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Abstract: We assess the impact of a potential TTIP bilateral free trade agreement on the EU and US bio-economies (feedstock, biofuels, by-products, and related competing crops) and major trade partners in these markets. The analysis develops a multi-market model that incorporates bilateral trade flows (US to EU, EU to US, and similarly with third countries) and is calibrated to OECD-FAO baseline for 2013–2022 to account for recent policy decisions. The major policy reforms from a TTIP involve tariff and TRQ liberalization and their direct contractionary impact on US sugar supply, EU biofuel production, and indirect negative effect on US HFCS production. EU sugar and isoglucose productions expand along with US ethanol and biodiesel and oilseed crushing. EU sugar would flow to the US, US biofuels and vegetable oil to the EU. We further quantify nontariff measures (NTM) affecting these trade flows between the EU and the US. EU oilseed production contracts, and EU crushing expands with improving crushing margins following reduced NTM frictions. Our analysis reveals limited net welfare gains with most net benefits reaped by Brazil and not the two trading partners of the TTIP.

Keywords: TTIP, bilateral trade agreement, biofuel, ethanol, biodiesel, sugar, nontariff measure

JEL Codes: F13, Q17, Q42, Q48

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1. Introduction

This paper presents a quantitative analysis of a potential EU-US Transatlantic Trade and Investment Partnership (TTIP), a bilateral free trade agreement, with a focus on its implications for bioenergy and associated feedstock markets. The investigation accounts for EU and US current trade and farm policies affecting biofuel and feedstock markets and energy policies setting bio-energy regulations and targets in these respective economies. Recent assessments of a TTIP already exist (Akhtar and Jones 2012; Atlantic Council 2013 and 2014; Bureau et al. 2014; Ecorys 2009; Fontagné et al. 2013; Francois et al. 2013; GED 2013; Hansen-Kuhn and Suppan 2013). However, a detailed investigation of the implications of a TTIP on the bio-economies of the two trade partners has not yet been provided to the best of our knowledge, while those sectors are gaining economic and political importance. We fill this void.

The objectives of the analysis are: (*a*) to assess the impact of the potential US-EU free trade agreement on respective bio-economies in the EU and the US (feedstock, bioenergy, related crops competing with feedstock); (*b*) to assess and decompose the impact of various policy components in the agreement (tariff, tariff-rate quotas, regulatory policies, NonTariff Measures (NTMS), and possible exceptions for sensitive products); and (*c*) to provide a more qualitative assessment of potential regulatory harmonization between the two countries on advanced and sustainable biofuels and on associated feestocks for policies too complex to be parameterized.

The topic is of importance because open borders between the two large trade partners will alter incentive and returns to produce feedstock and biofuels in both regions. Further, the bilateral policy change will alter trade patterns with third countries. Increased reliance on bilateral EU-US trade could compromise or expand the development of biofuel production capacity in third countries depending on the outcome.

The approach used in the analysis is based on a calibrated multi-market model that incorporates the spatial aspect of bilateral trade flows (US to EU, EU to US, and similarly with third countries of interest) for biofuel and feedstock markets and associated major crops competing for land use. Linkages between feedstock, bioenergy, and energy markets are explicit and inclusive of bio-renewable policies. More specifically, the modeling approach relies on micro-economic foundations reflecting optimizing behavior by economic agents. It also includes a simple, yet novel, approach to modeling bilateral trade with both intensive and extensive margins to trade. The approach allows having explicit bilateral trade, which cannot be modeled properly in many partial-equilibrium models in which all countries trade with the "world market" as in the Aglink-Cosimo model of the OECD or the FAPRI model. The extensive margin of trade is based on relative competitiveness of exporters and some cost threshold to export profitably. Competitiveness and thresholds change with a TTIP and new bilateral trade can take place. The analysis also captures the distributional gains and losses induced by the TTIP free-trade agreement across the modeled agricultural and biofuel sectors.

The decomposition of third countries accounts for the existing EU-Mexico trade agreement. Canada was currently finalizing negotiations on its own bilateral agreement with the EU but the latter had not led yet to an official agreement and implementation schedule when we undertook the analysis. These countries are integrated into NAFTA and trade diversion could potentially take place in absence of any of the three bilateral NAFTA-members-EU agreements required to make it diversion proof. Some rules of origin could also be eased if a total NAFTA liberalization is achieved (all NAFTA-sourced products to the EU), rather than country-specific rules of origin for goods going to the EU.

2. Policy Section

In the following sections, we focus on key farm, bio-energy, and trade policies relevant for our analysis and refer readers to OECD (2014), Bureau et al. (2014), and Schnepf (2010) for a more detailed coverage of the history and context of these policies.

2.1 Farm policies

Farm policies in the US and EU have reduced their distorting impact on world markets and on farmers' decisions at the margin. They have known and mostly small effects on exit decisions, credit constraints, and risk taking (Viaggi et al. 2010 ; Féménia et al. 2010; Bureau and Gohin 2009; and Bhaskar and Beghin 2009, for a review). They remain sizeable in terms of the implicit transfer going to farmers and relatively larger in the EU than in the US as a share of farm receipts. We describe key policies relevant of the two farm policies for our analysis.

2.1.1 US farm policy

US farm policy provides extensive price/income support, crop insurance, and revenue insurance, affecting risk taking by providing a subsidized safety net. These insurance programs are available for most crops. There is a new price support program called the price loss coverage that is triggered by prices falling below reference prices. There is also a new revenue support program called Agriculture Risk Coverage program, which is triggered by revenues falling below a moving average-based benchmark revenue level. These two programs are exclusive and based on base acreage, not on current land allocation. These programs have very limited effects in a high-world price environment as the one predicted in the OECD-FAO baseline and which abstract from production shocks. According to the OECD, the total support received by US farmers represents 8% of farm receipts in 2011–13 of which 22% is considered distortive by the OECD. For grains and oilseeds, the level of market price support (difference between world price and domestic price) is inexistent.

In contrast to this absence of direct price distortions in grains and oilseeds, US sugar policy remains highly distortive. It combines trade distortions (TRQ and high tariffs), as described in the trade protection section, and domestic markets interventions to limit production and to support prices. The marketing allotment systems sets the maximum US sugar volume that can be used in human consumption (based on stated expected consumption by food processors). However, it is rarely binding (set at a minimum of 85% of consumption), suggesting that trade restrictions are the key element of US sugar protection. Sugar producers (not the farmers) can take on loans. The producers then have to pass on a share of the loan to farmers. Loan rates are set at 18.75 cents per pound for raw sugar and 24.09 cents per pound for white sugar with some minor regional variations to account for location. The loans are “nonrecourse” so sugar can be forfeited to pay back the loan when it is advantageous. In our simulations, US sugar prices remain above loan rates in all simulations.

In 2013, USDA had to buy US sugar under the so-called Feedstock Flexibility Program to prompt prices above loan rates to avoid forfeiture. The sugar went to ethanol production but with few takers. This was an exceptional situation, however. Most of the times, USDA manages the TRQs restrictively such that domestic prices are much above loan rates as it is the case in 2014.

2.1.2. The EU Common Agricultural Policy

Most current components of the CAP are not product specific and are nearly decoupled from marginal decisions. The support level has been falling because of the CAP reforms and the high world price environment. The support received by farmers in 2011–13 represents 19% of farm receipts of which 26% was made of distorting support. Market price support for most crops except rice is zero. The reforms introduced in 2013 and 2014 hardly change this tendency. This means that the possible consequences of the CAP (2013 CAP reform) for feedstock in our analysis have to do with the sugar sector. Sugar production quotas will end in 2017, a major change for the sector in the EU, where quotas ensuring high guaranteed prices have been in place since the 1960s. Since 2006, the EU sugar sector has been profoundly transformed and rationalized. It has become a much more competitive sector, and in some member states, sugar production is probably more competitive than its US counterpart. The two remaining sugar distortions are production quotas to be removed in 2017 and the trade protection via TRQs and high tariffs faced by a few countries such Brazil and Australia. Until September 2017, the EU sugar policy includes production quota management, a reference price, a minimum guaranteed price to growers, and trade measures discussed below.[1] Other interventions in sugar markets by the EU Commission are possible but have not taken place during recent years. Unilateral EU commitments to refrain from using export refunds after the WTO ruling against its export subsidies, together with low budgetary resources, have worked well.

