THE IMPACT OF U.S. BIOFUEL MANDATE WAIVER DECISIONS ON WORLD ETHANOL AND BIODIESEL MARKETS

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Results presented here are preliminary and subject to change before the final version of this paper is completed.

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Abstract

The proposed regulations for 2014 released by the Environmental Protection Agency (EPA) set requirements for biofuels at levels below the maximums outlined in the Energy Independence and Security Act (EISA) of 2007. In waiving part of the mandate, the proposals dramatically reduce the volume available for advanced fuels but not corn based ethanol, commonly referred to as the "advanced gap". The existence of this opportunity has up until now been a driver of trade between the US and Brazil, and shrinking the gap will likely lead to those countries seeking markets elsewhere. In this paper the impact of alternative implementations of policy in the U.S. are analyzed. In the base case, decision making is implemented using the EPA 2014 proposal as a guide. In the first scenario the overall mandate is waived down to a smaller extent to a level which preserves the "advanced gap" at the levels envisioned in the RFS2. A second scenario then takes the first scenario and expands the biodiesel mandate from 1.28 billion gallons to 2 billion gallons. Increasing the advanced gap leads to both an increase in imports, but also an increase in exports of ethanol for the U.S., driven by the fact that the U.S. discriminates on the basis of feedstock where Brazil does not. The results presented here are the first to come from a new international global biofuels model, which is presented and discussed.

Key words: Global biofuels model, U.S. biofuels mandates

JEL classification codes: Q42, Q48

After a rapid expansion in the production and use of biofuels that has a profound impact on agricultural markets, a variety of factors have seen the rate of growth of the sector fall in recent years. In the European Union (E.U.), skepticism regarding environmental benefits has prompted calls for restriction on use of “first generation” fuels. In the U.S. the challenge of overcoming the “blend wall” has resulted in the proposal by the Environmental Protection Agency (EPA) to reduce mandate levels below the level legislated under the Energy Independence and Security Act of 2007 (EISA). Whereas in the past, biofuel markets have been dominated by the U.S., E.U. and Brazil it may be that in the future other markets may be the source of growth.

In this paper the first step in the development of a global model of biofuels for use in the FAPRI global modelling system is presented. The model is run simultaneously with the rest of the modelling system in order to determine the impacts of alternative mandated levels in the U.S. on the global system, and in particular U.S. biofuels trade. Conclusions are then drawn regarding important developments on world markets and their impact on trade, and for the future development of the model.

Background

Currently the U.S., EU and Brazil are the key players in the world biofuel market. In those countries, biofuel production and consumption are highly influenced by government policies. These policies change frequently, impacting trade flows and having knock-on effects on feedstock markets. In Brazil, the government encourages production through a mandated blending rate, tax incentive for the purchase of flex fuel vehicles and tax incentive for producing fuel ethanol. In

2013, Brazil increased the ethanol blend mandate from 20% to 25%, and there are plans to increase Brazil's biodiesel mandate from the 5% blend that has been in place from 2010 to 7 percent. In some years Brazil has sent significant quantities of ethanol to the U.S. to fill the advanced fuel requirement. However, the advanced biofuel requirement is reduced under the 2014 Renewable Fuel Standard (RFS) proposal. If the proposal were to form the basis of future RFS decisions, Brazilian producers would see a potential market for sugar-based ethanol shrink considerably. However, California's Low Carbon Fuel Standard (LCFS) might still provide an incentive to import sugarcane ethanol from Brazil, although the level of imports it could support remain a key uncertainty.

Currently in the U.S., the RFS largely determines ethanol and biodiesel consumption. The recently proposed biofuel requirements for 2014 determine a volume of ethanol use lower than that proposed under the Energy Independence and Security Act (EISA) of 2007. The 2014 RFS proposal revised the total renewable fuel target down to 15.21 billion gallons from the EISA 2007 target of 18.21 billion gallons (EPA, 2014). With total domestic consumption showing little growth, exports are likely to be viewed as one of the few ways to maintain U.S. ethanol production at current levels, and this implies an increased focus on international markets for U.S. biofuels industry. In recent years the destination for U.S. biofuels exports has varied as policies are changed, with Brazil, the E.U., Asia and Canada all at times being significant markets.

