TRADE DIVERSION EFFECTS OF PREFERENTIAL TRADE AGREEMENTS UNDER TARIFF RATE QUOTA REGIMES

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Abstract: With the Doha Round of negotiations having come to a standstill, more countries opt for preferential trade agreements with only a limited number of partners. Starting two recent negotiations, the Trans-Pacific Partnership and the EU-US trade deal, might mark the beginning of a new era in multilateral trade negotiations in a sense that they connect the largest but geographically distant players of the world market. The impact of preferential agreements on welfare and trade patterns has been subject to economic investigation for decades. Applied equilibrium models are key analytical tools in the ex ante assessment of trade negotiations, but are often criticized as being sensitive with regard to underlying assumptions and input data. For trade related impact assessment, assumptions relating to the aggregation and presentation of border protection instruments are of specific interest. This study contributes to the assessment of equilibrium modelling techniques with a focus on tariff rate quotas (TRQ) by systematically comparing simulated impacts on traded volumes and welfare under different implementation of TRQs. In the equilibrium modelling literature TRQ instruments are either modelled explicitly (linking the variable tariff rate and the fill rate of the quota threshold) or transformed into an ad valorem equivalent (AVE) tariff rate. In the standard Vinerian framework of welfare analysis, trade diversion occurs when imports from low cost producers in the rest of the world are displaced by exporters benefitting from trade preferences. The simulated shift in imports in an equilibrium model depends on the third country policy representation. With binding tariff rate quotas in the initial point, for example, shifts in traded volumes will be significantly different if the TRQ instrument is modelled explicitly or by its AVE tariff rate. This study demonstrates the sensitivity of simulated results by both developing a simple three country model of international trade and by implementing an illustrative EU-US trade deal scenario with the Common Agricultural Policy Regionalised Impacts (CAPRI) modelling system. The focus is on whether the choice of modelling TRQ instruments with third countries explicitly or by their AVE tariff rates has a significant impact on simulation results. In default, most policy instruments in CAPRI – including border protection and market intervention mechanisms – are modelled explicitly. Tariffs subject to quota limits are approximated with a smooth function mimicking the switching mechanism between preferential and out of quota rates. For the sake of this study this mechanism is optionally replaced with the AVE representation. CAPRI is then calibrated under both TRQ representations and the results of the same trade deal scenario are compared.

Keywords: tariff rate quota, CAPRI, trade diversion, EU-US trade deal

INTRODUCTION

The Doha Round of negotiations in the WTO has come to a standstill by the early 2010s. Many countries seem to consider now a multilateral agreement as rather unlikely and try to boost their trade relations instead by negotiating Preferential Trade Agreements[1] (PTA). Indeed, the number of PTAs and PTA negotiations has increased over the last few years, some of these such as the Trans-Pacific Partnership or the EU-US trade deal, could significantly affect global agricultural commodity markets That motivates a review of the toolbox used for ex ante economic analysis of trade agreements, specifically with respect to its ability to provide robust results on changes in welfare and trade patterns.

Applied equilibrium models are key analytical tools in the ex ante assessment of trade agreements. In the current study, we take a closer look to what extent third-country policy representation in equilibrium models has an impact on simulated trade patterns and welfare. The focus on third countries is motivated from the observations that modellers typically put high efforts to depict policy instruments subject to change under a PTA, i.e. between the negotiating partners, while using simpler representations for trade policy instruments related to third countries. We argue that this simplification introduces a significant error in the simulated impacts on welfare and trade.

In order to support our point, we focus on one specific border protection measure that has a potential to distort the estimated impacts: tariff rate quotas (TRQs). TRQs are quantity controls that regulate the amount of imported commodities by using two tariff tears. The vast majority of TRQs were introduced in the tarification process of the Uruguay Round of negotiations (URA) with the aim of allowing a minimum market access in case of high border protection as well as to convert preferential access existing before the URA to tariffs.