EU beet sugar production is the dominant form of sugar. Trade agreements with LDCs and the WTO ruling on subsidized exports forced the EU to cut its production significantly. Area grown in sugar beet in the EU-15 has halved in 20 years and beet yields have increased considerably along with yield in sugar exceeding 10% on EU average, and approaching 15% in some areas. Technical progress, combined with a large restructuring of sugar production (from 180 sugar plants to 105 currently), spurs the economic concentration around five multinational groups and a shift towards most efficient. Beets suffer from a structural cost handicap compared to cane production. Cane can be harvested over a longer time period and bagasse provides more energy than used by the refining process. Beets distillation and refining require fossil energy.

The removal of the sugar production quota system could result in a potential decrease in EU domestic sugar prices, benefiting food processors and the soft drink industry. The end of the quota system will remove current limitations on EU exports.

The EU soft drink industry has not shifted to isoglucose (syrup made from grains like corn) to abate high sugar cost, in contrast to the US soft drink industry using high-fructose corn syrup. EU isoglucose has been subject to production quotas to protect the EU sugar industry. In addition, imports of HFCS have been limited by high tariffs. This could change with free trade in HFCS/isoglucose under a TTIP, as shown later in our analysis.

2.2. Biofuel policies

[1] The reference price is €404.4 per MT for refined sugar (€335.2 per MT for raw sugar). Sugar factories are required to pay farmers a minimum price of €26.29 per MT for sugar beet for the production of quota sugar.

2.2.1. US biofuel policy

The US EPA is in charge of conceiving and implementing the US biofuel policy. The policy focuses on a minimum volume blended into transportation fuel, known as the Renewable Fuel Standard (RFS). The first RFS and its mandate came about with the Energy Policy Act of 2005. The target was to reach 7.5 billion gallons of ethanol into gasoline by 2012. A second piece of legislation, the Energy Independence and Security Act (EISA), known as RFS2, expanded the 2005 RFS to include diesel. RFS2 increased the volumetric target and time horizon of the mandate for renewable fuel to be incorporated into transportation fuel. It increased from 9 billion gallons in 2008 to 36 billion gallons by 2022. EISA identifies different renewable fuel types based on the feedstock and the fuel type (biodiesel, ethanol). The feedstocks include cellulosic, starch from corn and other sources, oil for biodiesel, and sugar. The mandate is decomposed into separate subcomponents as shown in Table 1 taken from Schnepf. All these biofuels have to satisfy different carbon savings as explained in Section 6 on biofuel standards. The estimation of carbon saving has been controversial and political (Schnepf). Conventional ethanol has to reach 15 billion gallons by 2015 and remain at that level until 2022. The advanced biofuel mandates increase over time to reach 11 billion gallons in 2022. The US EPA uses an identification system called Renewable Identification Number (RIN) to track the blending by refiners. There is a market for these RINs. Refiners who exceed their mandate can sell their excess RINs. The US currently produces in excess of the mandate and export ethanol profitably. Advanced biofuels receive special RINs worth more than the corn-ethanol RINs since advanced biofuels are scarcer or have to be imported.

The US used to have tax distortions to influence the blending and consumption of biofuels in transportation fuels. A blender tax credit was given for ethanol and then for biodiesel. These have expired at the end of 2011 for ethanol, and the end of 2013 for biodiesel. The matching tariff imposed on ethanol imports to offset the incentive to import for blending was also removed at the end of 2011.

The introduction of E15 was authorized by the EPA in 2010. Many specialists believe that there is an ethanol blending wall around 10% content of ethanol in gasoline, and roughly at 13 billion gallons in current market conditions. E15 is not recommended for older vehicles and car manufacturers are concerned about potential liability. The OECD-FAO baseline assumes that E15 is partially adopted in the US, which increases the domestic consumption of ethanol in the baseline trajectory.

Table 1. Expanded Renewable Fuel Standard Requirements Under P.L. 110-140

		Advanced Biofuels			
Year	Total RFS Mandate (billion gallons)	Total Advanced Biofuel Mandate (billion gallons)[a]	Cellulosic Biofuel Mandate (billion gallons)[b]	Biomass-Based Diesel Fuel (billion gallons)[b]	Unspecified (Effective Cap on Corn Ethanol)[c]
2006					
2007					
2008	**9.0**				9.0
2009	**11.1**	0.6		0.5	10.5
2010	**12.95**	0.95	0.0065[d]	0.65	12.0
2011	**13.95**	1.35	0.25	0.8	12.6
2012	**15.2**	2.0	0.5	1.0	13.2
2013	**16.55**	2.75	1.0	1.0	13.8
2014	**18.15**	3.75	1.75	1.0	14.4
2015	**20.5**	5.5	3.0	1.0	15.0
2016	**22.25**	7.25	4.25	1.0	15.0
2017	**24.0**	9.0	5.5	1.0	15.0
2018	**26.0**	11.0	7.0	1.0	15.0
2019	**28.0**	13.0	8.5	1.0	15.0
2020	**30.0**	15.0	10.5	1.0	15.0
2021	**33.0**	18.0	13.5	1.0	15.0
2022	**36.0**	21.0	16.0	1.0	15.0

Source: CRS analysis of P.L. 110-140.

2.2.2. EU biofuel policy

The EU biofuel policy is officially motivated by the EU strategy to reduce greenhouse gases emissions and dependence on foreign oil supply, and less officially, to support the farm sector. Biofuels boost agricultural demand without negative impact on world prices. The EU has had several directives to try to boost biofuels to be blended in conventional fuel using various incentives. Failure to meet voluntary targets brought a mandatory target for renewable energy in transport in 2009, the Renewable Energy Directive (RED).

The RED states that renewable fuels, including green electricity and hydrogen, should reach 10% of transport fuel in 2020. The RED introduces sustainability criteria: minimal greenhouse gas savings have to be achieved—some types of land are excluded for biofuels crops—and social standards have to be met (see Section 6 on these biofuel standards).

Second-generation biofuels benefit from additional incentives. Biofuels made out of ligno-cellulosic, non-food cellulosic, and waste and residue materials count double towards the goal, with a calculation made on an energy basis. A reference to the indirect carbon debt aspects was kept in the final text of the RED, but without accounting for Indirect Land Use Changes (ILUC). Beyond the RED, the Fuel Quality Directive (FQD) also plays a role. The FQD increases the biodiesel cap in blends and changes the gasoline specification with higher oxygen content. It translates in a potential increase to 10% ethanol blend gasoline or up to 22% ETBE blend. This feature could potentially create a quantitative ceiling for biodiesel, since the FQD de facto sets a blend cap of 7% biodiesel (for FAME biodiesel). In addition, FQD interferes with the RED as it includes a binding 2020 target to reduce lifecycle GHG emissions of fossil fuels. All fuel suppliers must cut 2010 GHG emissions by 6% in 2020, across all fuel categories supplied to the market. Fuel suppliers can achieve this target in various ways.

In summation, both the FQD and the RED provide incentives for the consumption of biofuels, with the important difference being that the RED targets energy content while the FQD focuses on GHG reductions. Both the FQD and RED 2020 targets could be met by using 10% biofuels (by energy content) with a GHG emissions saving of 60% on average. Sustainability criteria were introduced in the FQD, nearly identical to those included in the RED.

National Renewable Action Plans still foresee some 19.8 Mtoe of biofuel in transport in 2015 and 29.7 Mtoe toe in 2020 (see Table 1). The EU Commission forecasts that the 2020 consumption of biofuels in transport would be slightly above 20 Mtoe in 2020 under the current policy. Reaching the RED target would require boosting consumption up to 30 Mtoe, which would require measures that go far beyond the ones already adopted (2013 use is around 13 Mtoe). Various states have different targets and there is much uncertainty the lofty target will be reached in 2020.

