The Causes of Two-way U.S.-Brazil Ethanol Trade and the Consequences for Greenhouse Gas Emissions

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Abstracts

Biofuel policies in the US and Brazil can cause two-way ethanol trade, in which the countries export and import with each other simultaneously. A structural economic model and greenhouse gas (GHG) emission calculations are used to assess the interactions of biofuel policies and markets of these two countries. Results show that, at least under certain conditions, ethanol and feedstock prices decrease under a “No RFS” scenario in the U.S., while GHG emissions rise. If the RFS is maintained but Brazil allows domestic gasoline price to rise to reflect global petroleum prices, then ethanol and feedstock prices increase and GHG savings decrease as the use of anhydrous ethanol declines. We find that, at least under some conditions, two-way ethanol trade can have important emission impacts.

Introduction

Greenhouse gas (GHG) emissions reduction is advocated as a means to mitigate future climate change. Both the U.S. federal Renewable Fuel Standard (RFS) and the Low Carbon Fuel Standard (LCFS) in California differentiate biofuels by their levels of GHG emission reductions. According to the metrics used to implement both policies, the production of conventional (i.e. cornstarch based) ethanol has relatively higher GHG emissions than sugarcane based ethanol produced in Brazil. However, the majority of ethanol produced in the U.S. is conventional ethanol that is sold at most U.S. gas stations as a 10% blend with gasoline.

Brazil is unique in ethanol production and consumption. In Brazil, consumers have the option to use blended gasoline (E25) and hydrous ethanol (E100), which is readily available at the gas stations along with petroleum products. As of 2015, 68% of the total vehicle fleet is comprised pure hydrous and flex fuel powered vehicles (FFVs) (USDA GAIN Report, 2015). FFVs can use hydrous ethanol, though the decision to do so depends in part on the price competitiveness of ethanol relative to gasoline. According to the US biofuel mandates (Energy Policy Act 2005; EISA 2007; EPA 2010) the use of advanced biofuel that includes ethanol produced from sugarcane in Brazil results in up to 50% reduction in GHG emission. However, these studies assume the ethanol is produced and dehydrated in Brazil and then exported to US. The domestic consumption of ethanol in Brazil displaces the domestic gasoline use and the consequences regarding GHG savings are not considered in the previous studies. Almost all of the ethanol produced and used in Brazil is derived from sugarcane with a GHG emissions reduction rate that has been estimated to be as high as 76% (Macedo, Seabra, and Silva 2008). At the same time, Brazil has an ethanol use mandate of 27% that does not differentiate by GHG reductions.

The ethanol industry in Brazil generates another valuable byproduct called bagasse while producing ethanol from sugarcane in Brazil. Within the bioethanol plant in Brazil, bagasse has been widely used to replace fossil fuels in producing industrial heat and electricity in the sugar mill and the distilleries with the potential to reduce GHG emissions.

Ethanol trade connects US and Brazilian markets and, consequently, can influence the policy impacts. US RFS and Brazilian gasoline price controls both influence bilateral trade flows, opening the potential for two-way trade as each country simultaneously exports and imports ethanol with the other. This two-way trade situation and its implications have been studied in the past (Meyer and Thompson, 2012; Thompson, Whistance, and Meyer 2011), but with limited representation of the global biofuel market. In this study, a more detailed model of global biofuel markets is used to revisit those analyses in the context of the most recent RFS and LCFS implementation rules.

Background

Currently, there are two primary biofuel policies in the U.S. At the national level, there is the RFS, which was originally established in 2005 but was revised and expanded in 2007 as part of the Energy Independence and Security Act. It is now a nested use mandate that requires specific amounts of renewable fuel to be used each year, based in part on their level of GHG emission reductions. At the broadest level is the overall use mandate for renewable fuels that meet at least a 20% reduction in GHG emissions relative to a 2005 base emission level for petroleum products. There is not an explicit mandate for ethanol, however the legislation makes an allowance for conventional ethanol produced from corn to meet up to 15 billion gallons of the overall mandate. Nested within the overall mandate is a requirement for advanced renewable fuels that must reduce GHG emissions by at least 50%. This includes submandates for biomass-based diesel (attaining at least 50% GHG reduction) and cellulosic renewable fuels, which must attain at least a 60% reduction in GHG emissions. Sugarcane based ethanol, which the U.S. imports primarily from Brazil, qualifies as an advanced renewable fuel and may be used to meet that particular RFS requirement.

