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Building out alternative fuel retail infrastructure: Government fleet spillovers in E85 ☆

Kenneth S. Corts *

University of Toronto, 105 St. George St., Toronto, ON, Canada M5S 3E6

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ABSTRACT

One significant obstacle to meeting aggressive federal and state alternative fuel consumption targets is the relative scarcity of retail fueling stations that carry alternative fuels. Policies that encourage or mandate use of alternative fuel vehicles in government fleets, thereby increasing demand for such fuels, are one popular approach to stimulating further development of the alternative fuel retail infrastructure. I focus specifically on flex-fuel vehicles (FFVs) that burn E85, a combination of 85% ethanol and 15% gasoline, to study the impact of government fleet composition on retail alternative fuel infrastructure. Using data from six states in the Midwest that account for over 60% of US E85 stations, I show that government fleet adoption of FFVs leads to an increase in retail E85 stations. This finding persists when using instrumental variables techniques to address the endogeneity of government fleet FFV purchases.

1. Introduction

Due to concerns about carbon emissions, air pollution, and "energy independence," the US federal government and a number of state governments have set ambitious targets for reducing gasoline consumption through increased consumption of alternative and renewable fuels. While this can include alternative fossil fuels such as propane and natural gas (which burn cleaner than gasoline and may be more abundant domestically), the policy emphasis has increasingly narrowed to renewable fuels – primarily ethanol and biodiesel – which have lower lifecycle carbon emissions and can be domestically produced. Biodiesel, produced largely from waste and virgin vegetable oils, is blended with traditional diesel (typically at a ratio of 20% biodiesel or less) and burned in standard diesel vehicles. Ethanol is sold in low-percentage blends with gasoline (typically 10% ethanol) that can be burned in regular gasoline vehicles. In either of these cases, increasing renewable fuel consumption is simply a matter of getting more alternative fuel blended into the fuel supply burned in traditional vehicles. However, increases in ethanol consumption increasingly come from a higher-percentage blend (85% ethanol), known as E85, which can be burned only in specially equipped vehicles known as flex-fuel vehicles (FFVs). Because large increases in consumption of E85 require both the widespread acquisition of FFVs and the build-out of a retail distribution infrastructure for E85, this market is characterized by indirect network effects similar to those present in hardware–software markets. As a result, the diffusion of this technology requires solving the chicken and

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* Fax: +1 416 978 7030.
E-mail address: kenneth.corts@rotman.utoronto.ca

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egg problem created by such network effects. This paper examines some of the specific policies used to facilitate this diffusion in an effort to learn lessons that can ultimately be applied in other settings, as similar challenges will face other alternative fuel technologies such as hydrogen fuel cells and plug-in electrics.

In this paper I focus specifically on the use of government fleet acquisitions of FFVs as a stimulus to the development of the E85 retail distribution infrastructure. Many state and local government fleets buy FFVs, in part because of a federal mandate and a set of related programs implemented by state governments. Regulations requiring the acquisition of government fleet FFVs are intended to reduce conventional fuel consumption by government fleets directly, but also to reduce private consumption of conventional fuel by stimulating the availability of alternative fuels and alternative fuel vehicles for the public.[1] An array of tax credits and subsidies also provides other incentives for increased production, distribution, and retailing of E85. The combined effect of these policies, along with increases in gasoline prices, has been a rapid escalation of E85 availability and consumption in recent years.

I show in this paper that the acquisition of government FFVs does stimulate the establishment of E85 stations and that this result is robust to instrumenting to account for the endogeneity of government and individual vehicle purchasing behavior. In addition, this relationship is fairly robust across different states despite the fact that individual states have widely varying systems of tax credits and subsidies that affect the incentives to sell E85. Finally, contrary to suggestions by some industry observers, there is no evidence that the presence of gasoline stations affiliated with vertically integrated oil companies hinders availability of E85 in a market.

While alternative fuel consumption in general and the network effect aspect of their diffusion in particular are of interest to economists, little economics research on this subject exists. In a recent survey of economic policy issues related to automobiles, Parry et al. [16] discuss alternative fuels including E85 as one important response to the carbon emissions associated with gasoline consumption; they also specifically mention the difficulty of building an alternative fueling infrastructure as an impediment to increased consumption of alternative fuels. Di Pascoli et al. [7] note in their survey that a lack of access to a refueling network contributes to the lack of diffusion of alternative fuel vehicles. Kuby and Lim [12] analyze the technical problem of designing the planner's optimal network of alternative fuel stations. However, there appears to be no research examining the economic incentives for fuel stations to provide alternative fuels or the effectiveness of policies adopted to spur the development of a retail infrastructure for alternative fuels.

This paper takes a first step toward filling that gap in the literature. I draw on the methods employed in studies of other industries characterized by network effects. Many such studies appear in the recent industrial organization literature, including Gandal et al.'s [10] paper on CD players, Nair et al.'s [14] paper on PDAs, and Clements and Ohashi's [3] and Corts and Lederman's [5] papers on the video game industry. While most of this literature estimates both sides of the network effect – that is, the effect of "software" availability on hardware demand and the effect of "hardware" installed base on software availability – in this paper I focus exclusively on the effect of the installed base of FFVs on E85 availability due to data constraints described later.

2. Industry background

2.1. The rise of ethanol

The 2007 Energy Independence and Security Act, signed into law on December 19, 2007, established a renewable fuel standard (RFS) that requires fuel producers to use 9 billion gallons of US-grown biofuels in 2008 and 36 billion gallons of the same by 2022. While biofuels include for this purpose other fuels such as biodiesel, much of the increase mandated by this RFS is expected to come from ethanol. This represents a dramatic increase over 2007 US consumption of roughly 6 billion gallons of ethanol. Moreover, this 2007 level is roughly three times US consumption in 2002, so ethanol consumption had already been on a rapid increase prior to the establishment of this new goal.

Much of the increase in ethanol consumption comes through increased blending of ethanol in gasoline for use in conventionally fueled vehicles, all of which can burn blends up of to at least 10% ethanol. Ethanol is used in such low-level blends as one of the additives in premium gasoline, to meet explicit state regulations on ethanol content, and to meet federal clean-air requirements for reformulated gasoline (RFG) sold in urban areas. A small but increasing portion of ethanol consumption is accounted for by E85. However, this amount remains relatively small compared to overall ethanol consumption. For example, 2006 figures available for Wisconsin indicate that ethanol blended as E85 accounted for only 2 million gallons of a total of 130 million total gallons of ethanol blended with gasoline in all formulations.

[1] For example, the Department of Energy's final rule implementing the 1992 Energy Policy Act's fleet requirements states that: "To enable the Act's [conventional fuels] displacement goals to be met, alternative fuels must be readily accessible and motor vehicles that operate on these alternative fuels must be available for purchase. Thus, two important elements of reducing petroleum motor fuel consumption are: a nationwide alternative fuels infrastructure and the availability of alternative fueled vehicles for purchase at a reasonable cost by the general public in a wide variety of vehicle types and fueling options." [6].