Table 2. EU National Action Plans for Biofuel Use

Total renewable transport energy for EU 27	2010 (Mtoe)	2020 (Mtoe)	Share of total renewables (%)
Ethanol/ETBE	2.9	7.3	22.2
Biodiesel	11.0	21.6	65.9
Hydrogen renewable	0	0	0
Green electricity	1.3	3.1	9.5
Other biofuels	0.2	0.8	2.4
Total renewable	***15.3***	***32.9***	***100***

Source: National Action Plans

Biofuel represented 5.3% of transport fuel consumption in the EU in 2013. However, this accounts for those biofuels that are eligible to double counting. In physical terms, the share is 4.7%. Most of the recent increase in biofuel use comes from double counting provisions of regulations. As shown in Table 2, ethanol represented roughly 22% of the physical market in energy content. Growth in consumption has been anemic in recent years and negative this year. Declining gasoline consumption has been constraining and so are the lack of E10 availability and restrictions on imports.

2.3. Trade protection via tariffs and TRQs

2.3.1. Trade Protection in the US

US border protection on grain feedstock is negligible. The US has low or no tariffs on most feed grains, and several preferential agreements with zero-tariff on grains with Australia, NAFTA countries, and others. On food grains a similar picture emerges. Tariffs on wheat are $6.5/MT for durum wheat, and $3.5/MT for other wheat. Rye and oats are tariff-free. Barley has an import tariff of $1/MT for malting barley, and of $1.5/MT for other uses. Corn is tariff-free for seeds, yellow dent corn is $0.5/MT, and other corn is taxed at $2.5/mo. Sorghum imports are taxed at $2.2/MT.

US oilseeds and products also exhibit low border protection except for peanuts. Peanuts are not used for vegetable oil used in biodiesel. Peanuts are not grown in the EU. MFN tariffs are zero on soybean, copra, and sunflower seeds. Rapeseed imports face a $5.8/MT tariff. As for grains, preferential agreements with many countries allow for imports at zero-tariffs.

Some oils are protected. For example, the soy-oil MFN tariff is 19.1%, whereas palm oil imports are free of tariffs. The US is a natural exporter of soy oil given its competitive advantage in soybean production and low cost of crushing.

US sugar markets are highly distorted and protected at the border (Beghin and Elobeid 2014). US sugar farm policy is made possible through restrictions on imports. There is an extensive bilateral TRQ system limiting imports with prohibitive out-of-quota tariff rates on raw and white sugars. Domestic price levels historically have been two-to-three times the level of world prices. These price discrepancies were smaller in 2013 because of a large US supply but the difference became large again in 2014. The out-of-quota tariff is 15.36c/lb raw sugar and 16.21c/lb for refined sugar. Free imports come from Mexico under NAFTA but are limited by the low international competiveness of the Mexican sugar industry and by some rule of origin that limits exports to the US to the net balance of sweeteners (sugar production net of sugar and HFCS use) but with loose enforcement of that rule. The US sugar lobby has been very effective at limiting the influx of sugar imports under other agreements such as CAFTA, and the bilateral Australia-US agreement. As a result of the trade restrictions, domestic US prices remain high.

US ethanol protection decreased significantly at the end of 2011. The sizeable specific ethanol tariff put in place to offset the effect of the former blender tax credit was removed. A small ad valorem tariff remains on ethanol imports (1.9% on HS 22072000 and 2.5% on HS

22071000). The TRQs for ethanol from CBI countries entering at zero tariff have lost their "raison d'être" given the almost free-trade between Brazil and the US and the higher cost of transiting through the CBI countries to meet the TRQ conditions. The US does not have an official tariff line for biodiesel under HS 38249091-97, 15162098, or 15180091.The US imports biodiesel from Argentina, Germany, and Indonesia.

2.3.2. EU trade protection

At the EU border, exporters of several cereals face variable levies/tariffs. The rates are bound under the WTO Uruguay agreement as for the US, but a formula agreed upon during the Uruguay Round results in EU tariffs having a system of double ceiling. This de facto introduced some variable duties, capped with the bound tariffs, for specific cereals, namely high quality common wheat, durum, maize, rye, and sorghum, varying as a function of world prices within the limits of the bound rate. In addition, the EU has lowered its duties on grains such as corn when world prices are high in order to prevent the price of feedstuffs to rise too much. Bound tariffs (fixed) are high in sugar, and, to a lesser extent ethanol, but tariffs on oilseeds, cakes, and vegetable oil are bound at low levels. In the few sectors with high bound tariffs, preferential agreements have opened the EU market to imports and forced reform as is the case for the EU sugar industry. The resulting protection differs dramatically by origin of imports. US agricultural exports to the EU continue to face high tariffs in some categories, namely ethanol, biodiesel,[2] sugar, and isoglucose. That is, even though the US is hardly competitive in sugar, the EU applied external tariff puts the US in a less favorable situation than other countries benefiting from unilateral tariff concessions or a FTA with the EU in products where the US has a competitive advantage (grain, oilseed products, biofuels, and HFCS).

EU border protection for cereals is complex but it has ultimately been low over the recent years, in particular because of the relatively high world prices. The effectively imposed variable levies are low or null under current and foreseeable market conditions as those encapsulated in the OECD baseline used in our analysis. For low-quality soft wheat, barley, and corn there is a series of Tariff Rate Quotas (TRQs) and imports enter at a reduced tariff rate (in-quota rate).

The EU charges high specific import duties on sugar under the MFN regime. These EU tariffs are set at €339/MT of raw sugar for refining, and €419/MT of other raw sugar. Sugar containing imports face duty in proportion with the sugar content, sometimes in complex forms.

[2] The biodiesel tariff is only 6.5%, but in periods of high border prices the tax becomes significant.

Special safeguard clauses can take place when world prices are depressed. The EU market is much more open than suggested by the high MFN tariffs. Preferential imports of raw sugar take place under many agreements, including LDC countries under the Everything but Arms initiative, Economic Partnership Agreement (ACP) countries, Balkan countries, and partners from the Andean Pact, and Central American FTA arrangements. Sugar is imported at reduced or nil duty under various WTO TRQs, including those corresponding to compensations for the EU enlargement. TRQs include some 677 TMT of raw cane sugar for refining with quotas allocated to Brazil (334 TMT), Cuba (69 TMT), Australia, and India as well as a 254 TMT *erga omnes* quota. The TRQ allocated to India faces a zero duty, all other TRQ include a €98/MT in-quota tariff.

In addition, end-using industries can sometimes obtain sugar and isoglucose at world prices when the EU Commission allows duty free imports of sugar and isoglucose for industrial uses to avoid very high domestic prices. Altogether, the actual protection on sugar applies only to a limited number of countries, including Australia and Brazil, and even these countries are eligible to lower duty imports under TRQs.

After the 2005 WTO ruling against its trade policies, the EU stopped using various export subsidies, subsidizing re-exports of ACP sugar imported under preferential agreements. It also stopped granting export refunds for processed products. Under high world prices, the EU is a competitive exporter. Under a TTIP, high prices in the US market would induce EU exports to the US market. Isoglucose faces a duty of €507/MT of net weight. Tariff concessions exist and are similar to those made for sugar. The US faces the high tariff on its potential exports of HFCS. With bilateral liberalization, US HFCS would be competitive for use in EU food processing. Food technology is the limiting factors to the expansion of using isoglucose/HFCS after 2017 when isoglucose production quotas are removed. The technology is currently not well adapted for large uses of HFCS.