The Environmental Protection Agency is responsible for implementing the RFS. Each year, the EPA establishes renewable volume obligations (RVOs), which are then used to calculate a fuel mix that corresponds to the minimum level of biofuel use. For example, the overall 2015 requirement was set at 16.9 billion gallons which corresponds to a 9.5% blend mandate. In order to comply with this requirement, at least 9.5% of fuel supplied to the U.S. market had to be comprised of qualifying renewable fuels. Individual obligated parties could achieve their own targets by blending the requisite amount of renewable fuel and submitting the appropriate Renewable Identification Numbers (RINs) to the EPA, or they could purchase and submit the necessary RINs from other parties who have blended renewable fuel in excess of their own obligations.

At the state level, there exist policies that target fuel emissions and more are under consideration. The most notable is California's LCFS, which aims to reduce by 10% the carbon intensity (CI) of motor fuel use within the state by year 2020. Other states, such as Oregon and Washington, have either begun implementing their own LCFS –type policies, or have expressed interest in doing so. Similar to the RFS, the LCFS differentiates renewable fuels based on their level of GHG emission reductions, or CI ratings. However, the CI ratings are applied to much narrower categories and, in some cases, quite specific fuel production pathways. Furthermore, the LCFS requirements do not target a specific fuel mix as the RFS does. Rather, the CI reduction of the motor fuel pool is the target, and the fuel mix of the obligated parties is important only in as much as it meets the CI target. Similar to meeting the RFS, parties whose fuel mix does not meet the targeted CI may purchase credits from parties whose fuel mix exceeds the LCFS requirements.

Ours is not the first study to investigate these policies and their impacts on GHG reductions (Holland, Hughes, and Knittel 2009; Plevin et al. 2010; Khanna et al. 2011; Sanchez et al. 2012; Holland et al. 2013; Huang et al. 2013; Mosnier et al. 2013; Taheripour and Tyner 2013; Gohin 2014; Rajagopal et al. 2015).[1] While many of these studies focus on the land use change aspect, we instead focus on the policies' effects on fuel use within the U.S. and around the world. One of the earliest studies of this sort was Zhang et al. (2010), which used comparative statics to show that under some circumstances a policy change that encouraged ethanol production could lead to additional gasoline consumption and, potentially, negative environmental effects. Thompson et al. (2011) employed a structural partial equilibrium model of biofuels and petroleum products to analyze the effects of biofuel policies including the RFS. According to their results, as biofuel policies lead to substitution away from petroleum products in the U.S., those products become relatively more affordable elsewhere and there is a subsequent increase in the quantity demanded. This rebound effect offsets, to some extent, the GHG emission reductions in the U.S. On the other hand, Oladosu (2012) estimated that the indirect effects enhanced the direct emission reductions rather than offset them.

The estimated emissions factors, themselves, vary within the literature as well. As mentioned above, the implementing agencies estimate the emission factors that are used for compliance. However, many studies have looked at whether those factors are accurate and under what conditions they might be inaccurate. In their initial RFS ruling, the EPA estimated conventional ethanol GHG emissions totaled 79 kg CO2e/mmBtu (75 g CO2e/MJ) relative to the 2005 base emissions of gasoline that they estimated at 98 kg CO2e/mmBtu (EPA, 2010). The California Air Resources Board (CARB) estimated a CI rating for conventional ethanol (i.e.

[1] The related literature is far too extensive to list here, but interested readers are advised to seek out the following literature reviews for additional studies: Miyake et al. (2012); Broch et al. (2013); Adsumilli and Leidner (2014); Tokgoz and Laborde (2014); Warner et al. (2014); and Panachelli and Gnansounou (2015).

Midwest average) of 69 g CO2e/MJ before accounting for land use change (LUC) effects, which they estimated would add another 30 g CO2e/MJ to the total (CARB, 2011).

