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The Impact of the Transatlantic Trade and Investment Partnership on Agri-food Trade and Greenhouse Gas Emissions in the EU

An Environmentally Extended Input-Output Analysis

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Declaration

I hereby affirm that I have prepared the present paper self-dependently, and without the use of any other tools, than the ones indicated. All parts of the text, having been taken over verbatim or analogously from published or not published scripts, are indicated as such. The thesis hasn't yet been submitted in the same or similar form, or in extracts within the context of another examination.

Stockholm, August 2, 2016

Helena Robling
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Helena Robling

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Sammanfattning

För att begränsa den globala uppvärmningen till väl under 2 grader och uppfylla de globala mål som sattes upp under klimatkonferensen COP21 i Paris i december 2015 behövs betydande åtgärder av alla samhällets aktörer för att minska utsläppen av växthusgaser. EU har i enlighet med Parisavtalet satt som mål att minska sina utsläpp med minst 40 % fram till 2030. Samtidigt förhandlas ett transatlantiskt handelsavtal mellan EU och USA som syftar till att skapa det största frihandelsområdet i världen, ge ökad tillväxt och skapa arbetstillfällen på båda marknaderna. I likhet med andra storskaliga ekonomiska aktiviteter kommer handelsavtalet medföra miljökonsekvenser. Fram till idag har miljörörelsens kritik mot avtalet främst fokuserat på risken att miljöregleringar klassas som handelshinder och undermineras till förmån för liberalisering och ökade handelsströmmar. Avsevärt mindre uppmärksamhet har riktats emot miljöeffekterna av de uttalade ekonomiska målen med avtalet, det vill säga ökad export och import av varor och tjänster.

Denna studie undersöker miljöeffekterna av handelsavtalet TTIP, i form av de växthusgasutsläpp som kan förväntas av ökad handel i jordbruks och livsmedelsprodukter. En miljöutvidgad input-output modell används för att integrera miljö- och nationalräkenskaper och på så sätt åskådliggöra miljöeffekter av ett handelsavtal. Data hämtas från GTAP (Global Trade Analysis Project) och används för att utvinna en input-outputmatris för EU på vilken handelseffekter av TTIP simuleras i tre scenarier. Scenarierna baseras på tidigare jämviktsmodeller framtagna på begäran av flera aktörer; EU Kommissionen, Europaparlamentet och USAs jordbruksministerium (USDA). Vidare är handelseffekterna av ökad import och export inom EU översatta till växthusgasutsläpp med ursprung i förändringar av utbud och efterfrågan på jordbruks och livsmedelsprodukter genom utsläppsdata relaterad till produktionsprocessen av olika produkter.

Resultaten visar stora skillnader i utsläpp mellan de olika scenarierna. I enlighet med resultaten från USAs jordbruksministerium skulle TTIP leda till en minskning av jordbruksrelaterade växthusgasutsläpp inom EU med 6.4 miljoner ton koldioxidekvivalenter (-1.4 procent), på grund av minskad exportefterfrågan och produktion. Det scenario från CEPR som EU Kommissionen använder som underlag för TTIP förhandlingarna skulle leda till en ökning av jordbruksrelaterade växthusgasutsläpp inom EU med 28.1 miljoner ton koldioxidekvivalenter (5.9 procent), på grund av marginella ökningar i efterfrågan och produktion. Scenariot som baseras på Europaparlamentets beräkningar skulle leda till en ökning av jordbruksrelaterade växthusgasutsläpp inom EU med 88.7 miljoner ton koldioxidekvivalenter (18.8 procent), främst på grund av höga och potentiellt överskattade ökningar i exportefterfrågan. Skillnaderna mellan utfallen av de olika scenarierna förklaras främst av tekniska olikheter i jämviktsmodellerna, framförallt inkludering och kvantifiering av olika handelshinder.

Konsekvent i alla scenarier innefattar handel i kött och mjölkprodukter 65-80% av utsläppseffekterna. Eftersom TTIP har potential att påverka EUs klimatmål rekommenderas att specifika referenser till Parisavtalet inkluderas i handelsavtalets hållbarhetskapitel.

Abstract

To reach the goals set out by the Paris Agreement of limiting global warming to well below 2°C, significant reductions in greenhouse gas emissions driving climate change are required by all actors in society. The European Union has set ambitious targets to reduce its emissions by a minimum of 40% until 2030. At the same time, the EU and the United States are negotiating a Transatlantic Trade and Investment Partnership, aiming at creating the largest free trade area in the world and increase trade, boost growth and create employment on both markets. As all economic activities, such an agreement will have environmental consequences. Thus far, critique towards the agreement from an environmental perspective has primarily been concerned with the possibility of a "race to the bottom" of environmental regulation in the name of free trade. Less attention has been paid to investigate the environmental impact of the strictly economic consequences which are desired from both parties.

This study investigates the environmental impact of the TTIP, in terms of greenhouse gas emissions related to several best case scenarios of economic effects. The environmentally extended input-output analysis provides a tool for integrated national and environmental accounting which can be used to visualize the environmental impact of a trade agreement. The GTAP (Global Trade Analysis Project) database is in this study used for extraction of a corresponding Input-Output table for the European Union, on which simulations of the economic impact of TTIP is computed, based on findings from previous CGE models developed by researchers in both Europe and the U.S. Henceforth, the economic impacts of increased exports and imports are translated into GHG emissions associated with the demand driven change in production and supply driven change in consumption of agricultural and food products within the region, using trade and emissions data for every product in the sector.

The result show a large discrepancy in the GHG impact of the TTIP between previous CGE models. The projections from the USDA scenario would lead to a net reduction in EU GHG emissions from the agri-food sector of 6.4 million tons CO_2 equivalents (-1.4 percent), led by a reduction in export demand and corresponding output. The CEPR scenario would lead to an increase in EU GHG emissions of 28.1 million tons CO_2 equivalents (5.9 percent), led by marginal increases in output and final demand. The projections from the European Parliament would in turn lead to a net increase in GHG emissions of 88.7 million tons CO_2 equivalents (18.8 percent), led primarily by large and potentially overestimated percentage increases in export demand. The differences between the outcomes are mainly due to computational differences in the CGE models used, specifically the inclusion and quantification of non-tariff measures. Consistently throughout the scenarios, changes in trade flows in meat and dairy products amount for 65-80% of the emissions impact. Since the TTIP may potentially influence the climate goals of the EU, specific reference to the global climate efforts in the sustainability chapter is highly recommended.

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Abbreviations

AVE	**Ad Valorem Equivalent**
BSE	**Bovine Spongiform Encephalopathy**
CAP	**Common Agricultural Policy**
CEPII	**Centre d'Etudes Prospectives et d'Informations Internationales**
CGE	**Computable General Equilibrium**
CH_4	**Methane**
CEPR	**Centre of Economic Policy Research**
CO_2	**Carbon Dioxide**
COP21	**21st Conference of Parties**
G7	**Group of Seven**
G20	**Group of Twenty**
GHG	**Greenhouse Gas**
GI	**Geographical Indicators**
GMO	**Genetically Modified Organism**
GTAP	**Global Trade Analysis Project**
F-gas	**Fluorinated Gas**
EEIO	**Environmentally Extended Input-Output**
EIA	**United States Energy Information Administration**
EP	**European Parliament**
EPA	**United States Environmental Protection Agency**
EU	**European Union**

EQ	**Equivalents**
FAO	**Food and Agricultural Organization of the United Nations**
FTA	**Tree Trade Agreement**
I-O	**Input-Output**
IPCC	**Intergovernmental Panel on Climate Change**
MFN	**Most Favored Nation**
MRIO	**Multi-Regional Input Output**
MT	**Million (metric) Tons (1.000.000 kg)**
NTM	**Non-Tariff Measures**
N_2O	**Nitrous Oxide**
OECD	**Organization for Economic Cooperation and Development**
SAM	**Social Accounting Matrix**
SIA	**Sustainability Impact Assessment**
SPS	**Sanitary and Phytosanitary Measures**
TRQ	**Tariff-Rate Quota**
TTIP	**Transatlantic Trade and Investment Partnership**
UNFCCC	**United Nations Framework Convention on Climate Change**
U.S.	**The United States of America**
USDA	**United States Department of Agriculture**
WTO	**World Trade Organization**

I. Introduction

I.I Motivation and problem statement

The Transatlantic Trade and Investment Partnership (TTIP) is a bilateral free trade agreement currently under negotiation, with the potential to create the largest free trade area in the world. The first round of negotiations took place in July 2013 and the 13th round ended on April 29, 2016. According to the EU Commissioner of Trade Cecilia Malmström, it is the first time in EU and U.S. history that both parties negotiate against an equal counterpart in terms of trade volumes (Malmström *et al.*, 2016).

Currently, the negotiations are experiencing a very intense period. On the one hand, the time in office for the Obama administration is running out and a new president of the United States is likely to take a different approach towards the agreement. Therefore, the aim is to accelerate the process and sign an agreement before the end of the year. On the other hand, in Europe, recent documents released by Greenpeace Netherlands, encompassing draft consolidated texts where EU and U.S. negotiating positions are shown side by side, spur harsh criticism from NGO's and threatens unity among European leaders. Among the issues questioned by the opposition are a conceived threat to the use of the precautionary principle in the chemical approval process, increased trade in fossil fuels such as shale gas, and the proposed regulatory cooperation and investment settlement dispute mechanism which is believed to undermine democratic regulation in favor of corporate interests (Francis, 2016 May 2; Rankin, 2016 May 3; Sandahl & Jacobsson, 2016 May 13; Sheffield, 2016 April 25).

The overarching aim of the TTIP is to increase market access and induce regulatory cooperation, thus to remove barriers to trade and investment, and consequentially enhance trade between the United States and the EU. Positive effects on net trade and investment flows, as well as growth and employment in both markets, are identified by both parties as the primary motivation for the agreement (Bureau *et al.*, 2014; European Commission, 2016; USTR, 2016). A study conducted by the Centre for Economic Policy Research requested by the European Commission, concluded that the economic gains of the TTIP could be translated into an extra 545€ each year in disposable income for a European family of four (Francois *et al.*, 2013).

The debate on the environmental impacts of the food and agricultural component of the Transatlantic Trade and Investment Partnership has thus far primarily focused on the possibility that EU environmental and food safety regulations would be weakened in an effort to satisfy the objective of regulatory harmonization between the EU and U.S. agricultural export sectors. These consequences can be seen as collateral or unintended effects of the agreement and have been widely debated by opponents to the deal, both political actors and civil society (Larsson & Allvin, 2015). While the European Commission firmly holds that no compromises will be made in terms of environmental regulations or the use of the precautionary principle, and publish several negotiation texts to increase transparency of the negotiations, the protests against the TTIP continues (European Commission, 2016b; SPIEGEL ONLINE, 2016 May 6).

As opposed to above mentioned collateral effects, less attention has been paid to the environmental impacts of the *intended* effects of the agreement i.e., the consequences of the clearly stated objectives and goals of the deal. An increase in trade of agriculture and food commodities, in particular in products with comparably high rates of greenhouse gas emissions per unit, may lead to higher levels of global emissions as well as an increase in the total climate footprint of the European Union. An assessment of the environmental impact of the TTIP, rather than making a premature appraisal of the exact features of the policy arrangements within the deal, can make realistic assumptions about the consequences associated with a similar trade agreement, focusing on the effects that will come out of the "best case" scenario, in terms of economic effects.

This study aims to investigate the environmental effects in terms of GHG emissions which can be attributed to the economic effects of changing flows of exports from and imports to the EU, specifically in meat and dairy products, as a consequence of the economic aspirations of the Transatlantic Trade and Investment Partnership. It further highlights the importance of integrated environmental and economic national accounting as a necessary tool in policymaking for sustainable development and gives a comprehensive example of how this could be done in the future.

I.II Research question, objectives and statement of importance

The aim of this study is to investigate and answer the following research question:

What are the environmental impacts in terms of GHG emissions of the Transatlantic Trade and Investment Partnership, associated with the economic effects of import and exports to and from the EU in agricultural and food products, focusing particularly on meat and dairy products?

I.II.I Study Objectives

While several previous studies have reported economic effects of the TTIP and/or collateral effects of regulatory harmonization, this study aims at investigating the environmental effects in terms of GHG emissions which can be attributed to the effects of changing export and import patterns from and to the EU, as a consequence of the intended economic aspirations of the TTIP.

By making use of several economic impact assessments made of the trade effects of TTIP and transforming these results into corresponding GHG emission figures, the study identifies environmental effects associated with the intended outcome of the agreement, focusing on specific products with comparably high levels of GHG emissions, such as meat and dairy.

By constructing an environmentally extended input-output table, the study further aims at giving a comprehensive example of integrated economic and environmental national accounting for the European Union related to trade agreements such as the TTIP, which can be of interest to policymakers engaged in the negotiations as well as academia and the general public.

I.II.II Statement of importance

Policymakers involved in the negotiations of the TTIP, as well as the European citizens, should take into account the possible trade-off between environmental/climate goals and economic benefits associated with increased trade in agriculture products, specifically in products with a high carbon footprint such as meat and dairy. The Environmentally Extended Input-Output analysis (EEIO) can furthermore provide a comprehensive example of integrated economic and national accounting, and by highlighting its limitations and scope for analytical improvement, spur further and more far-reaching research on the topic.

I.III Research hypotheses

The intended trade effects of the TTIP are increases in bilateral trade flows between the EU and the U.S., in both imports and exports on both markets. Although different studies show a high level of discrepancy between results in terms of these trade effects, in particular for agricultural and food products, a general increase of trade in agricultural and food commodities can be expected as a result of a reduction in tariff levels, as well as the restrictiveness of tariff-rate quotas and non-tariff trade measures. An increase in exports on the EU market are expected to translate into an increase in output to satisfy the additional export demand, *ceteris-paribus*. An increase in imports of these products will in turn translate into an increase in final demand induced by the additional supply. Driven the by the intermediate linkages in the agriculture and food processing sector, the linearity feature of the I-O model is expected to report proportional increases in the GHG emission levels as a result of the TTIP.

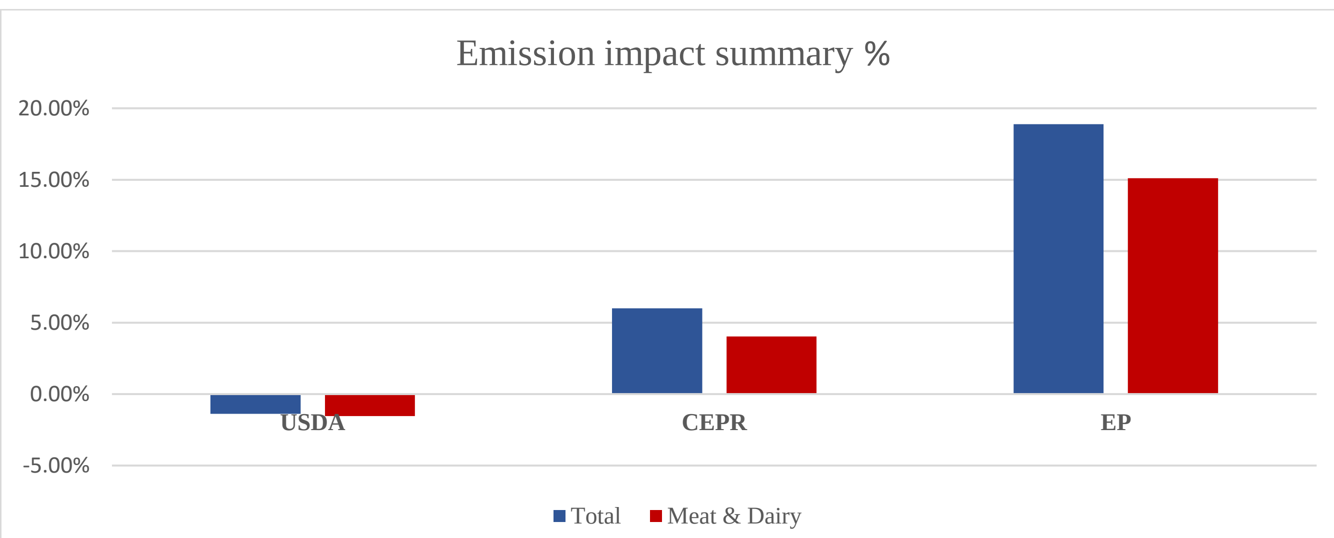
I.IV Methods and data

An EEIO model based on Leontief linear equations is in this study used to integrate greenhouse gas emission accounts in a standard I-O table of the European Union. A database containing the trade and emissions data for the EU27 from 2011 is extracted from GTAP9 and balanced using a Microsoft Excel spreadsheet template. The table contains 57 economic sectors, out of which 22 are considered agriculture and food processing, and 5 factors of production, including land use, skilled and unskilled labor, capital and natural resources. Emission data contains Carbon Dioxide (CO_2), Nitrous Oxide (N_2O), Methane (CH_4) and a compound of Fluoride gases (F-gas) in MT (million metric tons) CO_2 associated with production and consumption of all GTAP commodities. For computation, the inverse of an identity matrix minus the technical coefficients of intermediate transactions are used to derive a matrix of Leontief multipliers, for trade containing the intermediate interindustry relationships and for GHG the embedded emissions in these transactions within the EU. The results from three previous CGE analyses of the economic impact of the TTIP on the agriculture and food sectors, requested by the U.S. Department of Agriculture, the European Commission and the European Parliament, will be used as the reference changes in exports and imports associated with the agreement. The impact of changes in export and import on the EU27 market are computed by matrix multiplication of the interindustry multipliers with the changes in output and final demand in the GTAP agri-food industry categories as projected by the reports. The results are reported as percentage change in total output, and total GHG emissions in million metric tons CO_2 equivalents[1].

I.V Summary of results

Compared to 2012 levels of EU agricultural emissions, the impact range from a decrease of total EU emissions with 1.4 percent (USDA) to an increase with almost 20 percent (EP). Out of the total, the impact of the meat and dairy sector ranges from a decrease of emissions with 1.5 percent (USDA) to an increase with 15 percent (EP).

Figure I: Emission Impact Summary Total Impact and Meat & Dairy Sectors Impact



Source GTAP 9 data, Satellite GTAP Non- CO_2 emissions data set, Beckman *et al.*, (2015), Francois *et al.*, (2013) Bureau *et al.*, (2014), Füssel *et al.*, (2012)

[1] 1 Million metric tons= 1.000.000 kilograms. MT and Million tons in the text refer to million metric tons.

I.VI Scope and limitations of the study

The study investigates emissions impact of several TTIP scenarios within the EU27, for fixed relations and prices in the base year 2011. Considering the global character of greenhouse gas emissions, this limits the scope of our analysis to contain only local emissions in the EU, without taking into account trade and emission effects stemming from the impact of TTIP on U.S. production and consumption, which could be included in a full scale environmental impact analysis of the TTIP. Emissions embedded in consumption of imported goods are limited to final demand changes related to a fixed amount of imports added to the output account. Interactions are proportional and fixed in the baseline, implying that export and import scenarios are static and do not influence each other. In an equilibrium scenario allowing for prices to change and firms to substitute their inputs, it would be realistic to assume that they do. These effects, as well as distributional effects, lay outside the scope of an I-O analysis.

The analysis furthermore assumes homogenous industries and commodities and excludes the possible impact of changes in consumer preferences. The emissions data from GTAP does not include emissions from the transportation effects of trade, land use changes, nor take into account sequestration and forest carbon stock. With the former aspects leading to higher emission levels and the latter rather mitigating emissions, the consequences of exclusion of these effects are inconsistent and hard to determine. Agri-food trade is the focus of this study, and by overlooking the direct effects of the TTIP on other sectors of the economy the analysis limits the scope of drawn conclusions to consider only the impact of the TTIP on emissions stemming from these particular sectors.

The impact analysis of trade and the corresponding GHG emissions focuses on the strictly quantifiable aspects of the TTIP agreement, in monetary and emissions terms. As is the case for any quantitative analysis of social phenomena, there are ethical aspects and qualitative effects of the TTIP, which in all their complexity cannot be incorporated in our examination. In a broad sense, this includes the above mentioned "collateral" effects of a TTIP and the possibility of value based societal or cultural discrepancies regarding for example animal welfare and labor rights. In a more detailed sense, the quantification of non-tariff measures includes the monetarization of regulations and standards with varying purposes, which may very well go beyond strictly economic aims. As for any complex societal phenomena, an economic impact analysis will not be able to capture the full effects of their removal.

Finally, due to the static and linear character of the I-O model, the analysis does not present a clear counterfactual scenario, i.e. the development of EU trade and emissions in a scenario without the TTIP.

The thesis is organized as follows: Section I introduces the problem statement, research questions and hypothesis as well as give an overview of the data, methodology, scope and limitations of the study. Section II provides a background to the political aspects of the issues of transatlantic trade relations, the climate effects of agri-food trade and the TTIP sustainability chapter, as well as present some difficulties in trade effect estimation. Section III explains the GTAP data used and the process of database construction. Section IV outlines the methodology, conceptual framework and specific computational procedures. Section V provides the motivation behind the scenario analysis and process of selecting scenarios as well as highlight some explanations for differing results. Section VI reproduces and explains the most important results in terms of trade and climate effects and section VII analyzes the implications of the results, draw some policy recommendations based on the findings, as well as highlight the limitations of the analysis and present some scope for further research.

II. Transatlantic trade relations and greenhouse gas emissions in food trade: State of research, projection uncertainties and policy goals

This section gives a broad but detailed overview of the state of research regarding the two topics concerned in this study, transatlantic agricultural and food trade and its climate effects. On the one hand the section briefly discusses the state of transatlantic trade relations and historical conflicts, the relevance of agriculture in U.S.-EU trade, and describes the current tariff profiles of both markets in agriculture. It also highlights the importance of non-tariff measures (NTMs) in the TTIP and the difficulties in estimating their effects. On the other hand, the section introduces the reader to climate effects of agriculture and food trade and discusses the state of research regarding this topic through a synthesized literature review. Furthermore it gives an account of the climate goals of the EU related to the Paris Agreement and makes a brief analysis of the connection to the draft sustainability chapter in the TTIP. The chapter concludes by highlighting main findings of the literature review which will be of use for the following quantitative analysis.

II.I Transatlantic agricultural trade relations

In 2013, the EU and U.S. together accounted for almost half of global GDP and more than 30 billion dollars in bilateral agricultural trade (Beckman *et al.*, 2015). Even so, the transatlantic agricultural trade relations have been a conflicted issue for a long time. This may seem like a paradox, considering the low contribution of the agricultural sector to both economies GDP[2] and general trends further decreasing the importance of this sector in developed economies. There are, however, several, non-quantitative factors which lead to the agri-food sector being a particularly strategic one for policymakers, and of high relevance to the ongoing TTIP negotiations. A few of the reasons worth mentioning are high environmental and health impacts, as well as the importance of the sector for development of rural areas. Agri-food industries are commonly a matter of national pride (Bureau *et al.*, 2014) and issues such as food safety are often emotionally important to the general public (Josling *et al.*, 2014). Furthermore, the sector is highly protected on both sides of the Atlantic, and the Common Agricultural Policy (CAP) for 2014-20 totals 95 billion €, attributing agriculture with high relevance as an expenditure post (European Commission, 2015c). This section further outlines some of the issues affecting transatlantic agricultural trade relations.

In Josling, (1993) the controversies in EU and U.S. agricultural trade relations are described as a matter of differing philosophy regarding trade and agricultural policy, translated into rhetorical discrepancies and diplomatic tensions which have been difficult to overcome, occasionally allowing agriculture to block trade deals from which other industries might have benefitted (Josling, 1993, p 553; Beckman *et al.*, 2015). Fundamental philosophical differences, with the image of the U.S. as an open and unregulated market and the EU as a highly protectionist area, today are less obvious. While such differences may seem somewhat obsolete in the explanation of current state of transatlantic trade relations, the domestic policies of agricultural and rural support, as well as the approach towards NTMs and precautionary measures are still, at least according to the general public, marked by a dose of "we-they" system confrontation. Systemically, however, as pointed out by Josling, the similarities between the EU and U.S. are more striking than the differences, and the historical trade conflicts could more accurately be seen as conflicts among similar systems (ibid. p 555).

Over the years, several far going disputes have been a quite obvious barrier, complicating the transatlantic relations in agricultural and food trade. Even though the scope of this thesis does not allow for any in-depth analysis of all conflicted issues, some are appropriate to mention due to their current relevance to the general public and their potential to influence the TTIP negotiations. Some stakeholders within the EU have even expressed a desire to exclude agriculture completely from the TTIP negotiations, primarily due to the political sensitivity of the sector,

[2] Value added in the sector is 1.1% and 1.8% of total in the EU and US respectively, (Bureau *et al*., 2014)

but also increasingly due to difficulties in making a clear prediction of the impacts on EU farmers, and pragmatically due to the potential for conflicts to stagnate the process (Atlantische Initiative, 2015; EPHA, Demeter, 2015; European Parliament, 2016b).

The conflicts often reflect differing views on the role and function of the World Trade Organization's (WTO) agreement on Sanitary and Phytosanitary (SPS) measures. Restrictions and controls imposed on agriculture and food production and imports to protect human, animal or plant life or health, are under the agreement subject to the requirement that they do not arbitrarily or unjustifiably discriminate between members of the WTO, or constitute any disguised restriction on international trade (WTO, 1995; Josling *et al.*, 2014). A common dispute scenario has been that the EU imposes trade restrictions referring to the SPS agreement while the U.S. considers the measures to be unjustified and lack scientific proof of harm to human, animal or plant life or health (WTO, 1995:SPS:Article 2:2 & 5:5). The EU may then refer to the precautionary principle of a "safety first" approach where there is scientific uncertainty (WTO, 1995:SPS:Article 5:7). Conflicts have occasionally led to legal dispute settlement cases in the WTO, such as the EU imposed hormone beef ban or the delays in authorization of genetically modified organisms (GMO).

The use of growth promoting additives to livestock has been banned in the EU for production and import since 1989, leading to a dispute settlement panel ruling against the EU for imposing the ban without sufficient scientific proof of the alleged health risks of consuming hormone treated beef. The EU did not comply with the ruling but accepted retaliatory measures which included increasing market access of U.S. non-hormone beef by an autonomous tariff rate quota of zero duty for a total of 48 200 tons (Council of the European Union, 2012; European Parliament, 2013).

Regarding the approval of sale and production of GMO crops and seeds within the EU, the decision-making process has been considered by U.S. exporters as lengthy and complicated as posing equal restrictions as a *de-facto* ban on imports (European Union Centre of North Carolina, 2007). The WTO again ruled against the EU in this case (WTO: DS291, 292, 293, 2006), and the EU responded in 2015 by adopting a Directive (2015/412) allowing its member states to individually restrict or prohibit the cultivation of GMOs within their territory, a solution which some member states claim to be incompliant with WTO rules (European Parliament, 2013).

An interesting point regarding the GMO and beef hormone disputes in a TTIP context is that they are considered to be settled and non-negotiable from the EU side, while they are still considered to be causing restrictions on trade flows from the U.S. side, as they are both included as NTMs, subject to full removal in the economic impact report conducted by the USDA (European Parliament, 2013, 2016a; Beckman *et al.*, 2015).

Apart from the above mentioned conflicts, issues such as the low level of maximum residue limit tolerances for fruits and vegetables, as well as restrictions on the use of pathogen reduction treatments in poultry[3] and beef production are NTMs imposed by the EU, highly controversial for the general public, and considered trade restrictive by U.S. exporters (Arita *et al.*, 2015).

There are also SPS measures for which the desire of elimination is more pronounced from the EU exporters' side. As the EU milk quotas are abolished, and the reports on struggling European milk farmers are recurrent news in EU media, the need for new and alternative export markets for dairy products such as cheese and yoghurt becomes increasingly urgent (Josling *et al.*, 2014). The U.S. has for a long time imposed restrictions on the production and import of unpasteurized cheese to prevent the occurrence of bacterial pathogens. Since the majority of the EU cheese exports are made from unpasteurized milk, the EU in this case refer to the same arguments as the U.S. uses for the above mentioned conflicts, by claiming lack of scientific proof of health risks (Withworth, 2015).

[3] More commonly known as "chlorine-chicken"(Johnson, 2012)

Furthermore, the EU pushes to enforce the protections of geographical indications (GI)[4] to keep products not produced in a particular region from being sold under the same GI name in the U.S. They claim the standards to be upholding unjustifiable protection and national preferences which could harm the trademarks of generic products (Akhtar & Jones, 2013).

Conclusively, when it comes to regulatory harmonization or even mutual recognition of standards for SPS measures in the agri-food sector, it seems like the views differ quite vastly. The wish of the negotiations to create an attitude of "*What is good for us is good for you*" does hence not seem to be easily reached (Josling *et al.*, 2014). Drawing on the above mentioned conflicts, all possibilities of NTM reduction in the context of TTIP must be seen in the light of the fact that political obstacles regarding these issues may be insuperable.

II.I.I The role and relevance of EU-U.S. agricultural trade

From times-series trade data of GTAP9, figure I shows the bilateral EU-U.S. exports (solid green line) and imports (dashed red line) for EU27 in billion euros from 1995 to 2013, in raw agricultural products and processed goods. While the figures show an overall trade deficit for the EU in raw agricultural products, the processed food sector in the same year shows an overall and increasing trend of trade surplus, leading to a total trade deficit turning to a surplus in the late 90's and a continuing increase over time. In 2013 the surplus amounted to about 8 billion dollars. As outlined by Bureau *et al.*, (2014), decreasing imports from the U.S. is one of the reasons for the increasing trade surplus of the EU, which in part can be explained by the increasing relevance of emerging economies in South America for traditional U.S. export staples such as soy beans. For the USDA, relatively high trade barriers facing U.S exports to the EU, as well as regional trade agreements such as NAFTA, are identified as further explanations to the relative decline (Beckman *et al.*, 2015).

The U.S. is however no longer a market of high importance for agricultural goods to the EU, and its relevance as a trading partner in these sectors is steadily decreasing. Figure II shows that the relative importance of the US in EU agricultural exports in 2013 was below 5% and around 18% for processed food exports. The same pattern holds for imports where about 8% of the total EU agri-food imports came from the U.S. Reasons for this development are continuously found in the emergence of large exports markets in Asia and South America, and their increasing market shares in agricultural and food trade globally, which translates into an increasing relevance as trading partners of both the EU and US (ibid. p 15). The enlargement of the EU and the subsequent expansion of intra-EU trade can also be seen as an explanatory factor[5] (Beckman *et al.*, 2015).