EU border protection of ethanol depends on preferential agreements and the statistical classification of ethanol related products. Numerous fuel blends are imported under different classifications. The MFN tariff on ethanol for fuel is €19.20/hl for undenatured ethanol, and €10.20/hl for denatured ethanol. As for sugar and isoglucose, some ethanol imports occur with reduced duties under preferential agreements. Currently, the US face a higher than MFN tariff from added antidumping duties (currently €62.3/MT of bioethanol) that will expire by 2018. The list of tariff exemptions for undenatured ethanol is rather similar. As we consider the 2022 horizon in our analysis, we do not take into account the current anti-dumping duties and only consider the MFN tariff rate.

There is a zero tariff on oilseed imports in the EU. Soybean and rapeseed oil intended to be used in nonfood production faces a 3.2% MFN duty, while oil for human consumption faces a 6.4% MFN duty. Palm oil imported for industrial use faces zero duty, while palm oil for human consumption faces a 3.8% duty. Exemptions are as numerous as for ethanol and sweeteners. Biodiesel raises the same issue as ethanol blends regarding statistical classification. The MFN level of protection is at 6.5%. There are many exemptions (zero rate) under preferential agreements as noted before. Indonesia, Argentina, the US, and Canada face a higher protection due to antidumping/countervailing duties. In the case of the US, these duties were imposed after the "splash and dash" trade disruption. These special duties will expire between 2015 and 2018, depending on the country and are not incorporated in our analysis for 2022.

2.4. Nontariff measures

In addition to tariffs and TRQs, access to EU and US markets is also hampered by NTMs. NTMs often stem from regulations pushed by consumer organizations, and by producers when it is in their advantage, providing hybrid protectionism difficult to deconstruct. Barriers to imports of genetically modified (GM) products illustrate the issue as shown next.

2.4..1. GMO issues in the US

The US regulation of GMO crops is based on the product (crop) and processed form to assess food safety. US National (federal) regulations of GMO crops are undertaken by the USDA, US EPA, and the US FDA. These three federal agencies coordinate their action on GMOs. Health and environmental risk assessments have to be undertaken before a GMO crop is approved and the GMO crop has to meet standards set by State and Federal regulations (Fernandez-Cornejo et al. 2014). USDA's Animal and Plant Health Inspection Service (APHIS) regulates field testing of GMO crops and other GM products using required permits or more flexible notifications under special conditions. After multiple field tests, APHIS can be petitioned to obtain a nonregulated status to start commercialization of the crop, assuming negligible environmental or phyto-sanitary risk. GM plants engineered to produce a substance that affects pests are regulated by the EPA under pesticide regulations. The FDA's mandate is to keep the US food supply safe. Food containing GMO material should be safe for human consumption and the GMO input should be tested.

To date, numerous corn and oilseed GMO crops have been approved in the US for agricultural production and food consumption, but these approved crops suffer from asynchronous approvals abroad, especially in the EU. Their exports are somewhat restricted or risky because of co-mingling of approved and non-approved (in the destination country) commodities in bulk shipments as exemplified by US corn export blocked in China. US exports of corn and soybean to the EU face labeling requirements and have to be made of approved GMOs for utilization in feed and food.

GMO sugar beet have been approved in the US since 2010 and widely adopted but the beet approval was revoked in August 2010 by a federal court because the USDA had not done the proper environmental assessment. USDA authorized planting of the same GM beets in 2011 while the complementary assessment was done, circumventing the potential constraint implied by the court ruling.

2.4.2. EU GMO regulation

EU legislation on GMOs is fragmented, inconsistent, and the practical regulation is not always grounded in legal texts (de facto moratoria). It is highly restrictive regarding the possibility to grow GM crops and to import some GM products (Moschini).

Cultivation of GMOs is authorized at the EU level on a case-by-case basis after an application and a safety assessment. In practice, growing GM crops is restricted to a very limited number of corn varieties and some states have put bans. Recently, though, Member states have become so divided on the issue that there was no sufficient majority in the Council for or against a decision to approve GM events for cultivation or food and feed use, leaving the Commission by default to take the final decision. Since June 2014, the regulation allows any member state to prohibit cultivation of GM crops on its territory. In practice, there is only one GM crop produced in the EU (MON810 maize) in five member states.

Use and consumption of GMOs is less restricted than cultivation. The use of GMO-derived products in the food and feed chain is subject to an EU authorization, if the absence of risk for human and animal health and the environment can be established. The latitude left to member states to prohibit growing a GM crop does not allow them to ban trade of an EU approved GM crop. Currently, 50 authorized GMO varieties for food and feed use include 27 for corn, 7 for soybean, 3 for rapeseed, and 1 for sugar beet and others. Food and feed products containing

GMOs must be labelled as such with a tolerance of 0.9%. 68 GMO applications are at various stages of the approval process.

The EU used to import large quantities of maize by-products from the US for use as animal protein feed (CGF and DDGS). This trade has declined since 2007 because of asynchronous adoption of new GM varieties and co-mingling. Our model has less than .5 MMT of coarse grains flowing from the US to the EU. Most of the imports come from Brazil and Argentina and the rest of the world. The EU, whose soybean and meal consumption is 70% imported, nevertheless imports large quantities of GM soybean from Argentina, Brazil, and the US. Animals reared with GM feed do not require GMO labeling.

In sum, our assessment suggests that EU regulations on GMO are more stringent than those in the US, and the difference in approach between a product-based regulation in the US and a process-based regulation in the EU could be problematic. Currently they are not affecting trade in biofuels and their effects on feedstock trade is limited for oilseeds, but a potential source of frictions may come from asynchronous approvals especially for corn exports coming out of the US to the EU under a TTIP.

2.4.3. US biofuel sustainability standards

The US requires a life cycle assessment (LCA) analysis to establish GHG savings achieved with biofuels. Renewable fuels have to achieve a 20% reduction minimum to qualify with the carbon-saving provisions of the Energy Independence and Security Act (EISA) of 2007 and the following RFS2 program, which is met by conventional corn ethanol. Advanced biofuels have to achieve carbon savings of 50% minimum. This covers biodiesel from several processes, sugar-ethanol, and ethanol based on other starch than corn. Cellulosic biofuel is derived from cellulose or lignin from renewable biomass from existing land in production or dedicated crops, crop residues, planted trees and residues, algae, yard waste, and food waste. Currently, the US produces some bio-diesel and imports Brazilian cane sugar to meet the advanced biofuel component of the RFS2 mandate. Cellulosic ethanol is not commercially viable at any significant scale. Some states like California have additional standards to reduce the carbon intensity of energy used in transport fuels.

2.4.4. EU biofuel sustainability standards

The EU also requires a LCA on GHG savings. The RED conditions the counting of biofuels toward the stated target of 10% use in transportation to sustainability criteria. The RED specifies a 35% requirement for GHG emissions-saving threshold as a starting point. The threshold will increase. In 2018, biofuels plants in operation before mid-2014 must meet a GHG-saving threshold of 50%, and those put in operation after that a GHG saving threshold of 60%. At the end of 2017, the Commission plans to submit a review of policy and best scientific evidence on ILUCs to the European Parliament and Council. This could lead to revisions in the list of biofuels that can benefit from public support. Current LCAs only measure direct land use change. Default values or specific values can be used. A set of "standard default values" is included in the RED. The prospect of accounting for ILUCs in the LCA seems remote, given the political balance on this issue in the Council, and because ILUCs measurement requires making assumptions that might lead to legal challenges. ILUCs would make it impossible for most of the first generation biofuels (cane-based ethanol being an exception) to meet the GHG-saving threshold. The EU biodiesel industry is based on low-yield crops like rapeseed. Land displacement effects could be larger than for crops with a higher yield (e.g., sugar beets). In the simulations, we assume that the carbon implications of ILUC are excluded and that US ethanol and biodiesel meet the RED and can be imported in 2022.

Additional sustainability criteria included in the RED have to be met for biofuels to be eligible for financial support and to count against the national quotas that meet the RED biofuel target. Environmental criteria restrict land types used to grow feedstock. Excluded land types include natural forests, protected areas, high biodiversity areas, wetland and peat bogs. Converting forests for palm oil plantation is ruled out. Last, to comply with the RED, imports must come from countries that have ratified international conventions regarding labor rights, biotechnology risks, trade in endangered species and other environmental issues. The RED also includes a few unverifiable social criteria. Compliance with the sustainability criteria is certified through voluntary schemes submitted by operators to the European Commission.