Unlike the US, there is no biofuel policy in Brazil that explicitly targets the reduction of GHG emissions. However, sugarcane is the primary source of feedstock for the Brazilian bioethanol industry which reduces the GHG emissions relative to gasoline by up to 76% (Macedo, Seabra, and Silva 2008). Studies of the lifecycle GHG emissions and land use change related to the production and consumption of bioethanol in Brazil are limited. Macedo, Seabra, and Silva (2008) estimated Brazil's 2005/2006 GHG emissions associated with the production and use of fuel ethanol from cane. They also studied a 2020 scenario and found that there was a decrease in the GHG emissions in Brazil in 2020 over 2005/2006. In an earlier study, Macedo, Leal, and Silva (2004) analyzed the lifecycle GHG emissions from the production and use of ethanol under the typical conditions found in Brazilian sugar and ethanol mills. They further calculated the GHG emissions generated from the use of fossil fuel and estimated the GHG savings derived from the use of both anhydrous ethanol, which typically is blended with gasoline to produce a 25% ethanol-gasoline blended fuel known as Gasoline C (E25) and hydrous ethanol (E100). Using Inter-governmental Panel of Climate Change (IPCC) methods to estimate land use change emissions, Seabra, Macedo, and Leal (2014) estimated the CO2 emissions due to the direct land use change derived from sugarcane production in Brazil. They found negative emissions for all scenarios due to the increase of soil carbon stocks. The authors also suggested that the expansion of sugarcane until 2020 would not contribute to indirect land use change emissions.

The economic analysis of the bioethanol market within the context of GHG emissions considering the two-way trade between US and Brazil is limited and unexploited. The estimation of the GHG saving between US and Brazil that includes life cycle analysis, direct and indirect land use change, substitution of fossil fuel and bioethanol, and inclusion of transportation emissions, to our knowledge, has not been done so far. The primary objective of this study is to examine ethanol trade patterns and their implications for GHG emissions under different U.S. mandate scenarios. Our work achieves two outcomes: (1) we assess the market and policy circumstances that tend to lead to two-way trade and (2) we estimate the U.S. GHG emissions reduction of imported advanced ethanol taking two-way trade into account.

Modeling

The starting point is a multi-market, multi-region, partial equilibrium model that has been used for RFS and biofuel market analysis in the past. Examples of studies that use earlier or alternative versions of the model include: Barr et al., 2011; Dumortier et al., 2011, Meyer and Thompson, 2012 and Egbendewe-Mondzozo et al., 2015. The U.S. biofuel model that is employed in this study has been documented elsewhere (Whistance and Thompson, 2014). For this study, we develop an explicit Brazilian ethanol model to use in conjunction with the U.S. model. We further calculate the GHG emission savings derived from the consumption of conventional ethanol in the US and sugarcane based ethanol in Brazil based on the existing literature and GHG emission factors as shown in table 1 (CARB, 2012; Seabra, Macedo, and Leal, 2014; Macedo, Leal, and Silva 2004; RFA, 2011). In many respects, it is similar to the model that is used in Thompson et al. (2011). However, it does not include the detailed model of petroleum and petroleum products employed by that earlier study. The model here reflects market conditions as of January 2016 and has already been used as the basis for commodity market projections (Westhoff et al, 2016). A key assumption in relation to the current analysis is the baseline global crude oil price, which was assumed to be $85.64 by the end of the projection period in 2025.

Regarding US biofuel policy, the baseline take the finalized 2014-2016 RFS rules as given. This implies increasing percent-standard obligations for each renewable fuel category that reach 10.1% (overall), 2.01% (advanced), 1.59% (biomass-based diesel), and 0.13% (cellulosic). From there, we assume linear growth rates for each percent standard. The assumed overall requirement grows by 0.1 percentage points per year (i.e. 10.1% in 1016 to 10.2% in 2017), the advanced requirement grows by 0.01 percentage points per year, the biomass-based diesel grows by 0.025 percentage points per year, and the cellulosic requirement grows by 0.05 percentage points per year.