Furthermore, the agriculture and food sectors are of relative low importance and amounts to only 28% of the total EU trade with the U.S. (Bureau *et al.*, 2014, p 15). As mentioned above, even though these figures suggest a relative low quantitative importance of the sector in trade negotiations such as the TTIP, the sector is highly protected in both markets and subject to political controversy, which explains the prominent role in media coverage and literature concerning the TTIP.

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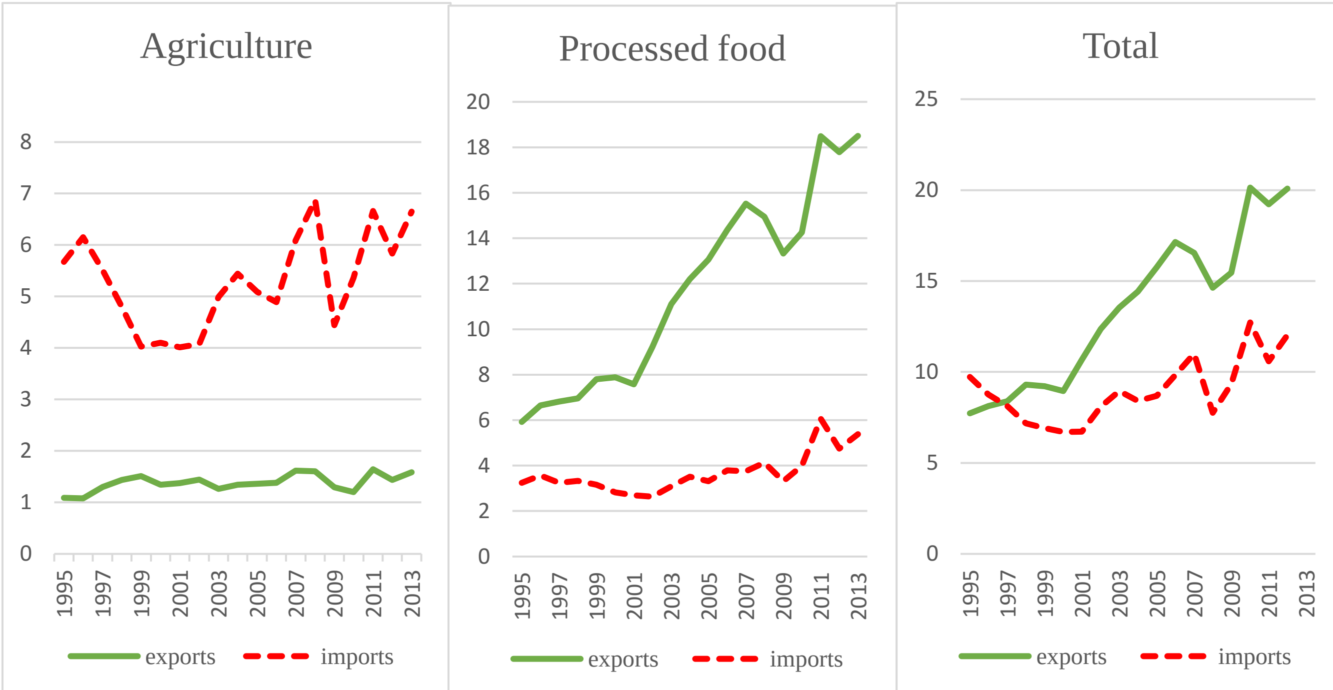
[4] Geographical names that aim to protect the quality and reputation of a distinctive product from a certain region, for example Parmesan cheese etc (Akhtar & Jones, 2013).

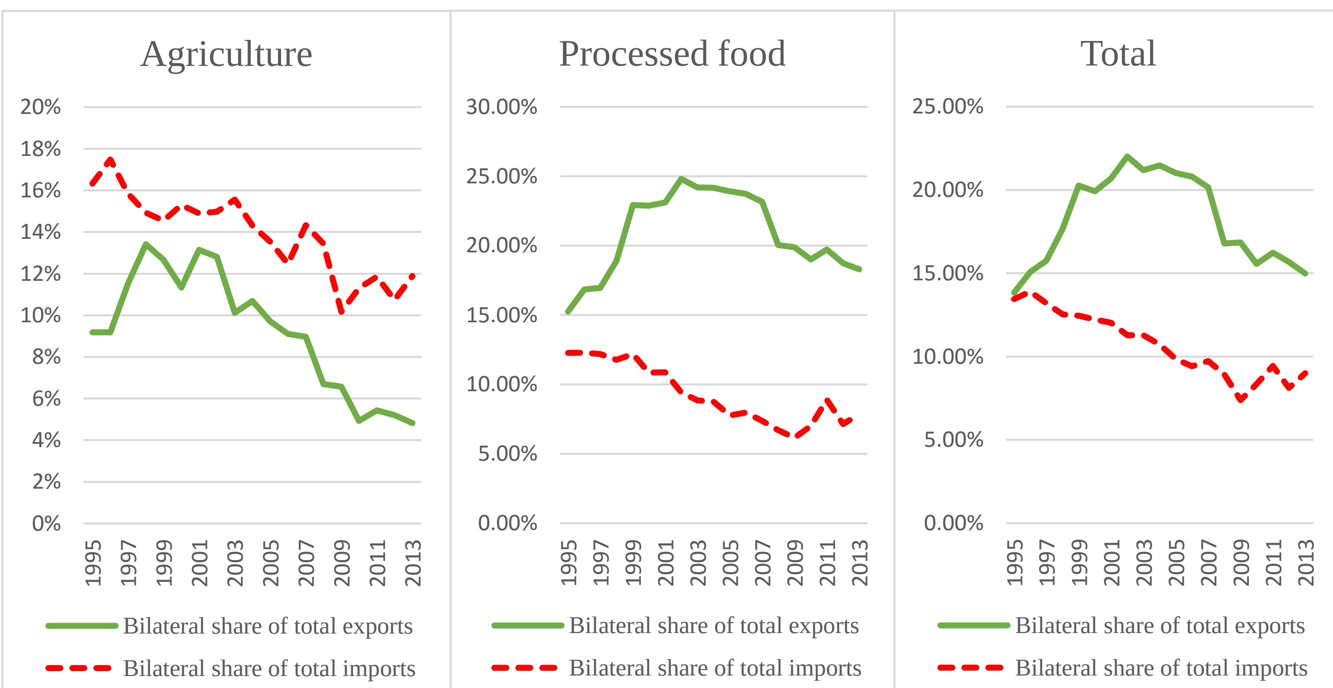
[5] Taking into account intra-EU trade, the relevance of the US market is even smaller (around 4 % in total exports and 2.5 % in imports of agri-food products in 2013)

Figure III: EU-US Agricultural and food trade, 1995-2013, billion dollars.



Source data: GTAP 9, Purdue University

Figure IIII: The relative importance of the U.S. in EU agricultural and food trade, 1995-2013, %



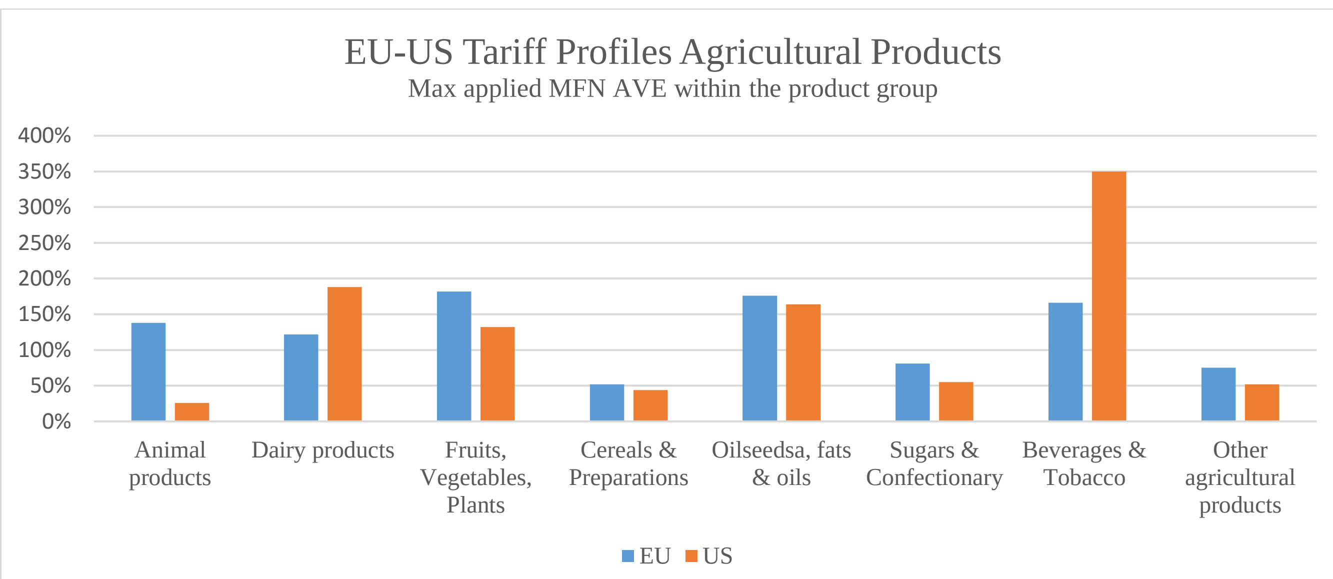
Source data: GTAP 9, Purdue University

II.I.II Tariffs profiles in agriculture

The average U.S - EU tariff rate for all economic sectors is currently quite low, *ad valorem* tariff rates are about 3.5% for the U.S. and 5.5 % for the EU (Akhtar & Jones, 2013). Due to this fact tariff reduction, which is normally the prime focus of trade agreements, has been given less importance and taken a secondary role as opposed to regulatory harmonization and NTM reduction in the economic impact literature of the TTIP (ex in Berden *et al.*, 2009; Francois *et al.*, 2013). On average, a comparably low tariff level is constant also for the agriculture and food industries[6]. Within these figures however, substantial "tariffs peaks" are present specifically for some particularly sensitive food commodities. To illustrate the presence of peaks in the agriculture sector, figure IV presents EU & U.S. maximum applied tariffs for particular commodity categories, based on estimates published in the World Tariff Profiles 2013 (World Trade Organization & International Trade Centre UNCTAD/GATT, 2013). According to these figures, the EU dairy sector is protected by a tariff of over 40% on average while the average tariff for the same sector in the U.S. is 17%. The maximum applied tariff for dairy seen in figure IV is however as high as 188% in the U.S. and 122% percent in the EU. While Beverage & Tobacco stands out in the U.S., peaking with a maximum MFN duty of 350%, animal products in the EU in comparison stands out as containing such "mega-tariffs", with a maximum applied MFN of 138%.

Furthermore, these figures are largely underestimated due to aggregation[7]. Trade-weighted estimates will further manipulate the result since the trade volume in the product categories with very high tariffs tend to be rather small and the average includes about 30% of the commodities that are already duty free (Josling *et al.*, 2014, p 4). The modelling framework of a computable general equilibrium (CGE) model implies that the higher the original tariff, the greater the impact of tariff removal will have on increasing trade flows for particular commodities. A reduction of tariffs for these products would hence lead to a substantial increase in trade. Due to this feature, even considering the political sensitivities surrounding these product groups, any realistic analysis of the economic impact of the TTIP would include the impact of tariff reduction or elimination in these sectors.

Figure IV: EU and U.S. Tariff profiles in Agriculture: Most Favored Nation (MFN) applied duties



Source: WTO, ITC and UCTAD, 2013

[6] Estimations differ (ex Josling et al. (2014) reports EU average tariff of 8,6% for agriculture, Francois et al (2013) report 3.7% for agriculture forestry & fisheries and 14.6% for processed foods, Fontagne et al. (2013) reports 12,8 % in agricultural products) mainly due to differing data sources and aggregation levels.

[7] There are for example 50 different tariffs for different quality and types of cheese (European Commission, 2005)

II.I.III NTM quantification and estimation difficulties
Since the general view is that the desired economic gains from a trade agreement between the EU and U.S. will not stem from traditional free trade agreement (FTA) concerns such as tariff reduction, the primary focus in the TTIP negotiations are rather on other trade barriers, the so called Non-Tariff Measures (NTMs) (Berden *et al.*, 2009; Fontagné *et al.*, 2013; Francois *et al.*, 2013). While NTMs in general may refer to any impediment other than tariffs or tariff-rate quotas which impose costs on exporters and thus acts as a barrier to trade[8], in the context of the TTIP they refer to aspects of harmonization, convergence or mutual recognition of administrative procedures, regulations and technical rules and standards between the U.S. and EU exports and imports markets (SRU, 2016). To illustrate the importance of NTMs for the TTIP outcome, as much as 80 % of the economic gains projected from the agreement have been accredited to the removal of costs associated with NTMs (Francois *et al.*, 2013).

To set up a modelling framework for ex-ante calculations of the potential impact of NTM removal is however a quite difficult task. There is a need for estimation of the trade restrictiveness of each NTM (i.e the additional cost to traders imposed by each case of differing bureaucracy, administrational procedure, regulation etc.) and a quantitative "translation" of this estimation to an AVE tariff equivalent value. The exception being the USDA study of Beckman *et al.*, (2015), which calculates the level of trade restrictiveness for selected NTMs particularly present in the agriculture and food sector[9], the general approach to NTMs in the TTIP impact evaluation literature is the use of a gravity model to calculate an average level of trade restrictiveness for all NTMs which are subject to removal and hence labelled as "actionable" (Berden *et al.*, 2009; Fontagné *et al.*, 2013; Francois *et al.*, 2013). Several of the studies use the results of Ecorys (Berden *et al.*, 2009), in which a business survey among EU and U.S. exporting firms as well as expert consultation provides the basis for their NTM estimations. The Ecorys study further reports the highest level of additional costs from NTMs for the food and beverage sector, with a 56.8 % tariff equivalent for imports from the U.S. to the EU and a 73.3% for EU exports to the U.S. (Berden *et al.*, 2009, p 86).

Many researchers, including Berden *et al.*, (2009) and Raza *et al.*, (2014), highlight the fact that only some NTMs present in transatlantic relations pertains to actionable differences, while others such as languages, cultures and currencies are NTMs which will not be subject to removal even in the most ambitious trade liberalization scenario. The fact that full NTM removal is not plausible nor desired for any of the negotiation parties is to some extent recognized by modelers, and their reports usually include results with a 25%-50% reduction of the average trade restrictiveness of NTMs, for the most ambitious liberalizations scenarios (Berden *et al.*, 2009; Francois *et al.*, 2013). It is realistic to presume that the definition and categorization of actionable NTMs will differ highly between the negotiating parties.

Similar to the case of tariffs, the initial level of trade restrictiveness of an NTM will be highly influential on the outcome of NTM removal. More specifically, the higher the costs of NTMs to trade, the greater the trade effect of removal will be (Raza *et al.*, 2014; SRU, 2016). While tariffs are less problematic to quantify, the assumptions underlying the quantification of the "true" cost of NTMs will prove to be an important explanatory factor for some differing results of economic impact evaluations of the TTIP[10].

Furthermore, NTMs differ from tariffs in terms of their purpose. To reuse the example of Sanitary and Phytosanitary measures in agriculture and food trade, these measures often claim to pursue public policy goals of consumer or environmental protection and their removal could be considered a social or environmental cost to the society (Raza

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[8] NTMs in abroad sense are defined as all non-price and non-quantity restrictions to trade in goods, services and investment, at federal and state level (ECORYS, 2009)
[9] Such as the NTM cases of the hormone beef ban and the approval process of GMOs, mentioned in section II.I.
[10] See more on factors influencing differing impact results in section V, for technical modelling issues of some impact results see Raza *et al*. (2014)

et al., 2014). This fact, which would reduce the costs of NTM existence or add to costs of NTM removal in terms of welfare effects, is not included in cost estimations of NTMs for any of the reviewed impact evaluations. Thus if tariff rates may illustrate the desire of industry protection from the producer side, NTMs to a greater extent illustrate public concern and consumer preference, taken the form of policy decisions (Bureau *et al.*, 2014; SRU, 2016). It may not always be an easy task to prove the non-existence of producer interest in NTMs, but following the above logic, when the desire of protectionist measures stems from consumers and public policy rather than from producers, the "true" costs of NTMs become increasingly difficult for economic and trade assessments to evaluate.

II.II Synthesis of literature review, TTIP

The majority of the economic impact studies of the TTIP which explicitly include the effects on the agriculture and food sector are conducted or requested by actors from within the EU. The fortunate fact that the USDA in November 2015 released a report on the topic allows the foundation for this thesis to stem from both sides of the negotiation table, which will contribute to giving a more realistic view of intended effects than it would if only researchers from one side were heard. The results from the reports differ widely and an extended section of the possible explanations for the discrepancies is included in section V. All studies examined report long term effects over a time span of minimum 10 years.

A study conducted by Ecorys (Berden *et al.*, 2009) on the request of the European Commission investigates the presence of NTMs for each industry sector and estimates the economic effect of their removal. The most ambitious scenario projects full removal of 50% of the average trade restrictiveness of all NTMs, including full removal of so called "*High and different levels of Sanitary and Phytosanitary Measures*" in the food sector. Still the increase in the EU food and beverage sectors' export is projected to only 0.8 %. While changes in imports are not explicitly reported, the study concludes that increased competitiveness will lead to a significant decline in import prices, spurring additional imports.

Another study conducted by the Economic Research Service of the U.S. Department of Agriculture (Beckman *et al.*, 2015) reports on the effect of full tariff and TRQ removal as well as removal of some sector-specific NTMs in agriculture, including the EU ban on hormone beef. It models the impacts on specific agricultural commodities and while the results differs within categories (EU exports of cheese and meat are expected to increase while bulk commodities such as wheat decreases) the overall effect is a 0.5% decrease in EU exports and a 1 % increase in EU imports. Import increases to the EU are particularly high for poultry. A projected change in consumer preferences could, according to the study, completely offset the gains of NTM removal.

Requested by the European Parliament, Bureau *et al.*, (2014) preform one economic impact analysis of the TTIP on the EU agri-food sector which includes a scenario of a 25% NTM removal, and another with the exclusion of meat and dairy products in the NTM removal scenario. Bilateral increases in EU-U.S. trade including meat and dairy are large in the most ambitious scenario, 56 % in EU exports and 118 % in EU imports. When meat and dairy are excluded, bilateral increases are 43% in exports and 82 % in imports. These somewhat inflated figures are explained to be the result of the initial low level of trade, as well as the bilateral character of estimations.

From the Centre for Economic Policy Research (CEPR) an economic impact assessment of the TTIP was requested by the European Commission, which provided the basis for the initial negotiations in 2013 (Francois *et al.*, 2013). The report shows the impact of full tariff removal as well as a 25% cut in the trade-restrictiveness of NTMs (corresponding to the less ambitious scenario in the Ecorys study). For the EU food processing sector, the study reports an increase in exports by 9.36% and imports by 10.07% while intra-EU trade is reported to decrease marginally. In the Agriculture, forestry and fisheries sector, exports increase by 0.22%, imports increase by 5.22% while intra EU-trade increases due to NTM removal benefiting exporters to all markets. It furthermore reports increases in CO_2 emissions for the EU of 3.600 tons, and 11.000 tons globally. The percentage change is less than 1 % and thus considered negligible.

CEPII - Centre d'Etudes Prospectives et d'Informations Internationales, performed an additional impact analysis of the TTIP in 2013 (Fontagné *et al.*, 2013) reporting results for full tariff removal and 25 % reduction in the trade-restrictiveness of NTMs. For agriculture, the simulation reports an increase in exports from the EU of 7% and total imports of 7.4%. The bilateral imports in the sector from the U.S. to the EU is estimated to increase by 168%. The relatively high increase in bilateral agricultural trade in comparison to other sectors is due to the high impact of complete tariff liberalization for this sector. The highest increases are reported for dairy and to a lesser extent meat products.

Lastly, in 2014 a study from Tuffts University was published, then showing an alternative view of the economic impact of the TTIP. Its author, Jeronim Capaldo, has ever since been extensively quoted by opponents to the agreement, and criticized by its promoters (for example Bauer & Erixon, 2015). Using a fundamentally different model than the CGE model used in most European studies[11], Capaldo simulates the impact of TTIP in a context of austerity and low growth and projects net losses for the EU in net exports as well as GDP, labor income and jobs. According to Capaldo, the TTIP would also lead to a reversal of European economic integration due to a significant reduction in intra-EU trade (Capaldo, 2014, p 1–3). While the alternative model of Capaldo has been widely criticized for ignoring supply and innovation effects of trade liberalization as well as making unrealistic assumptions about constant austerity and falling demand in Europe (Bauer & Erixon, 2015, p 5–7), the less optimistic results for the economic gains from a European perspective are to some extent echoed in the USDA study by Beckman *et al.*, (2015) showing a net decrease in EU agricultural exports.

In the economic impact literature, there is a general view that regulatory convergence in TTIP will set the base for a new international standard for other trading countries to follow, considering the economic weight of the TTIP parties in global trade (ex Josling, 2014). To this end, "harmonization spillovers" are by most studies assumed to reduce costs for third parties trade with the EU and U.S. and are hence considered to have a positive impact on global trade flows (ex Francois *et al.*, 2013, Fontagné *et al.*, 2013). The study conducted by the European Parliament does not assume harmonization spillovers but reports a limited decrease in trade with third countries, from 0-1.5 % (Bureau *et al.*, 2014 p 36). The possibility that the TTIP will have a significant trade distortionary effect, i.e that the increase in bilateral trade leads to a significant reduction in trade with third parties, is thus considered to be low or limited. As for the effects on intra-EU trade, Bureau *et al*. (2014) and Fontagné *et al.*, (2013) report a limited decline by between 2-3 % for agricultural products. In the USDA study however, large reductions in explicitly modelled intra-EU trade for specific agricultural commodities result in net export decreases for many goods, with the exception of cheese, fruits and vegetables and vegetable oil (Beckman *et al.*, 2015 table 11). The exact effects of TTIP on intra-EU trade thus remain unclear. For all simulations done in this study, intra-EU trade is taken into account, even if the level of detail varies between the reports used. The inclusion of intra EU-trade diversion however significantly increase the explanatory value of our analysis.

[11] The model is called United Nations Global Policy Model (GPM) and it's a macroeconomic model which is demand driven, but relies fundamentally on changes in government spending and income distribution as decisive for the economic output. The model has never previously been used to estimate effects of changes in trade policy. For a full critique of the model used by Capaldo, see Bauer & Erixon (2015)

II.III Climate effects of agricultural and food production

Agriculture and food production are essential parts of human welfare and provide nourishment to millions, employment and economic returns, and allow for a flourishing country side and a vivid landscape. However, industrial agriculture and food production also encompasses severe impacts on the natural environment and is a major contributor to global GHG emissions. According to figures by the Intergovernmental Panel on Climate Change (IPCC) from 1998, agriculture was contributing to over 20% of anthropogenic greenhouse gases contained in: 21-25 % of the total Carbon Dioxide (CO_2) emissions from deforestation, land use change and fossil fuels used on farms[12], 55-60 % of the total Methane (CH_4) emissions from rice paddies, land use change, biomass burning, enteric fermentation[13] and animal waste and 65-80% of the total Nitrous Oxide (N_2O) emissions from nitrogenous fertilizer use on cultivated soils and animal waste (Morita *et al.*, 2001).

More recent figures from FAO show a 14% increase in GHG emissions from crop and livestock production between the years 1990 to 2011; from 4.7 billion to 5.3 billion tons CO_2 equivalents[14]. On average and including forest conversion, degraded peatlands and biomass fires, agriculture, forestry and other land uses contributed to emissions of 10.2 billion tons CO_2 equivalents (Tubiello *et al.*, 2014). Meanwhile, the net GHG emissions from land use change and deforestation decreased by almost 10 % during the same period, as a result of decreasing acres of deforestation as well as increasing carbon sequestration (FAO, 2016).

According to official inventories of the EU member states, total GHG emissions (CO_2 and non-CO_2) from the source *agriculture* emitted 470.6 million tons CO_2 equivalents, which accounted for around 10.3% of total EU emissions in 2012 (Füssel *et al.*, 2012). According to technical reports from the European Commission, the main sources of the EU's agriculture emissions are N_2O emissions from agricultural soil management (mainly from application of manure and mineral nitrogen fertilizers) and CH_4 emissions from enteric fermentation (mainly cattle and sheep). A general decrease in the emission levels of the EU from 1990 to 2011, from 600 million tons CO_2 equivalents to 460 tons, was mainly achieved during the 1990's and is above all associated with productivity increases and a decrease in the number of cattle livestock, as well as implementation of agricultural and environmental policies and consequent improvements in farm management practices (Fellmann *et al.*, 2015). The study by Fellman *et al.*, 2015 build on the category *agriculture* as defined by the United Nations Framework Convention on Climate Change which does not take into account Carbon Dioxide (CO_2) emissions from land use, land use change and forestry, nor input processing or farm level energy consumption. Evaluations must hence be seen as to some extent underestimating the total GHG emissions from EU agriculture but serves as comparison to the GTAP data, and as an illustration of the particular importance of GHG gases other than CO_2 for the agricultural sector.

In the GTAP non-CO_2 database used in this study, which reports on global emissions of N_2O, CH_4 as well as a compound of Fluorinated gases (F-gases), the agricultural, forestry and fisheries sector amounts for 44 % of global non-CO_2 emissions (Burcu Irfanoglu & van der Mensbrugghe, 2015) and 46 % of the industry related emissions, as illustrated in figure V. This further highlights the importance of non-CO_2 emissions in the agri-food sector. The data on the agricultural sector's emissions originates from the FAOSTAT's (2014) emissions dataset which excludes land use, land use change and forestry. The dataset is constructed using globally standardized methods but is in GTAP subject to mapping to suit the sectoral aggregation[15] (ibid. p 3).

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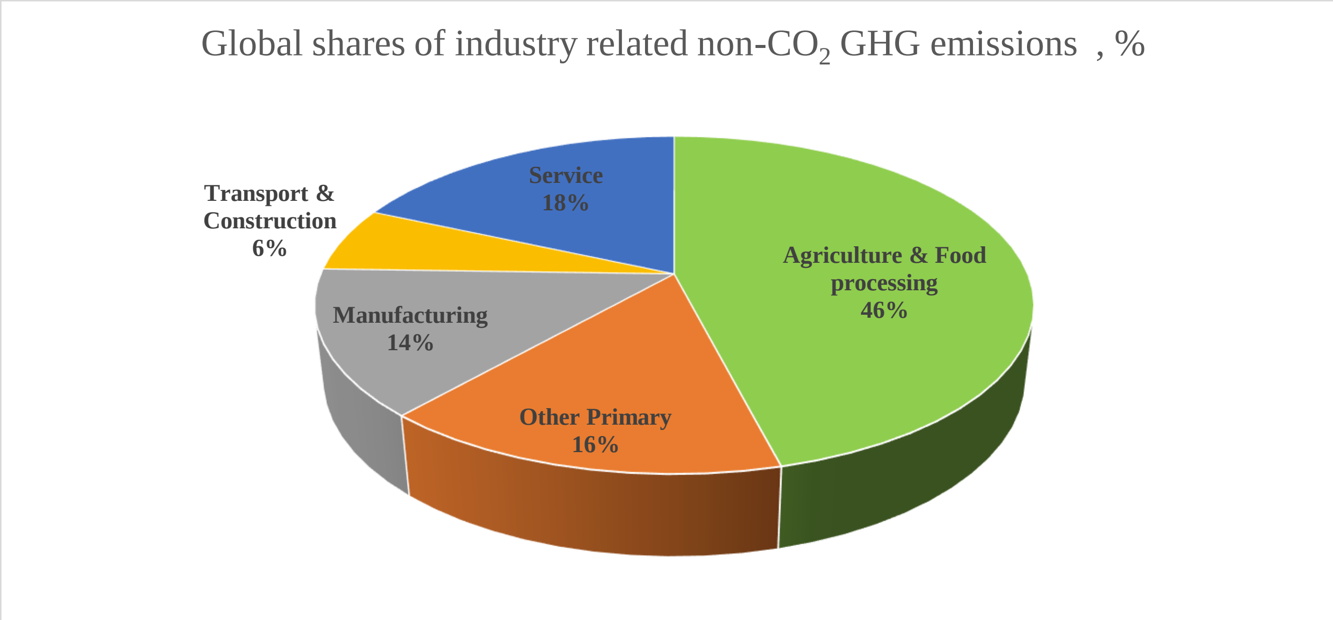
[12] Including input use such as agro-chemicals and machinery

[13] Digestive process of ruminant animals

[14] CO_2 eq. is a metric used to compare emissions from different greenhouse gases according to their global warming potential (FAO, 2016)

[15] See section III for a detailed description of the data used.

Figure V: Global Shares of Industry related non-CO_2 GHG emissions



Source: Satellite GTAP Non- CO_2 emissions data set Consold (2011), Purdue University

For the first time ever, scientists have recently calculated how much emissions from agriculture needs to decrease in order to reach the agreed target of limiting global warming to 2° C, set out by the Paris agreement. According to estimates from the University of Vermont, agriculture sectors non-CO_2 emissions must be reduced by 1 gigaton (or 1000 million tons) per year in 2030 (Wollenberg *et al.*, 2016) to meet the target. What is more, the same research shows that current mitigation practices such as nutrient management, input efficiency and sustainable intensification of cattle, is only capable of delivering 21-40 % of the reductions needed.

II.IV Synthesis of literature review, GHG emissions in agriculture and food trade

There is an increasing amount of scientific literature highlighting the complexities of the embedded climate effects of agricultural-and food production and trade. To accurately report on the climate effects of food, a wide perspective of impacts is needed, since production is global. The fact that an evaluation of climate effects of food cannot be limited to a domestic production perspective becomes increasingly clear as a larger part of the consumed food within an economic area is imported rather than produced domestically and importation in many places is crucial to assure domestic food supply. As the availability of heterogenic food products from all over the world increases, so does consumer demand for a variety of food, which due to climate conditions cannot be produced domestically. One example is the case of Sweden where around 50 % of the food products consumed are imported (Furustam, 2012).