[1] According to the WTO terminology trade agreements representing unilateral trade preferences fall into the category of Preferential Trade Agreement. The term Free Trade Agreement (FTA) is often used as a synonym in the corresponding literature.

In the vast body of the applied equilibrium modelling literature TRQs are either simplified to fixed ad valorem equivalent tariff rates or introduced as variable tariffs[2]. There are various approaches to explicitly model TRQs in an equilibrium framework. Two well established techniques are discussed in this study: (1) the smooth approximation of the switching mechanism between the two tariff tears and (2) orthogonality conditions describing the different market regimes[3] under a TRQ.

Welfare analysis of trade agreements is often made in the Vinerian framework (Viner 1950) of trade diversion and trade creation effects. Viner's insight was that joining a custom union may reduce welfare, and he separated two main impacts. Trade creation occurs when higher cost domestically produced goods in the consumption bundle are substituted with lower cost imports from the new partners. Trade diversion, on the other hand, is the shift of imports from low cost third country producers to imports from high cost producers enjoying trade preferences. Traditionally trade creation is considered as welfare improving, while trade diversion is connected with the opposite welfare effect. Unfortunately, the Vinerian framework is not exhaustive, i.e. effects that cannot be identified as trade diversion or creation can occur, and the welfare impacts under trade diversion or creation are sometimes ambiguous[4].

In order to measure the welfare impacts, a simple money metric definition is introduced in the study. It represents the income equivalent (expenditure) of the utility at constant prices of the initial point[5]. We also introduce a measure for the shift in imported volumes from third countries to members of the trade agreement. This measure only describes the change in trade patterns (traded volumes) without a clean-cut categorization of welfare effects.

In our study we first develop a simple three-country model of international trade with a minimum level of details that enables the demonstration of trade diversion and creation effects. A hypothetical scenario is analyzed with this framework introducing free trade between two regions while having different

[2] Under the variable tariff assumption applied tariff rate varies depending on the fill rate of the quota limits.
[3] Market regimes typically include the binding and the non-binding cases.
[4] The ambiguity in welfare impacts are due to the trade-off between gains from lower domestic prices and the forgone tariff revenues. For example, if the small country assumption does not hold the net welfare effects are ambiguous (Harrison, Rutherford, and Wooton 1993). It is also possible to construct examples when welfare increases under situations characterized as trade diversion (Kowalczyk 2000).
[5] The distribution of the TRQ rent to the home government and exporters depends mainly on the TRQ administration method applied, see e.g. (de Gorter and Sheldon 2000). The welfare calculation of the present study follows the standard approach in the literature and divides the quota rent equally between the two agents.

TRQ representations with the third one. A discussion follows highlighting the differences in obtained results. Then we move to the analysis of a more realistic scenario of an EU-US trade deal with the CAPRI modelling framework. CAPRI is a partial equilibrium model with a global coverage of agricultural commodity markets, featuring an Armington system for modelling bilateral trade. In the current study CAPRI is run with two different policy representations of third country TRQ instruments and the results are compared. The study concludes with comments and a short summary of the contrasted results.

1. METHODOLOGY

The following section starts with a discussion on the standard techniques to model tariff rate quotas in applied equilibrium models[6]. We then move to the presentation of our simple three-country model and a short description of the CAPRI modelling system concludes.

1.1. AVE representation of TRQs

In many equilibrium models, TRQs are simply represented by an equivalent ad valorem tariff rate. Many applied equilibrium models base their tariff information on the MAcMap-HS 6 database (Guimbard et al. 2012) that provides information on tariff duties and TRQs using an AVE measure. By the calculation of AVE practitioners usually face three problems: (1) selection of the correct unit value in order to convert specific tariffs into ad valorem equivalents; (2) find a shadow tariff that correctly represents the level of border protection of marginal imports and (3) suitable aggregation method from the HS classification levels to the commodity list of the equilibrium model.