Brazilian domestic fuel ethanol use is modeled as the sum of inelastic low-blend fuel use (complement) and elastic high-blend fuel use (substitute) (Szklo, Schaeffer, and Delgado, 2007). To satisfy Brazil's 27% ethanol blend mandate, anhydrous ethanol is blended with gasoline to produce what is known as "Gasoline C" (USDA-GAIN, 2015). As its use is positively linked with the consumption of Gasoline C, anhydrous ethanol use is considered a complement to gasoline. Total fuel consumption in Brazil is estimated in order to estimate blended anhydrous ethanol use. Hydrous ethanol use is modeled as a substitute to gasoline as its use increases with the increase in the price of Gasoline C. Equations 1-5 represent the ethanol and gasoline use and state controlled Gasoline C price in Brazil:

$$E_t^U = A_t^U + H_t^U + O_t^U \qquad (1)$$

$$A_t^U = \alpha G_t^U \tag{2}$$

$$G_t^U = \lambda_1 + \lambda_2 P_t^E + \lambda_3 P_t^G + \lambda_4 I_t + \lambda_5 \tag{3}$$

$$P_t^G = \kappa_1 + \kappa_2 P_t^F + \kappa_3 P_t^E + \kappa_4 \tag{4}$$

$$H_t^U = \beta_1 + \beta_2 \frac{P_t^E}{P_E^G} + \beta_3 I_t + \beta_4 \tag{5}$$

where, E_t^U is the ethanol use in year t; A_t^U, H_t^U, and O_t^U are the anhydrous ethanol use, hydrous ethanol use, and other non-fuel ethanol use in year t all on a volumetric basis; α is the government blending mandate level; GtU is the total volume of Gasoline C use in year t; λ_1, λ_2, λ_3, λ_4 and λ_5 are the slope, intercept and error terms corresponding to the total Gasoline C use equation; P_t^E, P_t^G and P_t^F are the global petroleum price of ethanol and gasoline in year t; I_t is the income term; κ_1, κ_2, κ_3, and κ_4 are the intercept, slope and error terms corresponding to the Brazilian Gasoline C price equation; β_1, β_2, β_3 and β_4 are the intercept, slope and error terms corresponding to the hydrous ethanol equation respectively.

Brazil's petroleum price is state controlled, and it does not vary identically with the global crude oil price. In the baseline projection, we assume that as the global crude oil price increases by 1%, Brazilian gasoline price will increase by 0.5%. The production of ethanol in Brazil is unique as the bioethanol plant is built within the proximity of the sugarcane field and production of ethanol depends on the price of sugar and ethanol. As the price of sugar increases, the production of ethanol decreases, and with an increase in ethanol price, sugar production decreases. The ethanol stocks are modeled as a function of production and ethanol price. The ethanol net exports depend on the domestic anhydrous ethanol price and the US

Omaha rack ethanol price. The linkage between the US and Brazilian ethanol trade is represented by figure 1.

GHG Savings

Annual GHG savings are estimated using conversion factors that are based on the existing literature (CARB, 2012; Seabra, Macedo, and Leal, 2014; Macedo, Leal, and Silva 2004; RFA, 2011) and reported in table 1. We consider three different components in the calculation of the GHG savings: 1) life cycle analysis, 2) direct and indirect land use change, and 3) transportation. The inclusion of GHG emissions derived from the two-way transportation of ethanol between the U.S. and Brazil sets this study apart from the other existing studies. For each country, US and Brazil, we estimate the GHG savings based on the total consumption of ethanol. We assume that all the ethanol imported by the US and Brazil is used solely for domestic consumption. We further summed the GHG savings associated with each country to determine the total GHG savings in the atmosphere derived from the use of ethanol replacing fossil fuel in the US and Brazil.

Scenarios and Results

Two biofuel scenarios, each corresponding to US and Brazil, are simulated. In one scenario, we estimate the impact of an elimination of the RFS in the US for the years beyond 2016. We further assume that obligated parties anticipated the RFS elimination to take place and, thus, did not carry any additional RIN stocks in the projection period. In the case of Brazil, we simulated a scenario assuming there is a change in policy such that the rising world crude oil price of the baseline projections causes a corresponding increase in the domestic gasoline price in Brazil. In other words, we assume that with a 1% increase (decrease) in the global crude oil price there will be a 1% increase (decrease) in gasoline price in Brazil.

