Relationship between biofuel production and future vehicle stocks under different oil price scenarios

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Overview

Over the last decade, expanding biofuel production has significantly changed the agricultural landscape in the United States. Between 2000 and 2015, the percentage of U.S. corn used for ethanol increased from below 6% to over 33%. Annual corn ethanol production increased on average by 28.5% between 2006 and 2010 and by 2.2% between 2010 and 2015. This increase in biofuel production has attracted significant attention from researchers and policy makers due to its effects on commodity prices (Zilberman et al., 2013; Condon et al., 2015), international trade (Elobeid and Tokgoz, 2008; Keeney and Hertel, 2009), land values (Du et al., 2008; Blomendahl et al., 2011), and land-use change and carbon emissions (Searchinger et al., 2008; Fargione et al., 2008; Fabiosa et al., 2010; Hertel et al., 2010; Dumortier et al., 2011). In 2017, ethanol consumption in the United States hit the so called "blend wall" which means that any future increase in ethanol production will be linked to the fuel consumption in the transportation sector. In this research paper, we extend a well established U.S. land-use change simulation model that has been used in previous research (Dumortier et al., 2013; Dumortier, 2016) to incorportate ethanol demand projections from the U.S. Energy Information Administrations 2018 Annual Energy Outlook (2018 AEO). The scenarios vary in terms of economic growth and oil prices which affects vehicle stock and vehicle miles traveled. Those scenarios allow us to determine how commodity prices and land allocation in the United States will evolve until 2050 given different demand in corn ethanol and biodiesel.

Methods

In a first step, we use the 2018 AEO to obtain projections of fuel demand, i.e., gasoline, diesel, E85, and biodiesel, under five scenarios: Referernce case, high economic growth, low economic growth, high oil price, and low oil price. The scenarios are organized along the two dimensions of economic growth andoil price which in turn result in different vehicle stocks and vehicle miles driven. Due to the increase in fuel efficiency, gasoline demand as well as ethanol demand are realtively stable over the projection horizon with a decrease in some scenarios.

In a second step, we extend the static model used in Dumortier et al. (2013) and Dumortier (2016) to a dynamic model that projects land allocation and commodity over the projection period until 20050. We focus on the three commodities that represent the largest area harvested in the United States, i.e., corn, soybeans, and wheat. In addition, we incorporate the Conservation Reserve Program (CRP) as an alternative to crop production. The CRP has decreased significantly since 2007 due to farmers not re-enrolling and taking advantage of the high commodity prices by putting acres back into crop production. We use CRP as an alternative to crop production which gives farmers the possibility to abandon crop prpduction if commoditiy prices frop below the level where it is profitable to be enganged in agriculture. The model consists of a demand system for the three commodities that includes feed, food, and export sectors as well as the soybean complex (soybean meal and soybean oil). The demand for each of the three commodities depends on the own price as well as the price of the other commodities and real disposable income. The demand for corn used for ethanol and the soybean oil used for biodiesel depends on the projections by the 2018 AEO. This captures any changes in the vehicle stock and the vehicle miles traveled due to different assumptions in economic growth, oil prices, and vehicle stock composition.

For the production side, we project crop yield over the years 2016 to 2050 based on data from the U.S. Department of Agriculture National Agricultural Statistics Service (NASS). Data of historical crop production cost is taken from the USDA Cost and Return database. Preliminary statistical analysis shows that changes in the commodity cost can be explained by lagged cost and changes in the price of oil. Due to the energy intensity of inputs (e.g., fertilizer), the oil price serves as a good predictor of changes of production cost. Because the 2018 AEO projects oil prices, it is possible to simulate future production cost of corn, soybeans, and wheat as well.

Based on the aforementioned data and the assumption that farmers are rational and profit maximizing agents, we can forecast the production decision of U.S. farmers based on the five scenarios from the 2018 AEO.

Results

Preliminary results show that in the reference case, corn ethanol demand decrease by 11.8% by 2050 with a decrease of up to 15.4% in the low economic growth scenario. The price effects on corn are moderate, i.e., decrease of 3.4%, in an initial scenario run which does not include changes in the production cost. In the high oil price scenario, there are a significant number of flex fuel vehicles being added to the vehicle stock which results in an increase in fuel ethanol demand. Also in the low oil price scenario, ethanol demand remains relatively stable. This is not caused by an additional number of flex-fuel vehicles on the road but by the higher vehicle miles traveled in the United States. We expect that especially in the scenario of low oil prices, farmers will benefit because the demand for ethanol will be stable paired with low production cost.

Conclusions

Increasing ethanol demand has brought significant change to the U.S. agricultural sector in terms or land-allocation, commodity prices, and land values. For farmers, policy makes, and rural communities, it is important to understand how the future evolution of biofuel demand, i.e., corn ethanol and biodiesel, affects commodity price under increasing yields, changing vehicle stock, and changes in the economic environment. Due to the blend wall that has been reached in 2017, future ethanol demand will be largely driven by the amount of gasoline consumped in the United States. The consumption depends on the vehicle stock compotion as well as the vehicle miles traveled. There is a wide range of possible outcomes in the energy sector as demonstrated by the scenarios of the 2018 AEO. This paper sheds some light on how the 2018 AEO projections translate into commodity price changes, land allocation, and farmers' welfare.

References

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