Generally, specific tariffs are converted simply by dividing the duty by a unit value. But there exists several approaches to calculate the unit value. In the case of MAcMap, for example, the exporter's reference group unit value is applied (Bouet et al. 2008). A hierarchical clustering divides reporting countries into reference groups based on their gross domestic product and trade openness.

CAPRI has its own tariff aggregation routines to calculate specific and ad valorem tariffs from the HS-6 level information in the Agricultural Market Access Database[7] (AMAD). A multi-step approach is applied to calculate unit values. After calculating the single import unit values at HS-6 level, the resulting

[6] The discussion below is restricted to the bilateral TRQ case for the sake of simplicity. However, the techniques presented here can be easily adapted to the case of multilateral TRQs too.
[7] The AMAD database is freely available under http://www.oecd.org/site/amad/

time series are cleaned with a variance based outlier detection algorithm. In the next step, normal distributions are fitted to the time series. The algorithm calculates the probability that the unit value observations were generated by the estimated distribution. Finally, an average of the single unit value and the world unit value is calculated using the probabilities from the previous steps as weighting factors.

Shadow tariffs of TRQs should reflect both on the marginal level of border protection and the resulting quota rents. The naive approach would be to use trade weighted averages of preferential and MFN tariff rates. This, however, would lead to an underestimation of the level of protection, in particular when a small quota overfill occurs. Indeed, in this case the ad valorem equivalent would be close to the preferential rate (indicating low protection) although imports close to the quota limit usually indicate a high level of protection. The corresponding quota rent would be close to zero too and hence probably underestimated.

To avoid the above underestimation of protection, MAcMap determines market regimes and the corresponding shadow tariffs based on the quota fill rate (Bouet et al. 2008). If import quantities are below 90% of the threshold, non binding quotas are assumed and the AVE is set to the preferential rate (setting the quota rent to zero at the same time). If import quantities are in the 90-99% range, the quota is assumed to be binding and prohibitive, and the AVE is the arithmetic average of preferential and MFN rates. The shadow rate is hence assumed to be half the difference between the preferential and MFN rate. In the last regime of quota overfill, the AVE is equal to the MFN rate and the per unit rent equal to the difference between the preferential and MFN rate. In those scenarios of the current study where TRQs are not represented explicitly, we apply the same methodology to calculate the shadow rate.

The core problem of the tariff aggregation is the choice of the weighting scheme. The applied weights are ranging from simple import weighted averages to world imports. The former suffers from the endogeneity[8] bias. The latter avoids endogeneity but takes no account of the individual trade patterns. MAcMap applies the reference group methodology. Aggregation weights are calculated by normalizing the bilateral trade values with the total value within the reference group. This method avoids some of the endogeneity bias but still reflects to the single economies' specifities. The approach taken in CAPRI is a combination of three different weighting schemes. Aggregate tariffs are an average of tariffs derived from (1) the naïve bilateral trade weighting, (2) weighting with average world import values and (3) simple arithmetic means.

[8] The endogeneity bias refers to the fact that the higher the tariff rate, the more restrictive it becomes and so the associated imports (and weights) become smaller.

1.2. Explicit representation of TRQs in equilibrium models

Tariff rate quotas can be easily introduced in a Mixed Complementarity Problem (MCP) framework using specific orthogonality conditions. The approach followed in some applications of the LINKAGE model (van der Mensbrugghe 2005) or GLOBE (Burrell et al. 2011), is based on the following conditions:

$$Q - I^{in} \geq 0 \quad \perp \quad r \geq 0 \qquad (1)$$

$$t^{MFN} - t^{\mathrm{Pr}ef} \geq r \quad \perp \quad I^{out} \geq 0 \qquad (2)$$

$$I \geq I^{in} - I^{out} \quad \perp \quad I^{in} \geq 0 \qquad (3)$$

Equation (1) represents the regime where imports (I^{in} "in-quota" imports) are less than or equal to quota limits (Q). If the imports are equal to the quota then tariffs are collected at the preferential rate but an excess demand leads to a quota premium rate[9] (r).

