not seem large relative to the 13 billion gallons of ethanol that can be consumed in 10 percent blends, in terms of accommodating scheduled increases in conventional biofuel mandates and the likely quantity of cellulosic and other advanced ethanol that will likely hit the market, it is quite important. The conventional biofuel mandate is scheduled to reach its maximum level in 2015 at 15 billion gallons. This will require about two billion gallons of consumption beyond E10. Approximately 50 to 100 million gallons of cellulosic ethanol will likely be produced by 2015 as well. This means that three billion gallons of ethanol consumption in E85 would accommodate 15 billion gallons of corn ethanol, 100 million gallons of cellulosic ethanol, and another 900 million gallons of imported sugarcane ethanol or domestically-produced ethanol that qualifies as an advanced biofuel. A side effect of expanding E85 consumption by this amount would be to demonstrate to consumers, retailers, and auto manufacturers the feasibility of expanding further the use of E85 as a motor fuel.