Still, as pointed out by Dalin & Rodriguez-Iturbe (2016), due to spatial heterogeneity of resource productivity, farming practices, climate and land and water availability, as well as the immobility of essential resources, the environmental impact of food production is highly dependent on the location of production. Trade can thus either increase or decrease the overall environmental impact of food, depending on the relative impacts in the exporting and importing region. Trade does however also distance consumers from the environmental impacts of production (ibid. p 1). Dalin & Rodriguez-Itrube review the quantitative literature of the role of trade in the environmental impacts of agriculture. According to their review of climate effect of food trade, the carbon equivalent intensity (CO_2^{eq}) of products can be calculated by dividing the amount of carbon emissions from total production of a particular food product by the amount produced. Transport emissions are rarely included in the attempts to quantify climate effects of food trade since these effects are usually conceived as small in comparison to production emissions, and may be overcome by the differences in emission intensity between trading regions. The authors however note that this is only partially true, for example trade in processed foods is more commonly dependent on carbon intensive air transportation than bulk agricultural commodities and hence is more likely to have a large climate impact apart from the production process (Cristea *et al.*, 2013; Dalin & Rodriguez-Iturbe, 2016). Lastly, the authors note difficulties in regional comparisons in issues such as land use change in tropical areas, since some commodities produced in these areas cannot be produced in other regions (for example palm oil and soy production). Hence a proper evaluation of the effects of trade in these commodities would require another counterfactual such as domestic cultivation of a substitute commodity rather than the particular product (ibid. p 7).

Consumption related emissions associated with international trade are usually calculated by adding imports and subtracting exports, as a contrast to territory based production emissions. Peters *et al.* (2012) review international flows of carbon emissions and distinguishes between "embodied" carbon from the production of goods which are traded internationally and "physical" carbon flows i.e. trade in products which themselves contain carbon. The authors conclude that in terms of embodied carbon, studies consistently show a net importation to developed economies from developing or poor economies. Europe as a whole imports 23% of its embodied production based emissions, while most of the consumption based emissions occur within the region. They also stress the need for inclusion of processed products when evaluating the flows of physical carbon. While the analysis conducted in this study does not allow for a distinction between physical and embodied carbon, the study highlights some of the estimation difficulties in determining the exact climate effects of agriculture and food trade.

One example from the literature of how the input-output approach can be used to identify the drivers of climate effects in food production is the case of the CO_2 emissions in the Chinese food industry, as presented by Lin & Xie, (2016). The authors highlight that the total output effect of an industry with relatively low carbon intensity, may be significant due to its large scale. The input-output approach serves to demonstrate the inter-industry flows within the Chinese food sector which proves to be highly relevant for the total carbon footprint of the sector. While the study assumes that imports can be substituted by domestic production, which is only partly true in the case of the European food commodity market, it shows that the total output effect driven by intermediate use and domestic final demand as opposed to export extension or import substitution, are the main drivers of CO_2 emissions in the sector. It is not clear whether the demand for intermediate inputs stems from export driven sectors or from domestic final demand. It does however suggest that changes in total output in the food sector will have an impact on the climate effects of the same sector, which is useful for the hypothesis construction of the current thesis.

Drawing further on the experiences from China, Zhang *et al.*, (2015) highlights the importance of non-CO_2 emissions in the agriculture and food sector, emission which in contrast to CO_2 has received little attention. According to the I-O analysis, the agricultural sector is responsible for 60 % of the country's non-CO_2 emissions, and in this case, a major driving force is indeed exportation (ibid p 105-106).

A closer look at the consumption perspective of environmental effects is found in an article by Edgar G. Hertwich (2011) who reviews literature of the life-cycle impacts of consumption, taking into account production as well as disposal of consumer goods (Hertwich, 2011). The authors hold that an accurate model for assessment of environmental impacts of imported consumer goods can be made by using so called multi-regional input-output analysis (MRIO) which take into account national differences in technology and trade patterns. They further emphasize the importance of non-CO_2 emissions for the assessment of the climate effects of food production and consumption, as the sector represents around 50 % of the global non- CO_2 emissions, mainly from land use change (ibid. p 32). Excluding land use change will result in significantly lower GHG emissions attributed to the agriculture and food sector, and may possibly underestimate the potential of mitigation efforts. The relative importance of imports as a driver of emissions is discussed and higher emissions in imported goods than exported goods is reported for most European countries (ibid. p 40). This result provides a strong argument for further investigation of the emissions impact of changes in imports as a result of trade agreements.

II.V The Sustainability Chapter in TTIP and EU Climate Policy Goals

It is today increasingly common for free trade agreements to include a so called sustainability chapter, in which the parties lay out their common interest in maintaining a high level of environmental protection and ambition to strive towards sustainable development (SRU, 2016). The TTIP is no exception from this rule, and the European Commission publicly released its first draft proposal of such a chapter in November 2015 (European Commission, 2015b). The draft affirms the commitment of both parties to promote development of international trade and investment in a way which contributes to the overarching objective of sustainable development, defined as (in order of appearance) *economic development, social development and environmental protection* (ibid. Article 1:1) It further mentions several global agreements and international agendas for sustainable development; from the Rio declaration of 1992 to the UN Summit of 2015 and the 2030 Agenda for Sustainable Development (ibid. Article 1:2). The chapter however makes no specific reference to the fight against climate change, which is noteworthy since a previous EU position paper outlining proposed core elements of such a chapter, made public on January 7, 2015 (European Commission, 2015) explicitly mentions the mutual commitments to the fight against climate change.

More specifically, in the position paper of January 7th, an article labelled *Climate change and green goods and services* includes reaffirmation of the parties' commitment to the UN Framework Convention on Climate Change (UNFCCC), to aim for an outcome with legal force of the UN Climate Change Conference and the implementation of the Paris Agreement (ibid. Article III:2). It furthermore states the shared objectives of promoting standards that respond to (in order of appearance) *environmental, climate, and economic needs* (ibid. Article III:2:4).

In the textual proposal there is on the contrary no such climate change article and the text is limited to stating the parties' "…*commitment to implement in domestic law the Multilateral Environmental Agreements to which it is a party*" (European Commission, 2015b), but without explicitly referring to neither climate change, the UNFCCC nor the Paris agreement. It does however conclude in part 5 of Article 10 that:

"…*nothing in the Agreement should prevent either Party from adopting or maintaining measures to implement the Multilateral Environmental Agreements to which it is a party, provided that such measures are not applied in a manner that would constitute a means of arbitrary or unjustifiable discrimination between the Parties or a disguised restriction on trade."*

As a contrast to this, the EU (and its 28 member states) on April 22, 2016 signed the Paris Agreement. The agreement will enter into force as soon as it has been ratified by countries representing 55% of the global greenhouse gas emissions, making it legally binding for ratifying parties (European Commission, 2016c). Among its stated efforts, the most prominent feature is the obligation of the international community to limit the increase in global average temperature to well below 2° C and pursuing efforts to limit the temperature increase to 1.5° C (United Nations Framework Convention on Climate Change, 2015).

Pursuing its legally binding contribution towards this global aim of reducing climate change caused by human activity, the EU in 2014 adopted a 2030 climate and energy framework, setting out as a key target the minimum reduction of greenhouse gas emissions by 40%, from 1990 levels, covering all sectors and all sources of emissions, including agriculture, forestry and other land uses (European Commission, 2015d, 2016a). Assessing the practical implications of the signing of the Paris Agreement on EU policy, a statement from the European Commission to the European Parliament and Council indicates that the global clean energy transition to reach the goals of the Paris Agreement will require changes in investment behavior and incentives across the entire policy spectrum (European Commission, 2016d). It furthermore requires a strong political determination to secure the transition to a climate resilient future in a socially just manner, to reach a global peak of greenhouse gas emissions as soon as possible and to achieve climate neutrality in the second half of this century. To reach this goal, climate change should remain on the political agendas of relevant international fora (ibid. p 3).

To the extent that trade policy and ongoing trade negotiations are concerned in the strategic documents of the EU implementation of the Paris Agreement, such policy is considered to reinforce the climate targets and accelerate mitigation efforts by liberalizing trade in green goods and services (ibid. p 8). In these documents there is no reference to climate impacts of trade in general, nor to consumption related emissions caused by a global market, increased importation and changing consumer behavior.

II.VI Summary of literature review and relevance for further quantitative analysis

This section has intended to grasp the complexity of the topics of transatlantic agri-food trade and climate change, with an aim towards diversity in positions and views. This is in part done out of respect for the ongoing negotiations and social debates, which would hardly benefit from premature conclusions, but more importantly to be able to identify the most important aspects of concern, on which we will keep the focus in our further analysis. Our main conclusions from this exercise are:

- The Economic Impact Assessment results from different sources differ widely. They will be influenced by a variety of factors including model and data used, aggregation and quantification specifics, political or economic aspirations and many other factors.
- Several conflicted areas will be hard to overcome in the negotiations and may raise voices for exceptions. There is a need to include reports from both sides of the negotiation table to broaden the analysis, but some common characteristics are desired.
- To analyze the impact of TTIP on agriculture and food trade we must include effects of both tariff reduction and NTM abolition on imports to and exports from the EU. While NTMs are particularly problematic to quantify and may fulfill purposes other than strictly economic ones, they play an essential role in determining the economic impact of the TTIP.
- For climate effects of agriculture and food trade, there is a need to integrate aspects related to the consumption of imported goods, since they make up a large part of the food basket of the average consumer in the global north, and has a large impact on the food related climate footprint.
- Effects on non-CO_2 greenhouse gas emissions need to be considered, since they are powerful climate gases and particularly present in the agri-food sector.
- If the changes in exports and imports as a result of the TTIP are found to have a significant impact on GHG emissions, this should be recognized in the sustainability chapter of TTIP in order to assure compliance with global climate efforts.

III. Data Sources and data base limitations

This section describes the GTAP data sources used for trade data and construction of the Input-Output table of EU27. It also describes the data used for construction of the CO_2 and non- CO_2 accounts used to extend the IO table to and EEIO table with emissions accounts. The section highlights the applications and limitations of all the data sources and procedures used and discuss the specific bias of potentially present in database construction. The specific steps of EU27 data base construction followed are outlined in subsequent section IV.

III.I GTAP 9 Trade data for I-O construction

The Global Trade Analysis Project (GTAP) data base version 9 records the global annual flows of goods and services within 57 sectors and commodities, 5 factors of production (land, skilled labor, unskilled labor, natural resources and capital) for 140 regions. It is based on individual contributions of data on bilateral trade and transactions, transport and protection matrices from countries, organizations and individual researchers around the world (Walmsley *et al.*, 2012). The GTAP data base is publicly available and regularly updated, the most recent version 9, which is used for this study, contains data for the base year 2011.

The GTAP data base can be used for construction of various general equilibrium models, such as Input-Output models, and is commonly used for this purpose in economic analysis of policy related to global trade, energy and the environment. Important to keep in mind when using GTAP, in particular for I-O construction, is the fact that even though a substantial part of the data in GTAP is based on national I-O tables, it originates from heterogeneous sources which have been modified for consistency (Purdue, 2015). The quality of I-O tables may hence vary across countries. For agriculture in particular, additional I-O data is sometimes collected from FAOSTAT and disaggregated to fit GTAP sectors. In the same sector, additional processing have been needed to ensure consistency with global data sources (such as EIA, OECD and Eurostat). Hence using GTAP for I-O analysis requires awareness of the limitations of data base construction (Walmsley *et al.*, 2012; Purdue, 2015).

The data in GTAP records sales and purchases for domestic and international economic activities, including international transportation services. As such it also reports on trade margins, trade, commodity and income taxes, savings, capital stocks depreciation and population for every country/region. A basic illustration of the structure of accounts in GTAP is found in Walmsley *et al.*, (2012) and is below ordered to illustrate the latest version 9 accounts and the construction of the I-O table of EU27 in this study. A complete description of the GTAP variables is found in Appendix I.

The economy is summarized by sales of the 57 domestic or imported commodities, among which 20 are considered to belong to the agri-food sector[16]. Inputs into production are shown in the first column. In figure III all values are at market prices, excluding taxes but including domestic margins. The I-O structure requires that the table is balanced, i.e. that total sales (sum of rows) equals total costs (sum of columns), inclusive of taxes, subsidies and other margins (ibid. p 3).

[16] Appendix III shows the GTAP sectors, as well as sectoral aggregation in the CGE results used for simulation.

Table I: Simplified view of the structure of the GTAP data in I-O table (excluding commodity taxes)

Note: See Appendix I for a complete description of the GTAP variables used.

	Intermediate transactions	**Final demand**					
	Domestic activities (57)	Households (1)	Government (1)	Investment (CDGS) (1)	Exports (140)	Global Transport	Total
Domestic commodities (57)	**VDFM**	**VDPM**	**VDGM**	**VDFM**	**VXMD**	**VST**	
Value Added Factors (5)	**VFM**						
Imported commodities (57 Agg)	**VIFM**	**VIPM**	**VIGM**	**VIFM**			
Total							

Source: Walmsey.,*et al* (2012)

The GTAP9 database also includes data on Carbon Dioxide (CO_2) emissions from fossil fuel combustion for all sectors, distinguished by fuel and by user (Purdue University, 2016). Emissions are available for domestic as well as imported purchases by firms, households and government, measured in million tons CO_2. The variables used for construction of the CO_2 account in the Environmentally Extended I-O (EEIO) table is **MDF** containing emissions from domestic input purchases by firms for exports, and **MIF, MIP** and **MIG** containing emissions from imported purchases by firms, private households and government, for imports. In the 2011 version of the GTAP used, the CO_2 emissions dataset is integrated in the core data set which facilitates the creation of an EEIO in our case, since it allows for a similar aggregation scheme to be used for the construction of the I-O table and the additional CO_2 emissions account. The data does not include emissions from land use change and forest carbon stock, leading to an underestimation of the total CO_2 impact. GTAP has made available a model for investigating land use change emissions, but the data does not refer to a similar agent or sectoral disaggregation like our model and the possibility of application is therefore limited.

Using trade statistics for EEIO has some further limitations when considering imported goods. The possibility of re-exportation of an imported product (common for example in the food processing sector) would imply that the end consumption is allocated elsewhere and the environmental impact hence corresponds to another market's consumers (Kitzes, 2013). In what follows, we have compensated for this potential error by the creation of an aggregate database and I-O table for the EU27 which contains extra and intra EU trade accounts. Since such re-exportation will often take the form of intra-EU trade, the final demand and corresponding emissions will remain within the EU.

III.II Satellite Data set: GTAP Non-CO_2 Greenhouse Gas Emissions data

The additional emissions dataset used in this study is developed by GTAP for the base year 2011 and contains information on emission levels by region and economic sectors for three major non-CO_2 gas-groups: Methane

(CH_4), Nitrous Oxide (N_2O) and a Fluorinated gases (F-gases), in million tons CO_2 equivalents. Furthermore, the database reports on the specific emission driver categories: consumption (final by households and intermediate by firms), endowment use (land and capital) and output. For the version 9, the emissions data for the agricultural sector is compiled by using FAOSTAT (2014). Additional aggregation mapping has been done to make the data consistent with the GTAP9 sectoral and regional categories[17]. Non-CO_2 emissions are categorized in livestock-related emissions, containing the categories "Enteric fermentation", Livestock and manure management" and "Pasture, range and paddock" as well as crop related emissions containing "Biomass burning", "Cropland soils" and "Rice cultivation".

For the satellite data sets, the aggregation software GTAPAgg is not available so the non-CO_2 accounts for the I-O of EU27 are constructed by summing firm emissions over all 27 member states. Additionally, emissions are summed over all emission drivers of production within the region (inputs, output and endowment use) for analysis of the export effect, while the US industries emission levels are used to compute the import effect. In GTAP Carbon Dioxide (CO_2) emissions are reported in Million metric tons CO_2 while non-CO_2 emissions are reported in Million metric tons of CO_2 equivalents. The units are thus considered equivalent and comparable.

There are hence four additional emissions accounts making up the EEIO, one for each type of GHG emission analyzed. For every emission type, an individual indicator of total direct emission per monetary unit of final demand is created, allowing the emission levels to fluctuate with the simulated changes in final demand and output.

III.III Aggregation and database construction bias of GTAP

All data used in this study stem from the version 9 GTAP database with the same base year (2011). The GTAP project aims to facilitate applied research in global trade and environmental impact analysis by providing a consistent and manageable database available for academic researchers. As mentioned above, in data base construction modelers make use of multiple sources of information, regional and national I-O tables, or other global bases such as FAOSTAT. To make varying sources of information consistent with the aims of the GTAP project, aggregation, disaggregation and other data calibration methods may be used, resulting in potential bias. The results of this study will hence be subject to the same potential bias and are only as valid as the data in GTAP 9 for the base year 2011 can be considered [18].

The datasets used to construct the non-CO_2 emissions data for agriculture are based on globally standardized emission estimation methods for national greenhouse gas inventories, applied to all countries and sectors. As such, the data does not stem from official reported emissions from governments. This possibly leads to discrepancy between GTAP emissions statistics and official country reports (Burcu Irfanoglu & van der Mensbrugghe, 2015).

In our case, significant aggregation bias could also stem from the creation of the aggregated database of a domestic EU27 I-O table, which does not take into account national or regional specific differences in structure and composition of the European agri-food industries, or any other potential differences between the European countries, which may be substantial. However, since emissions are global and the EU has set common climate goals, the average EU impact is considered as the most relevant one for our analysis.

[17] For a full description of GTAP non- CO_2 GHG emissions aggregation mapping see Burcu Irfanoglu & van der Mensbrugghe (2015)

[18] See further discussion of potential aggregation bias in section V.

IV. Methodology

The standard Input-Output model is in this study used for analysis of the trade effects of the TTIP trough interindustry transactions. This section outlines the theoretical base and application of the Input-Output model, and provides the conceptual framework of the continuing analysis. To integrate environmental impacts, the standard I-O is extended to contain emissions accounts. This section further explains the aims and most prominent features of this Environmentally Extended Input Output model. It also highlights the underlying assumptions of the model, which to some extent limits its scope of explanatory value. In what follows, the section goes through all nine steps of computational procedure used in this study, in detail.

IV. I Conceptual framework

Rather than evaluating the environmental impact of the *flows* of trade between the EU and U.S. markets as a consequence of the TTIP, this study focus on the *local* economic and climate effects of increased trade in agricultural products on the EU market, analyzed through an input-output table of the EU economy. The model builds on general trade theory and the results of previous economic impact assessments used for simulation are all CGE models of international trade. As a base for both CGE and I-O modelling lies the circular flow of market interactions between households, firms and the government within an economic unit. Households are assumed to own the production factors, rented by firms for use in production of goods and services purchased by households, other firms, or the government, which also provides governmental goods and services to firms and households, as well as collect taxes (Wing, 2011).

IV.I.I Input-Output analysis and Leontief relations

Sometimes called *inter-industry analysis* due to its primary focus on interdependencies between different sectors of the economy, the Input-output analysis was first developed by Wassily Leontief in the late 1930's (Miller & Blair, 2009). The model's basic foundations builds on strictly linear relations between the products of economic actors within a clearly defined geographic area. A table of the distribution of the producers' output throughout the economy is constructed from observed economic data of the area under consideration[19]. In this study, the sector specific data on agricultural commodities and industries, as well as all other sectors in the economy are collected from the GTAP database. All sectors are included for balance of the I-O table and consistency of the multiplier analysis, but the focus of the results report is on the agriculture and food sectors.

In the standard Input-Output model, the distribution throughout the economy of a commodity (output) produced by sector *i* can be written with the following equation, as exemplified by Miller & Blair (2009):

$$x_i = z_{i1} + \cdots + z_{ij} + \cdots z_{in} + f_i = \sum_{j=i}^{n} z_{ij} + f_i \qquad (1)$$

Where x_i is total production of a commodity from the sector *i*, z_{ij} is the demand for *i* in sector *j*, there is a total of *n* sectors in the economy, and f_i is final demand for *i* by end consumers, government and exports. A similar equation exists for each of the sectors of the economy, making up a matrix of linear relations (ibid. p 688). The distribution of each sectors sales in matrix notation can be summarized by:

[19] See table I of the GTAP I-O structure and Appendix II for the aggregated EEIO used

(2) $$\boldsymbol{x} = \mathbf{Zi} + \mathbf{f}$$

Where **x** is the column vector of output, **Z** is a matrix of interindustry transactions multiplied by a column vector of 1's represented by **i**, and **f** is the column vector of final demand including exogenous transactions between industries and households, government and other regions (exports).

Scenario analysis in the standard I-O model will show a corresponding change in output associated with a demand driven change in any of the exogenous accounts, through the interindustry linkages represented by **Z**. In this study, the results from previous CGE analyses of the economic impact of the TTIP for the agriculture and food sector will be used as the reference change in exports and imports associated with the agreement and applied accordingly to the GTAP data for these sectors, which will, due to intermediate transactions and interlinkages in the I-O table, result in a corresponding change in total output and final demand.

Imports are not treated in the same way as exports in an I-O model. While exports are considered a change in final exogenous demand from the rest of the world for commodities produced within the economy, imports are to be treated as a fixed additional inflow of commodities for intermediate or final consumption, i.e a change in exogenous supply. To illustrate the effect of a fixed change in supply, final demand will be treated as endogenous in a mixed I-O model and allowed to fluctuate as a variable expressing the change in imported commodities.

The linearity feature of the above equation is equal for all I-O tables. The coefficients of the I-O table derived for this study will hence be of fixed character and consequentially does not, in contrast to a CGE model, allow for prices to fluctuate over time. The results reported will in any I-O be proportional to the shock induced on the model by multiplication of a specific sector coefficient. In our particular case, the linearity feature of the I-O model is reflected in the high correlation between the I-O results and the CGE results used for simulation. This brings specific importance and attention to the CGE results used and provides the argument for a quite extensive discussion of the possible explanations of differing results in section V.

Furthermore, I-O analysis includes several assumptions which limits its scope of explanatory value (Miller & Blair, 2009; Lindberg *et al.*, 2012; Kitzes, 2013):

i) *Homogeneous products and technology*, which implies that firms use constant technology for production of primary, secondary and other commodities.

ii) The fixed price feature suggest *non-substitution in inputs* due to price or preference change.

iii) The linearity feature implicitly assumes *constant returns to scale* in production and *fixed proportions of inputs* are used for every output produced.

iv) *Perfectly elastic factor supplies*. Technical coefficients are calculated as the ratio of each input to its total output and there is no sluggishness in the response.

These assumptions suggest some limitations of the analysis. In a perhaps more realistic representation of economic relations, one would for example typically assume the equations to be of a non-linear character which would allow prices to be subject to change over time (James, 1994).

The I-O transactions table is hence most useful when seen as a static snapshot of inter-sectoral linkages within an economy for a given point in time (Lindberg *et al.*, 2012). No economic model is however free from assumptions. Other models used for investigation of similar relations may lack the straightforward computational procedure of the I-O model and often involve complex equations which severely limits the reproducibility and transparency of the results. Thus, keeping in mind throughout the analysis that the results presented in an I-O table are valid only for fixed relations in the base year, the constructed model will nevertheless give a sufficiently comprehensive and rigorous estimation of the economy wide sector interlinkages at a particular point in time and the resulting impact of changes in trade flows, as the scope and time frame of this thesis allows for.

IV.I. II EEIO Environmentally Extended Input-Output analysis

As explained by Bergström (1990), the Environmentally Extended Input-Output model (EEIO) aims at establishing a connection between well-known national economic accounting techniques and environmental impact analysis, by evaluating environmental issues using the terms and language of economic policy. By using this method, the analysis manages to integrate sustainability indicators in national accounting.

The goals of most of EEIO related to trade and food consumption analysis are outlined by Kitzes (2013) as:

- *To calculate the indirect (hidden, indirect, upstream) environmental impacts associated with downstream consumption activity, such as the total carbon emissions that occur when a person purchases and consumes a hamburger*

- *To calculate the amount of embodied environmental impact in goods traded between nations, such as how much nitrogen is released into the environment in the United States and then "exported" in wheat that is shipped to Denmark.*

The I-O scenario analysis in this study is extended to and EEIO by creating additional emissions accounts associated with agricultural and food production on the one hand and consumption of imports on the other. The change in export and import of agricultural products as a result of the TTIP is then converted to the corresponding change in GHG emissions associated with a change in consumption and production of these products, with a particular focus on changes in commodities associated with comparably high GHG emissions such as meat and dairy products.

I-O analysis of the trade effects of the TTIP is hence expected to show the corresponding change in consumption and production of specific agricultural commodities, through the interlinkages between sectors and economic actors within the EU. In extension, EEIO analysis make use of the GHG emissions data associated with agricultural and food commodities to demonstrate the corresponding change in greenhouse gases emitted within the region. As a result of the intended trade effects of the TTIP, production and consumption effects are expected to show a proportional change in the GHG emissions associated with the agriculture and food sector, a change which potentially is large enough to have an impact on EUs mitigation targets.

IV.II Method and computational procedure

In the following section the methodological procedure of the thesis is outlined in nine steps of computation, starting with the construction of the aggregated database of EU27. The following steps include construction and balancing of the I-O table, the calculation of the technical coefficients and the Leontief inverse multiplier matrix and the procedure of simulating a corresponding export shock on the exogenous final demand as well as an import shock on the exogenous output. It further provides a description of the construction of the emissions accounts for the EEIO table and the equations used for calculation of the total emission impact.

1. Access GTAP9 and construct aggregated EU 27 database

The Global Trade Analysis Project GTAP 9 data base comprises trade data from 2011 (the most recent source) and is primarily used with the CGE GTAP model. It can however be used to extract I-O tables for single countries with some limitations[20].

The default mode of the GTAP database includes a regional account for EU25 containing the member states belonging to the European Union in 2004. To harmonize the analysis with the underlying trade data of GTAP 9 from 2011 and to allow for a more realistic estimation of the impacts of the TTIP on the EU market, a data base of EU 27 is constructed by adding two additional national accounts, corresponding to the countries introduced as member states of the European Union the 1st of January 2007, Bulgaria and Romania. The aggregation is made using the GTAPAgg software package. GTAPAgg contains a set of mapping files which achieve regional flexibility and allow for modelers to independently aggregate individual countries to larger regions, in our case EU27. The procedure of using GTAPAgg to some extent diminishes the risk of aggregation bias due to regionalization.

2. Construct and balance aggregated I-O table for EU27

To construct the corresponding I-O table, data on economic transactions and interactions from all EU countries is accessed through GTAP9, as explained above. Data include monetary values of transactions between sectors for all countries within the region, in terms of goods and services purchased and sold. These transactions are *intra-industry transactions* and show the distribution of producers output throughout the other sectors of the economy. Additionally, purchases from end consumers or *exogenous* sectors, such as households, government and foreign trade are columns in the I-O table labelled *final demand.* Finally, non-industrial inputs needed for every sector to produce, such as primary factors, imports, taxes/subsidies and labor, are rows labelled *Value added* (Miller & Blair, 2009). The I-O table derived for this study more specifically includes data on all inter-industry and end use transactions within the EU27, including but not limited to, agriculture products and the food processing industry. For every sector, the interindustry sales and purchases of inputs, as well as final demand and value added data is aggregated to include all EU countries through the GTAPAgg program. Trade data on transaction values of domestic and international sales and purchases within the economy is extracted and added to an EXCEL template for I-O construction[21].

The I-O table is balanced so that total output equals total input for every account. Specific mathematical procedures, such as the RAS balancing method, exist. These are however not further treated within the scope of this study, as the I-O table derived from GTAP is assumed to be sufficiently balanced without use of specific balance equations. Some procedures to achieve balance are however applied, based on McDonald & Thierfelder, (2004) and with assistance from professor Yves Surry at the Swedish University of Agricultural Sciences. First, through separation of intra and extra-EU trade on the variable VXMD for exports, accounting for the fact that many exported commodities from the EU countries remains in the region EU27, but outside national borders. The export account is furthermore expressed at the market price value as opposed to world market price. Further, imbalances in the I-O table are attributed to unaccounted export subsidies for some commodities, which are reflected in some tax accounts showing negative figures. These are particularly present in the agricultural sector. The slight imbalance which remains is due to rounding and accounted for by computing the residual term and adding remaining decimals to the government purchases column.

3. Compute technical coefficients and the Leontief inverse matrix of I-O interindustry multipliers

To fulfill the specific purpose of this study, exports are isolated from the general exogenous final demand accounts. Building of the conceptual framework from previous section, equation (1) and (2) will be extended to imply;

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[20] See chapter III for specification of these limitations and a more extensive discussion on the data used in this study

[21] See chapter III for GTAP I-O structure and appendix I and II for variable description and aggregated EEIO table.

(3) $$x_i = z_{i1} + \cdots + z_{ij} + \cdots z_{in} + f_i + e_i = \sum_{j=i}^{n} + f_i + e_i$$

(4) $$\boldsymbol{x} = \mathbf{Zi} + \mathbf{f} + \mathbf{e}$$

Where f is final demand from households and governments and **e** is a column vector of exports, which in our model is allowed to vary with the TTIP impact. This makes no further difference to the analysis than to specifically highlight the impacts of trade and facilitate forthcoming scenario analysis.

In I-O analysis, a fundamental assumption is that the interindustry flows from sector *i* to *j* for a given year depend entirely on the level of output x_j for that same year. (Miller & Blair, 2009). To give a practical example of derivation of technical coefficients in this study, let's assume that sector *i* is soybean production and sector *j* is beef production. Some amount of soybean inputs are purchased by the beef sector and the level of interindustry sales will be the ratio of soybean input to beef output, the *technical coefficient*, here labelled a_{ij}

(5) $$a_{ij} = \frac{z_{ij}}{x_j} = \frac{value\ of\ soybean\ bought\ by\ beef\ sector}{value\ of\ beef\ production}$$

This implies that for production of beef, not only that the level of soybean is fixed according to the level of production of beef but also that the proportion of soybean input in beef production, as well as other inputs are used in fixed proportions (where the proportion is the ratio of technical coefficients for every input used).

Computing the ratio of technical coefficients for every input and every sector will result in a matrix table similar to the original I-O table with value data but replaced by a set of fixed technical coefficients reflecting the economic interlinkages, which we hereby will denote **A.**

(6) $$\boldsymbol{A} = \boldsymbol{Z}\hat{\boldsymbol{x}}^{-1}$$

Where $\hat{\boldsymbol{x}}^{-1}$ is the inverse of a diagonal matrix with the elements of vector $\boldsymbol{x}$ along the main diagonal. Creating an $n^x n$ (for *1* to *n* sectors) identity matrix of 1's in the main diagonal and 0 elsewhere: (ibid. p 20)

$\mathbf{I} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ which will imply:

(7) $$\mathbf{(I\text{-}A)} = \begin{bmatrix} (1-a_{11} & -a_{12} & \cdots & -a_{1n} \\ -a_{21} & (1-a_{22}) & \cdots & -a_{n2} \\ \vdots & \vdots & \ddots & \vdots \\ -a_{n1} & -a_{n2} & \cdots & (1-a_{nn}) \end{bmatrix}$$

The unique solution to our problem will be obtained by computing the Leontief inverse of the **(I-A)** matrix, in our case:

$$(8) \qquad \boldsymbol{x} = (\boldsymbol{I} - \boldsymbol{A})^{-\mathbf{1}}(\boldsymbol{f} + \boldsymbol{e}) = \boldsymbol{L}\,(\boldsymbol{f} + \boldsymbol{e})$$

The above relation implies that each of the gross outputs $\boldsymbol{x}$ for each sector is dependent on the interindustry transactions expressed in the Leontief inverse matrix, as well as the values of final demand and exports. This relationship will be further extended to include the emissions accounts for the EEIO.