Canada uses both corn and wheat as feedstock in ethanol production. In 2013/14, around 3,422 thousand MT of corn and 975 thousand MT of wheat was used as feedstock production (USDA, GAIN Report Canada 2013). The biofuels blend mandates in Canada vary across the provinces ranging from 5% ethanol blend in gasoline in Ontario to 8.5% in Manitoba. Because of logistic challenges and extremely cold climatic conditions, the Canadian government is not able to impose the mandate of 2% blend of biodiesel in diesel fuel and heating distillate oil (USDA, GAIN Report Canada 2013). Argentina has a huge biofuels industry consisting mainly of soybean oil based biodiesel, and sugarcane based ethanol as well as the growing use of grains in ethanol production. Since 2010, Argentina has mandated 5% ethanol blend in gasoline and 5% biodiesel blend in biodiesel (USDA, GAIN Report Canada 2013).

Biodiesel exports have been critical for Argentina as production capacity has increased, and the sector has been hit hard by a ban from the E.U. In the E.U., biodiesel is the main source of biofuels accounting 70% of the biofuels market primarily used for transportation with ethanol accounting for most of the rest. The E.U. has a target of ten percent of transport energy to come from renewable sources by 2020 (USDA, GAIN Report EU 27 2013). The E.U. target has been translated into member state based policies that have increased biofuels use, usually through differing levels of blending mandates reflecting the member states enthusiasm for biofuels. The E.U. has a large biofuels industry and its influence has meant that the E.U. has been quick to step in when countries outside the E.U. have obtained significant market share through barriers such as anti-dumping levies. This has had important impacts on trade flows.

Malaysia and Indonesia have emerged as sources of palm oil based biodiesel, with government policies playing an important role in the development of the industry (USDA, GAIN Report Malaysia 27 2013). Malaysian has a mandate of 5% blend of biodiesel in diesel and have proposed an increase to 10% by mid-2014. In Indonesia currently there are no mandates but the government has proposed a 5% mandate of biofuel mandate by the end of 2025. Production, consumption, and export of biodiesel has grown significantly in the recent years (USDA, GAIN Report Indonesia 27 2013).

Data and Methodology

A structural demand and supply model for biofuels is used.[1] The world biofuels market is cleared within a broad, multi-market multi-region partial-equilibrium modeling system of international agriculture. Ethanol is mainly obtained from corn in the U.S. and sugarcane in Brazil. In the U.S. soybeans, corn oil and other fats are used for production of biodiesel. Argentina is a key producer of soybean oil-based biodiesel. Canada is using both wheat and corn in the production of ethanol. Southeast Asian countries: Indonesia and Malaysia has started producing palm oil based biodiesel. While the U.S. and Brazil are two key biofuel consuming countries, EU members and many other countries also use these fuels. Figure 1 shows the country coverage for the modelling system.

The structure of the global biofuels model is shown in Figure 2. The model is solved for the market clearing world prices for ethanol and biodiesel, taking into account where possible the existing mandates, tax credits and trade policies for each biofuel All the biofuels producing and consuming countries are linked together through the trade volume. In the general structure of the model, the following identity is satisfied for each country/region and the world:

$$Beginning\ Stock_t + Production_t + Imports_t = Ending\ Stock_t + Consumption_t + Exports_t.$$

[1] For details of the FAPRI modelling approach see Meyers *et al* (2010).

In addition to domestic and trade policies, macroeconomic variables such as petroleum price, population, exchange rate, and GDP are considered as the exogenous variables in the model. The global biofuels model is linked with the FAPRI-MU's agricultural livestock and diary modeling system (Figure 3). The models solve simultaneously so the demand for feedstock required for the production of ethanol and biodiesel directly competes with feed and food uses of corn, sugarcane, soybean oil and palm oil.

The models follow the general structure of the pre-existing biofuels models for the U.S. and the E.U., although in order for the model to be tractable its scale is much smaller than the U.S. model as it requires a large degree of policy detail to be incorporated. On the production side, this means that capacity and utilization are modelled separately. This allows the long term dynamics of the industry to be captured. On the demand side consumption use is mainly determined by policies, in particular mandated blending rates in the countries concerned. Fuel use projections are taken from GAIN reports and at present in our global biofuels model energy markets including fuel use for transport is considered to be exogenous.

Data are obtained from several sources. U.S. crops quantity data are obtained from NASS and ERS, both of USDA. World agricultural commodity production and consumption data used in the model are primarily obtained from USDA-FAS (Foreign Agricultural Service) Production, Supply, and Distribution (PS&D) data set. Macroeconomic data sets are obtained from the International Monetary Fund (IMF) and IHS Global Insight while international biofuels data come from various sources including F.O. Lichts and U.S. GAIN reports on biofuels and other national reports. U.S. mandate waiver information is obtained from the EISA and the EPA proposal.