In the “No RFS” scenario, we find that the 2017-2025 average US Omaha FOB ethanol price decreased to $1.87 per gallon from the baseline ethanol price of $1.91 per gallon (table 2) as the consumption of ethanol decreases by 499 million gallons (figure 2). Without the RFS in place, there is less US demand for Brazilian ethanol and the hydrous and anhydrous prices in Brazil decrease by 2 and 3 cents per gallon, respectively. The lower ethanol prices in Brazil allow for increased ethanol use in Brazil by 62 million gallons (figure 2). The increase in ethanol use in Brazil comes mainly in the form of increased hydrous ethanol use (figure 3) as hydrous (E100) ethanol is cheaper than Gasoline C that includes anhydrous ethanol. Removing the RFS in the US has consequences in the feedstock market, too. The price of corn in the US could decrease by 7 cents per bushel while the raw sugarcane price in Brazil could decline by $4.68 per metric ton. The net US ethanol exports could increase by 183 million gallons, which replaces an almost identical amount of Brazilian ethanol exports (figure 2). The reason for US ethanol to displace Brazilian ethanol is that US ethanol becomes cheaper relative to Brazilian anhydrous in the scenario without the RFS. However, in terms of GHG emission savings, there is a decrease of 0.99 million mt of CO2e in GHG saving in the US while and in Brazil based on CARB conversion factors there is an increase of 0.20 million mt of CO2e GHG savings. Taking both effects into account, eliminating the RFS results in greater CO2e emissions. The US and Brazil together lose 0.80 million mt CO2e GHG savings associated with ethanol use. However, when GHG saving are estimated based on Brazilian studies (Macedo, 2008) we find GHG saving is increased by 0.67 million mt of CO2e due to increase use of ethanol that has higher GHG saving rates over studies done by CARB (table 3). Resulting in an lower overall decrease in GHG savings among the U.S. and Brazil compared to the case when CARB GHG saving conversion factors are used. The end result of this scenario is that, given the context and assumptions, the elimination of the RFS reduces overall ethanol use in the U.S. and consequently leads to an increase in GHG emissions. However, taking into account the changes in ethanol-related emissions in Brazil reduces the estimated impact by about one-fifth.

In the scenario where Brazil no longer controls the gasoline price, both Brazilian anhydrous and hydrous ethanol prices as well as the US Omaha ethanol price could increase. The main factor behind these ethanol price increases is the increased ethanol use in Brazil. The increasing crude oil price path we assume drives the average Brazilian Gasoline C price to $5.29 per gallon in the scenario from $4.55 per gallon in baseline. This policy change causes higher fuel ethanol use because consumers substitute between hydrous ethanol and Gasoline C (figure 3). In addition, there is increased demand for US ethanol exports, which increase by a net of 162 million gallons. At the same time, Brazilian net exports decline by 168 million gallons (shown in figure 2). Higher domestic fuel ethanol use in Brazil leads to an increase in the domestic ethanol production and an increase in sugarcane demand as the primary feedstock in Brazil. The raw sugarcane price increases by $7.88 per mt to $384.22 per mt compared to $376.34 per mt in the baseline projection.

With assumption of increasing crude price, higher GHG saving in Brazil is estimated. Using CARB conversion factors we find that the 2017-2025 average annual GHG savings in Brazil increase by 0.68 million mt CO_2e per year, and in the US, GHG savings decrease by 0.03 million mt CO_2e. Atmospheric GHG emissions within these two countries decrease by 0.65 million mt

CO_2e (i.e. GHG saving increase by 0.65 million mt CO_2e). However, when Brazilian (Seabra, Macedo, and Leal, 2014; and Macedo, Leal, and Silva, 2004) conversion factors are used, the Brazilian and total atmospheric GHG emission decrease (i.e. GHG savings increase) by 2.12 million mt CO_2e and 2.09 million mt CO_2e, respectively. The reason behind the higher GHG saving in case when conversion factors based on Brazilian studies are used, since those studies assume no emission derived from indirect use change .

Discussion and Conclusion

Here, an economic model is used to investigate the potential that the policies and potential for two-way trade in ethanol between the two largest ethanol producing and consuming countries could generate unexpected GHG emission impacts. The model represents ethanol and related markets, including feedstock markets, and takes into account such policies as the US RFS and Brazilian gasoline price policy. At present, we restrict the focus of this exercise on ethanol, although many other factors included in the model, not least biodiesel that also plays a role in US mandates, are not presented here. We also assume rising petroleum prices even though the future path of this key price is uncertain. We set aside these and certain other considerations to focus on a key question relevant to GHG-related policies. Namely, to what extent are the impacts of policy changes on GHG emissions affected by two-way ethanol trade between these countries.