4. Scenario Selection (previous CGE results) and sensitivity analysis

Having computed the matrix of I-O interindustry multipliers, the analysis moves on towards estimating the impact of a change in final demand, as a result of the TTIP. To do this, a corresponding change in exports for every sector is induced on the matrix to "shock" the model and simulate a change in total output vectors. The study makes use of results from previous reports using CGE models to predict the impact of tariff and NTM removal on the trade flows of the EU27 economy. The choice of values on imports and exports for our scenarios depends on availability of data on specific changes for all sectors of interest for this study.

To increase the transparency of the results, three scenarios are modelled: using the CGE results from reports conducted by both sides of the negotiation table.[22] While the I-O multipliers are identical and the simulation is executed in the same way in all scenarios, aggregation and some additional recalculations may be used to create robust results[23]. As the CGE results differ, the I-O simulations will to a high extent reflect these differences in each scenario. More details on the scenario analysis and the reports used are found in section II.II and V of this thesis.

5. Simulate the corresponding increase in exports and report results

The absolute change in exports will be reported as a column vector, for example: $\Delta\boldsymbol{e} = \begin{bmatrix} -0.2 \\ -0.9 \\ 0.5 \\ 0 \\ 2 \end{bmatrix}$

The vector is then multiplied with the Leontief inverse matrix **L** to calculate the corresponding change in total sector output associated with the export change. The result will be reported in a column vector with equal amount of rows as the L matrix and equal amount of columns as the vector $\Delta\boldsymbol{e}$ of export change.

6. Create a mixed model I-O table for supply driven import impact

I-O analysis of the import flows requires constructing a mixed model I-O table. Here we let output as a function of imported supply of agri-food commodities be exogenous and fixed, while allowing the final demand variables to be endogenous and vary as we simulate the import change. An example of a three sector model is found in (Miller & Blair, 2009 p 621-623) where final demand in sector 1 (f_1) and 2 (f_2) and output in sector 3 (x_3) are set as exogenous. Following this example with influence from the mixed model as constructed by Roberts (1994), the basic equations of the I-O (eq. 1 & 7) are rearranged to contain the new relationship:

[22] From the USDA, the European Commission and the European Parliament.
[23] Se Appendix III for Simulation results and recalculations

$$\text{(9a)} \qquad \begin{array}{llll} (1-a_{11})x_1 & -a_{12}x_2 & +0f_3 & = f_1 \quad + a_{13}x_3 \\ -a_{21}x_1 & +(1-a_{22})x_2 & +0f_3 & = f_2 \quad +a_{23}x_3 \\ -a_{31}x_1 & -a_{32}x_2 & -f_3 & = \quad -(1-a_{33})x_3 \end{array}$$

Where a_{ij} are the technical coefficients from eq. (5) In matrix form, expression (9a) becomes

$$\text{(9b)} \qquad \begin{bmatrix} (1-a_{11}) & -a_{12} & 0 \\ -a_{21} & (1-a_{22}) & 0 \\ -a_{31} & -a_{32} & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ f_3 \end{bmatrix} = \begin{bmatrix} f_1 & +a_{13}x_3 \\ f_2 & +a_{23}x_3 \\ & -(1-a_{33})x_3 \end{bmatrix}$$

Or, containing all variables in each equation:

$$\text{(9c)} \qquad \begin{bmatrix} (1-a_{11}) & -a_{12} & 0 \\ -a_{21} & (1-a_{22}) & 0 \\ -a_{31} & -a_{32} & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ f_3 \end{bmatrix} = \begin{bmatrix} 10 & a_{13} \\ 01 & a_{23} \\ 00 & -(1-a_{33}) \end{bmatrix} \begin{bmatrix} f_1 \\ f_2 \\ x_3 \end{bmatrix}$$

Using eq. (9c) and defining N and M matrices as:

$$\boldsymbol{M} = \begin{bmatrix} (1-a_{11}) & -a_{12} & 0 \\ -a_{21} & (1-a_{22}) & 0 \\ -a_{31} & -a_{32} & -1 \end{bmatrix} \quad \boldsymbol{N} = \begin{bmatrix} 10 & a_{13} \\ 01 & a_{23} \\ 00 & -(1-a_{33}) \end{bmatrix}$$

We can write:

$$\boldsymbol{M} \begin{bmatrix} x_1 \\ x_2 \\ f_3 \end{bmatrix} = \boldsymbol{N} \begin{bmatrix} f_1 \\ f_2 \\ x_3 \end{bmatrix}$$

The solution to the mixed model will be obtained by taking the inverse of the **M** Matrix

$$\text{(10)} \qquad \begin{bmatrix} x_1 \\ x_2 \\ f_3 \end{bmatrix} = \boldsymbol{M^{-1}N} \begin{bmatrix} f_1 \\ f_2 \\ x_3 \end{bmatrix}$$

In our particular case, agriculture and food processing sectors are set as exogenous, and we simulate the change in final demand for these commodities as a result of a fixed supply change due to imports in production and final consumption. Equation (10) will in our case be made up by two exogenous accounts

$$\text{(11)} \qquad \begin{bmatrix} f_{agri} \\ x_2 \\ f_{food} \\ x_n \end{bmatrix} = \boldsymbol{M^{-1}N} \begin{bmatrix} x_{agri} \\ f_2 \\ x_{food} \\ f_n \end{bmatrix}$$

Where the import changes are reported in the right hand column and the results in the left hand column.

7. Simulate the change imports and the corresponding impact on final demand and report result

In our case, we simulate the effects of a fixed change in agricultural and food processing supply, assuming that the fixed level of imports is either used in final production or consumed directly. Either way, the outcome of our simulation, is a corresponding change in endogenous final demand for agricultural and food commodities in the economy as a whole. The changes in final demand will be less than the actual import change due to the characteristics of the mixed model multipliers, showing the opposite relationship to the standard I-O model for which we simulate the output change as a function of changes in final demand. While this may lead to an overall underestimation of the impact of imports on emissions, it is a more realistic assumption than to assume that all additional imports will be directly used in domestic production.

The change in imports are reported as a fixed supply change in the exogenous accounts, in a column vector

$$\Delta x_{\text{agri}} = \begin{bmatrix} 0.5 \\ 1 \\ 0.8 \\ 0 \\ -0.2 \end{bmatrix} \text{ and } \Delta x_{\text{food}} = \begin{bmatrix} 2.2 \\ 6 \\ 0 \\ 12 \\ -0.2 \end{bmatrix}$$

Similar to the procedure in step 5, the column vector is multiplied with the mixed model multipliers in matrix

$\mathbf{M^{-1}N}$ to calculate the corresponding change in in final demand associated with the import change. The solution results in a column of Δf_{agri} and Δf_{food} while the remaining sectors show the indirect change in sector output x, as a result of the increased imports in the agriculture and food sectors. These indirect effects for non-agri-food sectors are likely to be small and are not included in the results reports.

8. Create EEIO Emissions accounts, indicators of total emissions and compute total emissions impact for each sector/commodity

To measure the effects on GHG emissions, we need a set of appropriate coefficients to translate output effects into GHG emission. We can do this by introducing a new row vector of emissions' accounts, expressing the amount of various pollutants directly emitted by each sector (E_i). Dividing the direct emissions by total output of the sector (x_i) we determine the *indicator of total direct emission per monetary unit* (E^*) (Velázquez, 2006).

$$E_i^* = \frac{E_i}{x_i} \qquad (12a)$$

Eq. 12a can also be expressed in matrix notation as the *emission coefficient*:

$$\boldsymbol{E}^* = \boldsymbol{E}'\hat{\boldsymbol{x}}^{-1} \qquad (12b)$$

Where elements $E^*$is the amount of emissions emitted per dollar of output from all sectors $[E_1^*, E_{2\ldots,}^* E_{i\ldots}^* E_n^*]$ $\boldsymbol{E}'$ are all direct emissions $[E_1^t, E_2^t, \ldots, E_i^t, \ldots, E_n^t]$ and $\hat{\boldsymbol{x}}^{-1}$ is the inverse of a diagonal matrix with the elements of **x** on the main diagonal.

The Leontief inverse matrix $L = (I\text{-}A)^{-1}$ from eq. (7) can then be used to define a row of vectors containing the *indicators of total emissions.* [24]

(13) $$\boldsymbol{E'^{t}} = \boldsymbol{E}^{*}(\boldsymbol{I}-\boldsymbol{A})^{-\mathbf{1}} = \boldsymbol{E}^{*}\boldsymbol{L}$$

Where E'^{t} are $\left[E_1^t, E_2^t, \dots, E_i^t, \dots, E_n^t\right]$

Total emissions of the economy can then be expressed by multiplying the indicator of total emissions by the quantity of output produced by each sector. In matrix notation total emissions are defined as:

(14) $$\boldsymbol{E} = \boldsymbol{E}^{*}\boldsymbol{x}$$

The production vector x can be reformulated to contain the Leontief inverse matrix **L** and final demand, Eq. 10a is hence re-written as:

(15) $$\boldsymbol{E} = \boldsymbol{E}^{*}(\boldsymbol{I}-\boldsymbol{A})^{-\mathbf{1}}(\boldsymbol{f}+\boldsymbol{e})$$

We can thus express **E** as the vector of total emission impact coefficients and, holding other exogenous accounts constant, compute *total emissions impact* associated with a change in exports by multiplying it with the column vector **e**, which will be the value change associated with the direct and indirect multiplier effects of exports derived in step 5.

The simulation on the emissions accounts is made separately for every emission type reported and a column vector of the total emissions impact for each emissions account ($\mathbf{E^{co2}}$, $\mathbf{E^{N2O}}$, $\mathbf{E^{CH4}}$, $\mathbf{E^{F}}$) shows the corresponding change in emissions per sector. Assuming equivalent units (MT CO_2 and MT CO_2 equivalents), summing over all **E'**s will give total GHG Emission impact E^{GHG} associated with the change in exports.

(17) $$E^{GHG} = \sum E$$

For imports, a mixed model is developed where agriculture is set as an exogenous account (see part 8 above), and final demand changes are driven by changes in import supply. Technically, a similar computation as for exports will be made. While the fixed supply change corresponding to imports is contained in the right hand side of eq. (11), we calculate the change in E'^{t} as a function of changes in final demand by multiplication with the simulation results, i.e. the left hand side of eq. (11). Emission coefficients for imports contains data based on CO_2 emissions embedded in private, government and intermediate firm consumption of imports and non-CO_2 emissions embedded in U.S industry production for every sector.

The total environmental impact associated with changes in imports and exports within the EU as a consequence of the TTIP can then be obtained by adding up the vector results and reporting them in an environmental impact summary section. Percentage values are calculated using 470.6 MT CO_2 from Füssel *et al.*, (2012) as the base value of total agricultural-related GHG emissions in the EU. Some specific attention is made in reporting the results for particularly heavy emitting sectors, such as meat at dairy products.

[24] Even though the technical coefficients of emissions can be recalculated, they are identical to the ones used for production, i.e the **A** matrix and are therefore reused here (see Velazquez, 2006 p 2030)

V. Scenario analysis: selection and motivation

Due to the linear feature of the I-O model, the results of this thesis will be highly influenced by the trade changes we expect will come from a TTIP. The following section therefore describes the motivation behind and the procedure for selecting the scenarios on which we base our I-O simulation. The decision includes considering the suitable levels of aggregation for the purpose of the study, as well as including alternative results in a scenario analysis, making sure that the results from reports commissioned by both sides of the negotiation table are taken into account. The section follows with a discussion of potential aggregation bias and a summary of the CGE results for the reports used. To comply with the aim of this thesis to calculate the climate impact of a "best case scenario" in terms of economic intentions of the TTIP, throughout the analysis the most ambitious (the highest level of trade liberalization) scenario from every report is used in the simulation.

V.I Scenario description and motivation

Several studies have examined the economic impact of the TTIP on the agricultural sector, as shown in section II.II. To construct a scenario analysis of the economic impact of the TTIP, this study makes use of different sources with the aim to, as far as this is possible, minimize potential biases arising from using a single study's results without taking into account alternative sources, views and procedures. Even though many of the reports studied in the literature review make use of similar economic models to estimate the effects of reducing barriers to trade in the current transatlantic context, their conclusions differ quite vastly. There are most likely multiple explanations to these differing results and given the complexity of the models, the discrepancies may be difficult to explain (Hess & Von Cramon-Taubadel, 2008). Furthermore, most of the reports do not provide sufficiently detailed model specifications to identify the factors driving these differences (ibid. p 208). However, with the aim to increase transparency and to provide some motivation for the selection of scenario, some of the potential explanations for differing results are outlined in what follows[25]:

(i) First and foremost there is a need to emphasize that the TTIP is currently undergoing political negotiations and differing *political and economic interests and aspirations* between the negotiating parties may very well be reflected in the results reproduced by studies undertaken on official requests from the U.S Department of Agriculture, the European Commission and the European Parliament, as parts in the negotiations process. These reports are often used as a basis for rhetorical argument towards the public and/or the negotiation opponent and thus must reflect, or at least not contradict, the political aims of the commissioner. While differences in political affiliation are seldom obvious to the reader nor reflected in a transparent way in the corresponding reports, they are nonetheless present and may be a reason for some results being presented while others are not. **Certainly**, any economic model is subject to assumptions related to the behavior of economic agents and the decision on which assumptions to make are influenced by the purpose of the research, regardless if this purpose is official and stated or "unofficial" and underlying.

(ii) Secondly, the studies will differ depending on their *scenario description*, i.e the level of ambition (trade liberalization) they assume will come out of the TTIP negotiations. All studies used for the economic impact scenarios of this thesis take into account tariff reduction as well as reduction of the trade restrictiveness of NTMs. In the USDA study, the most ambitious scenario include full tariff and TRQ removal as well as full removal of some selected NTMs including beef hormones and biotech restrictions. The European Parliament projects a full but progressive tariff removal starting in 2015, as well as a 25 % removal of average trade restrictiveness of NTMs and the CEPR

[25] The explanations are inspired by, but not limited to, the categories identified by Hess & Von Cramon-Taubadel (2008)

study assigned by the European Commission report similar scenarios but differ from the EP study in the model specifications as well as the level of sectoral aggregation.

(iii) Thirdly, *other model specifications* highly influence outcomes. While all studies taken into account are CGE models, there are several kinds of CGEs used and their result may differ depending on assumptions intrinsic to the specific model characteristics. The level of trade restrictiveness of NTMs (i.e. different estimates on the *Ad-Valorem* Equivalent of increased costs corresponding to NTMs) will be decisive for the simulated results (Bureau *et al.*, 2014). The USDA study for example, calculates *selected* NTMs through a specific Gravity model which takes into account that some NTMs (such as for example bans) are more trade distorting than others and thus allow the trade effect of NTM removal to fluctuate. This is contrasted to the other studies where a broad-based approach of the Gravity model where *standard* or *average* trade restrictiveness of NTMs are considered, which according to Beckman *et al.*, (2015, p. 3), tend to overestimate the costs of NTMs. Therefore only a limited number of "actionable" NTMs are included in these analyses.

(iv) Fourth, the *level of sectoral aggregation* and specification will influence the result. In contrast to other sectors, the agricultural sector is currently highly protected in both markets, with average tariffs for some products being very high and the presence of "tariff peaks" in specific products[26]. The specific importance of tariffs in the agri-food sector is the motivation behind the decision to only include studies explicitly modelling effects of tariff reduction in the analysis[27].The level of detail in which the studies have considered agricultural sector and food products will hence create differences in the estimated impact of tariff removal. As an example, the USDA study reports corresponding changes in trade for single commodities such as poultry, butter and cheese, while the CEPR study covers changes in aggregated agricultural and processed food sectors.

(v) Fifth, differences in the *data source* used will create discrepancies in the bases for model simulations on which the studies rely. The only study using the GTAP 2011 data used for constructing the I-O table in this study is the USDA report, the other studies use older versions of GTAP or the WTO MAcMap database. As databases on trade are updated they usually incorporate reductions in trade distorting protection due to international or bilateral efforts which reduces the impact of additional reductions. The meta-analysis conducted by Hess & Von Cramon-Taubadel, (2008) further show a negative correlation between newer GTAP databases and welfare gains from trade. This result is consistent with the literature review conducted for this study in which we saw a tendency for models using newer data reporting lower or negative increases in EU agricultural exports and imports as a consequence of the TTIP.

(vi) The study from the European Parliament demonstrate the *bilateral trade* change between the EU and US and not the total change in trade. To make use of this data, some additional calculations taking into account the share of bilateral EU-U.S. exports in total EU agricultural exports have been executed[28]. Furthermore, the intra-EU trade effects have been included in the European Parliament and CEPR studies by additional computation. The level of recalculation may result in some additional biases in the results.

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[26] See section II.I.II and Josling *et al.*, 2014

[27] The Ecorys study from 2009 (Berden *et al.*, 2009) which is often referenced in economic impact assessments of the TTIP only includes NTM removal in the scenario simulation and hence leave out trade effects of tariff removal. Therefore this study have chosen not to include the Ecorys model results in the analysis. The NTM estimates from the Ecorys study are however present as they are used in other reports, for example the CEPR study.

[28] See section II.I.I, Appendix III and Bureau et al. (2014)

As outlined by Hess & Von Cramon-Taubadel (2008) the results of any trade model will be a complex function of the many factors in the above mentioned categories, and the interactions between them, which in turn makes the task of comparing different simulation results very challenging for the researcher. Since the final result of this thesis will be highly dependent on the level of change in the economic impact scenario, it reports the change in imports and exports of agricultural and food products to and from the EU for different studies from varying sources. For every study, the most ambitious liberalization scenario is used for simulation of the economic impact on our I-O table. This is done to remain consistent with the "best case scenario" for any effort of increasing trade flows, i.e. the scenario which would result in the highest level of economic gains to be expected from both sides of the negotiation table. As such, the scenarios are not overly ambitious but take into account the fact that a full NTM removal is not desirable for any party. A particular share of the NTMs are hence considered "un-actionable" and excluded[29].

To determine with certainty which of the three scenarios is more realistic is a difficult task which due to time constraints must remain outside the scope of this thesis. The answer to our research question will rather take the form of a discussion on what factors will be influence the climate impact of a TTIP, than aiming towards the identification of a single digit impact which in any case would be highly uncertain.

V.II Aggregation and bias of CGE results

The results of the examined reports on the economic impact of the TTIP, are usually described as the overall effect of related trade liberalization procedures on the agricultural and food sector on average. This is the case in the CEPR report conducted on request by the European Commission. The first exception is the USDA report, in which the agri-food sectors are disaggregated to identify specific effects on each commodity on the HS6 level[30]. The European Parliament also provides some level of disaggregation in terms of the effects on specific commodities, although the authors hold that percentage changes on the commodity level are highly uncertain (Bureau *et al.*, 2014, p 37). The motivation behind disaggregation in the USDA study lies within the differing impact, particularly in the field of NTMs, between certain commodities, effects which until now have been unaccounted for in the literature. As an example, one NTM included in the USDA study is the EU prohibition on imports of beef and beef products produced with growth promoting hormones, which is affecting the beef sector in the U.S. Abolition of this restriction will thus have an impact on the beef sector, but will to a lesser or no extent affect the vegetable and fruit sector. Likewise, NTMs regarding plants and plant products will to a lesser extent have an impact on trade in the meat or dairy sector (Beckman *et al.*, 2015). These differing impacts are captured by the USDA report and using these results will consequentially serve our purpose of examining the specific impacts of the TTIP on the meat and dairy sector. Using the results for an aggregated agriculture and food processing sector, such as the CEPR results, to report impacts on specific commodities, may lead to severe issues of aggregation bias (Lindberg *et al.*, 2012). On the other hand, using the USDA results will not completely eliminate the possibility of bias, since the commodity level disaggregation is not as detailed in GTAP. This is for example the case for dairy products where data for butter, cheese, whey and other dairy have been aggregated to correspond to the GTAP sector "Dairy".

Furthermore, in our specific case, significant aggregation bias may stem from the creation of the aggregated database of a domestic EU27 I-O table, which treats the EU as a single market. While this is a reasonable assumption to make when it comes to trade barriers, the domestic I-O table ignores any national or regional specificities in structure and composition of European agri-food industries, differences which may challenge the potential of deductions from an average approach to determine local impacts.

[29] See further section II.I.II on NTM quantification

[30] Harmonized Commodity System 6 digit product categories

V.III Summary of CGE results

This section summarizes the CGE results used for the I-O simulation of the export and import effect of the TTIP. The reports that are considered to suit the purpose of this study and provide sufficiently detailed data on projected changes in agricultural and food export and imports are selected from the table of economic impact assessments below. The specific simulation results are outlined in Appendix III.

Table II: Review of TTIP Economic Impact Assessments on Agri-food sector

Reference/Author	Beckman et al. (2015) p.22	Bureau et al. (2014) p.36	Francois et al. CEPR (2013) p.64		Fontagne et al. CEPII (2013) p.9[31]	ECORY'S (2009) p.87
Commissioner	**USDA**	**European Parliament**	**European Commission**		**Independent French**	**European Comission**
Most ambitious Scenario description	Full Tarriff, TRQ removal. Selected NTM removal	Full Tarfiff removal, 25% NTM removal	Full Tariff removal, 25% NTM removal		Full Tariff removal, 50% NTM removal, harmonization spillovers	50% removal of NTMs
CGE model specifications	Conventional GTAP model	MIRAGE model	GTAP model; Imperfect competition		MIRAGE model; imperfect competition	Limited model information
Sector	Agri-food (35/47)	Agri-food (17/31)	Agriculture forestry, fis/heries + food proc (2/20)		Agriculture (6/34)	Food proc. Only (1/15)
Data set	GTAP 9 (2011)	GTAP/ MAcMap	GTAP 8 (2007)		MAcMap (2007)	Various sources
Bilateral exports		56.40%			149.5%	
Bilateral imports		116.30%			168.5%	
Total EU exports	-1,40%	20,28%[32]	0.34%/9.12%		27,9%[32]	0.80%
Total EU imports	1.33%	17,44%[33]	5.22%/10.07%		22,92%[33]	0.10%

USDA CGE Results

Table III shows the CGE results for exports from the USDA study. The study paints an overall pessimistic picture of the impact of the TTIP on EU Agri-food exports with decreasing exports for many commodities, most notably Pork exports decreases by as much as 48 %, soybean by 11.39 %, coarse grains by 9. 47 % and Butter by 7.09%. While the study projects an overall bilateral increase in exports for most commodities, the negative results in several

[31] Fontagne *et al*., (2013) and Ecorys (2009) are used only for reference, not in scenario simulation.

[32] Recalculated from share of US exports in total EU exports, see Bureau et al (2014) p 15, 17 and section II.I.I of this study.

[33] Recalculated from share of US imports in total EU imports, see Bureau et al (2014) p 15, 17 and section II.I.I of this study.

cases stem from the explicit inclusion of intra-EU trade in the model, which according to the projections of the USDA will cause a net total decrease in exports for the EU in many commodities (Beckman *et al.*, 2015, p 22).

For imports the projections are positive to a larger extent. Importation of pork meat is estimated to increase by 26.29%, coarse grains by 8.97 % and soybeans by 3.30%. Furthermore, we see a 12.35 % increase in imports of butter.

Table III: EU Agri-food industry Export and Import Change %, USDA

Sector	Exports	Imports	Sector	Exports	Imports	Sector	Exports	Imports
Paddy Rice	-3.45%	-0.72%	Bovine	-0.87%	-0.83%	Whey	-2.08%	6.05%
Wheat	0.17%	0.05%	Hogs	-2.23%	-0.64%	Powdered milk	-0.47%	1.60%
Coarse grains	-9.47%	8.97%	Poultry and eggs	0.87%	-0.28%	Butter	-7.09%	12.35%
Fruits	2.84%	0.22%	Other animals	0.78%	-0.03%	Cheese	1.59%	0.85%
Vegetables	2.42%	1.52%	Raw milk	3.84%	-1.04%	Other dairy products	0.16%	0.25%
Nuts	-0.33%	0.14%	Beef	-4.13%	4.28%	Processed sugar	-0.93%	1.93%
Soybeans	-11.39%	3.30%	Pork	-48.38%	26.29%	Sugar preparations	-0.31%	0.74%
Rapeseed	1.81%	0.71%	Poultry meat	-0.24%	0.76%	Processed rice	-4.86%	0.77%
Other oil seeds	1.76%	0.74%	Other meats	0.09%	0.33%	Prepared f_v	-0.01%	0.33%
Sugarcane/beet	0.89%	-1.02%				Cereal preparations	-0.09%	0.60%
Other crops	1.26%	-0.39%				Processed feed	-1.15%	-1.50%
Vegetable oil	3.16%	-0.56%				Other foods	0.13%	0.49%
						Beverages and tobacco	0.09%	0.55%

Source: Beckman *et al.*, (2015) p. 22

CEPR CGE results

The study conducted by the Centre for Economic Policy Research on request by the European Commission shows more optimistic figures for the EU agri-food sector in terms of exports. The agriculture, forestry and fisheries sector is projected to increase its exports by 0.22 %, or 490 million euros, and the food processing industry by 9.36 % or 16624 million euros. The data reported does not explicitly include intra-EU trade for each sector, but effects of trade diversion are reported separately as an increase in agriculture, forestry and fisheries sector exports of 269 million euros and a decrease in processed food of -425 million euros (Francois *et al.*, 2013, p 55). Taking intra-EU diversion into account, in total the projected export increase for the EU agricultural sector is of 0.34 % and for the food processing sector 9.12 %. For imports raw agricultural products increase by 5.75% and processed foods increase by 10.17%. The aggregated change in both exports and imports are recalculated as the share in total export of each individual sector.[34]

[34] Including intra-EU trade, see Francois *et al* (2013) p 55, 66 and appendix III for recalculation.

EP CGE Results

The study from the European Parliament reports an increase in bilateral agricultural trade of 56 %, especially prominent in the meat, dairy and sugar sectors for which exports are projected to increase more than 200%. The large percentage increases for both exports and imports are however stated to be interpreted with caution, as they stem from very low initial levels and insecure estimates of initial trade flows (Bureau *et al.*, 2014, p. 36–39). The study does not explicitly include intra-EU trade but reports a general decrease of intra-EU trade flows of -2.1 % for the agri-food sector, which is included in the simulation as an average effect on all traded commodities. The bilateral changes in each of the 16 individual agri-food sectors are added to the initial export level. Recalculation of the bilateral increase is made by the average share of exports to the U.S. in total EU exports, which according to the EP study in 2012 was around 13 % (Bureau *et al.*, 2014, p 14 and section II.I.I of this paper).

The same logic holds for imports as the projected import changes are generally higher in the EP paper than for other reports and face the risk of overestimation. For milk and dairy, highly inflated percentage increases (2089%!) in imports is almost entirely attributed to reduction in NTMs, which include the U.S. regulation on unpasteurized cheese and full tariff liberalization, considered highly uncertain.[35].

[35] This finding can be contrasted to the exclusion of NTMs for dairy in the USDA report.

VI. Results

In the following chapter, the results from the input-output simulation are reported for changes in exports as well as imports, highlighting some estimation uncertainties within each scenario. The corresponding changes in greenhouse gas emissions as a result of each trade scenario are then reported and discussed. The chapter ends with a summary of the environmental impacts.

V.IV Export effects

The following section reports the simulation of the export effect of the TTIP, using the standard I-O model. While all economic sectors are included in the multiplier analysis, the impact on the non-agricultural sectors is only the indirect effect of a change in agri-food trade. This effect is overall small in our results and the focus of the results report therefore remains on the agriculture and food sectors. Furthermore, due to the above mentioned technical specificities of CGE modeling, as well as the purpose of the research, each study reaches varying conclusions about the economic effects of the TTIP. To increase the robustness of this works findings, estimated economic impacts from several sources have been included with the aim to provide a comparative analysis. The technical differences however limits the comparability between the studies and the forthcoming analysis hence rather serves as an illustration of the widely differing results of different modelers and the high level of uncertainty regarding the "true" economic impact of the TTIP.

V.IV.I Economic Impact Reports: Export effect

Figure VI (a-c) show the multiplier effects on commodity output of a simulated change in agri-food exports for the EU27, using the results from the USDA, CEPR and European Parliament. As the reports differ widely in their projected export effects, the I-O simulations shows equally large discrepancies. Consistent increases are only to be seen for vegetables, fruits and nuts (1.1%, 0.5%, and 5.7 %) oilseeds (0.5%, 2.3%, and 3.21%) and vegetable oils and fats (1.24%, 4.23% and 3.71%). For the rest of the commodities, the USDA scenario shows negative results, in many cases due to the explicit inclusion of intra-EU trade in the CGE model, which will cause a net total decrease in exports for the EU in many commodities. The increases in the USDA results are all due to NTM removal[36] (Beckman *et al.*, 2015, p 22).

For animal and meat products, the USDA scenario shows a significant reduction in exports, while the CEPR and EP show constant increases, primarily in processed meat (2-3 % in CEPR and 9-13% in EP). The reduction in "Meat products nec" of 3.9% in the USDA scenario stems from a projected decrease in EU pork exports by 48 %, the result of NTM abolition of the EU bans on the use of Ractopamine and Pathogen reduction treatments in pork production. The elimination of this NTM would to this extent benefit the US low cost pork production on the expense of EU exports (NPPC, 2013; Beckman *et al.*, 2015). Even though the USDA study reports a slight increase in wheat exports, given the decrease in meat production the inter-industry relations leads to an overall decline in wheat output in the I-O simulation. In the milk and dairy sector the USDA scenario shows a small reduction due to the aggregation of the dairy sector in GTAP. The projected export increase for cheese of 1.79 % is outweighed by the reduction in butter, whey and other dairy products[37]. For the other scenarios, the CEPR simulation shows an increase of 2% for both milk and dairy while the EP show an increase of 6-7%.