Baseline and scenarios

The first step in the modelling process is the generation of a baseline. The models that form the basis of this analysis were simulated in January 2014 using policies agreed at that time and using market available then. Incorporation of the global biofuels model meant that a new baseline was generated which differs slightly from the official FAPRI baseline, so figures that are presented here are not official FAPRI outlook figures, but are close. The projections included the 2014 RFS proposal and the farm bill for the U.S., for example. Incorporating policy for the E.U. is harder as although there is a policy in place for 10 percent of transport fuels to come from renewables, there is no clear path as to how that might be comprised and it seems that there is general agreement that first generation biofuels potential to account for much more of that target is limited. An assumption is made that for the projection period in the E.U. there is little growth in use of biofuels that use foodstuffs as their raw material.

For the U.S., the assumption is that in the future the EPA uses a similar decision making process to that in the 2014 proposal, i.e., the level of the mandate is based on the ability of the market to absorb the fuel. Production of cellulosic ethanol sees limited growth, as does the use of ethanol in the high level blend fleet, but the changes are small. These are both areas where there are significant uncertainties. In the past FAPRI baselines have included a more significant advanced fuel requirement, and this has led to large ethanol imports from Brazil (projected to be the cheapest advanced fuel) and some exports to Brazil from the U.S. (as Brazil does not discriminate by feedstock). The reduction in the advanced fuel requirement in the EPA's proposal means that for the 2014 baseline, U.S. trade in ethanol is reduced.

Two scenarios are run to examine the impact of different waiver decisions on world biofuels markets and trade.

i) Scenario 1 (S1): In this scenario an assumption is made similar to that which was used by FAPRI prior to the 2014 EPA proposal. Here the overall mandate is waived down to a level which preserves the "advanced gap"[2] at the levels envisioned in the RFS2.

ii) Scenario 2 (S2): Scenario 2 is the same of Scenario 1 with the exception that the biomass based diesel mandate is expanded from 1.28 billion gallons to 1.8 billion gallons, with the impact that the "advanced gap" shrinks. In the models this means that less of the RFS requirements are met by sugar based ethanol.

Results

The results that are presented in this paper are the first using the global biofuels model and are preliminary. They will be reviewed and will likely be different to those presented at the conference and contained in the final version of the paper.

[2] The "advanced gap" is the part of the mandate not allocated to either biodiesel or cellulosic ethanol that can be filled only by and advanced fuel. It cannot currently be met using corn grain based ethanol.

The results of the scenario simulations are presented in Table 1.Under both scenarios the volume of biofuels used in the U.S. increases as the mandate is reduced by a smaller amount than in the EPA 2014 proposal that underlies the baseline. The prices of both ethanol and biodiesel increase. Some of the increased use comes from corn based ethanol, but a much bigger expansion occurs change is in the advanced fuel requirement. Both scenarios see a large increase in use of sugar based ethanol, sourced from outside the U.S. In S1 imports of ethanol rise by 2.2 billion gallons (Figure 4). Exports also increase by 560 million gallons as U.S. corn based ethanol becomes more competitive with other country's ethanol (Figure 5). Although bilateral trade is not modelled explicitly, some of this ethanol would probably flow to Brazil, as has happened in the past.

In S2 the increase in imports is lower, at 1.8 billion gallons as the biomass based biodiesel mandate expansion means that the "advanced gap" is smaller than in S1. Although the biomass based diesel mandate is expanded by 720 million gallons in S2 in comparision to S1, the expansion of consumption of biomass based diesel is less than this, as under S1 consumption levels increase as some of the increase in the advanced gap is met through Renewable Identification Numbers (RINs) that have been demoted. Both scenarios see increases of ethanol and biodiesel prices of between 9 percent and 14 percent (Table 1).

In contrast to the situation for ethanol, trade in biodiesel experiences relatively little change. One reason for this is that there is ample capacity currently unutilized in the U.S. to increase production. Also, the international biodiesel market has been characterized in the past by significant barriers to trade and so the elasticities with respect to price differentials are smaller than for ethanol. Improving the characterization of biodiesel markets is a priority for the development of the model.

