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Feasibility of meeting increased biofuel mandates with E85

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ABSTRACT

The Environmental Protection Agency implements the Renewable Fuel Standard through annual blending mandates for different categories of biofuels. In its proposed rule released for the 2014, 2015 and 2016 calendar years, EPA reduced mandates because the volume of ethanol that consumers can easily use is lower than the original mandates specified in the Renewable Fuels Standard. This study estimates the demand for E85 using a new dataset that allows direct inference about the demand from the data. We report on how owners of flex vehicles in two metropolitan areas responded to changes in the price of E85. Using our new estimates of consumer demand, we find that owners of current flex vehicles in all US metro areas would consume 285 million gallons of E85 if it was priced at parity on a cost-per-mile basis with E10, and one billion gallons of E85 if it was priced to save drivers 20% on a cost-per-mile basis.

1. Introduction

The U.S. Renewable Fuel Standard (RFS) requires the Environmental Protection Agency (EPA) to specify annual blending mandates for different categories of biofuels. EPA issues overall mandates for renewable fuel and advanced biofuels as well as specific mandates for cellulosic biofuel and biomass-based diesel. The difference between the renewable fuel mandate and the advanced biofuel mandate can be met with corn ethanol so it is commonly known as the corn ethanol mandate, although it can be met with any qualifying biofuel. The 2016 corn ethanol mandate is 14.5 billion gallons. EPA has proposed to increase this mandate to 14.8 billion gallons in 2017. The US Energy Information Agency (EIA) currently estimates that US consumption of motor gasoline will be approximately 143 billion gallons in both 2016 and 2017 (EIA, 2016). EIA estimates that 99% of U.S. gasoline contains 10% ethanol (E10), which implies that 14.2 billion gallons of ethanol will be consumed in E10. Simple arithmetic demonstrates that if the corn ethanol mandate is going to be met with ethanol, then 400 and 600 million gallons of ethanol must be consumed in blends containing more than 10% ethanol in 2016 and 2017 respectively.

The two approved U.S. blends that contain more than 10% ethanol are E15 and E85. The number of stations that sell E15 is currently quite small, whereas about 2,800 stations currently sell E85. Thus, sales of E85 must be high enough to meet the corn ethanol mandate in 2016 and 2017. EPA (2015) was explicit about their expectation writing in its 2015 proposed rule about E85: "Thus we believe it is possible for the market to reach volumes perhaps as high as 600 million gallons under favorable pricing conditions" (p. 33, 127). If the 2016 and proposed 2017 mandates are to be met with a combination of E10 and E85, then between 400 and 800 million gallons of E85 must be consumed.[1]

Only motorists who drive flex fuel vehicles (FFVs) should fuel their car with E85. Cost-minimizing drivers with easy access to E85 should choose E85 when the cost per mile of driving with it is lower than with E10. Accounting for the lower energy content of ethanol, this occurs when the pump price of E85 is 22% lower than E10.

The RFS compliance mechanism uses Renewable Identification Numbers (RINs) in a tradable permit program to lower the price of biofuels enough to induce mandated consumption levels. Pouliot and Babcock (2016) explain in detail how the ethanol RIN market works for conventional ethanol. A RIN is generated with every gallon of ethanol produced. After the gallon is blended with gasoline, its RIN is detached and sold (or simply transferred in the case of vertically integrated blenders) to refineries to show compliance with mandates. The market price of RINs is endogenous to the mandated volume: the more difficult it is to consume a given volume of ethanol, the higher the price of RINs.

The RIN price is effectively a tax on wholesale gasoline that subsidizes wholesale ethanol, thus the RIN price reflects the marginal compliance cost of the RFS. The wholesale price of ethanol is typically quoted inclusive of the RIN. Thus, in a competitive market, a higher RIN price means a lower net cost of ethanol going into retail fuel but a higher cost for gasoline going into retail fuel thereby decreasing the cost of producing E85 relative to E10 (Whistance et al., 2014).

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[1] Throughout this paper, we fix the ethanol content of E85 at 75%, although it can contain anywhere from 51% to 83% ethanol.

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To better explain why a high RIN price can make E85 attractively priced, suppose that the wholesale price of ethanol at a blending station is $1.40 per gallon and the RIN price is $0.65 per gallon. The blender pays $1.40 for the ethanol and the attached RIN. To break even on the transaction, the blender can sell the RIN for $0.65 and price the ethanol in the blended fuel at $0.75 per gallon. If the gasoline in the blended fuel costs $1.35, the blender can create E85 (75% ethanol and 25% gasoline) at a break-even cost of $0.90 per gallon, and E10 at a break-even cost of $1.29. Assuming a $0.75 per gallon retail-to-wholesale markup including federal and state gasoline taxes (Pouliot and Babcock, 2014), the retail price of E10 is $2.04 per gallon and the retail price of E85 is $1.65 per gallon, resulting in a 19% discount on the price of E10. If the RIN price increases to $0.85 per gallon because of an increase in the ethanol mandate and everything else remains constant, then the break-even price of E85 at retail is $1.50 per gallon and the price of E10 at retail is $2.02 per gallon, making the price of E85 26% lower.[2] Thus, a higher RIN price makes it possible to price E85 at levels that are attractive to consumers.