V.IV.I.I Estimation uncertainties and reasons for discrepancy:

The level of detail in agricultural commodities expressed in the USDA study serves our purpose of investigating the effect of a change in agricultural and food trade as a result of the TTIP, while avoiding some problems of

[36] For fruits and vegetables, the NTM reduction considers EU restrictions on maximum residue limits of pesticides etc. for US producers and US import approval processes for EU producers

[37] Worth noticing that NTM reduction for unpasteurized cheese is mentioned in the USDA paper but excluded from their simulations. All impacts on the dairy sector in the USDA report thus stem from tariff removal.

aggregation bias[38]. While the USDA and the EP studies provide estimations with a specific focus on the agri-food sectors, the CEPR approach is economy wide and does not give any detailed account of specific impacts on agricultural and food trade, which may result in loss of detail and accuracy. To tackle this problem, disaggregation is made according to the share of each commodity in total exports, which in some cases may be misleading.

Average EU tariffs for agricultural and food products are generally higher than U.S. tariffs. Tariff removal will thus have a greater impact on U.S. exports to the EU than vice versa. In the USDA study, intra EU trade diversion will be the driver of the net reduction in EU exports for many commodities, while this effect has a much lower impact in the other studies. One reason for this may be the level of aggregation and the explicit inclusion of intra-EU trade in the USDA CGE model.

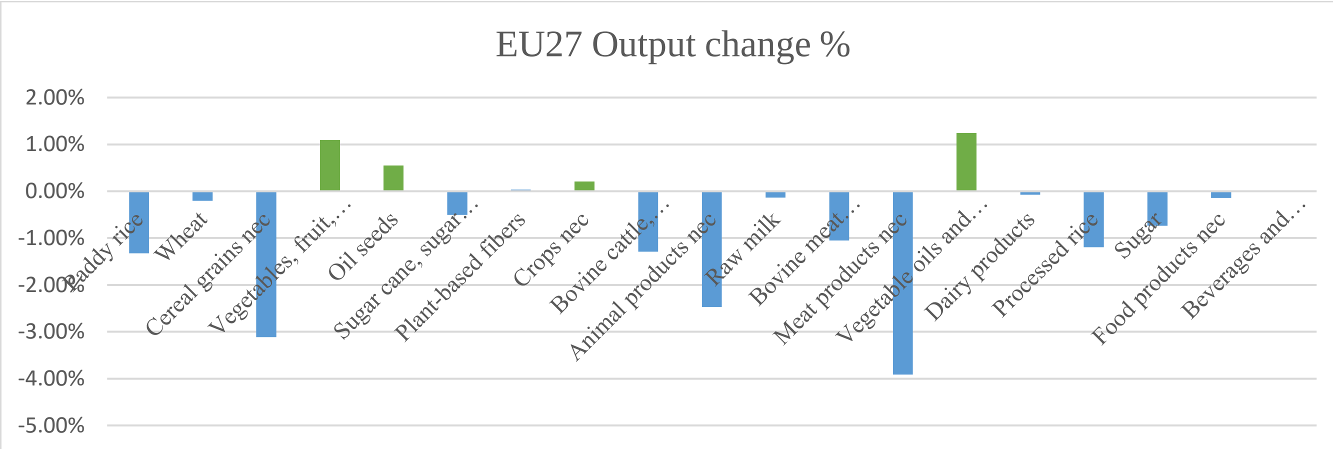
The added cost of NTMs are specifically calculated for individual products in the USDA study, while the average NTM calculations by Ecorys are used in the other studies. More detailed NTM calculations may imply more accurate estimations of their costs. However, the USDA study envisions full elimination of the trade restrictiveness of NTMs in sensitive areas such as the ban on imports of hormone treated beef, the approval process of GMOs and the above mentioned pork steroids, regulations which the European Commission continuously holds as non-negotiable (European Parliament, 2016a). Therefore, the results reported by the USDA, as well as the computed I-O results in that scenario, are to be seen as somewhat overestimated in terms of the realistic impact of NTM reduction in a TTIP context.

In the EP study, as highlighted by the authors and mentioned above, the large percentage increases reported are a result of low initial levels of trade and highly complex policy processes posing different estimation challenges to the modelers. The results should therefore be interpreted with much caution, in particular for bovine meat, cereals and sugar. Furthermore, sectoral disaggregation is made according to import shares of raw and processed commodities in the case of dairy and sugar, which may lead to misleading estimates for example in the case of sugar cane/beet.[39] Finally, the recalculation from bilateral to total export change is done by the average share which may differ across commodities, as is the case for the average level of the intra-EU trade diversion of -2.1%.

[38] See appendix III for aggregation tables used for simulation
[39] See appendix III Simulation Results IMPORTS

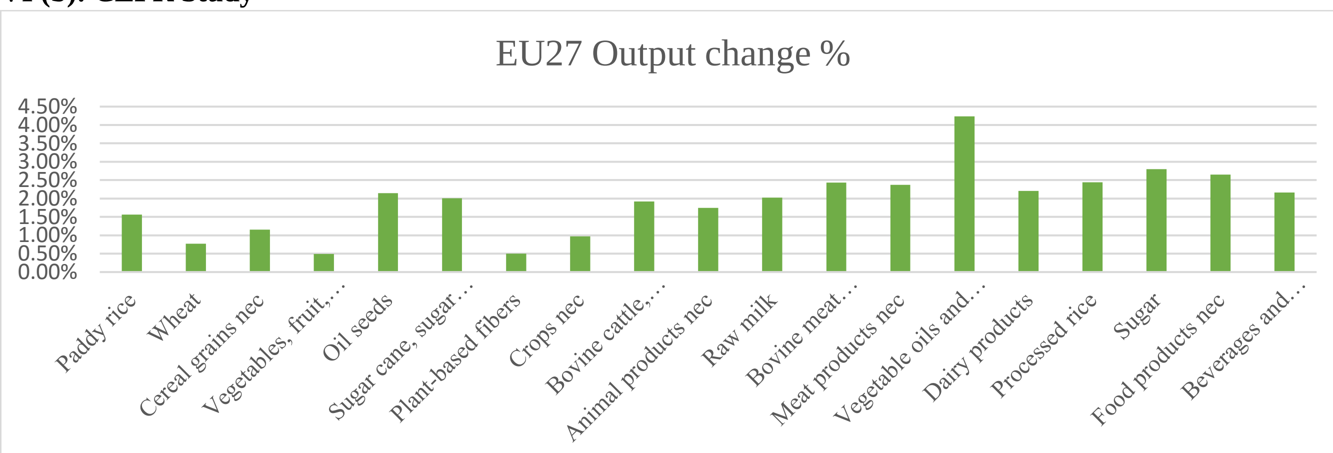
Figure VI: Multiplier effects as of changes in exports resulting from different TTIP scenarios

VI (a): USDA Study



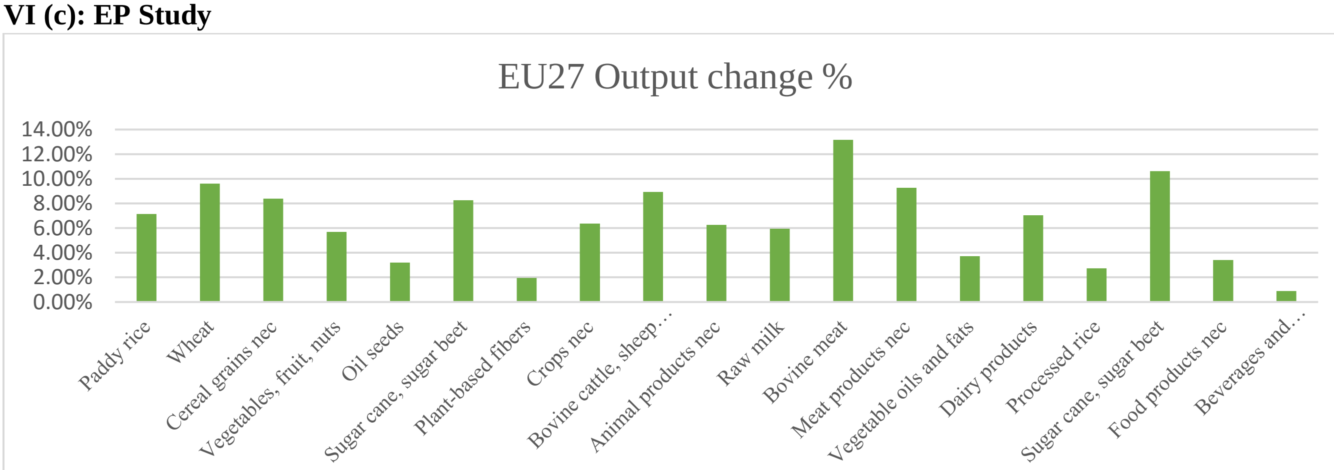
Source: Own calculations from GTAP9 data & Beckman *et al* (2015)

VI (b): CEPR Study



Source: Own calculations from GTAP9 data & Francois *et al* (2013)

VI (c): EP Study



Source: Own calculations from GTAP9 data and Bureau *et al* (2014)

V.IV.II Environmental Impact Report: Export effect

Figure VII (a-c) shows the GHG emissions related to the change in output in the agri-food sector associated with the above export I-O simulations. The results are consistent with the linearity feature of the I-O model, showing increased emissions from the sectors which experience an increase in output due to the TTIP and a decrease in production related emissions for the sectors which experience a decrease in output. The results are reported per sector and per emission, showing the high relevance of CH_4 emissions in the whole sector. As was true for the economic effect, the impact on GHG emissions varies depending on which scenario we use for simulation. While the USDA scenario shows an overall decrease in GHG emissions from the agri-food sectors of 9.12 million tons (MT) CO_2 equivalents (eq.), the CEPR scenario shows increases of 19.32 MT CO_2 equivalents and the EP scenario shows increases of 68.68 MT CO_2 equivalents.

For meat and dairy, perhaps the most striking result is the decrease in emissions in the USDA scenario of 8.38 MT amounting for over 90 % of the overall emissions impact. In the CEPR scenario, the combined increase in the meat and dairy sectors is 13 MT CO_2 eq which is 68 % of the overall emissions increase in the agri-food sector. In the EP scenario, emissions increases are unsurprisingly seen to be inflated in the animal, meat and dairy sectors which combined show a total increase in emissions of 54 MT CO_2 eq, 78 % of the total impact of the sector. The impact of the raw milk sector might be misleading since the increase in output in raw milk as a result of an export change is likely overestimated, due to the small export market for raw milk.

The relatively large impact of the food processing sector is also consistent in the results. To a great extent however, the impact is a total output effect. For example, in the results from the CEPR scenario (figure VI (b)) "food products nec" increase in output by 2.5 % which results in an value change of output of 16965 million dollars, translated in an increase of 2.6 Mt CO_2 eq. This category includes all prepared and preserved foods that are traded internationally and naturally has a big market share of exports. In terms of GHG intensity, it is a comparably heavy emitter of CO_2, emitting twice as much CO_2 as any other sector, illustrating the particular relevance of the total output effect for CO_2 emissions.

The sectors that consistently showed an increase in exports throughout all scenarios show very minor impacts on GHG emissions. Combined, the vegetables, fruits and nuts, oil seeds and vegetable oils and fats increase its emissions by 0.4 MT CO_2 eq in the USDA scenario, 0.8 MT CO_2 eq in the CEPR and 2.06 MT CO_2 eq in the EP scenario, which is consistently less than 5 % of the total impact of the sector.

To make a real world comparison of the climate impact implied by these figures, we can compare them to the total EU emissions from the source *agriculture* in 2012, or we can make use of the Greenhouse Gas Equivalencies Calculator from the United States Environmental Protection Agency (EPA). According to the EPA calculator, a decrease in GHG emissions by 9.12 million tons of CO_2 (or CO_2 eq) consistent with the export effect in the USDA scenario is equal to 1.9 million passenger vehicles driven for one year[40] (U.S. EPA, 2014), and amount for about 1.9 % of the total EU agricultural emissions (Füssel *et al.*, 2012).

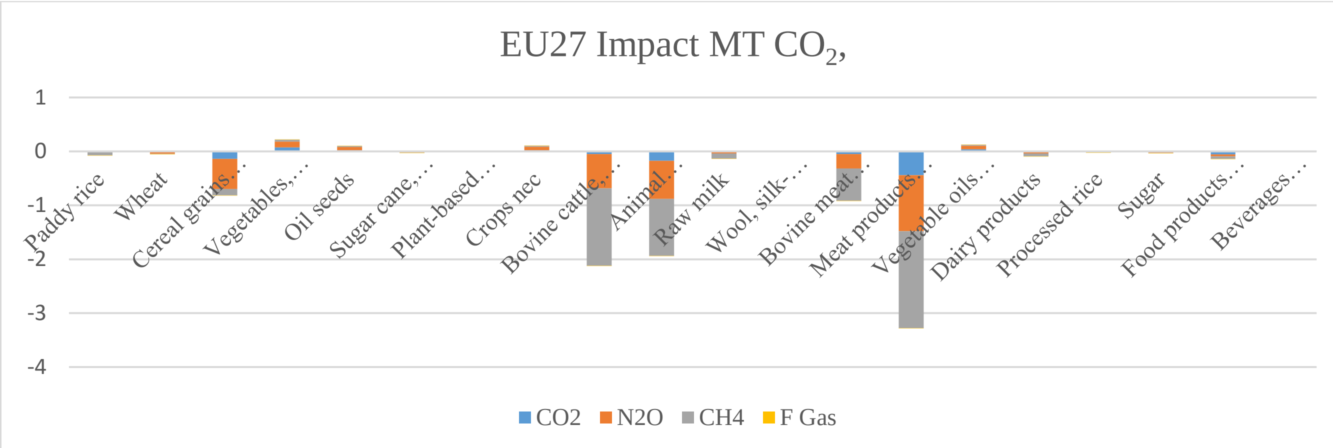
Using the same sources for comparison, the increase in emissions of 19.32 million tons CO_2 eq in the CEPR scenario corresponds to 4.08 million passenger vehicles driven for one year and 4.1 % of EU agricultural emissions. 68.68 million tons CO_2 in the EP scenario corresponds to 14.5 million passenger vehicles driven for one year and 14.6 % of total EU agricultural emissions[41].

[40] Assumed here to be driven on E10 - 90% gasoline and 10% ethanol.

[41] As noted above, 470 million metric tons CO_2 eq from the source agriculture does not include input processing nor farm energy consumption. It does not include food processing (Fellman *et al.*, 2015)

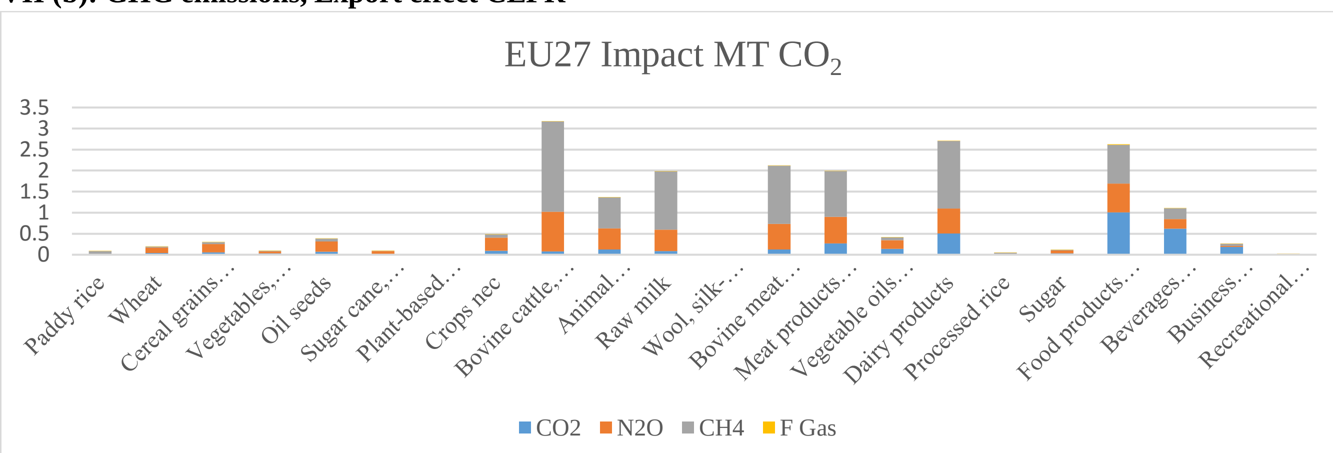
Figure VII: Climate effects from different TTIP scenarios, Export effect

VII (a): GHG emissions, Export effect USDA



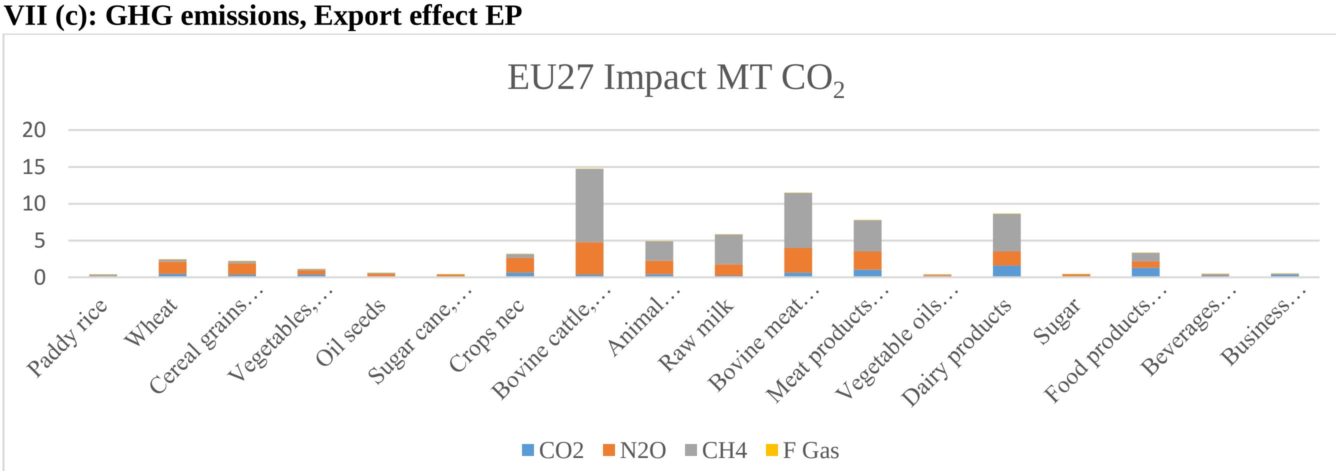
Source: Own calculations, data source GTAP9 and Satellite GTAP Non- CO_2 emissions data set.

VII (b): GHG emissions, Export effect CEPR



Source: Own calculations, data source GTAP9 and Satellite GTAP Non- CO_2 emissions data set.

VII (c): GHG emissions, Export effect EP



Source: Own calculations, data source GTAP9 and Satellite GTAP Non- CO_2 emissions data set.

V.V Import effects

Using the interindustry multipliers derived by the mixed I-O model, this section shows the simulation results of a change in imports on EU27 final demand as projected in the three TTIP scenarios. In general, EU imports are expected to show a slightly higher increase than exports in all scenarios. However, the simulation results below show the corresponding changes in final demand, in which the multiplier effect as a percentage of total output is smaller than the actual import change. This is due to the specific characteristics of the mixed model multipliers. Since imports are computed as a fixed share of supply, output is assumed to be embedded in the final demand change. We use CO_2 emissions data associated with imports for private, government and firm use and for non CO_2-emission use U.S. industry emission levels as a proxy for the embedded emissions in imports consumed.

V.V.I Economic Impact Report: Import effects

The changes in final demand in the three import scenarios are captured by figures VIII (a-c). Consistent increases are seen in the processing sector, bovine meat (1.1%, 0.9% and 0.7%) other meat (0.4%, 1.2% and 2.1%) and dairy (0.4%, 0.78% and 13.95%). The inflated results of the EP scenario for dairy stem from the inclusion of above mentioned NTM estimates[42], as well as uncertain base values, and are considered overestimated. Still, all reports consistently show an overall increase in imports of meat and dairy as opposed to the exports for which the USDA scenario projected negative figures.

For many of the commodities of which the EU is expected to increase its imports due to the TTIP, the effect on final demand is significantly reduced by the share of each commodity in the aggregated category. For example, importation of pork meat is estimated to increase by 26.29% in the USDA scenario but due to the low share of pork imports in the “meat products” category[43], this increase only results in a 0.39% increase in final demand of the “meat products” sector[44].The same pattern is present in the dairy sector where the 12.35 % increase in imports of butter is hidden by the low share of butter in dairy sector imports[45]. As was the case for exports, processed food imports on average increase more relative to raw agricultural products in all three cases.

What can be illustrated in a comprehensive manner by the EP import scenario are the interlinkages between raw milk and the dairy sector. An increase in supply of raw milk will have a significant impact on final demand for dairy products, since raw milk is an essential input in all dairy products. It also reflects the relevance of including NTMs for dairy in the simulation, as the results from the USDA deliberately exclude this NTM, possibly on political grounds.

[42] Dairy NTMs includes U.S. restrictions on unpasteurized cheese, not included in the USDA scenario, see footnote 37

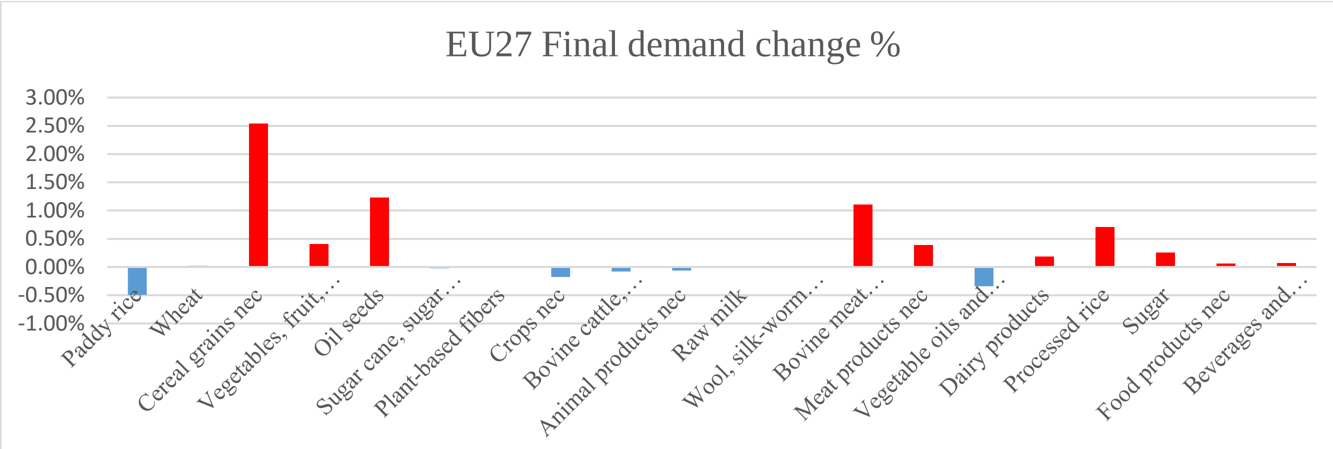
[43] Pork meat is 25,13 %, poultry is 55, 86% and other meats are 19.20 % of this aggregated GTAP category

[44] Note that changes are reported as percentage of total output and not of total imports.

[45] Butter 11.6 %, Cheese, 41,43%, Whey 2.95% and Other dairy 42.35%

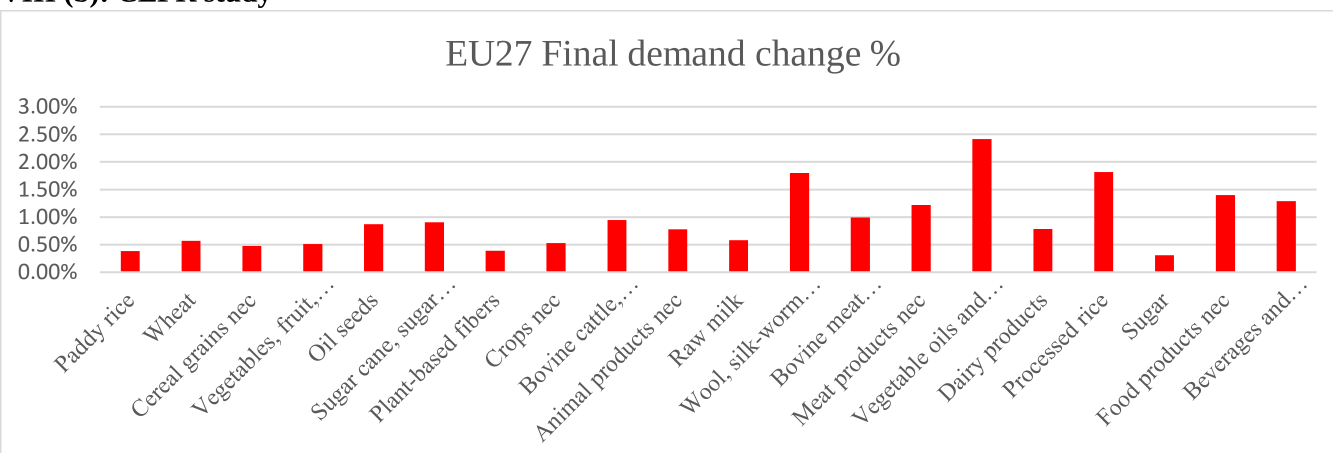
Figure VIII: Multiplier effects as of changes in imports resulting from different TTIP scenarios

VIII (a): USDA study



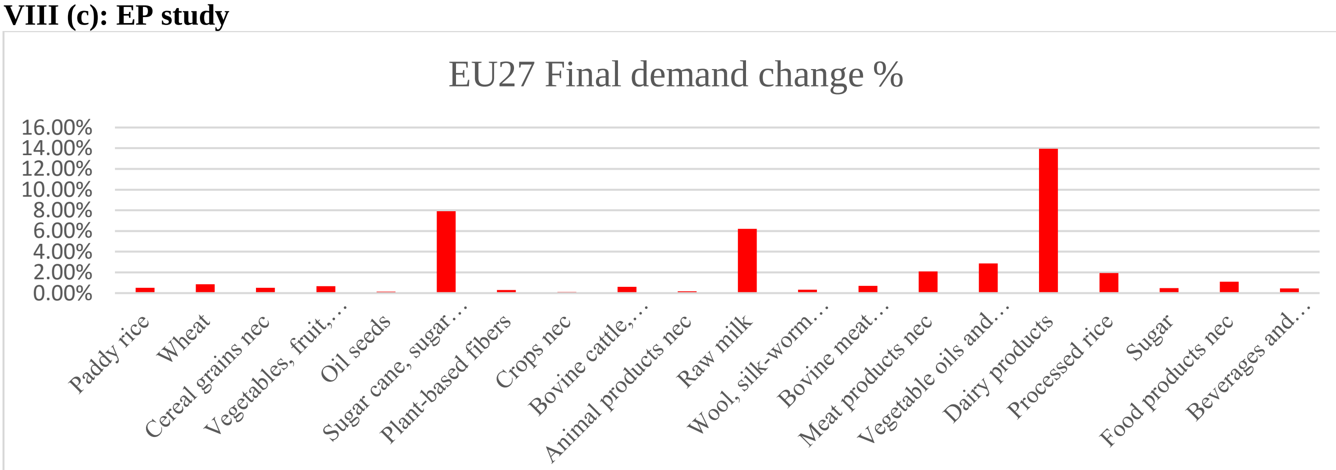
Source: Own calculations from GTAP9 data and Beckman *et al* (2015)

VIII (b): CEPR study



Source: Own calculations from GTAP9 data and Francois *et al* (2013)

VIII (c): EP study



Source: Own calculations from GTAP9 data and Bureau *et al* (2014)

V.V.II Environmental Impact Report: Import effects

Figure IX (a-c) shows the GHG emissions associated with the change in final demand in the agri-food sector associated with the I-O import simulations. Consistent with the findings of above reported changes in final demand for every scenario, GHG emissions increase in the sectors for which we see an increase in final demand due to imports, although the increases are asymmetric due to differing absolute values and emission intensities between commodities. The total GHG impact in the respective scenarios are increasing emissions of 2.66 million tons CO_2 eq for the USDA, 8.21 million tons CO_2 eq for CEPR and 20.26 million tons CO_2 eq in the EP case.

For the meat and dairy sectors, their particular importance for the overall emission impact is somewhat smaller for imports than for exports. In the USDA scenario, the meat & dairy sectors stands for 46% of the increase in GHG emissions, due to the small changes in final demand. This impact is almost entirely due to an increase in imports of bovine meat products, for which 1.1% increase in final demand leads to an increase in emissions of 900.000 tons CO_2 eq. In the other scenarios, meat and dairy amounts for 63% and 87 % of the overall impact on emissions. In the EP report over 50 % of the emissions increase can be attributed to the dairy sector.

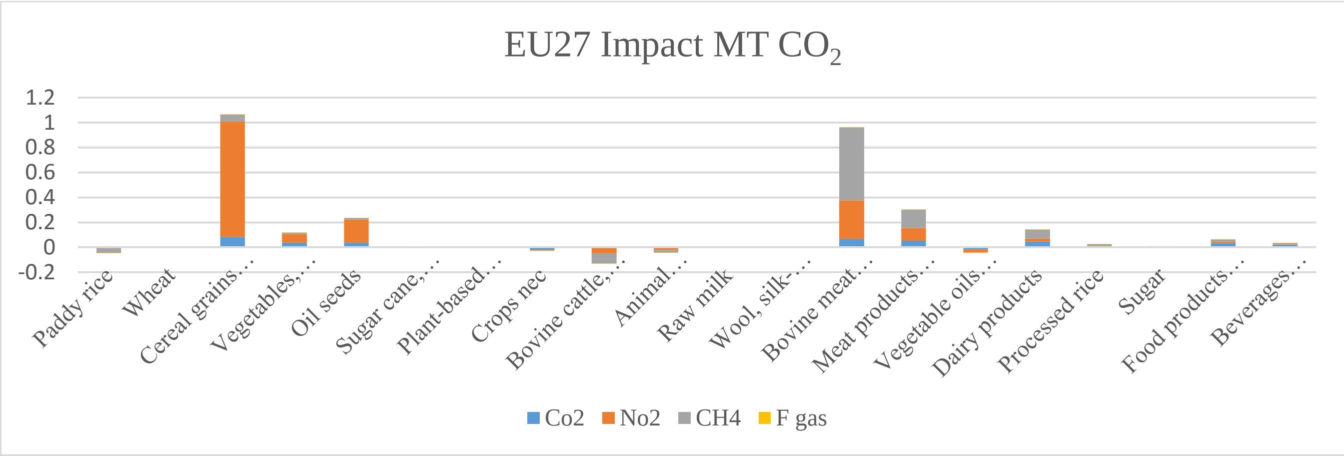
The CEPR scenario (Figure IX (b)) serve as an illustration of the asymmetric impact of different commodities. Here, the marginal increases in bovine cattle imports and final demand of 1% results in comparably a large increases in emissions of 1.5 MT CO_2, particularly strong in CH_4 emissions. Comparing further a 1.4 % increase in final demand for “food products nec” results in an emission increase of 1.3 MT CO_2 Eq, which is significantly larger than the increase in emissions from the “vegetable oils and fats” sector of 0.3 MT CO_2 Eq, showing a similar percentage increase in final demand. The difference can be explained by the value change and the emissions multiplier, which for vegetable oils and fats are significantly lower.