Discussion and Conclusion

Policy has played a central role until now in both the growth of biofuels use globally, but also in the size and direction of trade flows. For the U.S., the focus has been the domestic market, where growth of ethanol use has been strong driven by its competitiveness in low level blends. Hitting the blend wall has meant that domestic growth has stalled, and the difficulty in developing other markets for either E-15 or high level blends the EPA has proposed a reduction in biofuel use requirements. In the FAPRI baseline for 2014 this has meant that corn use for ethanol does not increase. Variation in the volume of corn use for ethanol will therefore in future be determined by fuel use in the U.S., and the volume of exports. The aim of the model presented here is to produce more information on the potential for global biofuels market and their interaction with the U.S.

In this paper the impact of different implementation of U.S. policy are examined for their impact on trade. Increasing the advanced gap leads to both an increase in imports, but also an increase in exports of ethanol for the U.S., driven by the fact that the U.S. discriminates on the basis of feedstock where Brazil does not. Changes in the level of biodiesel requirements have largely been met domestically given the large amount of overcapacity in the U.S. biodiesel industry. The details of policy both in the U.S. and around the world are likely to be important for biodiesel trade flows, as the recent example of Argentina has shown.

As a combination of the blend wall and a waived mandate restrict use in the domestic market, reducing import requirements for ethanol to the U.S., both the U.S. and Brazil will seek alternative markets in other parts of the world. Some of these markets are fickle and highly protected, such as the E.U. Other markets will emerge, however, as ethanol is increasingly substituted for gasoline in low level blends. These markets are uncertain and research is scarce on what will be an increasingly important issue for biofuel producers and, by extension, the people that grow their inputs.

It is hoped that with more work the FAPRI global biofuels model can become part of the official FAPRI baseline system. Areas for work include development of endogenous demand for transport fuels, richer incorporation of existing policies, investigation as to the potential of emerging markets and incorporation into the global modelling system.

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Table 1. Preliminary results for different RFS2 implementation choices.

	Baseline		Scenario 1			Scenario 2		
	Avg. 2010-13	Avg. 2021-22	Avg. 2021-22	Change from baseline	%	Avg. 2021-22	Change from baseline	%
United States Ethanol				(million gallons)				
Production	13,474	14,807	15,466	659	4%	15,666	859	6%
Imports	227	155	2,368	2,213	n/a	1,938	1,783	n/a
Domestic Use	12,966	14,277	16,584	2,308	16%	16,448	2,172	15%
Exports	288	684	1,245	561	82%	1,150	466	68%
Ending Stocks	728	870	889	19	2%	893	23	3%
United States Biomass Based Diesel				(million gallons)				
Production	944	1,528	1,925	397	26%	2,016	488	32%
Domestic Use	867	1,364	1,765	401	29%	1,857	492	36%
Net Exports	27	65	61	-4	-6%	60	-5	-7%
Ending Stocks	73	96	101	5	5%	102	6	6%
Brazil Ethanol				(million gallons)				
Production	6,566	8,452	9,424	972	11%	9,359	907	11%
Imports	161	129	197	68	53%	187	57	44%
Domestic Use	6,104	7,493	6,849	-644	-9%	7,152	-341	-5%
Exports	719	1,086	2,769	1,683	n/a	2,391	1,305	n/a
Ending Stocks	194	52	56	3	6%	55	3	n/a
Price				(U.S. dollars per gallon)				
Brazil Anhy. Ethanol S.P.	2.58	2.04	2.32	0.28	14%	2.29	0.26	13%
U.S Biodiesel Rack	4.42	3.33	3.62	0.29	9%	3.70	0.36	11%
Feedstock Use				(million MT)				
United States Corn	125	130	135	5.53	4%	137	7	6%
United States Soybean Oil	1.96	2.02	2.80	0.79	39%	3.08	1	53%
Brazil Sugarcane	316	412	459	47.34	11%	456	44	11%

Ethanol	Biodiesel
Argentina	Argentina
Brazil	Brazil
	European Union
Canada	Indonesia
European Union	Malaysia
United States of America	United States of America

Figure 1. Countries modeled for ethanol and biodiesel.