This study finds that removing the RFS requirements in the U.S. could lead to lower ethanol use, both advanced and conventional, which in turn would lead to a decrease in ethanol and corn prices all else equal. Despite rising petroleum product prices over the projection period, a substitution effect occurs in which motor gasoline replaces a portion of the motor fuel demand that was filled by ethanol in the baseline. Thus, the decrease in advanced and conventional ethanol use could also lead to a decrease in GHG savings. The effects are tempered by our assumption that ethanol would continue to be the most widely used octane enhancer and that, partly as a result, E10 remains nearly ubiquitous in the U.S. This assumption results in sustained E10 use even in the case of an RFS elimination, so impacts on ethanol and ethanol feedstock markets, as well as on US GHG emissions, are limited. The results shown in this study would understate the effects that might occur if E10 use was no longer prevalent.

On the other hand, if the Brazilian government allows the domestic Gasoline C price to reflect the assumed increase in world crude oil prices, then ethanol and sugarcane prices would also increase. The higher price for the petroleum product tends both to decrease overall fuel use and to push more consumers towards ethanol, leading to greater GHG savings.

We also find that, under this set of assumptions, policy-driven two-way ethanol trade between the U.S. and Brazil has limited consequences on GHG savings. Port-to-port transportation of ethanol has fewer GHG emissions than the emissions derived from the feedstock production activities, transportation, and use of ethanol in the domestic markets. GHG emission estimates vary, sometimes widely, in the literature. The results here are based on two such estimates. Based on a structural model that relates key policies to markets and certain emission estimates, the results of this study indicate that two-way ethanol trade between the U.S. and Brazil may not have large ramifications regarding GHG emissions.

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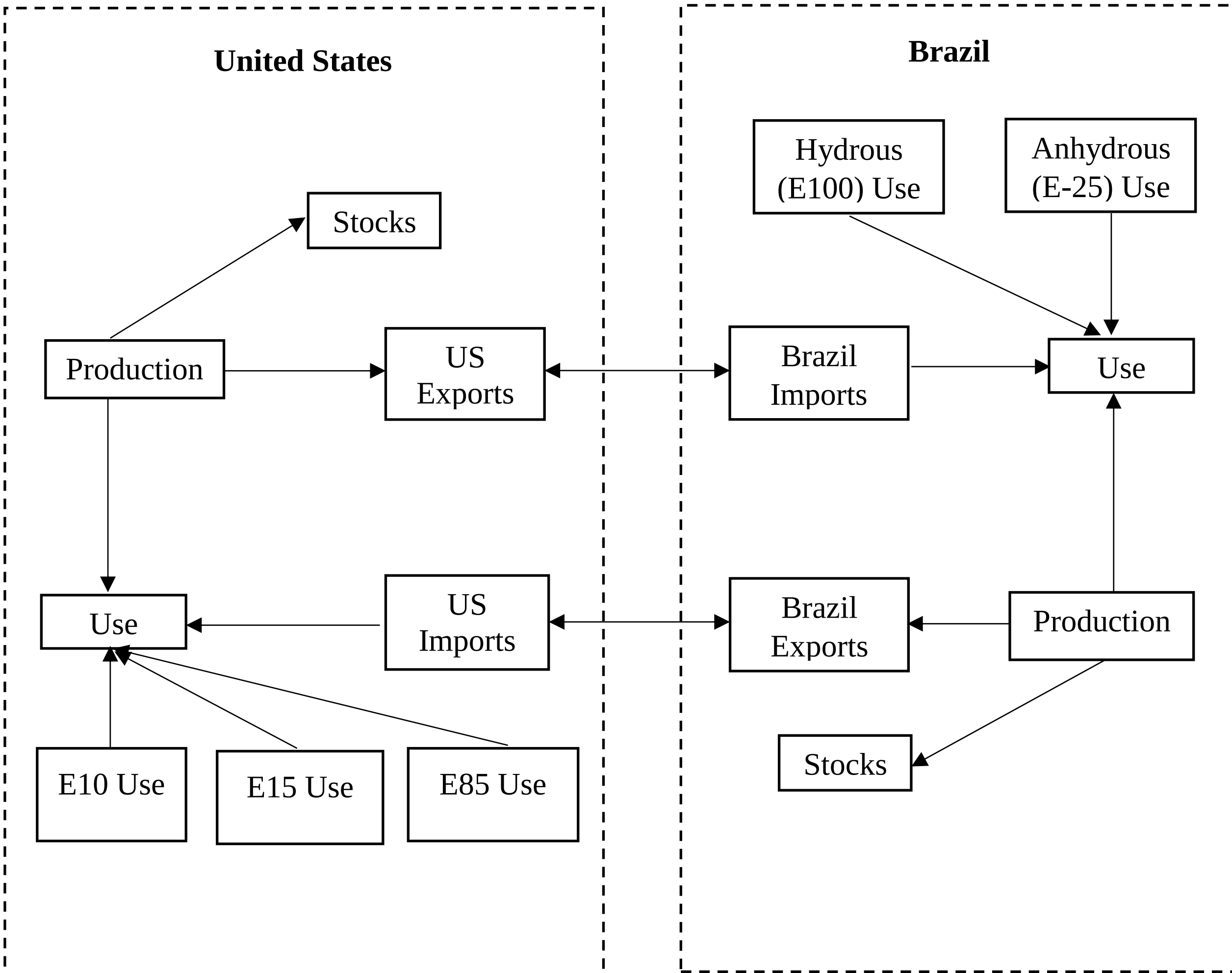