2.4.5. Maximum residue limits affecting feedstock crops

Next we look at the stringency of maximum residue limits (MRLs) set on pesticides on crops and food items in the EU and the US. These are based on USDA FAS data and using aggregation formulas developed by Li and Beghin (2014). Two scores are developed (score1, score 2), one using default values for pesticides not explicitly mentioned and the other using only the pesticides explicitly regulated. These scores are shown in Table 3 below. Any score value larger than 1 indicates MRLs more stringent than the Codex international standard, which is based on science and gauged as non-protectionist.

Table 3. Maximum Residue limits on Pesticides in US and EU agriculture

country	product	score1	score2
European Union	Sorghum grain	1.259	1.199
European Union	Soybean	1.242	1.211
European Union	Corn grain	1.197	1.197
European Union	Wheat grain	1.156	1.083
European Union	Sunflower Seed	1.156	1.054
United States	Wheat grain	1.083	1.083
United States	Soybean	1.067	1.067
European Union	Oat grain	0.998	0.884
United States	Sorghum grain	0.942	0.942
European Union	Peanut	0.925	0.788
United States	Peanut	0.898	0.898
United States	Oat grain	0.883	0.883
United States	Corn grain	0.872	0.872
European Union	Sugar Beet Roots	0.821	0.821
United States	Sunflower Seed	0.695	0.695
United States	Sugar Beet Roots	0.614	0.614

Table 3 shows that soybean, sunflower seeds, sorghum, and corn exhibit protectionism in the EU and little in the US, whereas wheat MRLs are somewhat protectionist in both economies. Sugar crops seem to be loosely regulated in both economies. It is not possible to directly use these results on MRL stringency in our model. However, MRLs on pesticides used for oilseeds and for coarse grains in Europe are more stringent than those in the US. This fact corroborates our NTM simulation results in which the oilseed complex in the EU was affected by a reduction in frictions. The stringency differential regarding MRLs for coarse grains did not manifest itself in the NTM simulation, however. The negligible changes in sugar crops in the NTM simulation are consistent with the lack of stringency in MRLs for these crops.

2.4.6. NTM ad valorem equivalents

Several studies provide broad-brush aggregate characterizations of NTM regimes in terms of their tax effect on bilateral trade flows usually expressed in ad valorem equivalent (AVEs) (Kee et al. (2009); Bureau et al. (2014); Beghin et al. (forthcoming), among others). Most, if not all, of these AVE estimates suffer from substantial conceptual and empirical limitations. One key limitation is that the aggregation of various NTM policies into a count or frequency variable makes it unclear what regulation or policy is inducing a particular effect on trade. Next, we review these estimates, but as shown, rationalizing their variations remains a frustrating exercise.

The newest estimates come from Bureau et al. (2014) who look at the impact of SPS and TBT regulations on bilateral trade in the US and Europe. For the US, the mean and median

AVEs in agriculture are 47.8% and 22.5%. In the EU, the corresponding central values are 53.6% and 37.5%. Medians are less sensitive to extreme values than means are, so we give more credence to the median AVEs. These AVEs suggest that NTMs are larger impediments in the EU than in the US. This finding is broadly consistent with recent estimates using older data (Beghin et al. forthcoming). The latter authors find individual AVEs near zero for most US crops and vegetable oils, whereas their estimates for 9 large EU countries are 29% for oilseeds, 22% for wheat, 31% for coarse grains, and 77% for vegetable oil. These figures parallel the MRL stringency story, but we cannot link the two elements since we do not know the detailed SPS and TBT regulations captured by the NTM aggregate proxy in Bureau et al.

Fontagné et al. use both the CGE modeling approach of Ecorys (2009) and Kee et al. (2009) to obtain NTM AVEs in agriculture. These AVEs are high (51.3% on average in the US and 48.2% in the EU). Ecorys also use a CGE model but with a single aggregate agricultural sector and estimates NTM AVEs of 56.8% for the EU and 73.3% in the US. These high AVE estimates are obtained with a CGE model approach; the implied reversal of relative magnitude between the US and the EU compared to the econometric estimates leave us quite uncertain, however. We use an alternate approach based on price differentials in our trade reform analysis later on.

3. The Partial Equilibrium Multimarket Model

3.1. Model characteristics

We develop a partial equilibrium (PE) multi-market multi-country model based on a modified Aglink-Peatsim structural approach with well-specified supply and demand decisions by decentralized optimizing agents (Somwaru and Dirkse, 2012). Food and energy processing sectors are incorporated using GTAP modeling information to consistently account for resource flows. Supply and demand are specified for each market in each country/region. Bio-energy demands/uses are set exogenously according to declared policy objectives for 2022. See the policy section on this point.

The model covers the following sectors: ethanol from corn and other grains, ethanol from sugar, bio-diesel, coarse grains, wheat, raw sugar, refined sugar, beet, cane, isoglucose or high fructose corn syrup, corn gluten feed, distiller grains, oilseeds, vegetable oils, and meals. The country coverage includes Argentina, Australia, Brazil, Canada, China, the EU, Mexico, the US and an aggregate rest of the world.

An extensive welfare analysis is provided, a feature which often eludes this kind of partial equilibrium analysis (for example, FAPRI or Aglink analyses do not provide welfare impacts). Welfare measures are consistently specified based on the model structure for producers, consumers, and taxpayers. To provide a consistent welfare assessment on agricultural production we follow the approaches of Pope and Just (2003) and Carpentier and Letort (2012). The latter approach accounts for cross-price effects in agricultural production and is based on explicit and sound micro-economic foundations.

The Aglink-Peatsim approach is modified to account for bilateral trade and the possibility of an extensive margin to trade (new bilateral trade via a new trading country pair). The PE modeling approach adopted for the analysis innovates on this point and departs from both the traditional Armington type of structure which is ill-suited to capture new trade flows and from the aggregate trade flow approach of FAPRI and Aglink type of models. The bilateral trade approach broadly follows the suggestions of Nolte et al. (2010) and Coleman (2009). Bilateral trade is explicit and the sum of bilateral trade flows is calibrated on the aggregate trade flows in and out of any given country provided by the Aglink projections. As a consequence, NAFTA trade flows are explicitly accounted for between the US, Mexico, and Canada. Trade diversion is captured by this feature as we can assess the impact of the potential EU-US bilateral agreement on third countries like Brazil, which are major participants in many bio-energy and feedstock markets.

The calibration of bilateral trade flows is done using BACI data from the CEPII as explained in the data section and is based on relative competitiveness of countries. Countries not currently exporting a certain product face a marginal trade cost threshold that can be overcome after a trade reform lowering the landed cost of goods below the threshold. The drawback of this approach is that it requires expert opinion to establish a competitiveness ranking of countries in the sectors being analyzed that includes NTB and domestic preferences dimensions.

The policy and trade cost coverage includes bio-energy policy targets and mandates in the EU and the US, border tariffs, TRQs, some taxes, transportation costs, and reflect the 2013 CAP reform with its planned implementation in the coming decade. Of course, unit production cost at the margin is also captured by the model and is part of the landed unit cost of goods. In the reform scenarios, UE and US trade barriers are removed whereas trade distortions in other countries remained unaltered. Note that we consider the impact of a TTIP agreement fully implemented in 2022 and that we assume that all current anti-dumping and retaliatory policies affecting biofuel trade have been removed. We also make an attempt to capture nontariff barriers in the model by accounting for their implicit effect on price differentials between the EU and the US once all tariffs, quota rents, taxes and transportation costs are accounted for. We attribute the remaining unit price differential to non-tariff measures. This approach is often used to capture NTMs but it is admittedly a simple approach to the complex problem of quantifying the various effects of many NTMs. In the NTM section, we discuss the available evidence on EU and US NTMs and its limitations.