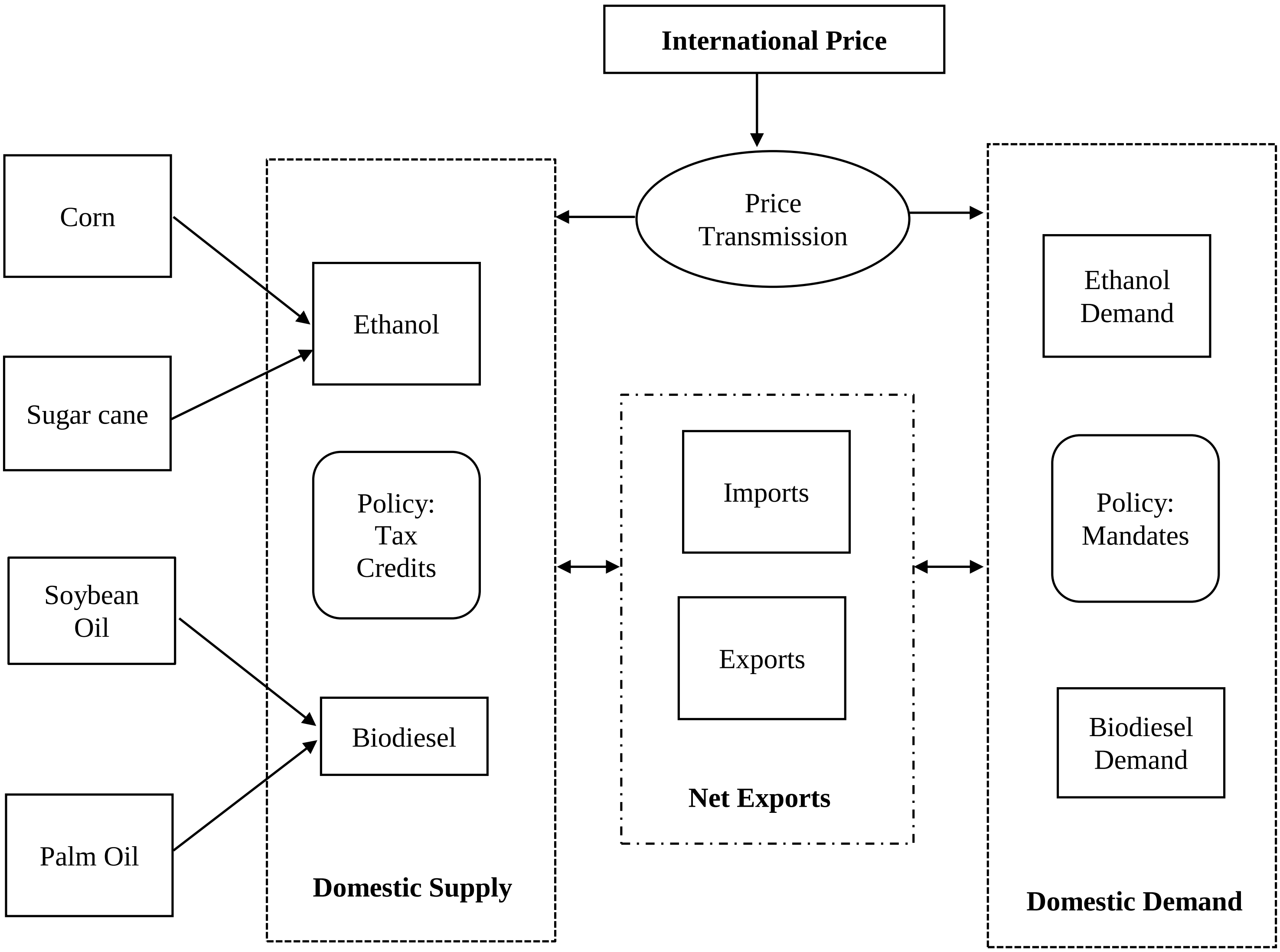

Figure 2. Global biofuels model.