The second condition represents an upper bound on the quota premium rate: it cannot exceed the difference between the MFN and preferential tariff rates. The economic interpretation is that the quota premium rate is only at its upper bound if "out-of-quota" imports occur (I^{out}). Equation (3) simply sets total imports being the sum of in and out of quota imports. The latter equation links the TRQ mechanism to the market balances of an equilibrium modelling framework.

Another approach to model TRQ instruments explicitly is to introduce a smooth approximation of the switching mechanism between preferential and MFN tariff rates. Using smooth functions facilitates finding a numerical solution for the optimum as most optimizing algorithms work with first and second order derivatives. The family of sigmoid functions is especially suitable to mimic the switching mechanism, and this is the functional form utilized in CAPRI (Britz, 2012) and in one of the alternative scenarios in our simple theoretical model.

Under the sigmoid representation applied tariff rates are a function of bilateral trade flows. The sigmoid function is calibrated so that the saddle point is close to the quota level[10] and the minimum and maximum of the function equal to the preferential and MFN rates. The steepness of the sigmoid function defines how sensitive the applied rate is in respect to the changes in imported quantities[11]. In

[9] The quota premium rate is the shadow tariff applied on the marginal imports. It defines the quota rent per unit of imports. These denominations are used interchangeably in the text.

[10] Having a small distance between the saddle point and the quota level makes it possible to calibrate the function to any applied rates between the preferential and MFN ones.

[11] The steepness should be sufficiently large to mimic the switching mechanism close enough but also sufficiently small to ease the numerical solution (the more flat the function the easier to find the optimum numerically).

opposite to the MCP approach, the smooth approximation allows to calibrate the model against a rent even if the quota is not fully filled or to a per unit rent below the full tariff difference in case of quota overfill. That can be advantageous under certain data constellations. The MCP approach would in these cases require shifting the TRQ quantity.

1.3. Simple theoretical model of international trade

In the following section a simple three country model with only one traded commodity is constructed. The model implicitly maximizes producer and consumer surplus increased with tariff revenues under perfect competition. The model is formulated as an MCP problem. The behavioural equations for demand are derived from a Generalized Leontief expenditure system. Supply functions are derived from a normalized quadratic profit function. Supply and demand elasticities are subject to regulatory conditions: homogeneity conditions for the elasticities, positive definite Hessian for correct curvature, symmetry and adding up in case of the demand system.

Bilateral trade relations are modelled following the Armington approach, i.e. commodities are differentiated based on the place of origin. Thus, in the utility function of the representative consumer, domestically produced and imported goods are separated. Following the traditional, it is presented as a two stage decision problem (Gilbert and Tower 2012). In the first stage consumers minimize their expenditure necessary to get a given level of utility of the composite good. In the second stage we solve for the optimal demand of the single domestic and imported goods. With the CES Armington aggregators, substitution elasticities (both for the composite good and the single commodities) are exogenously determined and the shift and share parameters are calibrated to the observed price-quantity framework.

The above assumptions mimic the structure of the CAPRI market model; our objective is to derive theoretical conclusions that can be verified (or at least demonstrated) with the CAPRI modelling system. Nevertheless, our assumptions are general enough to make conclusions that are relevant for a larger family of applied equilibrium models.

1.4. The CAPRI modelling system

CAPRI is a comparative static partial equilibrium model, focusing primarily on the countries of the European Union but covering the global agricultural commodity markets as well (Britz and Witzke 2013). CAPRI consists of mathematical programming models depicting EU agricultural supply and a global equilibrium model for the agricultural commodity markets.

The programming models of the EU supply can work at regional or farm type level[12]. The supply models and the global market model are interlinked in an iterative process to find a common equilibrium. The mathematical programming models provide the response of the EU agricultural sector to changes in market prices calculated by the market model. In turn, the EU supply functions in the market model are calibrated to this response in every iteration (Britz 2008).