Using the same comparison as we did for exports, the increases in GHG emissions as a result of imports would in the USDA import scenario be equivalent to 500.000 passenger vehicles driven for a year[46] and comprises 0.6 % of total EU agricultural emissions, the CEPR import scenario would lead to emissions equivalent to 1.7 million passenger vehicles driven for a year and comprises 1.88 % of the total EU agricultural emissions while the EP scenario results in emissions equivalent to 4.2 million passenger vehicles driven for a year and 4.3% of the total EU agricultural emissions (Füssel *et al.*, 2012; U.S. EPA, 2014).

[46] In Sweden there where about 4.6 million passenger vehicles in 2015 (Svahn, 2016)

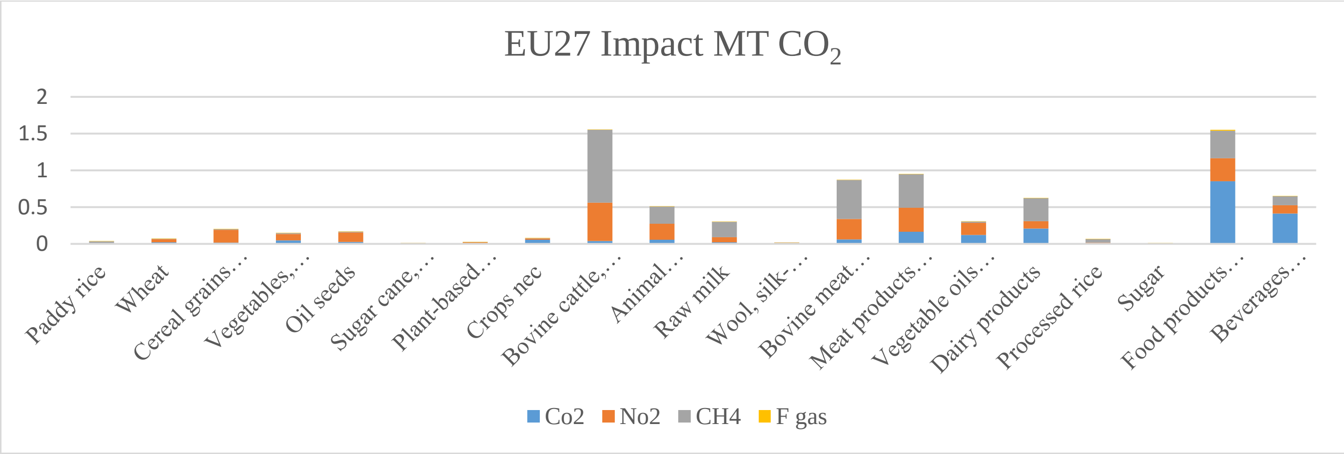
Figure IX: Climate effects, Import effect

IX (a): GHG emissions, import effect, USDA



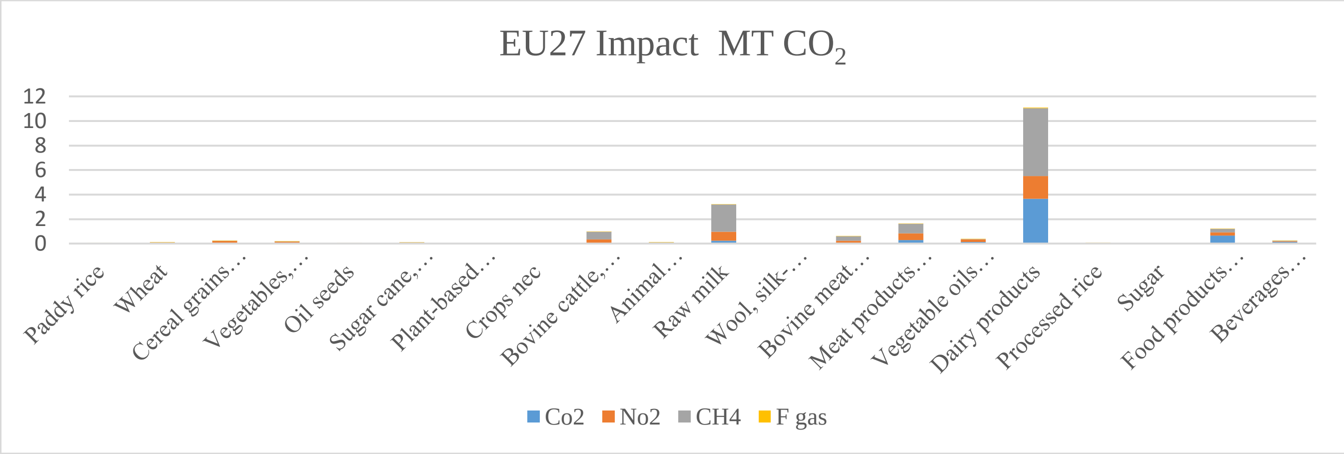
Source: Own calculations, data source GTAP9 and Satellite GTAP Non-CO_2 emissions data set.

IX (b): GHG emissions, import effect, CEPR



Source: Own calculations, data source GTAP9 and Satellite GTAP Non- CO_2 emissions data set.

IX (c): GHG emissions, import effect, EP



Source: Own calculations, data source GTAP9 and Satellite GTAP Non- CO_2 emissions data set.

V.VI Summary Environmental impact

The total impact on EU greenhouse gas emissions related to changes in imports and exports in agri-food commodities as a result of the Transatlantic Trade and Investment partnership are summarized in table IV. The summary shows a large discrepancy between projections, depending on which scenario that is used for simulation. We have previously noted that the reasons for the differences in results are manifold but all stem from a linear relationship with output and final demand changes, and the specific projections of the report used for simulation. The USDA scenario would lead to a reduction in agri-food related greenhouse gas emissions of 6.4 million tons CO_2 equivalents, which seems like an optimistic situation. The reduction is however caused by significant decreases in produced output, especially in the export sector, which may not be considered a desirable outcome of the agreement for the EU. One possibility would be to assume that the reduction in export related emissions would be met by a significant increase in emissions from imports, which is only the case to a limited extent and for some commodities, namely cereal grains and bovine meat products. Due to the inclusion of particularly sensitive NTMs which would benefit U.S. exporters on the expense of EU exporters and the exclusion of others which would benefit the EU more, the USDA projections and the corresponding emissions reduction are considered to be somewhat underestimated.

The scenario of the CEPR study requested by the European Commission would result in an increase in GHG emissions related to imports and exports in the agri-food sectors of 28. 15 million tons CO_2, which is around 6 % of the lowest estimate of total agricultural GHG emissions within the EU[47] (Fellmann *et al.*, 2015). The major part stems from export increases which in percentage terms are modest but in value and in terms of emissions are significant. Here it is obvious that while export increases are the highest in vegetable and oil fats, the emission impact is notably higher in bovine meat, dairy and "other food products". The estimates of the CEPR study are economy wide and does not allow any in-depth analysis of specific agricultural commodities, which may lead to an aggregation bias from which the direction is hard to determine.

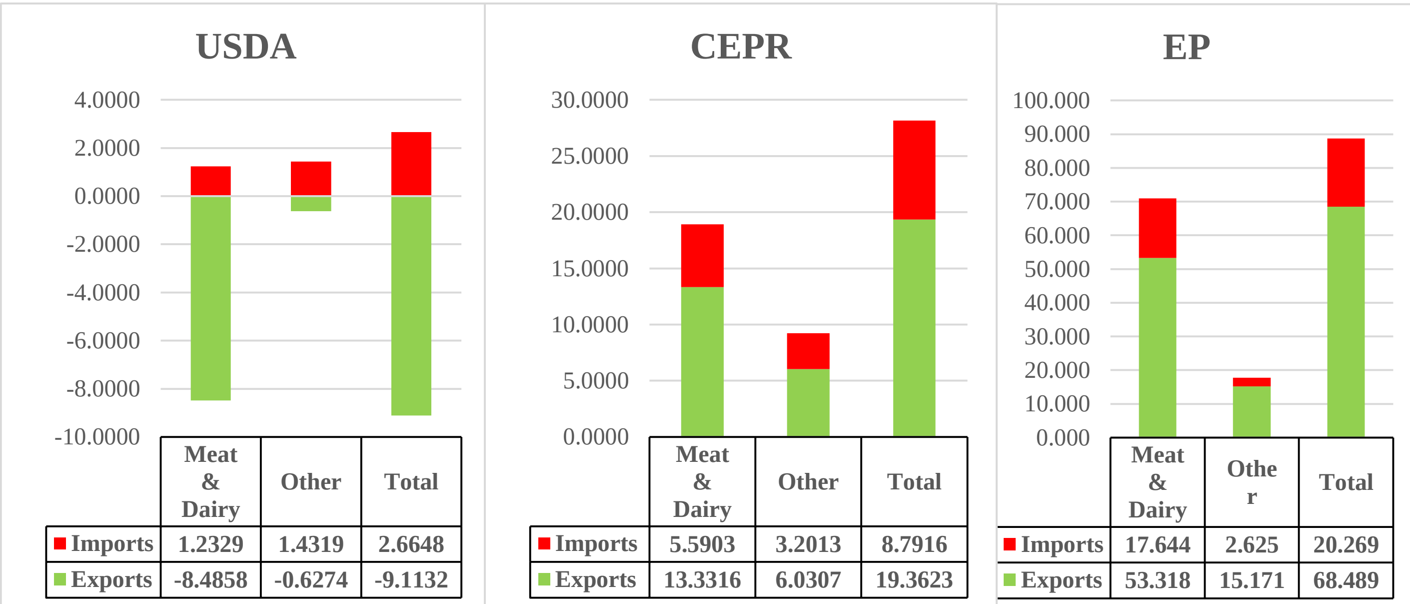
The scenario of the European Parliament study shows an increase in emissions of 88.7 MT CO_2 equivalents, 18 % of EU agricultural emissions, of which 77 % percent stems from increased agri-food exports. Although specifically concerned with the impact of a TTIP on EU agriculture, the EP scenario is considered the most problematic in terms of highly uncertain and overestimated results in the base. To some extent the large increases can be explained by the initial levels of protection (both tariffs and NTMs) which in the agricultural and food sector are higher than in any other sector. 100% tariff elimination thus have strong and possibly unrealistic impacts, leading to the recommendation that the GHG estimates in this scenario should be interpreted with caution.

Table IV: Total Greenhouse Gas Emission Impact; Million ton CO_2 equivalents.

	Emissions impact Scenarios		
	USDA	**CEPR**	**EP**
Exports	-9.1132	19.3623	68.489
Imports	2.6648	8.7916	20.269
Total	-6.4485	28.1539	88.7581
Meat & Dairy	-7.2529	18.9219	70.9624

[47] As noted above, 470 million metric tons CO_2 eq from the source agriculture does not include input processing nor farm energy consumption. It does not include food processing

Figure X: Scenario comparison GHG emissions impact MT CO_2 equivalents



USDA	Meat & Dairy	Other	Total
Imports	1.2329	1.4319	2.6648
Exports	-8.4858	-0.6274	-9.1132

CEPR	Meat & Dairy	Other	Total
Imports	5.5903	3.2013	8.7916
Exports	13.3316	6.0307	19.3623

EP	Meat & Dairy	Othe r	Total
Imports	17.644	2.625	20.269
Exports	53.318	15.171	68.489

What is consistent throughout all scenarios is the prominent contribution of trade in meat and dairy commodities on the impact of agri-food imports and exports on GHG-emissions. For all the reports, the meat & dairy sector, including trade in both raw and processed products, accounts for between 65-80 % of the total emissions impact of the TTIP. In several cases, very marginal increases in final demand for meat and dairy products have a comparably large impact on GHG emissions. To the extent that the projections show trade increases in these sectors, the emissions impact is significantly stronger, in particular for CH_4 emissions but also for N_2O and CO_2. Furthermore, the food processing industries show to be relatively emissions intense in comparison to raw agricultural products, with the exception of beverage and tobacco commodities. With most of the results projecting increases of trade in the food processing sectors, the impact of GHG emissions from this sector are proven highly significant.

VII. Conclusive discussion and policy implications

This thesis aimed at assessing the climate effects of changes in trade in agricultural and food products as a consequence of the TTIP. It also intended to show an example of integrated environmental and economic accounting for the *ex-ante* evaluation of major policies.

By making use of several CGE modelling reports for simulation of the intended effects of the TTIP on imports to and exports from the EU, our results are divided into three possible scenarios; First, one in which the EU GHG emissions decrease by -1.4 %, a second one in which they increase by 6 % and a third one in which they increase by 18 %. While we thereby affirm inconsistencies in assessing the true impact of the TTIP and broaden the validity of our conclusions, we also encounter the impossible task of determining which of these scenarios is to be considered more realistic. Some of the reasons for discrepancy have previously been highlighted, such as model and data used as well as aggregation and quantification procedures, which facilitate the interpretation of the individual reports. What more proves to be a determining feature of the CGE results is political ambition and affiliation. Regarding our results, we are able to draw some conclusions about climate consequences, without making premature judgements on the exact outcome of intense high-level negotiations, which goes well beyond the scope of this paper.

The climate effects of the TTIP, as analyzed in this study, are highly influenced by the variation in trade flows. In many cases we see that the larger the increase in trade as a result of the TTIP, the greater is the estimated emissions impact, and vice versa. This effect is however not overall consistent, nor is it the only effect seen. As some traded commodities with low GHG intensity are increasingly traded, the emissions impact is marginal. This is for example the case in trade of vegetable oils and fats, fruits, vegetables and nuts[48] and oil seeds[49]. For other products, the absolute value effect as well as high emission intensities lead to large emission changes driven by very small changes in final demand. This is the case for the “other crops” category which included seeds production, “other foods” including all prepared and preserved foods, as well as all meat and dairy products. For all reports, the meat and dairy sector comprises between 65-80 % of the total emissions impact. This finding indicates that the climate effects of the TTIP are not only a question of how much trade flows change but what type of commodities are traded. As highlighted previously, this also implies that a demand change could possibly offset a large part of the impacts seen. If demand was redirected towards less GHG intense sectors, the emissions impact of agri-food trade could be significantly reduced. Since particularly sensitive sectors in terms of tariff and non-tariff barriers, such as meat and dairy, also seem to be the most GHG intense sectors, exclusion of these sectors from the agreement could possibly reduce the overall climate impact of the TTIP. On the other hand, these sectors are also the ones in which tariff and NTM reductions would have the largest impacts on trade and thus bring about the most significant economic gains.

Another obvious effect is the impact of trade in processed food. In several reports processed food trade is projected to increase more than raw agricultural commodities in a future TTIP scenario. Not only does a higher level of processing imply a larger environmental footprint in general, but these products commonly lead to higher transportation emissions from air transport. A larger increase in processed foods hence increase the possibility of unaccounted emission impacts due to transportation.

The results show a vast discrepancy between different scenarios, and as consequence highlights the high level of uncertainty regarding the economic, as well as the environmental effects of the TTIP. While the European

[48] Including transportation could possibly increase the GHG intensity of trade in these products to the extent that they are transported by air.

[49] Keeping in mind that our emissions data does not encompass land use changes, which would possibly increase the emission impact of some oil seeds such as soy beans.

Parliament scenario results are likely overestimating the emissions impact of a TTIP due to uncertain baseline estimates, the USDA scenario might very well be underestimating it due to the inclusion of highly sensitive trade barriers benefitting U.S. exporters on the expense of EU exporters. The scenario in which we use the results from the Centre of Economic Policy Research (CEPR) requested by the European Commissions can be conceived as the most realistic one in terms of projecting the trade and greenhouse gas impacts of the TTIP. While this scenario lacks some precision in determining the specific impacts on agriculture and food commodities and show only aggregated estimates possibly containing some level of estimation bias, the level of detail may not always be decisive in determining the most accurate outcome. As have been shown, the more detailed projections from the USDA and the European Parliament, in their aim to explicitly quantify effects of rather qualitative phenomena such as regulations stemming from aspects of consumer concern and public opinion, rather overestimate the possibility and the desirability of a TTIP to overhaul these barriers to trade.

The agri-food sector is however unique; in contrast to other sectors and bilateral EU-U.S. trade in general, tariffs are occasionally extremely high and NTMs are particularly present and highly sensitive. But these non-tariff trade barriers are political instruments with differing purposes which are not easily quantified. As an example, regulations regarding animal welfare and labor rights are rather expressions of governments' responses to public demand for social equality and humanity, than a tool for market protection. Considering these aspects, monetarization of regulations which are put into place by governments on democratic request and making a case for their abatement on a strictly economic basis may be questioned from an ethical point of view. In any case, monetary quantification of NTMs requires several more or less realistic assumptions and no economic analysis of the TTIP can be said to fully grasp all specificities embedded in these regulations, nor account for effects of their removal which may go far beyond the scope of economic or trade policy.

Contrasting the result of this study with the global 1000 million ton mitigation needed from agriculture to reach the goals of the Paris Agreement, a TTIP may undermine the possibility for the EU and global climate efforts to reach their mitigation targets. The more isolated economic and trade policy is kept from agricultural and climate policy, the larger the risk of backlashes in climate efforts becomes, and instead of providing a holistic view of societal sustainability, the lack of effective policy towards agricultural transition becomes permanent. The current thesis provides a means for integrated environmental-economic accounting which could aid decision makers in setting political priorities towards this aim. Still, other efforts are clearly needed to reach the global pledge of reducing GHG emissions from agriculture. Some of the political efforts involved could be focusing on:

- Specific climate targets for agriculture and food production on EU and national levels
- Public support to research in new alternative climate friendly agriculture, and its practical application
- Support and spread best practices globally, trough international cooperation
- Dietary change including public advice on climate friendly diets in the global north.

Furthermore, it is highly recommended by the author of this study to include specific reference to the Paris Agreement in the sustainability chapter of the TTIP, to assure adequate attention to and compliance with global climate efforts.

The CEPR study reports the climate effects of the TTIP to be negligible. The results of this study, by including other GHG emissions than strictly CO_2, contradict that conclusion and suggests that the climate effects of such a large policy decision are potentially substantial and cannot be neglected when evaluating the sustainability effects of such an agreement. According to our view, considering the insecurities regarding the economic effects and contrasting the climate effects with the determined reduction targets of the Paris agreement, setting political priorities to the advantage of climate goals within the EU could possibly affect the desirable scope of a TTIP.

VI.I Limitations of the analysis and scope for further research

This study investigates the emissions impact of several TTIP scenarios within the EU27, using a Leontief Input-Output model of fixed relations and prices for the base year 2011. While the use of the Input-Output model to analyze economic and environmental impact of major trade policies is widely spread and the model works as a comprehensive tool to visualize inter-sectoral linkages, the results of any I-O simulation are to be interpreted in the light of several theoretical and computational limitations, some of them being particularly present in our analysis:

The TTIP is an economy-wide agreement with consequences that reaches well beyond the scope of this thesis, which focuses on only two of several important economic sectors. Agriculture and food processing, being some of the more sensitive sectors for both negotiating parties are, if any reservations where to be allowed, quite likely to be subject to exceptions in the agreement. As the time runs out for the Obama administration, such a scenario becomes increasingly realistic. Furthermore, the European Parliament projects as little as 8 % of the economic gains of the TTIP can be attributed to agriculture. The overall economic impact of the TTIP for all sectors could be better illustrated in a CGE model, which would be able to include the possibility of price changes and input substitution as well as the income and distributional effects of such an agreement. The suitability of a CGE model to determine the economic impact of the TTIP is highlighted by the fact that this analysis has relied on three CGE models for scenario simulation. Such an analysis would however require a longer time frame and additional computational exercises, as well as access to suitable software tools. Also considering the aim of this thesis, which goes beyond the strictly economic impact assessment, it is not certain that a CGE model could perfectly suit our specific purpose.

Considering climate effects, the sustainability chapter of the TTIP highlights the possibility of increased trade in so called green technology. In our analysis we do not include any other effects apart from the production processes, in which we assume homogenous products and technology, an assumption that very well may be challenged if more climate friendly technologies are developed and spread to reduce the climate footprint of agriculture. Taking into account the above mentioned research findings of the limitations of current mitigation practices in agriculture, the current possibilities of any large emission reduction due to alternative technology can thus be considered limited.

Moreover, the I-O table used is created as a domestic market, and impacts are only seen within the EU27. Considering the global character of greenhouse gas emissions and the bilateral character of the TTIP, this further limits the scope of our analysis to the extent that it excludes trade and emission effects on U.S. soil, which should be included in a full scale environmental impact analysis of the TTIP. A Multiregional Input-Output (MRIO) model would more accurately capture trade flows between the markets as well as the embedded emissions and physical carbon flows as a result of changing trade patterns. It could also create a more representative model of global supply chains which encapsulate national differences in technology and trade patterns using a footprint approach. Such a model could possibly increase the emissions impact of imports. One limitation of the MRIO approach is however that imports are produced with domestic technology, which is seldom the case as emission intensities in production are highly heterogeneous on a global scale.

The structure of the I-O is not ideally suited for evaluating the emissions related to consumption. To be able to draw some conclusions on emissions embedded in consumption of imported goods, our analysis is limited to final demand changes related to a fixed amount of imports for intermediate and final consumption. As such, the multiplier effect is lower than the actual change in imports and can be considered underestimated. Furthermore, our analysis does not consider the possible impact of changes in consumer preferences. A plausible TTIP scenario is that reductions in NTMs will have an impact on consumer preferences on both markets which in turn may dampen or enhance the economic gains as well as the effects on GDP. A Social Accounting Matrix analysis would be more suitable to capture effects on household demand and consumption as well as government revenues and the impacts on the labor market.

The emissions data from GTAP does not include emissions from the transportation effects of trade or land use changes nor does it take into account sequestration and forest carbon stock. With the former aspects leading to higher emission levels and the latter rather reducing emissions, the consequences of an exclusion of these aspects are inconsistent and hard to determine. Finally, due to the static and linear character of the Input-Output model, the analysis does not present a clear counterfactual scenario, i.e the development of EU trade in a future scenario without the TTIP. While it is improbable that European agriculture and food trade would experience any large boost from another trading partner in the absence of a TTIP, the I-O model doesn't allow us to make any predictions on future developments.

VIII. Epilogue

On May 13th 2016, a 400 page draft Sustainability Impact Assessment (SIA) conducted by Ecorys and involving consultation with more than 500 stakeholders, was published by the European Commission. With the aim of extending the analysis towards other societal aspects than strictly economic indicators, such an approach can be seen as an effort to internalize the public concern of the environmental consequences of the TTIP. The study use the CEPR report from 2013 and assess an economy wide, CGE translation of changed energy demand to GHG emissions projected until the year 2030, and compare it to a baseline scenario. For agriculture, the SIA reports a close to 0 change in CO_2 emissions. Calculating the social costs of emissions as €20 per ton CO_2 emitted and estimating a social cost of €91 million, we can roughly calculate that the total CO_2 emissions in the most ambitious scenario is around 4.5 Million tons CO_2. It is not suitable, however, to compare these results to our findings since they do not include non-CO_2 emissions, nor provide for sectoral disaggregation, but are estimated based on the change in energy demand (Ecorys, 2016b, pp 181–186).

One clear limitation of the new Ecorys study according to our view, is the failure to include NTM reduction in the food processing sector. The food processing sector being one of the more sensitive part of the negotiations, for which the outcome is still highly uncertain, exclusion is comprehended. On the other hand, and as we have argued in this study, the sector is also highly relevant in terms of environmental impacts and GHG emissions, exclusion hence limits the analysis in terms of the agri-food sector impact. The available report is in a draft stadium and currently open for stakeholder feedback[50]. A final interim report containing recommendations based on its conclusions, is scheduled before the end of the year (Ecorys, 2016a).

While the decision to conduct a rigorous sustainability assessment of the TTIP, which in contrast to many of the previous economic impact assessments is stakeholder reviewed, is highly encouraged by the author of this study, a more comprehensive assessment would include the expected effects of NTM reduction in food processing, as well as clearly present the absolute changes in overall GHG emissions. This is encouraged since even impacts which taken separately seems minor in the eye of the spectator in reality remain troublesome, for the challenges of agricultural climate mitigation, for the ambitious reduction targets stated in the Paris Agreement, and for the global commitment to a sustainable future.

[50] Until June 9, 2016

IX. Bibliography

Akhtar, S. I. & Jones, V. C. (2013). Proposed Transatlantic Trade and Investment Partnership (TTIP): In Brief. *Current Politics and Economics of Europe*, 24(1), pp 107–122.

Arita, S., Mitchell, L. & Beckman, J. (2015). *Estimating the Effects of Selected Sanitary and Phytosanitary Measures and Technical Barriers to Trade on U.S Agricultural Trade* [online]. Washington D.C: United Stated Department of Agriculture. (EER 199).

Atlantische Initiative, ed. team. *TTIP, Farming and Food - Your Opinion - Atlantic Community*. [online] (2015-11-10) (www.atlantic-community.org). Available from: http://www.atlantic-community.org/-/ttip-farming-and-food. [Accessed 2016-04-14].

Bauer, M. & Erixon, F. (2015). *”Splendid Isolation” as Trade Policy: Mercantilism and Crude Keynesiansim in ”the Capaldo Study” of TTIP.* European Centre for International Political Economy. Available from: http://www.ecipe.org/app/uploads/2015/04/1-Occasional-Paper_v4.pdf. [Accessed 2016-04-19].

Beckman, J., Arita, S., Mitchell, L. & Burfisher, M. E. (2015). *Agriculture in the Transatlantic Trade and Investment Partnership: Tariffs, Tariff-Rate Quotas, and Non-Tariff Measures* [online]. Washington D.C: United Stated Department of Agriculture. (ERR-198).

Berden, K. G., Francois, J., Thelle, M. M. & Tamminen, M. S. (2009). *Non-tariff measures in EU-US trade and investment–An economic analysis.* Report Number OJ 2007/S 180 [online], 219493. Available from: https://www.gtap.agecon.purdue.edu/resources/download/5177.pdf. [Accessed 2016-04-13].

Burcu Irfanoglu, Z. & van der Mensbrugghe, D. (2015). *Development of the Version 9 NON-Co2 GHG Emissions Database.* Purdue University. Available from: https://www.gtap.agecon.purdue.edu/resources/download/7813.pdf [Accessed 2016-04-13]

Bureau, J.-C., Disdier, A.-C., Emlinger, C., Fouré, J., Felbermayr, G., Fontagné, L. & Jean, S. (2014). *Risks and opportunities for the EU agri-food sector in a possible EU-US trade agreement*. Diss. European Parliament’s Committee on Agriculture and Rural Development. Available from: https://hal.archives-ouvertes.fr/hal-01173038/. [Accessed 2016-02-28].

Capaldo, J. (2014). *The Trans-Atlantic Trade and Investment Partnership- European Disintegration, Unemployment and Instability*. Global Development and Environment Institute Working Paper No.14-03 Available from: http://www.tradeunionfreedom.co.uk/wp-content/uploads/2013/01/14-03CapaldoTTIP.pdf. [Accessed 2016-04-13].

Council of the European Union (2012). *The transatlantic trade dispute on ”hormones” in beef comes to an end* - Press release. Council of the European Union. Available from: http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/agricult/129788.pdf. [Accessed 2016-04-14].

Cristea, A., Hummels, D., Puzzello, L. & Avetisyan, M. (2013). Trade and the greenhouse gas emissions from international freight transport. *Journal of Environmental Economics and Management*, 65(1), pp 153–173.

Dalin, C. & Rodriguez-Iturbe, I. (2016). Environmental impacts of food trade via resource use and greenhouse gas emissions. *Environmental Research Letters*, 11(3), p 35012.

Ecorys (2016a). *Draft Interim Technical Report published online | Trade SIA Transatlantic Trade and Investment Partnership (TTIP)*. Available from: http://www.trade-sia.com/ttip/draft-interim-technical-report-published-online/. [Accessed 2016-05-31].

Ecorys (2016b). *Trade SIA on the Transatlantic Trade and Investment Partnership (TTIP) between the EU and the USA - Draft Interrim Technical Report* [online]. Luxembourg: European Commission.

EPHA, Demeter (2015). Conference conclusions TTIP - Increased Trade For Better Living? European Policy Conference, 15-16 June, Brussels. *Proceedings of TTIP - Increased Trade for Better Living? European Policy Conference*, Brussels, juni 16 2015. Brussels: EPHA Demeter Joint Press Release.

European Commission. *TTIP – 12th round of talks, 22-26 February - Trade - European Commission*. [online] (2016-02-08). Available from: http://trade.ec.europa.eu/doclib/press/index.cfm?id=1454. [Accessed 2016-02-18].

European Commission (2005). *AVE - Ad Valorem Equivalents - MAP brief*. Directorate General for Agriculture and Rural Development. Available from: http://ec.europa.eu/agriculture/trade-analysis/map/brief1.pdf. [Accessed 2016-04-15].

European Commission (2015a). *EU Position Paper Trade and Sustainable Development Chapter/Labour and Environment*: EU Paper outlining issues and elements for provision in the TTIP. Available from: http://trade.ec.europa.eu/doclib/docs/2015/january/tradoc_153024.pdf. [Accessed 2016-05-04].

European Commission (2015b). EU Textual Proposal - *Trade and Sustainable Development*. Available from: http://trade.ec.europa.eu/doclib/docs/2015/november/tradoc_153923.pdf. [Accessed 2016-05-03].

European Commission. *European Commission - Press release - The common agricultural policy (CAP) and agriculture in Europe – Frequently asked questions*. [online] (2015c-10-22) (European Commission Press Release Database). Available from: http://europa.eu/rapid/press-release_MEMO-13-631_en.htm. [Accessed 2016-06-01].

European Commission (2015d). *The Paris Protocol – A blueprint for tackling global climate change beyond 2020*. European Commission. Available from: http://eur-lex.europa.eu/resource.html?uri=cellar:e27fdb4d-bdce-11e4-bbe1-01aa75ed71a1.0003.03/DOC_1&format=PDF. [Accessed 2016-05-05].

European Commission. *2030 climate & energy framework - European Commission*. [online] (2016a-28) (Climate Action 2030 climate & energy framework). Available from: http://ec.europa.eu/clima/policies/strategies/2030/index_en.htm. [Accessed 2016-05-05].