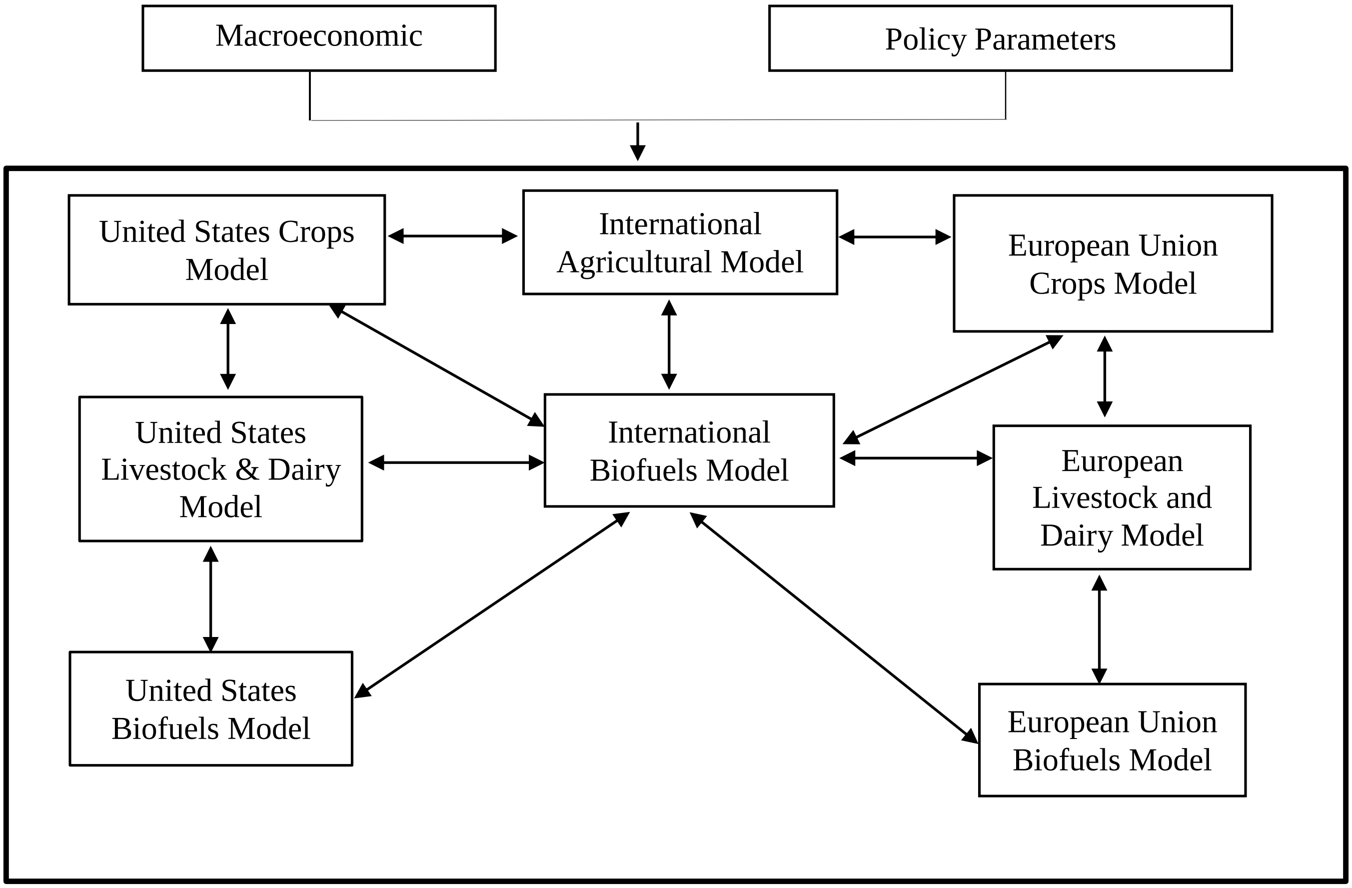

Figure 3. Schematic diagram of the model interaction between agriculture, livestock, and dairy, and biofuels.