3.2. Data

For calibration, policy parameters are collected from WITS (tariffs, TRQs, some NTMs), official national policy documents, and from EU sources such as TARIC. Elasticities parameters, initial data and baseline results are gathered from existing economic models (the USDA PEATsim model (Somwura and Dirkse, 2012), and the OCDE/FAO Aglink/Cosimo (OECD, 2007). The quantity and price data used to calibrate the model come from the 2013 OECD-FAO Aglink projections for 2013–2022 (OECD 2013). Quantity variables include production, various uses, and aggregate imports and exports by country.

The aggregate trade flows are then allocated in bilateral shares of the total using BACI world trade database from the Centre d'Etude Prospectives et d'Informations Internationales (CEPII) in Paris on bilateral trade flows. By default, we apply the average of 2006–11 trade shares to the aggregate estimate from the outlook for 2022 to derive the physical flows of commodities and goods between any pair of countries in 2022. For some products such as ethanol where trade is growing, we allocate total trade flows into bilateral trade flows according to country price differentials and known policy measures (Meyer et al. 2013). There are limited data on DDG trade. For that reason we only cover US exports of DDGs to other countries.

4. Scenarios

The "business-as-usual" baseline scenario is calibrated on the 2013 Aglink-FAO agricultural outlook in its final year of 2022. Policy reform scenarios are then undertaken. We undertake two bilateral free-trade scenarios decomposing policy types (tariffs and TRQ removal in the two countries in one scenario, then a 50% reduction of trade cost from NTMs). We also undertake two scenarios of unilateral liberalization of the EU-US bilateral trade to see what import-competing sector is affected in the EU and then the US. We report the main impacts of the bilateral free trade scenarios in Tables 4 and 6.

In addition, we run an alternative baseline with reduced US bio-energy targets and then recompute a similar analysis of free bilateral trade in deviation from the new baseline. The alternative baseline assumes that the non-advanced biofuel US mandate is reduced from 14.79 billion gallons (55.90 billion liters) to 13.01 billion gallons (49.25 billion liters) (i.e., the actual 2014 non-advanced biofuel mandate). In addition, cellulosic ethanol is capped at 1 billion gallons (3.79 billion liters). Biodiesel is kept at 1.656 billion gallons. The mandate on advanced biofuel is reduced from 10.91 billion gallons (41.21 billion liters) to 7.99 billion gallons (30.24 billion liters), a 27.6% reduction. The reduction is based on assumptions in the OCDE outlook assuming a partial increase in non-cellulosic biofuel to offset some of the cellulosic reduction. This alternative baseline with its less ambitious US biofuel targets lowers the marginal cost of ethanol in the US and provides stronger incentives to export to the EU with a TTIP.

These additional scenarios and their implications are briefly discussed in the results section. In addition, some sensitivity analysis is conducted on elasticities in the model shaping the sugar-HFCS/isoglucose substitution. These alternative characterizations are discussed in the results section. Results are presented in the tables in levels for the baseline and then in percentage deviations for the reform results. Levels of quantity variables are in metric tons (MT) for all goods, except biofuels, which are expressed in hectoliters. Prices are in US dollars per physical unit (metric ton or hectoliter).

5. Results from Policy Scenarios Simulations

5.1. Tariff and TRQ liberalization

5.1.1. Market effects

We first look at the impact of removing border tariff protection and bilateral TRQs between the two trade partners. There are direct effects from removing protection in highly protected sectors (EU ethanol, US sugar, EU isoglucose, and EU bio-diesel to a lesser extent) and then indirect effects via demand for agricultural inputs in activities, substitution in feed and sweetener use, and in land allocation for crops. The table shows supply changes (production, aggregate imports), and then changes in use (feed, food, industrial, aggregate exports). The variable “Other use” is assumed exogenous in the model because it is residual use. Price changes are shown last. For each variable, except “Other use,” the percent change is shown along with the 2022 baseline level.

Table 4. Impact of Tariff and TRQ Removal on EU and US Bio-economies

EU	% change Production	2022 baseline Production	% change Imports	2022 baseline Imports	% change Feed	2022 baseline Feed	% change Food	2022 baseline Food	% change Industrial	2022 baseline Industrial	% change Exports	2022 baseline Exports	2022 baseline Other use	% change Price	2022 baseline Price
Wheat	-0.8%	148593	-16.7%	5527	3.0%	55534	0.1%	58786	-86.2%	7753	16.1%	17746	14273	-2.0%	238.2
Co. grains	-0.5%	160571	-39.5%	8867	2.1%	117794	0.1%	9850	-77.5%	15144	83.5%	5960	20566	-1.7%	281.4
Oilseeds	0.3%	33832	-5.6%	18981			0.0%	681	-2.0%	48402	0.0%	662	3089	-0.1%	524.7
Beet	4.3%	116855							4.3%	116855				5.8%	33.0
Cane															
Veg. oil	-1.9%	17164	-1.1%	10315			0.1%	11485	-3.7%	13694	4.8%	876	1414	-0.1%	1288.7
Meals	-1.9%	30180	4.2%	26317	1.6%	52500					-8.7%	3997	0	-0.1%	243.6
Raw sugar			61.3%	878					14.4%	867	3757%	11		4.0%	438.7
White sugar	20.8%	18760	57.5%	735			-1.4%	18334			366.7%	1249	88	3.5%	558.2
Biodiesel	-2.9%	18282	23.0%	2346							0.0%	98	20530	-0.2%	1872.4
Ethanol	-77.6%	12261	240.8%	3949							0.0%	112	16098	-15.5%	1058.4
HFCS	12.4%	1281	129.5%	29			15.1%	1306			0.0%	5		-1.7%	406.0
CGF	2.3%	2712	-61.2%	120	-0.4%	2833								0.6%	149.0
DDG	-89.8%	6913	2482.1%	162	-30.8%	7075								13.6%	202.4
USA	% change Production	baseline Production	% change Imports	baseline Imports	% change Feed	baseline Feed	% change Food	baseline Food	% change Industrial	baseline Industrial	% change Exports	baseline Exports	baseline Other use	% change Price	baseline Price
Wheat	-1.3%	56722	-2.2%	3805	3.5%	6016	0.1%	27780			-4.3%	24455	1425	-1.2%	266.8
Co. grains	0.8%	370659	11.2%	2573	-0.5%	122494	-0.1%	10445	9.4%	168681	-18.8%	63483	9362	1.6%	228.4
Oilseeds	0.2%	105101	8.6%	936			-0.1%	1204	15.1%	54820	-17.6%	45449	4340	0.6%	426.8
Beet	-36.0%	24849							-36.0%	24849				-30.9%	53.2
Cane	-33.5%	28859							-33.5%	28859				-29.8%	39.4
Veg. oil	12.6%	13206	231.4%	3076			-2.5%	11455	35.4%	3175	504.2%	1575	-77	6.3%	1009.2
Meals	13.9%	46549	-35.9%	3603	0.1%	41261					57.5%	8892	1	-2.7%	412.6
Raw sugar	-33.5%	3637	-55.0%	1745					-40.6%	5371	0.0%	12		-18.4%	572.3
White sugar	-38.5%	9758	479.7%	1057			12.2%	10715			0.0%	148	48	-15.1%	780.9
Biodiesel	19.2%	6267									1107.4%	109	6158	5.1%	1730.0
Ethanol	10.2%	79997	0.0%	14585							121.1%	6711	87675	2.6%	723.9
HFCS	-20.2%	10909	-5.4%	167			-30.3%	8208			9.6%	2869		-0.4%	354.3
CGF	-20.2%	6463	21.4%	183	-23.8%	5112					-3.3%	1534		6.6%	149.0
DDG	13.0%	47031			4.3%	35458					39.6%	11573		-4.0%	188.9

The liberalization of trade between the EU and the US has a large impact on their ethanol markets. In the EU, ethanol price falls by 15% and there is a massive increase in imports (from the US) and a substantial fall in ethanol output as well for DDGs. In the US, production is stimulated and exports more than double (121% increase) stimulated by the EU trade opening and higher prices. Exports of DDGs expand by 40% and its price falls because of the near fixity between ethanol and DDGs. Feedstock use in each region experiences associated changes. In the EU, feedstock use (coarse grains and wheat in industrial use) and associated imports fall along with the price of coarse grains; lower DDG output is compensated by larger DDG imports. In the US, the reverse occurs, with an expansion of coarse grains used in industrial use (ethanol), a reduction of coarse grain exports, and a small increase in coarse grain production responding to higher corn prices.