The most important factor determining the level of compliance costs associated with a given level of the ethanol mandate is the RIN price required to lower the relative price of E85 enough to induce consumers to buy enough of it to meet the mandate. EPA has found it difficult to set mandate levels that balance consideration of compliance costs with meeting the ethanol blending targets of the RFS. The gap between the renewable fuel mandate and the advanced biofuel mandate in the RFS legislation was scheduled to rise to its maximum level of 15 billion gallons in 2015, which would have required consumption of 1.47 billion gallons of E85 to meet.[3] EPA decreased mandates in 2014, 2015 and 2016 because it determined that consumers would not buy enough E85 to achieve a 15-billion-gallon mandate even if RIN prices increase enough to drive the blender cost of ethanol to zero. The reason why EPA made this determination was a combination of too few retail outlets that sold E85 and too few FFVs in areas that did sell the fuel.

Because the demand for E85 is key to determining the cost and feasibility of meeting blending targets, much effort has been targeted at its estimation. Models of consumer switching behavior between E85 and E10 include work by Anderson (2012), Liu and Greene (2014), de Gorter and Drabik (2015) and Pouliot and Babcock (2016). Drabik, et al. (2015) use Brazilian data and a logistic curve to model fuel switching decisions. de Gorter and Drabik (2015) adopt a similar approach to modeling the choice of E85 versus E10 in the United States. The parameters of the logistic function are calibrated using previous E85 demand points from the literature. Pouliot and Babcock (2014) derive a demand function for E85 in the United States that captures the distribution of preferences over E10 versus E85 as well as the cost associated with finding the nearest gas station selling E85. One weakness of their approach was that they calibrated the distribution of preferences of U.S. consumers for E85 relative to E10 using estimates from Brazil. Pouliot and Babcock (2014) estimate that 800 million gallons of ethanol could be consumed nationwide as E85 with a cap of around one billion gallons as the blender cost of ethanol approaches zero.

Our contribution here is to use a unique dataset to provide improved estimates of FFV owners' willingness to buy E85, and to use the willingness-to-pay estimates to obtain more accurate estimates of the tradeoff between ethanol consumption levels and marginal compliance costs. Given the focus on ethanol in meeting RFS blending mandates, we focus on compliance with the RFS mandate from an increase in the consumption of ethanol that is endogenously brought by an increase in the price of RINs for conventional ethanol. Our results provide more relevant estimates of the tradeoff between mandate levels and marginal compliance costs than provided by Pouliot and Babcock (2014), because they are based on daily retail prices and fuel sales obtained from the owner of a major U.S. chain of retail gasoline outlets. The data cover all sales from that fuel retailer between 2011 and 2014. During this period the price of E85 relative to E10 has varied dramatically, allowing us to trace out how consumption of E85 varies with its price. Here we report on how owners of FFVs in two metropolitan areas responded to changes in the price of E85. Perhaps uniquely, this chain's aggregate market share in the metro area was much greater than 90%, thus allowing us to estimate the proportion of owners of FFVs in the area who chose to switch from E10 to E85 at various prices.[4]

Extrapolating these new direct estimates of consumer demand to all metro areas, we calculate that current owners of flex vehicles in all US metro areas would consume 285 million gallons of E85 if it is priced at parity on a cost per mile basis with E10, and 1 billion gallons of E85 if it is priced to save drivers 20% on a cost per mile basis. These estimates assume that no new E85 stations are installed. If 5,000 new stations are installed, then between 675 million and 1.2 billion gallons of E85 would be consumed in E85 in US metro areas if E85 were priced at parity with E10. The consumption level depends on whether the new fuel stations are strategically located. We provide consumption estimates if fewer than 5,000 stations actually get installed. These estimates understate total US E85 consumption because consumption in non-metro areas is not included.

2. Model of the demand for E85

The demand for E85 depends on three factors: (1) infrastructure to dispense E85; (2) the size of the FFV fleet; and (3) motorists' willingness to pay for E85 relative to E10. Below we describe each of these factors and how they affect the total consumption of E85. We then show how these factors can be combined into a single equation as in Pouliot and Babcock (2014) to model the aggregate demand for E85 and discuss the limitations of inference based on such a calibrated equation.

2.1. E85 fuel stations

A limited number of fuel stations offer E85. The 2013 County Business Patterns annual series reports that there are about 112,500 fuel stations in the United States (US Census Bureau, 2015). Out of those, about 2,800 public fuel stations offer E85 (Alternative Fuels Data Center, 2016). The scarcity of fuel stations carrying E85 is a major obstacle for the expansion of the consumption of ethanol through E85. Several states (mainly in the Midwest) have provided financial incentives for the installation of E85 pumps. More recently, USDA announced that 21 states will receive funds for the installation of 5,000 pumps offering higher blends of ethanol (USDA, 2015).

Data from Alternative Fuels Data Center (2016) show that the largest concentration of E85 pumps is in the Corn Belt where most of the ethanol is produced but where population density is relatively low. Many large population centers are served by just a few E85 pumps. The limited distribution of E85 is a significant constraint in the expansion of E85 consumption as most motorists do not have access to an E85 pump on their regular commute (Pouliot and Babcock, 2014).

[2] The increase in the price of RIN would cause a slight increase in the price of gasoline because the RIN is effectively a tax on gasoline. With an increase in the price of RIN of $0.20 per gallon and an ethanol blending mandate of 10%, the price of gasoline increases by $0.02 per gallon. We ignore this small increase in these calculations.

[3] Gasoline consumption in 2015 was 140.7 billion gallons, which implies consumption of ethanol in E10 was 13.9 billion gallons (140.7*0.99*0.10), thereby requiring 1.1 billion gallons of ethanol or 1.47 billion gallons of E85.

[4] To obtain access to the data we needed to sign a non-disclosure agreement whereby we agreed not to identify the company that generated the data. We cannot identify the two metro areas because if we did, then that would reveal the identity of the retailer.