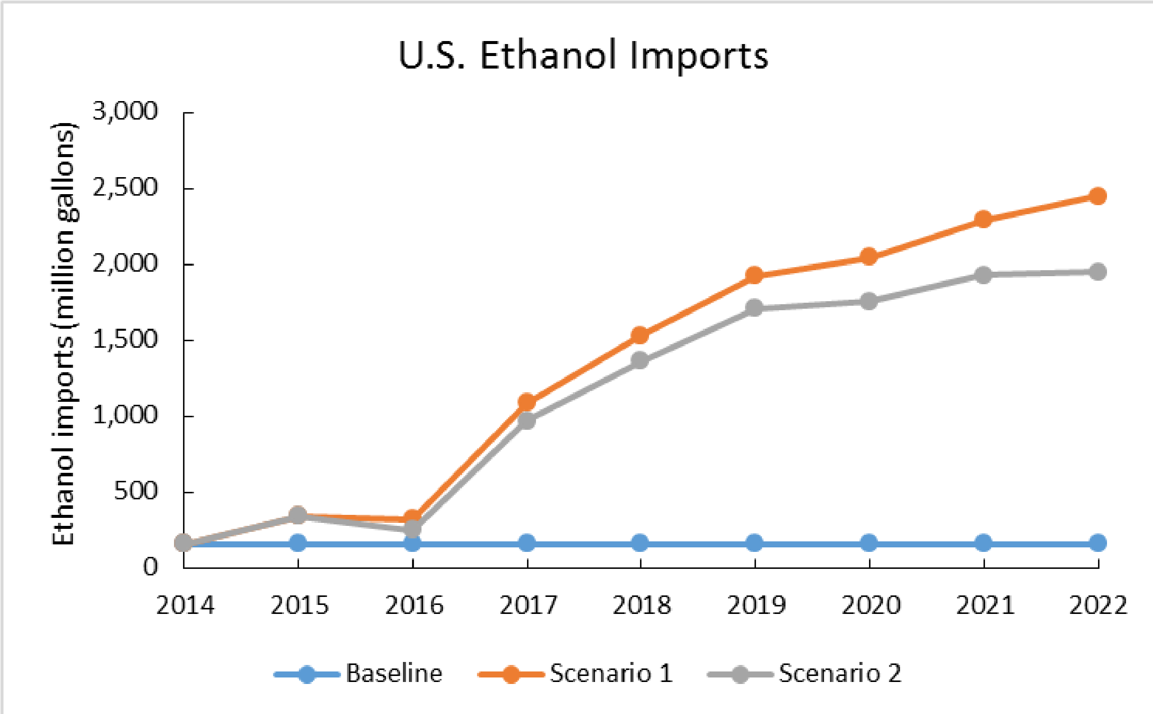

Figure 4. The path of U.S. ethanol imports trade under alternate scenarios

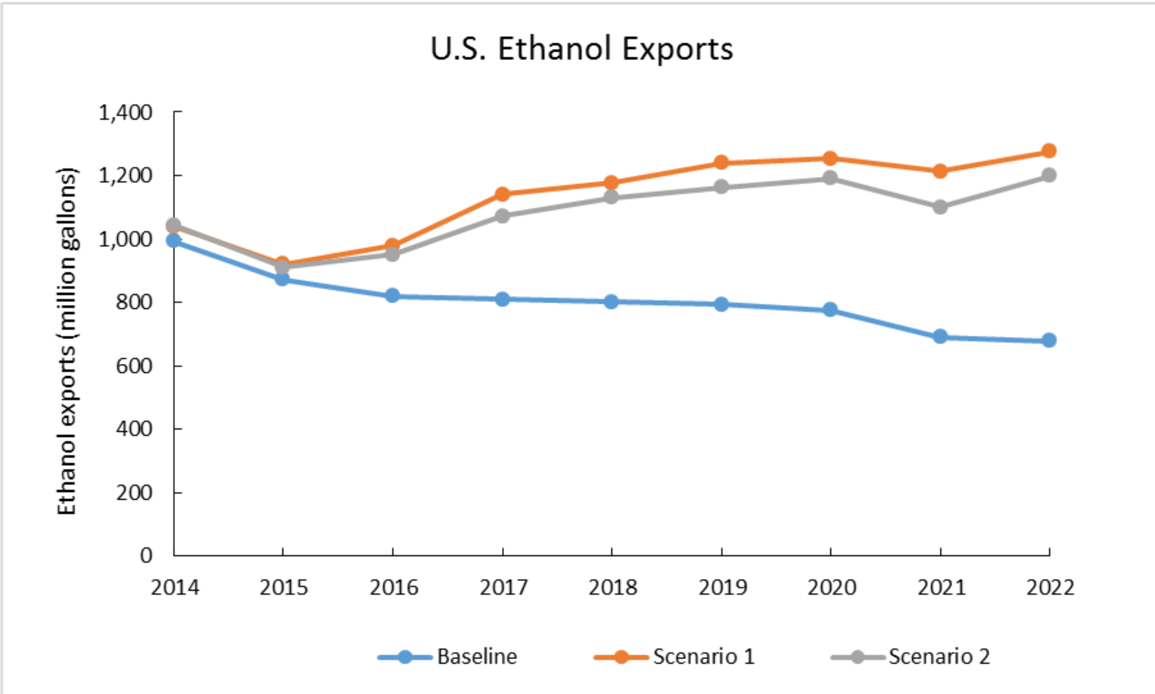

Figure 5. The path of U.S. ethanol exports under alternate scenarios