Changes in the bio-diesel markets echo the changes in the ethanol markets. EU biodiesel production contracts by 3% and imports expand by 23%. In the US, biodiesel expands by 19% and exports more than double, going to the EU. The vegetable oil and oilseed use follow these changes in biodiesel markets. In the EU, industrial use of oils contracts by nearly 4%, oil and meal production contract by 2% and so does the volume of oilseeds crushed. Meal imports from the US make up for the reduced domestic availability of EU meal. US oil and meal production expands by roughly 13% with more oilseeds being crushed (a 15% increase in industrial use) and fewer oilseeds being exported (an 18% reduction). Given the small changes in relative agricultural prices in the US for grains and oilseeds, the changes in agricultural production for these commodities are nearly negligible with slightly more coarse grains and oilseeds produced and a bit less wheat. In the EU, corresponding changes are also moderate with wheat and coarse grains falling slightly and oilseeds output inching up by 0.3% given that wheat and coarse grains prices fall proportionally more than oilseed prices do.

Changes in sweetener markets are the third important set of results in the simulations. Sugar trade liberalization between the EU and the US induces a massive contraction of both raw and refined sugar productions (34% and 38%) in the US and a humongous increase (480%) in imports of refined sugar (mostly sugar coming from EU white sugar). Raw sugar imports into the US contract given the availability of inexpensive white sugar and the contraction of the US cane refining sector. Sugar prices fall by 18% (raw) and 15% (refined). Beet and cane productions contract by 36% and 34% with falling farm prices. Sugar prices remain above the loan rate levels for sugar. Food use of white sugar increases by 12%.

Conversely in the EU, sugar production expands by 21% to export to the US (an increase of 367% from a small base to 1,249 MT). EU beet output increases by 4%. Beets are also grown for ethanol which explains the smaller relative increase in EU beet output relative to the EU white sugar expansion. The EU white sugar price increases by roughly 4% and white sugar consumption falls by a bit more than 1%.

The changes in the isoglucose/HFCS markets are a bit more convoluted as the baseline protection is not really needed. EU protection disappears inducing a modest decrease in EU prices and a corresponding modest HFCS trade flow from the US to the EU. In addition to these small direct effects, powerful indirect effects occur through substitution in food processing between sugar and isoglucose/HFCS and these are in opposite directions in the US and the EU. In the US, cheaper sugar is substituted for HFCS, and in the EU cheaper HFCS is substituted for sugar. Consumption of the sweetener composite sugar-HFCS increases in the US but falls slightly in the EU. In the EU, isoglucose production increases because grain prices have fallen and margins have improved despite the loss of protection at the border. In the US, production of HFCS falls because of the reduced use of HFCS in food processing, lower output prices, and deteriorating margins from higher corn prices.[3] Production of gluten feed, the byproduct of HFCS/isoglucose follows the directions taken by HFCS/isoglucose in the two regions with a smaller effect in the EU given that other grains are used for isoglucose production.

5.1.2. Effects on third countries

Third countries are also affected, especially Brazil, Argentina and Mexico. These changes come from trade diversion created by a TTIP agreement—what was going to third countries now goes to TTIP markets—and by changes in world prices (lower for wheat, higher for corn, sugar, and ethanol). Brazil produces and exports more white sugar and ethanol, exports more oilseeds and grows more sugar cane. Vegetable oil and meal production contract and so do exports. In Argentina, coarse grain and cane productions increase and so does ethanol production. Biodiesel production and exports contract by 18% and 32%, but from a small basis. In Mexico, vegetable oil and meal production decrease because cheaper imports from the US can substitute for these domestically produced products. Mexico’s HFCS industry is adversely affected by the surplus of HFCS in the US. Canada’s oil and meal productions are also negatively affected (a decrease of about 7%). Canada’s ethanol industry also benefits from the higher prices in the US and its

[3] In the sensitivity analysis we investigate the robustness of our results with respect to the unknown elasticity of substitution between isoglucose and sugar in food processing.

ethanol and DDG productions increase. The surplus of HFCS in the US induces an increase in HFCS imports to Canada and a contraction of its own HFCS industry as in Mexico.

5.1.3. Welfare impact

The welfare impact of a TTIP on the EU and US bio-economies is shown in Table 5. Distributional effects across sectors and between suppliers and users are substantial in the EU and the US, but with small net welfare gains for both partners. In the EU agricultural producers lose about $1.235 billion from losses in grain sectors that are larger than gains in sugar beet production. The ethanol and biodiesel industry lose and sugar producers gain with a net loss to the industrial sector. Feed is cheaper (cheaper meal is more important than more expensive DDGs in Europe) and feed users gain in the net. Similarly, biofuel users gain through lower prices for biofuels. Tax revenues fall with the loss of tariff revenues on US products with nil tariffs after liberalization and the trade diversion away from non US products. In the US, the farming industry gains as a whole ($767 million), with sugar growers losing a lot and coarse grains and oilseed producers gaining more. Among third countries, noticeable gains occur for Brazilian and Chinese agricultural production given higher prices for coarse grains, oilseeds, and sugar crops. Food, feed, and biofuel users lose in these two countries. The aggregate figures are sizeable because these countries are sizeable, especially China. On a per capita basis, these effects would look small in all countries/regions. We note that welfare gains in Brazil exceed those in the EU or the US.

Table 5. Welfare Effects on the Bio-economy from a TTIP Agreement (Million Dollars)

Sector/agent	EU	USA	Brazil	Argentina	Mexico	Canada	China	Australia
Agricultural production	-1235.4	766.6	858.8	45.1	98.0	15.0	811.3	-13.4
Industrial production	-480.7	336.0	27.1	-84.2	-1.9	-7.6	1.1	2.3
Feed users	672.1	278.4	-117.9	-10.5	19.8	-8.6	-516.1	2.6
Food users	-6.4	676.9	-110.5	-4.4	-95.4	-7.3	-248.2	-4.5
Biofuel users	2731.5	-1918.9	-349.5	8.2	-5.6	-20.6	-139.3	-10.3
Other users	165.4	-28.4	-15.6	-1.7	-5.5	-0.3	-198.4	1.6
Tax payers	-1788.4	-17.0		-225.1		9.9	-43.9	
Rents			-4.7	-0.8	-15.6			-6.9
Total	58.3	93.7	287.7	-273.5	-6.1	-19.5	-333.4	-28.5

5.2. NTM liberalization

Given the uncertainty, if not skepticism, surrounding the available NTM ad valorem equivalents in US and EU agricultural trade, this scenario uses adjusted EU-US price differentials attributed to NTMs, net of tariffs, transportation cost, and rents. This scenario assumes a decrease in friction cost in EU-US bilateral trade by reducing EU-US price differentials not explained by tariffs or transportation margins. We reduce the adjusted price differential by 50%. This is obviously a first-order approximation that abstracts from quality differentials (olive oil and soy oil are not perfect substitutes). The price differentials are high for oilseeds and oils ($85/MT for oilseeds, $120/MT for oils), and much less for grains ($21/MT for wheat and $9/MT for coarse grains). The differentials include friction cost and quality differentials. Their partial reduction provides some sense of market integration impact if frictional NTMs are reduced. Not all NTMs are protectionist or decrease welfare. The results of this scenario are shown in Table 6. They are in percent deviation from the baseline in 2022.

