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Price risks for biofuel producers in a deregulated market

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ABSTRACT

In a deregulated fuels market, biofuels and fossil fuels are close substitutes. Without blend mandates or flexible subsidy schemes, biofuels will lose competitiveness in times of low oil prices or expensive feedstock prices. This paper provides a quantitative outlook of a potential post-mandate era for the US biofuels industry and highlights the importance of focusing on the random nature of feedstock and gasoline prices. The calibrated gasoline/ethanol model predicts that under all likely scenarios the distribution of profits for a representative ethanol unit will be in the range of −2$/g to 2$/g. We also observe that even with a sufficient subsidy to keep the average ethanol price competitive, ethanol plants may shut-down 40%–60% of the time. The skewness of ethanol producer's profit is in the range of 2.3–2.5, in contrast to the 0.91 skewness of corn feedstock prices. We discuss the effects of improved technical efficiency, higher subsidies, willingness to pay, and price volatility on ethanol plant shutdown frequency. A set of possible risk management strategies to protect the biofuels sector in a deregulate scenario is offered.

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1. Introduction

This paper offers an alternative view of the US biofuels industry's future by simulating a market in which ethanol and gasoline coexist and compete with each other. The competitiveness of the biofuels sector vary widely if the transportation fuel market is deregulated and blend mandates are removed. The biofuels' competitiveness will largely depend on prices of fossil fuels, but also on the prices of feedstock and raw materials (e.g. natural gas, electricity, etc) and the efficiency of biofuels.[1] The current period of low oil prices (around $50 per barrel) is an example, in which biofuels producer could not have competed with such low gasoline prices without the blend mandates.

In a free market for transportation fuels, gasoline and ethanol will be close substitutes and competitors. If car engines are flexible enough to burn any blend of the two types of fuels, consumers will endogenously increase the share of the fuel source with the lowest energy-adjusted market price. When gasoline is cheaper, they will by more gasoline, and when ethanol is cheaper they will demand more ethanol. At the end of the day, there will be a single equilibrium price for both fuels, similar to the model suggested by Lapan and Moschini [15].[2] During the periods when oil is relatively expensive or feedstock is cheap, the biofuels sector will enjoy a large markup and consequently will earn more profit. On the other hand, during the periods of low oil prices or expensive feedstock, biofuels producers may need to temporarily shut down their production, produce with a loss, or produce alternative outputs such as sugar. Overall, the profit function of the biofuel refiners in a deregulated market will constantly switch between states of significantly high and significantly low (or zero) profit levels.

The boom-bust nature of the biofuels industry has been discussed in the previous literature. Hochman et al. [12] consider the impact of demand for food on the profitability and the waves of bankruptcy in the biofuels industry. However, to the best of our knowledge, no formal analysis of the impact of volatile gasoline prices on biofuel producers' profit has been presented. Several papers have focused on a scenario analysis of the future of biofuels

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[1] One alternative view to the competitiveness of the ethanol in the current US market is its use as an alternative source of octane and oxygen. The high octane of ethanol (around 113) helps refiners produce a cheaper 84-octane gasoline rather than the more expensive 87-octane gasoline. Supporters of this view argue that even with low oil prices, ethanol will still be less expensive than most other octane enhancing options. Based on the fact that RINs prices are always positive and significantly higher than zero, we disagree with this argument.

[2] This scenario is a relevant case for Brazil. The US market is still not perfectly matched with this assumption because the share of flex cars as well as the stations for E15 and E85 are limited. However, going forward the US market is also expected to experience an increase in the number of flex engines.

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(e.g. Zhao et al. [32]); however, their focus has mainly been on comparing multiple *deterministic* paths and not on random shifts in the relative price of crude oil and biofuels production along a projected path.

Our paper aims at filling this literature gap by explicitly modeling the stochastic nature of competitiveness in the biofuels sector. Our contribution to the literature is twofold. First, we offer a detailed theoretical characterization of a deregulated biofuels market and provide empirics regarding the key relevant factors. The conceptual model and variables introduced in this study can be used by other researchers for future research. Second, we introduce a calibrated simulation model to quantify the impact of direct competition between the biofuels sectors and the oil refinery industry.

Through the model simulation we show that under the realistic parameter values biofuels producers cannot expect a positive *expected* profit in a fully deregulated market and need some subsidy (around 60 cents per gallon) to break-even and survive. We then calculate the distribution of profits and the likelihood of ethanol plants shutting down under various scenarios. The calibrated model produces a range of [-2$/g, 2$/g] for the profits for a representative ethanol plant. The model suggests that with a subsidy of 1.3 $/g the frequency of ethanol plant shutdown is reduced to 10% of time. We also change multiple underlying key parameters (e.g. the technical efficiency of ethanol plants, the volatility of gasoline price, the level of subsidy) and examine their impact on the likelihood of plants' shutdown.