Figure 1. Schematic diagram of the two-way ethanol trade between US and Brazil.

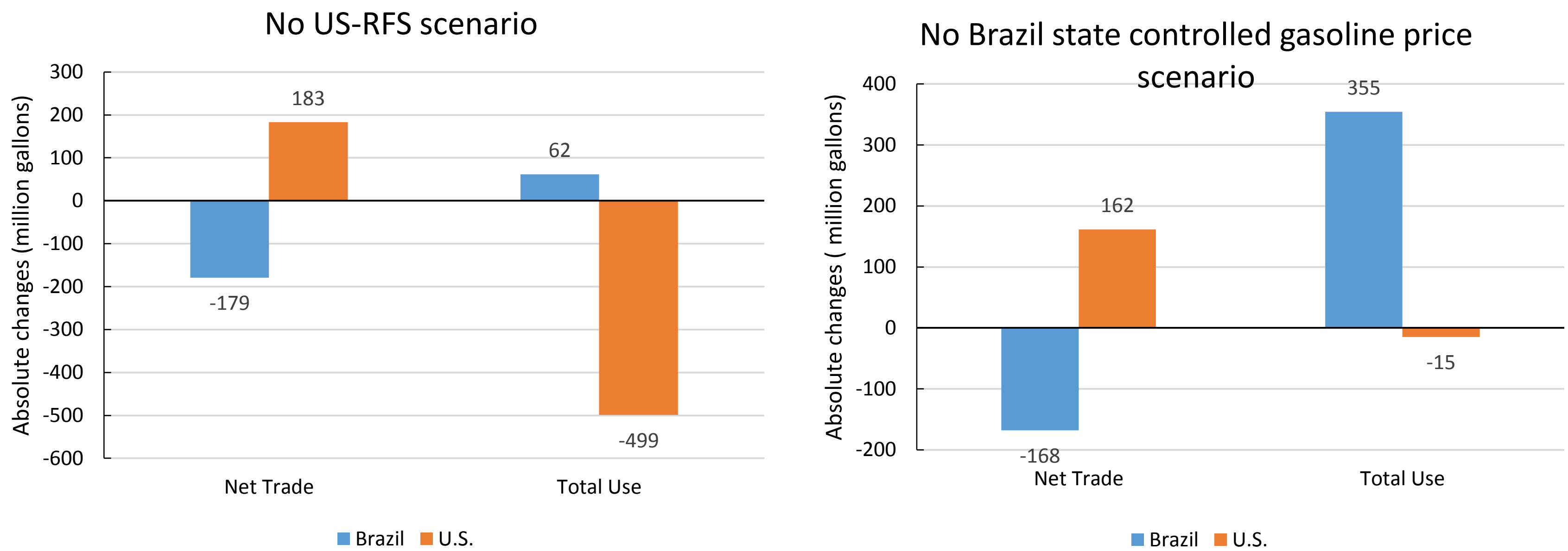

Figure 2. Comparison between changes in net trade and total ethanol use in the US and Brazil under two different scenarios: i) No-US RFS and ii) No Brazil state controlled gasoline price.