Notably, the reduction of friction costs directly and substantially affects the oilseed complex and vegetable oils. Other direct aggregate effects are small to negligible, except on trade flows. The indirect effects on biodiesel are significant because of the cascading effects from the oilseed complex. Lower frictions induce an increase in imports of oilseeds in the EU and a contraction of their own oilseed production. The cost of crushing falls since oilseeds are cheaper (-5.2%), but oil prices fall as well with lower friction (-5.5%). In the net, crushing expands by 23%. With cheaper vegetable oil, EU biodiesel production expands by 2.6%. The complementary situation emerges in the US. Oilseed production expands along with bilateral exports to the EU (not shown in the aggregate table). More oilseeds are crushed in the US (+3.2%), benefiting from higher international prices for oilseed products. Oil and meal are exported in larger volumes. Higher oil prices in the US hinder bio-diesel production.

The oilseed simulation is corroborated in the qualitative section of the paper looking at nontariff measures. We also note that in the results shown in Table 6, several US-EU bilateral trade changes are “dramatically” large for grains and oilseeds with percent multipliers (%Δexports/%Δcost) above 10. This is a feature of the model coming from the assumption of homogenous goods and the assumed large shock on NTMs.

5.3. Sensitivity analysis

For sensitivity analysis, we ran an alternative baseline with reduced biofuel targets in the US. The main baseline assumes that the US mandate is as projected in the OECD baseline. US ethanol is supposed to reach 21.133 billion gallons and biodiesel 1.656 billion gallons. Cellulosic ethanol is assumed to reach 4.32 billion gallons, which is 27% of the targeted volume of the RFS2 mandate. In addition, the blend wall is assumed to come late in the OECD baseline

Table 6. Real Effects in % from Reducing "NTM" Excluding Transportation and Tariffs

EU	Production	Imports	Feed	Food	Industrial	Other	Exports	Price
Wheat	0.1%	68.2%	0.8%	0.0%	1.7%	0.0%	18.4%	-0.5%
Co. grains	0.2%	20.6%	0.5%	0.0%	1.6%	0.0%	20.2%	-0.5%
Oilseeds	-2.4%	64.0%		1.0%	23.4%	0.0%	0.0%	-5.2%
Beet	0.2%				0.2%			-0.3%
Cane								
Veg. oil	23.2%	-23.7%		4.4%	3.3%	0.0%	67.6%	-5.5%
Meals	23.3%	-22.3%	-0.3%			0.0%	33.2%	0.1%
Raw sugar		-0.3%			-3.2%		226.9%	0.0%
White sugar	0.1%	-1.8%		-0.1%		0.0%	1.8%	-0.1%
Biodiesel	2.6%	-20.3%				0.0%	0.0%	-3.4%
Ethanol	1.1%	-3.5%				0.0%	0.0%	-0.1%
HFCS	0.7%	30.0%		1.4%			0.0%	-0.5%
CGF	0.1%	-15.1%	-0.5%					0.2%
DDG	1.7%	-27.5%	1.0%					-0.3%
USA	**Production**	**Imports**	**Feed**	**Food**	**Industrial**	**Other**	**Exports**	**Price**
Wheat	0.4%	18.8%	-0.8%	-0.1%		0.0%	4.1%	1.1%
Co. grains	-0.2%	3.6%	0.0%	0.0%	-0.4%	0.0%	0.3%	0.6%
Oilseeds	1.0%	43.5%		-0.4%	3.2%	0.0%	-0.5%	2.0%
Beet	0.1%				0.1%			0.7%
Cane	0.1%				0.1%			0.7%
Veg. oil	2.6%	195.7%		-1.0%	-1.6%	0.0%	414.9%	2.4%
Meals	2.9%	-5.9%	0.1%			0.0%	12.5%	1.2%
Raw sugar	0.1%	0.0%			0.1%		0.0%	0.4%
White sugar	0.1%	-0.5%		0.0%		0.0%	0.0%	0.3%
Biodiesel	-0.9%					0.0%	-51.3%	1.2%
Ethanol	-0.3%	0.0%				0.0%	-3.8%	0.1%
HFCS	-0.3%	-0.4%		-0.1%			-0.9%	0.3%
CGF	-0.3%	3.8%	0.0%				-0.9%	1.2%
DDG	-0.4%		-0.8%				0.8%	1.5%

because the OECD baseline assumed that E15 is partially adopted in the US and flex-fuel vehicles are only needed in the last three years of the outlook to satisfy all the mandates. In the alternative baseline described in the scenario section, a 4.7 billion gallon ethanol reduction takes place relative to the main baseline in 2022. This translates into a substantial increase in imports of cane ethanol in the US and lower marginal cost for US ethanol. The free-trade scenario in deviation from the alternative baseline gives slightly different impacts compared to those described in previous sections. US ethanol is more competitive relative to EU ethanol under the alternative baseline because of lower US/EU relative ethanol prices.

With a TTIP, larger liberalization effects ensue on US production and export. Similarly, there are accentuated DDGs effects from a TTIP under the alternative setup. Other results are nearly similar. We also ran alternative scenarios with different elasticities of substitution between sugar and HFCS/isoglucose to see if this parameter was pivotal in the results, which it is not. Results are available from the authors.

6. Conclusions

We analyzed the impact of a potential TTIP agreement between the EU and the US with a focus on their bio-economies and associated feedstock markets. Consistent with their respective border protection structure in agriculture and bioenergy markets, substantial effects would take place first in biofuel production and trade and second in sugar markets and trade.

US ethanol would expand and exports to the EU would follow, inducing a contraction of the EU ethanol industry. More moderate effects take place in biodiesel markets and trade paralleling the ethanol outcomes. For sugar, EU production would expand and flow to the US where a significant contraction of the sugar industry should be expected. Finally, the changes in sugar have an impact on isoglucose/HFCS markets with contraction experienced in the US because of cheaper sugar, and expansion of production in the EU because sugar has become more expensive at the margin. Welfare changes are small in the net but with large transfers between users and producers in the markets noted above and because of sizeable price effects. US sugar interest groups are likely to oppose a TTIP, and so are biofuel interests in the EU for the obvious reasons predicted in our analysis.

NTM creating frictions between the two bio-economies tend to occur in the oilseed complex. Reducing these frictions would have some impact as well. EU oils seed production would contract because of lower prices, EU imports would expand and oil and meal production would expand in both countries because of improved crushing margins. Biodiesel in the EU would slightly expand because of cheaper oil.

Effects on third countries are limited and come from trade diversion created by a TTIP. Trade is diverted from third countries to EU-US trade. World prices change moderately. With noted higher prices for sugar and ethanol, Brazil produces and exports more white sugar and ethanol, and exports more oilseeds. The surplus of HFCS in the US induces an increase in HFCS imports to Canada and a contraction of its own HFCS industry as it does in Mexico. Oilseeds and oil production decrease moderately in several countries.

The qualitative assessment of NTMs suggests that EU sustainable criteria for biofuels should be monitored for changes motivated by ILUC and which could invalidate the current sustainable status of most biofuels with the exception of Brazilian ethanol. Other NTMs in agriculture include GMO regulations affecting seed use for growing feedstock crops in the EU and GMO crops use in processed feed or food products. Asynchronous approvals could be a problem although the EU has approved a sizeable number of GMO crops for utilization in feed and food processing. In addition, differences in pesticide regulations could also create some frictions. AVE tax-equivalent estimates of aggregate NTM regimes are somewhat informative but variable and contradictory across estimation techniques (econometric estimate or CGE model-based). The current state of affairs on the measurement of their effects is poor and much ambiguity remains because these AVEs lump heterogeneous policies and requirements and only look at net trade flows without separating their effect on export supply and import demand.

Our analysis was confined to biofuels and associated feedstocks. Important effects in other markets under a full TTIP could affect our findings. These indirect effects would come from sectors with strong linkages to the 14 commodity markets analyzed here, such as dairy and livestock sectors. Our future research plans to extend the analysis presented here include all food and feed sectors.

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