The overall analysis suggests a skewed distribution of revenues for stand-alone biofuels units. The calibrated model for gasoline/ethanol predicts that even with a sufficient subsidy to keep the average ethanol price competitive, ethanol plants may shut-down 40–60% of the time The skewness of biofuels producers' profits is in the range of 2.3–2.5, in contrast to the 0.91 skewness of corn feedstock prices. The effect of time-varying correlation between the crude oil and feedstock prices is also examined. The increased correlation in recent years can be a positive development, because this correlation can provide a partial relief to biofuel producers by reducing the frequency of periods in which oil products are substantially cheaper than biofuels.

The paper is organized as follows. Section 2 provides a review of relevant literature as well as the big picture of the biofuels industry in the United States. The calibration and simulation exercise is introduced in Section 3. Section 4 presents and discusses the results of the model and the simulation. Finally, Section 5 reviews a set of possible risk management strategies. For the interested reader a micro-founded theoretical model as well as additional details of the simulation model are presented in the Appendix.

2. Problem context

In this section we offer a more detailed description of the background. We first begin with a review of the relevant literature and then present information on the past and future prefect of biofuels competitiveness in the US.

2.1. Relevant literature

The existing literature on biofuels has discussed risk factors for investment in biofuels plants. For example, Ghoddusi et al. [10] suggest that volatile feedstock yield can pose threats for energy security under a scaled scenario. There are few papers in the literature focusing on the possible substitution between gasoline and ethanol. Anderson [2] and Salvo and Huse [22] study preferences for switching between gasoline and ethanol and estimate the elasticity of ethanol demand as a function of gasoline prices. Lapan and Moschini [15] offer an open-economy general equilibrium model of gasoline and biofuels production to examine the impact of non-quota policies such as taxes and subsidies on market outcomes.

Our work has benefited from insights offered by several closely-related papers. In particular, Westbrook et al. [30] study the effect of commodity prices on meeting RFS2 targets and conclude that at extreme oil prices (at least $215/barrel) RFS2 will be satisfied without requiring an enforcement mechanism. Du and Carriquiry [7] model the relative price of ethanol and gasoline in Brazil and concludes that demand forces (caused by drivers' ability to switch between the two fuels) bring those two prices to an equilibrium. Ghoddusi [9] studies the option value of producing ethanol in a regulated market. The paper argues that ethanol and gasoline are both substitutes and complements (depending on the relative prices) thanks to the RFS. In this paper we relax the assumption of enforced blend mandate and study a market with free competition between gasoline and ethanol.

2.2. Data sources

Monthly wholesale prices of New York Harbor gasoline and Brent crude oil are downloaded from the website of Energy Information Administration (EIA). Monthly prices of corn (the proxy for biofuels feedstock price) are obtained from Bloomberg. Following the usual industry practice that prices of a front-month futures contract are used as a proxy for spot prices. To work with real price all historical prices are converted to 2010 $ using the CPI index obtained from the Bureau of Labor Statistics. Ethanol production cost data has been obtained from the United State Department of Agriculture (USDA). Futures prices of corn, ethanol, crude oil, and gasoline are obtained from Bloomberg.

2.3. Structure of market

First generation biofuels in the US have experienced a secular growth in the past decade. However, they have hit the so-called blend wall - the maximum demand for blend with conventional gasoline. Additional expansion of the first-generation biofuel production capacity is only possible through a higher level of blend mandate or through the supply of biofuel as a stand-alone fuel.

A direct competition between biofuels and oil-based fuels is a likely scenario for the future. Even in today's market, the removal or reduction of blend mandates can quickly put biofuel producers in a direct competition with gasoline and diesel producers. In 2014 US biofuel producers expressed concerns about a reduced blend level, which subsequently forces them to supply their excess production - the quantity beyond the mandatory blend demand - to domestic or international markets.[3] Thus, the risk analysis offered in this paper can be a relevant concern for the near future. Brazil is another example where ethanol producers directly compete with volatile gasoline prices.[4]

Fig. 1 shows the trend of ethanol's market in the US transportation fuels market. The share has reached 10% and is expected to stay at that level. On alternative scenario is that if advanced and second-generation biofuels producers fail to resolve technical and economic obstacles, the share of first-generation ethanol may go

[3] http://oilprice.com/Alternative-Energy/Biofuels/Producers-Panic-as-Ethanol-Mandate-Loses-Support.html.

[4] Brazil enforces a volumetric time-varying ethanol mandate around the range of 20%–25%. However, thanks to the high penetration rate of flex cars and competitive prices of sugarcane ethanol the actual share of ethanol typically far exceeds the minimum blend level.

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