European Commission. *EU negotiating texts in TTIP - Trade - European Commission*. [online] (2016b-03-21). Available from: http://trade.ec.europa.eu/doclib/press/index.cfm?id=1230. [Accessed 2016-05-20].

European Commission. *Paris Agreement - European Commission*. [online] (2016c-04-21) (Climate Action Paris Agreement). Available from: http://ec.europa.eu/clima/policies/international/negotiations/paris/index_en.htm. [Accessed 2016-05-04].

European Commission (2016d). *The Road from Paris: assessing the implications of the Paris Agreement and accompanying the proposal for a Council decision on the signing, on behalf of the European Union, of the Paris agreement adopted under the United Nations Framework Convention on Climate Change* COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL. European Commission. Available from: https://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/1-2016-110-EN-F1-1.PDF. [Accessed 2016-05-05].

European Parliament (2013). *Principal EU-US trade disputes - Library Briefing*. Library of the European Parliament. Available from: http://www.europarl.europa.eu/RegData/bibliotheque/briefing/2013/130518/LDM_BRI(2013)130518_REV1_EN.pdf. [Accessed 2016-04-14].

European Parliament. *Answer to a written question - Study on the impact of TTIP on agriculture - P-001308/2016*. [online] (2016a-03-17) (European Parliament Parliamentary questions). Available from: http://www.europarl.europa.eu/sides/getAllAnswers.do?reference=P-2016-001308&language=EN. [Accessed 2016-04-14].

European Parliament. *Written question - Study on the impact of TTIP on agriculture - P-001308/2016*. [online] (2016b-02-22) (European Parliament Parliamentary questions). Available from: http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+WQ+P-2016-001308+0+DOC+XML+V0//EN. [Accessed 2016-04-14].

European Union Centre of North Carolina (2007). *The EU-US dispute over GMOs: Risk perceptions and the Quest for Regulatory Dominance*. University of North Carolina. Available from: http://europe.unc.edu/wp-content/uploads/2013/08/Brief0705-GMOs.pdf. [Accessed 2016-04-14].

FAO. *FAO - News Article: Agriculture's greenhouse gas emissions on the rise*. [online] (2016). Available from: http://www.fao.org/news/story/en/item/216137/icode/. [Accessed 2016-05-05].

Fellmann, T., Van Doorslaer, B., Witzke, P., Huck, I., Weiss, F., Salputra, G., Jansson, T., Drabik, D., Leip, A. & Institute for Prospective Technological Studies (2015). *An economic assessment of GHG mitigation* *policy options for EU agriculture* [online]. Luxembourg: Publications Office. Available from: http://bookshop.europa.eu/uri?target=EUB:NOTICE:LFNA27097:EN:HTML. [Accessed 2016-04-13].

Fontagné, L., Gourdon, J., Jean, S. & others (2013). Transatlantic trade: Whither partnership, which economic consequences. *CEPII Policy Brief* [online], 1. Available from: http://www.ifoinstitut.net/dms/ifodoc/docs/Akad_Conf/CFP_CONF_VSI/VSI_2014/vsi14-rmd-Felbermayr/Papers/vsi14-rmd-Gourdon.pdf. [Accessed 2016-04-13].

Francis, D. (2016). TTIP Leak Puts Obama's Economic Legacy at Risk. *Foreign Policy*. Available from: https://foreignpolicy.com/2016/05/02/ttip-leak-puts-obamas-economic-legacy-at-risk/. [Accessed 2016-05-20].

Francois, J., Manchin, M., Norberg, H., Pindyuk, O. & Tomberger, P. (2013a). *Reducing Transatlantic Barriers to Trade and Investment - An Economic Assesment* [online]. London, UK: Sentre for Economic Policy Research. (TRADE10/A2/A16).

Francois, J., Manchin, M., Norberg, H., Pindyuk, O. & Tomberger, P. (2013b). *Reducing Transatlantic Barriers to Trade and Investment: An Economic Assessment* [online]. Institue for International and Development Economics. (20130401).

Furustam, C. (2012). *En trygg luvsmedelsförsöjning globalt och i Sverige-Hur ser utmaningeen ut?* [online]. Stockholm: Lantbrukarnas Riksförbund.

Füssel, H.-M., Jol, A. & others (2012). *Climate change, impacts and vulnerability in Europe 2012 an indicator-based report.* [online],. Available from: http://www.envia.bl.uk/handle/123456789/4221. [Accessed 2016-06-01].

Hertwich, E. G. (2011). THE LIFE CYCLE ENVIRONMENTAL IMPACTS OF CONSUMPTION. *Economic Systems Research*, 23(1), pp 27–47.

Hess, S. & Von Cramon-Taubadel, S. (2008). A Meta-Analysis of General and Partial Equilibrium Simulations of Trade Liberalisation under the Doha Development Agenda. *World Economy*, 31(6), pp 804–840.

James, D. (1994). *The Application of Economic Techniques in Environmental Impact Assesment*. Dordrecht; Boston: Kluwer Academic Publishers. (Environment & Management; 4).

Johnson, R. (2012). US-EU Poultry Dispute on the Use of Pathogen Reduction Treatments (PRTs). *Congressional Research Service*, pp 7–5700.

Josling, T. (1993). Agricultural Trade Issues in Transatlantic Trade Relations. *World Economy*, 16(5), pp 553–573.

Josling, T. (2014). A transatlantic free trade deal: implications for food and agricultural policy.(Cardwell, R., Ed) *Estey Centre Journal of International Law and Trade Policy*, 15(2), pp 187–198.

Josling, T., Tangermann, S. & Centre for European Policy Studies (Brussels, B. (2014). *Agriculture, food and the TTIP: possibilities and pitfalls* [online]. Brussels: Centre for European Policy Studies. (TTIP series no. 3; 99).

Kitzes, J. (2013). An introduction to environmentally-extended input-output analysis. *Resources*, 2(4), pp 489–503.

Larsson, M. & Allvin, R. (2015). *I Frihandelns Goda Namn-En Genomlysning av Debatten och Forskningsläget om Konsekvenserna av TTIP*. Stockholm: Cogito & Katalys.

Lin, B. & Xie, X. (2016). CO2 emissions of China's food industry: an input–output approach. *Journal of Cleaner Production*, 112, pp 1410–1421.

Lindberg, G., Midmore, P. & Surry, Y. (2012). Agriculture's Inter-industry Linkages, Aggregation Bias and Rural Policy Reforms: Agriculture's inter-industry linkages. *Journal of Agricultural Economics*, 63(3), pp 552–575.

Malmström, C. (2016). *"Vi tummar inte på miljökrav i TTIP"*. [online] (2016-05-19) (DN.SE). Available from: http://www.dn.se/debatt/repliker/vi-tummar-inte-pa-miljokrav-i-ttip/. [Accessed 2016-05-20].

McDonald, S. & Thierfelder, K. (2004). *Deriving a global social accounting matrix from GTAP versions 5 and 6 data*. [online],. Available from: http://docs.lib.purdue.edu/gtaptp/22/. [Accessed 2016-05-28].

Miller, R. E. & Blair, P. D. (2009). *Input-output analysis foundations and extensions* [online]. Cambridge; New York: Cambridge University Press. Available from: http://dx.doi.org/10.1017/CBO9780511626982. [Accessed 2016-02-23].

Morita, T., Robinson, J., Adegbulugbe, A., Alcamo, J., Herbert, D., La Rovere, E. L., Nakicenovic, N., Pitcher, H., Raskin, P., Riahi, K. & others (2001). Greenhouse gas emission mitigation scenarios and implications. *Climate change*, pp 115–166.

NPPC (2013). *National Pork Producers Council Comments on the ”Transatlantic Trade and Investment Partnership”.* NPPC. Available from: http://www.nppc.org/wp-content/uploads/P-National-Pork-Producers-Council-USTR-2013-0019-TTIP-5-10-13.pdf. [Accessed 2016-05-12].

Peters, G. P., Davis, S. J. & Andrew, R. (2012). A synthesis of carbon in international trade. *Biogeosciences*, 9(8), pp 3247–3276.

Purdue, U. *GTAP Data Bases: GTAP 9 Data Base*. [online] (2015-12-03) (https://www.gtap.agecon.purdue.edu). Available from: https://www.gtap.agecon.purdue.edu/databases/v9/default.asp. [Accessed 2016-02-28].

Purdue University. *GTAP Data Bases: GTAP 9 Satellite Data and Utilities*. [online] (2016-02-22). Available from: https://www.gtap.agecon.purdue.edu/databases/Utilities/default.asp. [Accessed 2016-05-11].

Rankin, J. *Doubts rise over TTIP as France threatens to block EU-US deal*. [online] (2016-05-03) (the Guardian). Available from: http://www.theguardian.com/business/2016/may/03/doubts-rise-over-ttip-as-france-threatens-to-block-eu-us-deal. [Accessed 2016-05-20].

Raza, W., Grumiller, J., Taylor, L., Tröster, B. & Von Arnim, R. (2014). *ASSESS_TTIP: Assessing the claimed benefits of the Transatlantic Trade and Investment Partnership* [online]. Policy Note, Austrian Foundation for Development Research (ÖFSE).

Roberts, D. (1994). A Modified Leontief-Model for Analyzing the Impact of Milk Quotas on the Wider Economy. *Journal of Agricultural Economics*, 45(1), pp 90–101.

Sandahl, J. & Jacobsson, A. *”Med TTIP-avtalet riskeras skyddet för hälsa och miljö”*. [online] (2016-05-13) (DN.SE). Available from: http://www.dn.se/debatt/med-ttip-avtalet-riskeras-skyddet-for-halsa-och-miljo/. [Accessed 2016-05-29].

Sheffield, H. *TTIP: Barack Obama says trade deal should be signed by the ”end of the year” | Business News | News | The Independent*. [online] (2016-04-25) (independent.co.uk). Available from: http://www.independent.co.uk/news/business/news/ttip-obama-says-trade-deal-should-be-signed-by-the-end-of-the-year-a6999456.html. [Accessed 2016-05-20].

SPIEGEL ONLINE, H. G. *The TTIPing Point: Protests Threaten Trans-Atlantic Trade Deal*. [online] (2016-05-06) (SPIEGEL ONLINE). Available from: http://www.spiegel.de/international/world/protest-movement-threatens-ttip-transatlantic-trade-deal-a-1091088.html. [Accessed 2016-05-20].

SRU (2016). *Environment and Free Trade: Envrionmentally Sound Design of the TTIP* [online]. Berlin, Germany: German Advisory Council on the Environment. (19).

Svahn, T. (2016). *Trafikanalys: Fordon 2015* [online]. SCB. (2016:4).

Tubiello, F. N., Salvatore, M., Cóndor Golec, R. D., Ferrara, A. F., Rossi, S., Biancalani, R., Federici, S., Jacobs, H. & Flammini, A. (2014). *Agriculture, forestry and other land use emissions by sources and removals by sinks.* Statistics Division, Food and Agriculture Organization, Rome [online],. Available from: http://www.uncclearn.org/sites/default/files/inventory/fao198.pdf. [Accessed 2016-05-05].

United Nations Framework Convention on Climate Change (2015). *Adoption of the Paris Agreement* FCCC/CP/2015/L.9/Rev.1. Proceedings of 2015 United Nations Climate Change Conference, Paris, France, december 12 2015. Paris, France.

US EPA, O. *Greenhouse Gas Equivalencies Calculator*. [online] (2014-04). Available from: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator. [Accessed 2016-05-13].

USTR. *Transatlantic Trade and Investment Partnership (T-TIP) | United States Trade Representative*. [online] (2016-02-18) (United States Trade Representative). Available from: https://ustr.gov/ttip. [Accessed 2016-02-18].

Velázquez, E. (2006). An input–output model of water consumption: Analyzing intersectoral water relationships in Andalusia. *Ecological Economics*, 56(2), pp 226–240.

Walmsley, T. L., Aguiar, A. H. & Narayanan, B. (2012). *Introduction to the Global Trade Analysis Project and the GTAP Data Base* Working Paper no 67. Centre for Global Trade Analysis, Purdue University. Available from: https://www.gtap.agecon.purdue.edu/resources/download/6122.pdf. [Accessed 2016-03-16].

Wing, I. S. (2011). Computable general equilibrium models for the analysis of economy-environment interactions. *Research tools in natural resource and environmental economics* [online], 255. Available from: http://people.bu.edu/isw/papers/cge_chapter.pdf. [Accessed 2016-02-28].
Withworth, J. *FDA calls for info and reveals risk assessment for raw milk cheese*. [online] (2015-08-06) (FoodQualityNews.com). Available from: http://www.foodqualitynews.com/Industry-news/Cheese-made-from-unpasteurized-milk-on-FDA-agenda. [Accessed 2016-04-15].
Wollenberg, E., Richards, M., Smith, P., Havlík, P., Obersteiner, M., Tubiello, F. N., Herold, M., Gerber, P., Carter, S., Reisinger, A., van Vuuren, D., Dickie, A., Neufeldt, H., Sander, B. O., Wassmann, R., Sommer, R., Amonette, J. E., Falcucci, A., Herrero, M., Opio, C., Roman-Cuesta, R., Stehfest, E., Westhoek, H., Ortiz-Monasterio, I., Sapkota, T., Rufino, M. C., Thornton, P. K., Verchot, L., West, P. C., Soussana, J.-F., Baedeker, T., Sadler, M., Vermeulen, S. & Campbell, B. M. (2016). Reducing emissions from agriculture to meet the 2°C target. *Global Change Biology* [online],. Available from: http://doi.wiley.com/10.1111/gcb.13340. [Accessed 2016-05-17].
World Trade Organization & International Trade Centre UNCTAD/GATT (2013). *World tariff profiles 2013*. [online]. Geneva, Switzerland: World Trade Organization. Available from: https://www.wto.org/english/res_e/booksp_e/tariff_profiles13_e.pdf.
WTO (1995). *Agreement on the Application of Sanitary and Phytosanitary Measures*. World Trade Organization. Available from: https://www.wto.org/english/docs_e/legal_e/15-sps.pdf. [Accessed 2016-05-17]
Zhang, B., Chen, Z. M., Qiao, H., Chen, B., Hayat, T. & Alsaedi, A. (2015). China's non-CO2 greenhouse gas emissions: Inventory and input–output analysis. *Ecological Informatics*, 26, pp 101–110.

Appendix I: GTAP VARIABLE EXPLANATION SHEET (3 pages)

V=Value	P=Private demand	X=Export demand	S=Source
D=Domestic	G=Government demand	M=Market price (excluding taxes, including domestic margin)	
I=Imports	F=Firm demand	A=Agents price	D=Destination

VARIABLE	GTAP DECRIPTION	UNIT	COMMENT
VDFM	Intermediates. **Firms** domestic purchases at market prices	Million US Dollar (2011)	
VDFA	Intermediates. **Firms** domestic purchases at agents prices		+ Taxes – subs Below (VDFA-VDFM= taxes) VOA= EVFA (returns to factors in each sector) +VIFA+VDFA
VDPM	Intermediates. **Household** domestic purchases at market prices		
VDPA	Intermediates. **Household** domestic purchases at agents prices		
VDGM	Intermediates. Government domestic purchases at market prices		
VDGA	Intermediates. Government domestic purchases at agents prices		
VIGA	Intermediates. Government imports at Agents prices		
VIGM	Intermediates. Government imports at Market prices		
WXWD	Trade. Bilateral exports at world prices		FOB price (difference WXWD -WXMD=export tax or subsidy)
WXMD	Trade. Bilateral exports at market prices		Exporters domestic price
VST	Trade. Exports for International Transportation, Market prices		Transport margin, different types of transportation

VIFA	Intermediates. Firms imports at **Agents** prices		Difference VIFA-VIFM =tariffs
VIFM	Intermediates. Firms Imports at **Market** prices		
VIMS	Trade. Bilateral Imports at Market Prices		Importers domestic price
VIWS	Trade. Bilateral imports at World Prices		CIF prices. WIMS-WIWS? Import tax?
WTWR	Margins of international trade		VIMS-VIWS="transport cost"
VIPA	Intermediates. Household Imports at Agents Prices		
VIPM	Intermediates. Household imports at Market prices		Should be the same as VIPA if there is no domestic tax.
TVOM	Sales of domestic product, at market prices		
VFM	Endowments. Firms Purchases at Market prices		
EVFA	Endowments. Firms Purchases at Agents Prices		value added at factor cost
EVOA	Endowments. Value Output at Agents prices		VFM-EVOA=PTAXFACTORS
VDEP	Capital Stock. Value of Depreciation		
SAVE	Savings. Net expenditure at Agents prices		CGDS = Capital Goods
MDF	Co2 emissions from domestic product in current production	MT Co2	
MIF	Co2 emissions from imports in current production		
MDP	Co2 emissions from private consumption of imports		
MDG	Co2 emissions from government consumption of imports		
SUM Co2	MIF+MDP+MDG		By sector import share
NCQE	Non Co2-emissions associated with	MT Co2 eq.	

	endowment by industries		
NCQO	Non-Co2 emissions associated with output by industries		
NCQF	Non-Co2 emissions associated with input use by industries		
SUM GHG	NCQE+NCQO+NCQF		

Appendix II
Aggregated EEIO table (2 pages)

Sectors	Agriculture	Primary	Food processi	Manufacturin	Transport & (	Service	Household Demand	Government Demand	Investment Demand	Exportations Goods and services	Transport services	Total output
										Total (EU+ROW)		
Agriculture	45153.3246	182.5877	225008.2897	40124.8734	23762.0663	16144.7497	78911.7463	174.7864	4613.6033	125106.7223	0.0000	559182.7498
Other primary	3440.2328	5857.3674	4811.0421	134628.1433	23644.1264	24264.6330	2238930.2160	26200.8250	116.9970	71066.7544	0.0000	303631.4961
Food prcessing	31267.8953	410.9555	235891.9303	28795.4398	134081.0533	58109.4013	813807.2834	1401.6978	17.4946	387740.2339	0.0000	1691523.3853
Manufacturing	47773.9562	29913.0390	122786.9929	2748098.4289	1027465.3709	656676.3738	1389655.4534	24464.4067	508102.1376	4499147.6726	0.0000	11054083.8320
Transport & Construction	16893.5807	26413.4164	94129.6315	497256.2235	1111476.7038	645935.8303	2065275.5537	42392.2860	1694284.9732	560136.1445	329887.2500	7084081.5938
Service	48406.2207	37086.3729	187170.2455	1080820.7354	1031462.4496	2988865.7059	3217662.7969	3717360.0104	495738.1503	953665.7188	0.0000	13758238.4063
Land	63916.9623	0.0000	0.0000	0.0000	0.0000	0.0000						63916.9623
Labor & capital	249435.2686	115170.1881	407695.4319	2545899.2659	2178168.5684	6982902.4055						12479271.1283
Natural resources	9552.8430	36683.6797	0.0000	0.0000	0.0000	0.0000						46236.5227
Sales Taxes (Imports)	489.5024	367.9035	1204.1495	20646.6778	57319.1237	4121.6689						84149.0259
Sales Taxes (domestic)	1083.1969	1968.8443	4968.4330	77740.6240	146526.6632	23566.4320						255854.1934
Factor User Taxes	-25101.7511	17664.0306	74956.2195	574418.7188	430834.0049	1377963.2466						2450734.4692
Production Taxes	1209.1791	3714.6960	93909.4193	589413.0623	88615.7845	150725.6585						927587.7997
Imports	65662.3385	28198.4150	238991.6000	2716241.6389	830725.6787	828962.3008						4708781.9719
CO_2 (MDIF)	32.3332	6.6481	17.1125	753.0922	608.0758	43.3048						1460.5666
N_2O (SUM GHG	179.7714	0.3099	0.1275	59.3299	3.5081	43.0947						286.1416
CH_4 (SUM GHG)	242.1055	55.3608	0.3515	53.9813	50.8468	188.7748						591.4207
F Gas (SUM GHG)	0.0000	0.0000	0.0000	152.3195	0.0000	0.0000						152.3195
Total GHG	454.2102	62.3188	17.5915	1018.7230	662.4307	275.1742						2490.4484
Total outlays	559182.7498	303631.4961	1691523.3853	11054083.832	7084081.594	13758238.406	9804243.0498	3811994.0124	2702873.3560	6596863.2465	329887.2500	44254984.5130

Appendix II
Aggregated EEIO table (2 pages)

I-O Exports Breakdown			
	INTRA-EU EXPORTS	EU EXPORTS TO ROW	TOTAL
Agriculture	94267.2092390	30839.5130890	125106.7223280
Other primary	45336.7241210	25730.0302730	71066.7543940
Food prcessing	276232.0949700	111508.1389180	387740.2338880
Manufacturing	2717186.0061070	1781961.6665010	4499147.6726080
Transport & Construction	293475.5058590	266660.6386730	560136.1445320
Service	527750.1406520	425915.5781260	953665.7187780
Total	3954247.6809480	2642615.5655800	6596863.2465280

Aggregated Emissions accounts imports							*US Technology
	Agriculture	Other primary	Food processing	Manufacturing	Tranport &	Service	Total
SUM CO2	31.71090606	38.0809513	43.6441832	1058.760141	523.88731	114.7616227	1810.845112
N2O (SUM GHG*)	163.791605	0.760643	0.206582	64.605102	6.479802	40.441793	276.285527
CH4 (SUM GHG*)	178.893008	109.696906	0.176291	68.235178	36.241754	124.3255	517.568637
F Gas (SUM GHG*)	0	0	0	155.079161	0	0	155.079161
Total GHG	374.3955191	148.5385003	44.0270562	1346.679582	566.60886	279.5289157	2759.778437

Appendix III: Simulation Results (1:8 pages)
USDA EXPORTS

Aggregation table		Export values (million dollars 2011) USDA p 5			Export change USDA p 20		
USDA	I-O	value	Agg sum	Agg shares	%	%	value
Paddy Rice		293.92		100%	-3.45%	-3.45%	-10.1082
Wheat		14708.52		100%	0.17%	0.17%	24.9612
Coarse grains		9827.02		100%	-9.47%	-9.47%	-924.4828
Fruits	Fruits, vegetables and nuts	19547.32		51.33%	2.84%		
Vegetables		15475.43	38084.32	40.63%	2.42%	2.41%	912.2018
Nuts		3061.57		8.04%	-0.33%		
Soybeans	Oil seeds	903.05		12.61%	-11.39%		
Rapeseed		3855.43	7162.68	53.83%	1.81%	0.1290%	9.1491805
Other oil seeds		2404.2		33.57%	1.76%		
Sugarcane/bee		105.73		100.00%	0.89%	0.8900%	0.9455713
Other crops		21633.7		100%	1.26%	1.2600%	264.60271
Bovine	Bovine	5728.52		100%	-0.87%	-0.8700%	-49.52803
Hogs	Animal products nec	6223.94		43.29%	-2.23%		
Pultry and eggs		5189.89	14377.07	36.10%	0.87%	-0.4906%	-67.62271
Other animals		2963.24		20.61%	0.78%		
Raw milk		63.28		100%	3.84%	3.8400%	1.2936164
Beef	Bovine	18688.85		100%	-4.13%	-4.1300%	-772.7413
Pork	Meat products nec	14233.45		32.28%	-48.38%		
Poultry meat		22277.33	44098.93	50.52%	-0.24%	-15.7210%	-6959.463
Other meats		7588.15		17.21%	0.09%		
Vegetable oil		20239.27		100%	3.16%	3.16%	637.96154
Whey	Dairy products	2493.31		4.86%	-2.08%		
Powdered		1916.72		3.74%	-0.47%		
Butter		5193.16	51306.56	10.12%	-7.09%	-0.13%	-70.38726
Cheese		20504.14		39.96%	1.59%		
Other dairy		21199.23		41.32%	0.16%		
Processed	Sugar	6104.51	10316.48	59.17%	-0.93%	-0.68%	-183.8912
Sugar		4211.97		40.83%	-0.31%		
Processed rice		1218.35		100%	-4.86%	-4.86%	-59.58213
Prepared f_v	Food products nec	25101.55		16.08%	-0.01%		
Cereal preparations		31557.11	156135.66	20.21%	-0.09%	-0.01%	-11.93072
Processed feed		8598.88		5.51%	-1.15%		
Other foods		90878.12		58.20%	0.13%		
Beverages and		84236.35		100.00%	0.09%	0.09%	75.883859

I-O agri-food sectors output change		multiplier effects	As % of total
sector	value	value	%
Paddy rice	-10.1082	-17.0625	-1.33%
Wheat	24.9612	-79.1723	-0.20%
Cereal	-924.4828	-1109.1147	-3.11%
Vegetables,	912.2018	931.3361	1.10%
Oil seeds	9.1492	119.0933	0.55%
Sugar cane,	0.9456	-27.9011	-0.51%
Plant-based	0	0.420921794	0.04%
Crops nec	264.60271	176.3021429	0.21%
Bovine	-49.52803	-584.7196595	-1.29%
Animal	-67.62271	-2141.434364	-2.47%
Raw milk	1.2936164	-94.58649678	-0.13%
Wool, silk-	0	-0.347952046	-0.08%
Forestry	0	-8.898231026	-0.02%
Fishing	0	-25.36307293	-0.08%
Coal	0	-7.46819455	-0.03%
Oil	0	-9.698589106	-0.01%
Gas	0	-1.490758353	-0.01%
Minerals	0	-13.19334084	-0.01%
Bovine	-772.7413	-786.2079483	-1.05%
Meat	-6959.463	-7036.316766	-3.91%
Vegetable	637.96154	623.4107101	1.24%
Dairy	-70.38726	-242.2346944	-0.08%
Processed	-59.58213	-60.21933837	-1.19%
Sugar	-183.8912	-199.8652287	-0.74%
Food	-11.93072	-894.4464687	-0.14%
Beverages	75.883859	1.471689964	0.00%

Appendix III: Simulation results
CEPR Exports

Aggregation table		Export values (million dollars 2011) I-O GTAP9			Export change CEPR p 55, 64				I-O agri-food sectors output change		Multiplier effects	As % of total output
I-O sectors	CEPR	value	agg sum	Agg shares	% * see below	agg value	value		sector	value	value	%
Paddy rice	Agriculture, forestry, fisheries	292.992	125106.722	0.23%	0.34%	425.363	0.996172606		Paddy rice	0.996173	20.115265	1.57%
Wheat		14683.081		11.74%			49.92247559		Wheat	49.922476	302.08787	0.77%
Cereal grains		9762.226		7.80%			33.19156699		Cereal grains	33.191567	409.89561	1.15%
Vegetables,		37780.145		30.20%			128.4524914		Vegetables,	128.452491	419.4751	0.49%
Oil seeds		7092.426		5.67%			24.11424766		Oil seeds	24.114248	468.00309	2.15%
Sugar cane,		106.244		0.08%			0.361229481		Sugar cane,	0.361229	110.13489	2.01%
Plant-based		572.398		0.46%			1.946154689		Plant-based	1.946155	5.846675	0.50%
Crops nec		21000.215		16.79%			71.40073047		Crops nec	71.400730	824.74677	0.97%
Bovine cattle,		5692.876		4.55%			19.35577998		Bovine cattle,	19.355780	871.713	1.92%
Animal		13784.723		11.02%			46.86805703		Animal	46.868057	1511.4221	1.74%
Raw milk		33.688		0.03%			0.114538952		Raw milk	0.114539	1423.1536	2.03%
Wool, silk-		342.668		0.27%			1.165069952		Wool, silk-	1.165070	1.605824	0.37%
Forestry		6043.721		4.83%			20.54865039		Forestry	20.548650	76.898965	0.15%
Fishing		7919.321		6.33%			26.92569072		Fishing	26.925691	192.44066	0.64%
Bovine meat	Processed foods	18710.443	387740.234	4.83%	9.12%	35361.909	1706.392434		Bovine meat	1706.392434	1820.5303	2.44%
Meat products		44268.664		11.42%			4037.302163		Meat products	4037.302163	4267.7266	2.37%
Vegetable oils		20188.656		5.21%			1841.20545		Vegetable oils	1841.205450	2121.9149	4.23%
Dairy		52239.754		13.47%			4764.265556		Dairy products	4764.265556	7038.6782	2.20%
Processed rice		1225.970		0.32%			111.8084391		Processed rice	111.808439	123.29509	2.45%
Sugar		6991.004		1.80%			637.5796008		Sugar	637.579601	761.2791	2.80%
Food products		159800.344		41.21%			14573.79135		Food products	14573.791350	16965.332	2.65%
Beverages and		84315.398		21.75%			7689.564338		Beverages and	7689.564338	8562.7377	2.17%

* Recalculation total export change including intra-eu trade OBS, extra EU trade as a proxy of total trade

Agriculture	projected ch	value million eu	Total trade
extra EU	0.22%	490	222727.273
intra EU	0.12%	269	
Total	0.34%	759	

Food processi	projected cl	value million eu	Total trade
extra EU	9.36%	16622	177585.5
intra EU	-0.24%	-425	
Total	9.12%	16197	