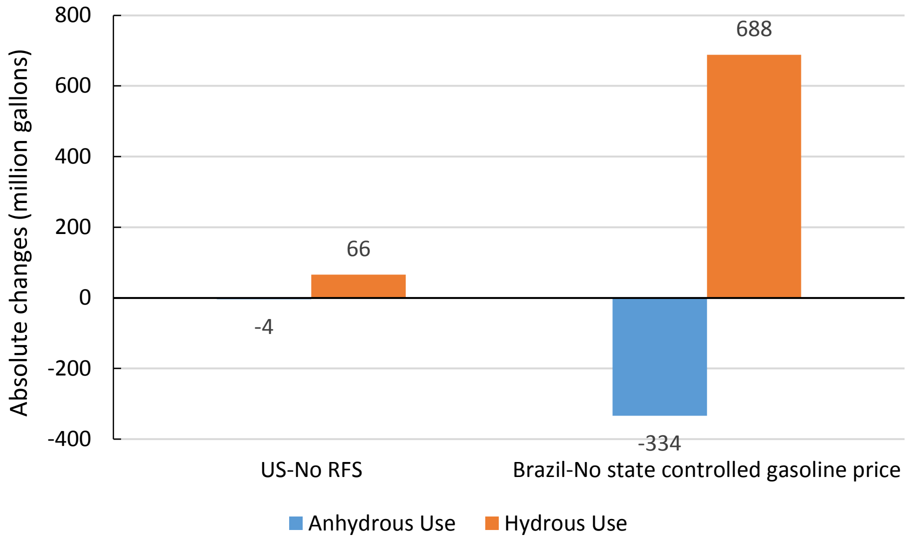

Figure 3. Comparison between changes in anhydrous and hydrous ethanol use in Brazil under two different scenarios: i) No-US RFS and ii) No Brazil state controlled gasoline price.

Table 1: Conversion factors used in the calculation of GHG savings

Brazil	Units	Brazil Study*	CARB**
Life Cycle Analysis			
Anhydrous Ethanol	Kg Co2 eq. /l	3	
Ethanol	gCo2 eq. /MJ		87
Land Use Change			
Sugarcane	g Co2 eq. /l	78	
Sugarcane	gCo2 eq. /MJ		-46
Transportation* **			
US to Brazil	gCo2 eq. /MJ	-4	
USA			
Life Cycle Analysis			
Ethanol	gCo2 eq. /MJ		9
Land Use Change			
Corn	gCo2 eq. /MJ		-30
Transportation			
Brazil to US	gCo2 eq. /MJ		-4

*Seabra, Macedo, and Leal (2014); Macedo, Leal, and Silva (2004)
**CARB (2012)
***RFA (2011)

Table 2. Price effects under alternative scenarios, 2017-2025 averages

	Baseline	No RFS	Oil Price
Fuels (US - $/gallon)			
Ethanol (FOB Omaha)	1.91	1.87 *(-0.04)*	1.92 *(0.01)*
Gasoline C	4.55	4.54 *(-0.01)*	5.29 *(0.74)*
Hydrous ethanol (Sao Paulo)	1.81	1.79 *(-0.02)*	1.86 (*0.05)*
Anhydrous ethanol (Santos)	2.05	2.02 *(-0.03)*	2.10 *(0.05)*
Feedstocks			
Corn (US - $/bu)	3.93	3.86 *(-0.07)*	3.95 *(0.02)*
Raw sugar (Brazil - $/mt)	376.34	371.66 *(-4.68)*	384.22 *(7.88)*

Note: Italics indicate changes from baseline levels.

Source: Authors calculation.

Table 3. GHG savings (million mt CO2e) under alternative scenarios, 2017-2025 averages

	Baseline	No RFS	Oil Price
U.S.	11.54	10.54 *(-1.00)*	11.51 *(-0.03)*
Brazil			
Macedo (2008)	83.50	84.17 *(0.67)*	85.62 *(2.12)*
CARB (2012)	24.92	25.12 *(0.20)*	25.60 *(0.68)*
Total			
Macedo (2008)	95.04	94.71 *(-0.33)*	97.13 *(2.09)*
CARB (2012)	36.46	35.66 *(-0.80)*	37.11 *(0.65)*

Note: Italics indicate changes from baseline levels.

Source: Authors calculation.