The market model currently covers 77 countries (grouped in 40 country blocks) and 47 commodities. Bilateral trade relations are captured using a two stage Armington. Border protection and market intervention measures are explicitly represented: bi- and multi lateral tariff rate quotas, export subsidies, public intervention, flexible levies and the entry price system for fruits and vegetables in the EU. Tariffs are aggregated from HS-6 level to the commodity list of CAPRI. Bound and applied rates of specific and ad valorem tariffs are derived mainly from AMAD. The implementation of bilateral trade agreements is based on the respective legal texts, applying specific aggregation rules for tariff lines if necessary.

2. SIMULATION RESULTS

In the following section the results of the simple three country model and that of the illustrative EU-US trade deal are presented. In the case of the theoretical model, a detailed sensitivity analysis with regard to the key parameters has been also conducted.

2.1. Results of the theoretical model

The assumptions on market and trade balances as well as on price relations and policy instruments in the calibration point have significant impacts on simulation behaviour. Therefore a quick walk through on the main assumptions follows.

In the hypothetical scenario, regions R1 and R2 negotiate a free trade agreement (FTA). R1 is assumed to have a bilateral TRQ with R3. In the other trade relations we generally apply a unique tariff of 25% ad valorem. In the first scenario the FTA is implemented under a simple AVE representation of the TRQ. In the calibration point we assume imports of R1 from R3 being at the quota level and set the shadow tariff to half of the general 25% ad valorem. In the other two scenarios the FTA is introduced under explicit TRQ

[12] Geographical regions and farm types closely follow the ones used in the EUROSTAT databases and in the Farm Accountancy Data Network (NUTS2 administrative regions and typology of farms). This facilitates building up a consistent database for the model using these information sources. In the current study we only apply CAPRI at the level of NUTS2 regions.

representations: (1) smooth approximation of the two-tier tariffs with a sigmoid function and (2) orthogonality conditions in an MCP framework. It requires a decision to which quota rent the TRQ functions should be calibrated to. By default, a binding quota is assumed with 100% fill rate, and the shadow tariff is set to half of the 25% general tariff rate. Later on a sensitivity analysis is performed with regard to the quota rents in the calibration point.

The share of imported goods in the Armington composite good has naturally an impact on the simulated results. In our baseline, both export and import flows are assumed between all countries. The trade volume is set to around 10% of domestic supply and varies from trade flow to trade flow by introducing a small random error. In order to initialize the Armington system, a random difference is introduced in the market price levels at the calibration point. By default, the Armington substitution elasticities are set to 4 at the first tier and to 7 at the second one. However, a sensitivity analysis will follow assuming different combinations for the elasticities.

After calibration, the same scenario (complete free trade between R1 and R2) is run under the three TRQ representations. Trade diversion below is defined as the substituted third country imports in the consumption bundle through imports from FTA partners. Results are presented as changes in physical quantities relative to the baseline levels in Table 1. The TRQ function prevented the drop in R1 imports from R3, i.e. trade diversion impacts are overestimated when neglecting the explicit third country policy representation. The opposite is true for trade creation, where the AVE representation slightly underestimates the impact on R1. The increased impact on trade creation under explicit TRQ representation is the result of a drop in the shadow rate and accordingly a larger expansion in import demand. There are no significant differences in simulated impacts under the two explicit representations of TRQs.

Table 1: Total trade diversion measures (changes in imports from R3, relative to baseline)

	Region	AVE representation	Sigmoid representation	Orthog. Conditions repr.
Trade diversion	R1	30,8	0,4	0,0
	R2	19,8	23,9	24,0
Trade creation	R1	109,7	116,4	116,2
	R2	104,7	101,6	101,6

Source: own calculations

As trade creation impacts outweigh the trade diversion impacts for the FTA partners (in absolute terms), a standard Vinerian analysis would suggest a positive welfare impact and so would recommend a strategy of joining the FTA.