Appendix III: Simulation Results
EP EXPORTS

Aggregation table		Export values (million dollars 2011) I-O GTAP9			Export change EP p 39, 36, 15					I-O agri-food sectors output change		multiplier effects	As % of total output
I-O	EP	value	value	%	Bilateral change	US export	agg value	diversion intra EU	total	sectors	value	value	%
Paddy rice	Cereals	292.992		1.18%						Paddy rice	62.608	91.764	7.14%
Wheat		14683.081	24738.299	59.35%	167.90%		5399.628	-113.392	5286.236	Wheat	3137.574	3762.516	9.61%
Cereal grains		9762.226		39.46%						Cereal	2086.054	2989.671	8.39%
Vegetables, fruit, nuts	vegtables & fruits	37780.145	37780.145		90%		4420.277	-92.826	4327.451	Vegetables, fruit, nuts	4327.451	4837.407	5.70%
Oil seeds	Oil seeds	7092.426	7092.426		31.80%		293.201	-6.157	287.044	Oil seeds	287.044	699.206	3.21%
Sugar cane,	Sugar	106.244	7097.248	1.50%	297.20%		2742.093	-57.584	2684.509	Sugar cane,	40.186	454.273	8.27%
Processed		6991.004		98.50%						Plant-based	18.431	22.848	1.95%
Plant-based fibers	Fibre crops	572.398	572.398		25.30%		18.826	-0.395	18.431	Crops nec	4051.809	5391.339	6.36%
Crops nec	Oth crops	21000.215	21000.215		151.60%		4138.722	-86.913	4051.809	Bovine cattle,	223.156	4051.114	8.92%
Bovine cattle, sheep	Cattle	5692.876	5692.876		30.80%		227.943	-4.787	223.156	Animal products	296.669	5429.022	6.27%
Animal products nec	Anim prod	13784.723	14127.390	97.57%	16.50%	13.00%	303.033	-6.364	296.669	Raw milk	10.230	4172.375	5.94%
Wool, silk-worm		342.668		2.43%						Wool, silk-worm	7.196	8.972	2.08%
Forestry	Forestry	6043.721	6043.721		0.70%		5.500	-0.115	5.384	Forestry	5.384	120.162	0.23%
Fishing	Fishing	7919.321	7919.321		31.70%		326.355	-6.853	319.502	Fishing	319.502	613.620	2.04%
Bovine meat	Red meat	18710.443	18710.443		404%		9826.725	-206.361	9620.364	Bovine	9620.364	9838.296	13.16%
Meat	White	44268.664	44268.664		289.0%		16631.737	-349.266	16282.471	Meat	16282.471	16669.961	9.27%
Vegetable oils and fats	Vegetable oil	20188.656	20188.656		58.2%		1527.474	-32.077	1495.397	Vegetable oils and	1495.397	1861.491	3.71%
Dairy	Dairy	52239.754	52273.442	99.94%	238.6%		16214.176	-340.498	15873.678	Dairy	15863.449	22498.351	7.04%
Raw milk		33.688		0.06%						Processed	124.355	138.398	2.75%
Processed	Other food	1225.970	161026.313	0.76%	79.70%		16683.936	-350.363	16333.574	Sugar cane,	2644.323	2887.387	10.63%
Food		159800.344		99.24%						Food	16209.218	21739.243	3.40%
Beverages and tobacco products	Beverage & tobacco	84315.398	84315.398		22.90%		2510.069	-52.711	2457.358	Beverages and tobacco products	2457.358	3487.869	0.88%

Appendix III: Simulation Results
USDA IMPORTS

Aggregation table		EU Import values (million dollars 2011) USDA p 5			Import change USDA p 20		
USDA	I-O	Value	Agg sum	Agg shares	%	Agg chang	Value
Paddy Rice	Paddy Rice	885.81		100.00%	-0.72%	-0.72%	-6.377832
Wheat	Wheat	9866.35		100.00%	0.05%	0.05%	4.933175
Coarse grains	Coarse grains	10098.72		100.00%	8.97%	8.97%	905.85518
Fruits	**Fruits, vegetables and nuts**	27076.34		51.86%	0.22%		
Vegetables		18817.8	52207.07	36.04%	1.52%	0.68%	354.43661
Nuts		6312.93		12.09%	0.14%		
Soybeans	**Oil seeds**	6232.68		41.29%	3.30%		
Rapeseed		5532.26	15095.78	36.65%	0.71%	1.79%	269.606
Other oil seeds		3330.84		22.06%	0.74%		
Sugarcane/bee	Sugarcane/bee	118.61		100.00%	-1.02%	-1.02%	-1.209822
Other crops	Other crops	38908.58		100.00%	-0.39%	-0.39%	-151.7435
Bovine	**Bovine cattle,**	4293.78		100.00%	-0.83%	-0.83%	-35.63837
Hogs	**Animal products nec**	6702.7		47.44%	-0.64%		
Pultry and		4181.5	14129.59	29.59%	-0.28%	-0.39%	-55.5791
Other animals		3245.39		22.97%	-0.03%		
Raw milk	Raw milk	152.81		100.00%	-1.04%	-1.04%	-1.589224
Beef	**Bovine Meat**	19477.42		100.00%	4.28%	4.28%	833.63358
Pork	**Meat products nec**	10034.3		25.13%	26.29%		
Poultry meat		22234.19	39934.43	55.68%	0.76%	7.09%	711.66903
Other meats		7665.94		19.20%	0.33%		
Vegetable oil	Vegetable oil	28835.26		100.00%	-0.56%	-0.56%	-161.4775
Whey	**Dairy products**	1197.32		2.95%	6.05%		
Powdered milk		900.23		2.21%	1.60%		
Butter		4497.43	40654.96	11.06%	12.35%	2.04%	828.47418
Cheese		16841.68		41.43%	0.85%		
Other dairy		17218.3		42.35%	0.25%		
Processed rice	Processed rice	1853.2		100.00%	1.93%	1.93%	35.76676
Processed	**Sugar**	7805.47	10526.12	74.15%	0.74%	0.75%	78.709483
Sugar		2720.65		25.85%	0.77%		
Prepared f_v	**Food products nec**	29628.26		18.57%	0.33%		
Cereal		24360.7		15.27%	0.60%		
Processed feed		7531.7	159583.56	4.72%	-1.50%	0.38%	611.47017
Other foods		98062.9		61.45%	0.49%		
Beverages and tobacco	Beverages and tobacco	56589.88		100.00%	0.55%	0.55%	311.24434

Exogenous sectors output change		Multiplier effects	As % of total output
Sector	Value	Value	%
Paddy rice	-6.377832	-6.341613	-0.8%
Wheat	4.933175	7.4117632	0.0%
Cereal grains	905.8552	902.50599	2.5%
Vegetables,	354.4366	340.50551	0.4%
Oil seeds	269.6057	267.73804	1.3%
Sugar cane,	-1.209822	-1.299688	-0.3%
Crops nec	-151.7435	-149.3901	-0.2%
Bovine cattle,	-35.63837	-36.07846	-0.7%
Animal	-55.5791	-55.852	-0.3%
Raw milk	-1.589224	-0.429682	-0.3%
Bovine meat products	833.6336	821.06401	1.1%
Meat products	711.669	696.24397	0.4%
Vegetable oils	-161.4775	-171.3032	-0.3%
Dairy products	828.4742	570.56751	0.4%
Processed rice	35.76676	35.297976	0.7%
Sugar	78.70948	68.561898	0.3%
Food products	611.4702	359.11579	0.1%
Beverages and	311.2443	269.00807	0.000882

Appendix III: Simulation Results CEPR IMPORTS

Aggregation table		EU Import values (million dollars 2011) GTAP9			CEPR projected import change % p 55, 64				Exogenous sectors output change		Multiplier effects	total output
I-O sectors	CEPR	value	Agg sum	%	% *see below		agg value	Value	Sector	Value	Value	
Paddy rice		107.4824		0.2%				6.17860788	Paddy rice	6.1785828	6.1786079	0.38%
Wheat		4795.591		8.3%				275.673747	Wheat	179.49823	275.67375	0.57%
Cereal grains		4396.0157		7.6%				252.704225	Cereal grain	236.17728	252.70423	0.47%
Vegetables,		7879.0846		13.6%				452.927856	Vegetables,	100.18937	452.92786	0.51%
Oil seeds		3338.0181		5.8%				191.885413	Oil seeds	187.80548	191.88541	0.87%
Sugar cane,	Agriculture, forestry, fisheries	877.36109		1.5%		Agriculture, forestry, fisheries		50.4349553	Sugar cane,	49.143937	50.434955	0.90%
Plant-based		80.74892	57726.7004	0.1%	5.75%		3318.4097	4.64183814	Plant-based	2.5585719	4.6418381	0.39%
Crops nec		9278.9131		16.1%				533.396768	Crops nec	464.14467	533.39677	0.53%
Bovine cattle,		7557.2876		13.1%				434.429409	Bovine cattl	431.85888	434.42941	0.95%
Animal		11775.15		20.4%				676.892508	Animal prod	645.19253	676.89251	0.78%
Raw milk		7502.6155		13.0%				431.286594	Raw milk	407.52983	431.28659	0.58%
Wool, silk-		138.43269		0.2%				7.95778023	Wool, silk-w	7.0239418	7.9577802	1.80%
Bovine meat		7952.726		3.3%				809.025798	Bovine meat	809.0258	809.0258	0.99%
Meat products		22911.64		9.6%				2330.78668	Meat produc	2330.7867	2330.7867	1.22%
Vegetable oils		13536.414		5.7%				1377.05091	Vegetable oi	1377.0509	1377.0509	2.41%
Dairy products		36365.956		15.2%				3699.48579	Dairy produ	3699.4858	3699.4858	0.78%
Processed rice	Processed foods	970.41038	238991.6	0.4%	10.17%	Processed foods	24312.465	98.7192364	Processed ri	98.719236	98.719236	1.82%
Sugar		1464.2486		0.6%				148.95709	Sugar	148.95709	148.95709	0.31%
Food products		100544.38		42.1%				10228.3169	Food produc	10228.317	10228.317	1.40%
Beverages and tobacco		55245.82		23.1%				5620.12241	Beverages a	5620.1224	5620.1224	1.29%

* Recalculation total import change including intra-eu trade OBS, extra EU trade as a proxy of total trade

Agricultur	projected c	value milli	Total trade
extra EU	5.22%	2657	50900.383
intra EU	0.53%	269	
Total	5.75%	2926	

Food proce	projected c	value milli	Total trade
extra EU	10.70%	8628	80635.514
intra EU	-0.53%	-425	
Total	10.17%	8203	

Appendix III: Simulation Results

EP IMPORTS

Aggregation table		EU Import values (million dollars 2011) GTAP9			Import change EP p 39, 36, 15					Exogenous sectors output change		Multiplier effects	As % of total output
I-O	EP	Value	Value	%	Bilateral change	Average bilateral share	Agg value	Diversion intra EU	Total	sectors	value	value	%
Paddy rice	Cereals	107.4824		1.16%						Paddy rice	10.275318	6.478857	0.50%
Wheat		4795.591	9299.089	51.57%	122.00%		907.5911	-18.59818	888.9929	Wheat	458.4585	330.062	0.84%
Cereal grains nec		4396.016		47.27%						Cereal grains nec	420.2591	188.1409	0.53%
Vegetables, fruit, nuts	vegtables & fruits	7879.085	7879.085	100.00%	96.80%		610.1563	-15.75817	594.3981	Vegetables, fruit, nuts	594.39814	563.3223	0.66%
Oil seeds	Oil seeds	3338.018	3338.018	100.00%	15.00%		40.05622	-6.676036	33.38018	Oil seeds	33.380181	30.73467	0.14%
Sugar cane,	Sugar	877.3611	2341.61	37.47%	624.70%		1170.243	-4.683219	1165.56	Sugar cane,	436.71526	433.8209	7.90%
Processed		1464.249		62.53%						Plant-based	3.6433913	3.555737	0.30%
Plant-based	Fibre crops	80.74892	80.74892	100.00%	58.90%		3.804889	-0.161498	3.643391	Crops nec	410.28395	105.4502	0.12%
Crops nec	Oth crops	9278.913	9278.913	100.00%	58.10%		431.2839	-18.55783	412.7261	Bovine cattle,	277.503599	272.4042	0.60%
Bovine cattle, sheep and	Cattle	7557.288	7557.288	100.00%	48.40%		292.6182	-15.11458	277.5036	Animal products nec	148.83789	140.9757	0.16%
Animal products nec	Anim prod	11775.15	11913.58	98.84%	18.30%	8%	174.4148	-23.82716	150.5877	Raw milk	4404.8769	4356.052	6.20%
Wool, silk-worm cocoons		138.4327		1.16%						Wool, silk-worm cocoons	1.544453	1.468753	0.34%
Bovine meat	Red meat	7952.726	7952.726	100.00%	365.00%		2322.196	-15.90545	2306.291	Bovine meat	591.2525	522.3491	0.70%
Meat products nec	White meat	22911.64	22911.64	100.00%	1037.00%		19007.5	-45.82328	18961.67	Meat products nec	3950.3728	3789.211	2.11%
Vegetable oils and fats	Vegetable oil	13536.41	13536.41	100.00%	154.40%		1672.018	-27.07283	1644.945	Vegetable oils and fats	1644.9451	1443.512	2.88%
Dairy products	Dairy	36365.96	43868.57	82.90%	2089.50%		73330.7	-87.73714	73242.97	Dairy products	60716.6	44551.63	13.95%
Raw milk		7502.615		17.10%						Processed rice	105.03722	97.54988	1.93%
Processed rice	Otherfood	970.4104	101514.8	0.96%	137.80%		11190.99	-203.0296	10987.96	Sugar	401.73758	129.3371	0.48%
Food products		100544.4		99.04%						Food products	10882.924	7031.907	1.10%
Beverages and tobacco	Beverage & tobacco	55245.82	55245.82	100.00%	54.60%		2413.137	-110.4916	2302.646	Beverages and tobacco	2302.6458	1840.606	0.47%

Appendix III: Simulation results
GHG impact EXPORTS

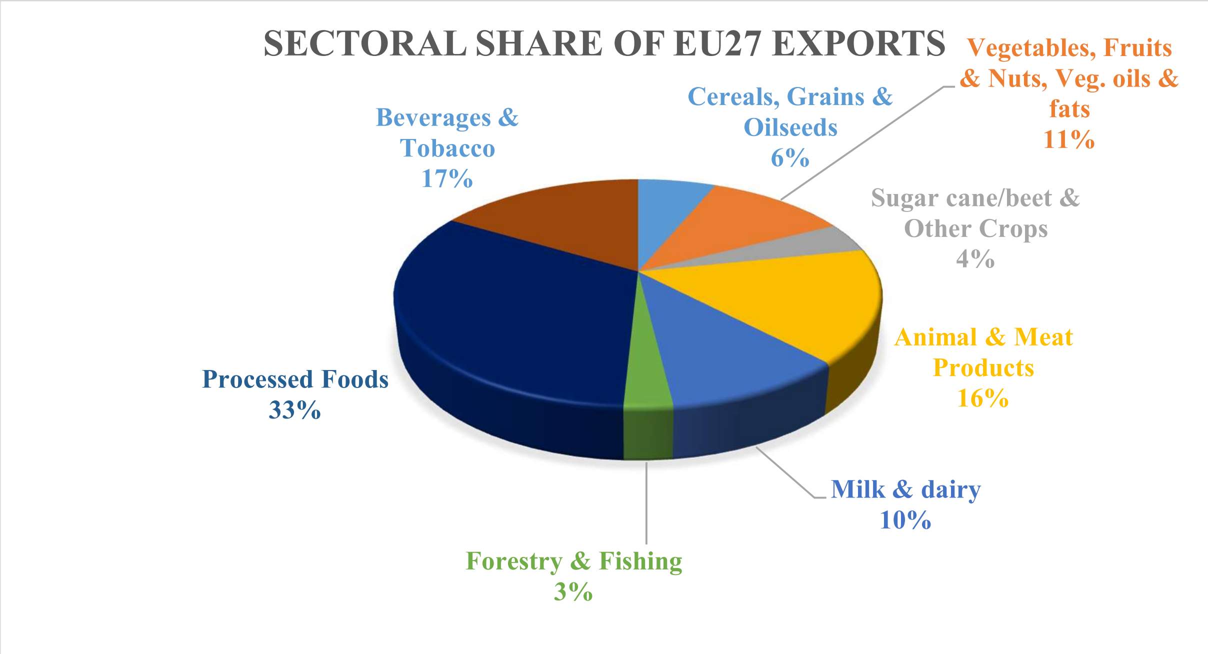
	ET export multipliers																					
	Indicator of total emissions				**USDA**	Emissions impact MT Co2 eq					**CEPR**	Emissions impact MT Co2 eq					**EP**	Emissions impact MT Co2 eq				
	MDF, SUM GHG (EU Technology)				value						value						value					
Sector	CO2	N2O	CH4	F Gas	mn dolla	CO2	N2O	CH4	F Gas	Total	mn doll	CO2	N2O	CH4	F Gas	Total	mn doll	CO2	N2O	CH4	F Gas	Total
Paddy rice	5E-05	0.0002	0.004	8E-07	-17.062	-9E-04	-0.003	-0.067	-1E-05	-0.071	20.115	0.0011	0.00334	0.0793	2E-05	0.0837	91.764	0.005	0.015	0.36	7E-05	0.382
Wheat	0.0001	0.0004	9E-05	1E-06	-79.172	-0.01	-0.035	-0.007	-9E-05	-0.0514	302.09	0.037	0.13209	0.0267	0.0003	0.1961	3762.5	0.4609	1.645	0.33	0.004	2.443
Cereal g	0.0001	0.0005	1E-04	1E-06	-1109.1	-0.142	-0.555	-0.122	-0.001	-0.8191	409.9	0.0523	0.20504	0.0449	0.0005	0.3027	2989.7	0.3816	1.496	0.33	0.003	2.208
Vegetab	8E-05	0.0001	4E-05	5E-07	931.34	0.0762	0.1047	0.0349	0.0005	0.21632	419.48	0.0343	0.04716	0.0157	0.0002	0.0974	4837.4	0.3958	0.544	0.18	0.003	1.124
Oil	0.0002	0.0005	1E-04	1E-06	119.09	0.0188	0.062	0.0164	0.0002	0.09734	468	0.0738	0.24354	0.0646	0.0006	0.3825	699.21	0.1102	0.364	0.1	9E-04	0.571
Sugar ca	1E-04	0.0007	7E-05	1E-06	-27.901	-0.003	-0.019	-0.002	-3E-05	-0.0236	110.13	0.0108	0.07467	0.0075	0.0001	0.0931	454.27	0.0447	0.308	0.03	6E-04	0.384
Plant-ba	4E-05	0.0002	9E-05	9E-07	0.4209	2E-05	8E-05	4E-05	4E-07	0.00014	5.8467	0.0002	0.00118	0.0005	5E-06	0.002	22.848	0.001	0.005	0	2E-05	0.008
Crops ne	0.0001	0.0004	1E-04	8E-07	176.3	0.0202	0.066	0.0172	0.0001	0.10347	824.75	0.0944	0.30873	0.0802	0.0007	0.484	5391.3	0.6171	2.018	0.52	0.004	3.164
Bovine c	9E-05	0.0011	0.002	8E-07	-584.72	-0.051	-0.636	-1.436	-4E-04	-2.1232	871.71	0.0761	0.94761	2.1409	0.0007	3.1653	4051.1	0.3538	4.404	9.95	0.003	14.71
Animal p	8E-05	0.0003	5E-04	6E-07	-2141.4	-0.172	-0.712	-1.053	-0.001	-1.9381	1511.4	0.1216	0.50228	0.7431	0.0009	1.3679	5429	0.4367	1.804	2.67	0.003	4.913
Raw milk	6E-05	0.0004	1E-03	5E-07	-94.586	-0.006	-0.034	-0.092	-5E-05	-0.1315	1423.2	0.0875	0.50918	1.381	0.0007	1.9783	4172.4	0.2564	1.493	4.05	0.002	5.8
Wool,	0.0001	0.0003	6E-04	4E-06	-0.348	-4E-05	-1E-04	-2E-04	-1E-06	-0.0004	1.6058	0.0002	0.00054	0.001	6E-06	0.0017	8.9724	0.0009	0.003	0.01	3E-05	0.01
Forestry	7E-05	2E-05	6E-05	5E-07	-8.8982	-6E-04	-2E-04	-5E-04	-4E-06	-0.0014	76.899	0.0056	0.00153	0.0047	4E-05	0.0119	120.16	0.0088	0.002	0.01	6E-05	0.019
Fishing	0.0002	4E-05	8E-05	7E-07	-25.363	-0.004	-9E-04	-0.002	-2E-05	-0.0074	192.44	0.0331	0.00703	0.0161	0.0001	0.0564	613.62	0.1055	0.022	0.05	4E-04	0.18
Bovine r	7E-05	0.0003	8E-04	9E-07	-786.21	-0.052	-0.265	-0.597	-7E-04	-0.9157	1820.5	0.121	0.61427	1.3835	0.0016	2.1204	9838.3	0.6541	3.32	7.48	0.008	11.46
Meat products nec	6E-05	0.0001	3E-04	7E-07	-7036.3	-0.441	-1.038	-1.799	-0.005	-3.2842	4267.7	0.2676	0.62979	1.0914	0.0031	1.9919	16670	1.0454	2.46	4.26	0.012	7.781
Vegetable oils and fats	6E-05	1E-04	3E-05	7E-07	623.41	0.0401	0.0613	0.02	0.0005	0.12183	2121.9	0.1365	0.20852	0.0681	0.0016	0.4147	1861.5	0.1198	0.183	0.06	0.001	0.364
Dairy pr	7E-05	8E-05	2E-04	1E-06	-242.23	-0.017	-0.021	-0.055	-2E-04	-0.0932	7038.7	0.5011	0.59786	1.6019	0.007	2.7078	22498	1.6017	1.911	5.12	0.022	8.655
Processe	3E-05	2E-05	3E-04	8E-07	-60.219	-0.002	-1E-03	-0.02	-5E-05	-0.0234	123.3	0.0038	0.00198	0.0419	9E-05	0.0478	138.4	0.0043	0.002	0.05	1E-04	0.054
Sugar	4E-05	1E-04	1E-05	6E-07	-199.87	-0.008	-0.02	-0.003	-1E-04	-0.0304	761.28	0.03	0.075	0.0103	0.0004	0.1157	2887.4	0.1139	0.284	0.04	0.002	0.439
Food pro	6E-05	4E-05	5E-05	9E-07	-894.45	-0.053	-0.036	-0.049	-8E-04	-0.1387	16965	1.0085	0.68462	0.9214	0.0159	2.6305	21739	1.2923	0.877	1.18	0.02	3.371
Beverag	7E-05	3E-05	3E-05	1E-06	1.4717	0.0001	4E-05	4E-05	1E-06	0.00019	8562.7	0.6184	0.23208	0.2516	0.0082	1.1104	3487.9	0.2519	0.095	0.1	0.003	0.452
										-9.1132						19.362						68.49

Appendix III: Simulation Results

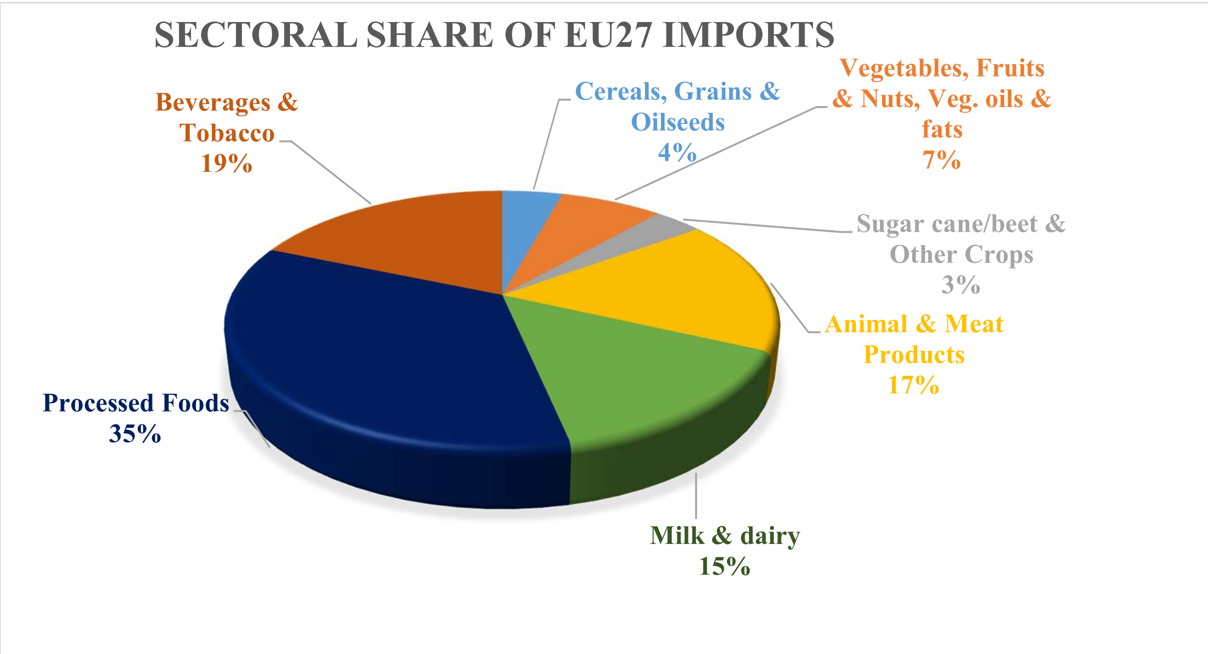
GHG Impact Imports

	ET import multipliers																					
	Indicator of total emissions				**USDA**	Emission impact MT Co2 Eq					**CEPR**	Emission impact MT Co2 Eq					**EP**	Emission impact MT Co2 Eq				
	SUM CO2, SUM GHG																					
	(Import related and US technology)				Value						Value						Value					
Sector	CO2	N2O	CH4	F Gas	mn dollar	CO2	N2O	CH4	F Gas	Total	mn dolla	CO2	N2O	CH4	F Gas	Total	mn dollar	CO2	N2O	CH4	F Gas	Total
Paddy	0.0002	0.0008	0.00621	1.2E-06	-6.3416	-0.0015	-0.0052	-0.039	-8E-06	-0.046	4.9284	0.0012	0.00405	0.0306	6E-06	0.0358	6.47886	0.0015	0.0053	0.0402	7.9E-06	0.04709
Wheat	1E-04	0.0002	3.1E-05	1.9E-06	7.41176	0.0007	0.0014	0.0002	1E-05	0.0023	223.24	0.0217	0.04103	0.007	0.00042	0.0701	330.062	0.0321	0.0607	0.0103	0.00062	0.1037
Cereal	9E-05	0.001	6E-05	2.1E-06	902.506	0.0842	0.9268	0.0538	0.0019	1.0667	168.95	0.0158	0.17351	0.0101	0.00035	0.1997	188.141	0.0176	0.1932	0.0112	0.00039	0.22238
Vegetabl	0.0001	0.0002	3.1E-05	8E-07	340.506	0.0367	0.0689	0.0106	0.0003	0.1164	432.69	0.0466	0.0876	0.0134	0.00035	0.148	563.322	0.0607	0.1141	0.0175	0.00045	0.19265
Oil seeds	0.0001	0.0007	4.6E-05	2.5E-06	267.738	0.0361	0.1862	0.0124	0.0007	0.2354	189.71	0.0256	0.13195	0.0088	0.00048	0.1668	30.7347	0.0041	0.0214	0.0014	7.8E-05	0.02702
Sugar	7E-05	0.0001	1.4E-05	2.2E-06	-1.2997	-9E-05	-0.0002	-2E-05	-3E-06	-3E-04	49.699	0.0035	0.00602	0.0007	0.00011	0.0103	433.821	0.0308	0.0526	0.0059	0.00098	0.0902
Plant-	0.0002	0.0045	0.0002	9.9E-07	-0.0067	-1E-06	-3E-05	-1E-06	-7E-09	-3E-05	4.6055	0.001	0.02065	0.0009	4.6E-06	0.0226	3.55574	0.0008	0.0159	0.0007	3.5E-06	0.01744
Crops nec	0.0001	3E-05	1.5E-05	1.3E-06	-149.39	-0.0194	-0.0047	-0.002	-0.0002	-0.027	447.15	0.058	0.01409	0.0067	0.0006	0.0794	105.45	0.0137	0.0033	0.0016	0.00014	0.01873
Bovine	9E-05	0.0012	0.00231	1E-06	-36.078	-0.0033	-0.0436	-0.083	-4E-05	-0.13	430.48	0.0391	0.52054	0.9934	0.00044	1.5535	272.404	0.0247	0.3294	0.6286	0.00028	0.98302
Animal	8E-05	0.0003	0.00035	8.3E-07	-55.852	-0.0047	-0.0179	-0.02	-5E-05	-0.042	672.49	0.0566	0.21586	0.2357	0.00056	0.5087	140.976	0.0119	0.0453	0.0494	0.00012	0.10664
Raw milk	6E-05	0.0002	0.00051	6.8E-07	-0.4297	-2E-05	-7E-05	-2E-04	-3E-07	-3E-04	409.76	0.0231	0.06824	0.2093	0.00028	0.3009	4356.05	0.2454	0.7255	2.2247	0.00297	3.19852
Wool,	0.0014	1E-05	2.2E-05	3.7E-06	-0.0194	-3E-05	-2E-07	-4E-07	-7E-08	-3E-05	7.7663	0.0112	9.2E-05	0.0002	2.9E-05	0.0115	1.46875	0.0021	2E-05	3E-05	5.5E-06	0.00218
Bovine	8E-05	0.0004	0.00071	1.1E-06	821.064	0.0682	0.3075	0.5856	0.0009	0.9622	741.97	0.0616	0.27788	0.5292	0.00083	0.8695	522.349	0.0434	0.1956	0.3725	0.00059	0.61216
Meat	8E-05	0.0001	0.00021	9.5E-07	696.244	0.0527	0.1037	0.1441	0.0007	0.3012	2191	0.1659	0.3263	0.4535	0.00207	0.9478	3789.21	0.2869	0.5643	0.7844	0.00358	1.6392
Vegetabl	0.0001	0.0001	1.6E-05	1.1E-06	-171.3	-0.0173	-0.0231	-0.003	-0.0002	-0.043	1210	0.1225	0.16352	0.0189	0.00138	0.3063	1443.51	0.1461	0.1951	0.0226	0.00164	0.36539
Dairy	8E-05	4E-05	0.00012	1.3E-06	570.568	0.0471	0.0236	0.0708	0.0007	0.1422	2500.9	0.2062	0.10358	0.3103	0.00327	0.6234	44551.6	3.6741	1.8451	5.5272	0.05831	11.1048
Processed rice	0.0001	7E-05	0.00053	8.9E-07	35.298	0.0038	0.0025	0.0188	3E-05	0.0252	91.721	0.0099	0.00656	0.0488	8.2E-05	0.0654	97.5499	0.0105	0.007	0.0519	8.7E-05	0.06953
Sugar	5E-05	2E-05	6.2E-06	8.5E-07	68.5619	0.0035	0.0013	0.0004	6E-05	0.0053	83.564	0.0043	0.00159	0.0005	7.1E-05	0.0065	129.337	0.0066	0.0025	0.0008	0.00011	0.01
Food	1E-04	3E-05	4.2E-05	1.2E-06	359.116	0.0342	0.0125	0.0149	0.0004	0.0621	8968.9	0.8539	0.31318	0.3728	0.01075	1.5506	7031.91	0.6695	0.2455	0.2923	0.00843	1.21569
Beverages and tobacco	8E-05	2E-05	2.4E-05	1.3E-06	269.008	0.0219	0.0058	0.0064	0.0003	0.0344	5104	0.4147	0.11016	0.121	0.00652	0.6524	1840.61	0.1495	0.0397	0.0436	0.00235	0.23525
										2.6644						8.1292						20.2616

APPENDIX IV: SECTORAL SHARES OF TRADE EU 27 (2011)



Source: GTAP9, Purdue University (2011)



Source: GTAP9 Purdue University (2011)