Our money metric calculations support the positive impact on total welfare for the FTA partners, and result in net losses for R3 (Table 2). Country R3 loses a significant share of its TRQ rent, part of the tariff revenues due to the decrease in imports and the agricultural sector lose out as well due to the shrinking export possibilities. The small increase in consumer welfare does not compensate for the above losses.

According to the sensitivity analysis, simulated trade diversion impacts in R1 tend to increase in parallel with the Armington elasticities. Interestingly, the explicit TRQ representation delivers significant trade diversion impacts only when the first level elasticity (Armington1) is sufficiently low and, at the same time, the second level elasticity (Armington2) is sufficiently large. In this case only a small increase in the share of total imports is possible but, at the same time, the origin of imports can be shifted rather freely (Figure 1). Trade creation impacts also tend to increase with larger substitution elasticities. In that case, however, the explicit TRQ representation delivers larger effects for country R1 due to a drop in the shadow rate of the TRQ.

The sensitivity analysis with respect to the shadow rate in the calibration point indicates that trade diversion impacts in R1 are hardly simulated above 9% shadow rate. Above that level the quota rent successfully prevents imports dropping below the quota threshold, i.e. the shift in the excess demand function is insufficient to reduce imports from R3. This suggests that setting the shadow rate to the arithmetic average of the preferential and MFN rates in our default simulation prevented any decrease in R3 imports.

2.2. Simulation results of the EU-US trade deal

In the illustrative scenario of the EU-US trade deal, the trade of agricultural commodities is assumed to be fully liberalized[13]. The same FTA scenario is examined with two different model versions: (1) the standard CAPRI version[14] representing TRQ instruments of the EU explicitly and (2) a modified version with the EU TRQs represented by their AVE equivalents. We have a similar setup as in the theoretical model above: EU plays the role of R1, the US represents R2 and finally the rest of the world can be associated with R3. Below the aggregated welfare impacts and some indicators related to trade diversion and creation are presented.

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[13] Proposals for the EU-US trade deal might contain e.g. sensitive products that are not subject to full liberalizations. The authors are also aware that changes in non-tariff barriers might have even larger impacts than tariff reduction and that restricting the analysis only to the agricultural sector has a serious impact on the welfare results.

[14] CAPRI is distributed with a version control system where the versions are identified with a revision number. In this study we used the revision 2655 of CAPRI.

EU imports from third countries decrease to a greater extent under the AVE representation, however with significant differences across commodities. The difference is the most pronounced for meat, where the AVE scenario delivers a -88% decrease in third country imports while the sigmoid representation predicts a decrease of only -1%. In general, trade diversion impacts are overestimated in the CAPRI results when neglecting the explicit TRQ representation.

The overall welfare effect is extremely small according to the money metric used in CAPRI. Under the AVE representation, EU gains from TRQ rents collapse to the rent collected by EU exporters under third countries' bilateral or multilateral TRQs. The drop in tariff revenues is significantly larger (-33%) in the AVE scenario compared to the sigmoid representation (-15%). The change in agricultural profits is of different signs in the two scenarios. Under the AVE representation agricultural profit slightly increases due to the underestimated trade creation impacts. The sigmoid representation scenario, on the other hand, delivers a negative impact on agricultural profits, replicating the results obtained with the simple three-country model above (Table 3).

CONCLUSIONS

In this study the importance of third country policy representation with respect to simulated trade diversion and trade creation impacts of FTAs is discussed. The focus is on evaluating the robustness of ex ante simulations with applied equilibrium models with regard to the representation of third country TRQs: whether they are modelled explicitly or with an AVE tariff rate.

The impacts are first evaluated in a simple three-country equilibrium modelling framework, also with performing a sensitivity analysis concerning the key model parameters. Finally, an illustrative EU-US trade deal scenario is conducted with the CAPRI modelling framework both under explicit and AVE representations of TRQs.

Simulation results in both modelling frameworks suggest that by neglecting an explicit TRQ representation, equilibrium models tend to overestimate trade diversion impacts. At the same time, trade creation impacts are slightly underestimated, leading to an overall ambiguous net difference in total welfare compared to the explicit representation.

The sensitivity analysis with the theoretical model illustrated that key model parameters have significant impacts on the simulated results. Our intention is not to suggest that simulation results are seriously flawed by model assumptions and input data, but rather to draw the attention on the importance of representing third countries in detail when assessing bilateral FTAs. With an era of large scale preferential agreements ahead, improving the representation of third (and sometimes small) countries in applied equilibrium models cannot be neglected.

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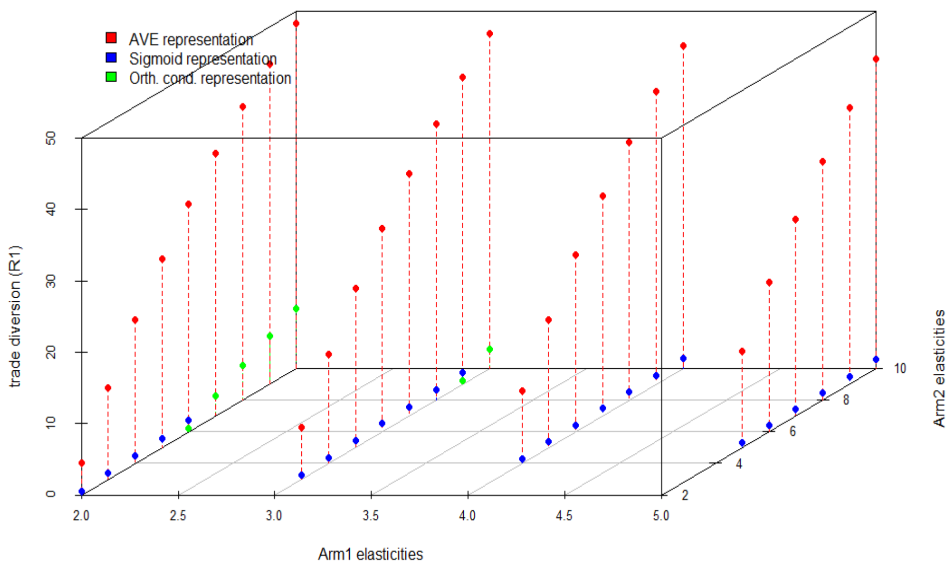
ANNEX

Table 2: Welfare impacts in the three-country model (percentage change relative to baseline)

Region	Money metric cat.	Scenario		
		AVE representation	Sigmoid representation	Orthog. Conditions repr.
R1	Consumer welfare	5,3%	6,9%	6,9%
R1	Agricultural profit	0,2%	-0,8%	-0,8%
R1	TRQ rent to governm.		-76,5%	-77,3%
R1	Tariff revenues	-81,1%	-100,0%	-100,0%
R1	Total	1,8%	2,6%	2,6%
R3	Consumer welfare	2,3%	1,2%	1,2%
R3	Agricultural profit	-5,1%	-2,6%	-2,6%
R3	TRQ rent to exporters		-76,5%	-77,3%
R3	Tariff revenues	-9,0%	-4,2%	-4,1%
R3	Total	-0,2%	-0,4%	-0,4%

Source: own calculations

Figure 1 Sensitivity Analysis of simulated trade diversion impacts with respect to the Armington substitution elasticities (three-country model)



Source: own calculations

Table 3: EU welfare changes in the EU-US FTA scenario

	Scenario	
	AVE representation	Sigmoid representation
Total	0,0%	0,0%
Consumers welfare	0,0%	0,0%
Profit of Agriculture	1,0%	-0,7%
Tariff revenues	-32,7%	-15,1%
TRQ Rent (to government)		-2,6%
TRQ Rent (to exporters)	-16,1%	-20,0%

Source: own calculations