Does Regional and Sectoral Aggregation Matter? Sensitivity Analysis in the Context of an EU-Korea FTA

Jong-Hwan Ko[1] and Wolfgang Britz[2]

[1]Division of International and Area Studies, Pukyong National University, Korea
jonghko@pknu.ac.kr
[2]Institute for Food and Resource Economics, University of Bonn, Germany
wolfgang.britz@ilr.uni-bonn.de

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1. Introduction

Computable general equilibrium (CGE) models and partial equilibrium (PE) models has been widely used in the context of trade policy analysis. In such studies, a decision on the aggregation level with regard to regions and sectors is needed. Quite often, that decision is made a priori before the model runs, and a "systematic" analysis of trade policy on its impact is not undertaken. There is ample evidence that sectoral aggregation matters in trade analysis. So far, however, limited evidence exists about how the regional aggregation level affects results in CGE and PE applications. We take an FTA between EU and South Korea as an example to analyze how the sectoral and regional aggregation level affects results. The EU-Korea FTA became effective in July 2011 and thus provides a real world example which is not only of academic interest. South Korea's agricultural markets, while showing with the exception of rice relatively low self-sufficiency levels, are generally protected by rather high tariffs. Therefore, we have an example in which some larger effects on domestic prices, consumption, production and trade patterns from an FTA are expected.

In order to analyze the effects of the EU-Korea FTA, we use the GTAP model in combination with different configurations of the GTAP data base. All configurations can be assumed "plausible" a priori in the light of "what matters in that type of analysis": who are the important trading partners? Which sectors are expected to be most affected? Specifically, in addition to different sectoral aggregation levels, we consider different aggregation levels (1) with regard to trading partners indirectly affected by the FTA to take a closer look at trade diversion effects and (2) with regard to the regional aggregation level of the EU (one block or individual countries). Additionally, we also compare our findings from the GTAP model with the results from a PE for agricultural and food products, namely the CAPRI model to shed light on questions of the effects of border protection instruments such as TRQs which are explicitly considered in the PE, in comparison to ad-valorem tariffs used in most of the standard GTAP applications.

Thus, our analysis aims to show on the one hand to what extent regional and sectoral aggregation matters, while on the other lobbying for more systematic sensitivity analysis of regional and sectoral aggregation levels and cross-model comparisons.

2. Literature review: Aggregation

3. Sensitivity analysis with an Armington model

In order to abstract from the given data constellation and parameterization in a specific policy experiment such as in our case study on an EU-South Korea FTA, we conduct sensitivity analysis with stochastically drawn data. Equally, in order to focus on the possible main reason why results differ depending on the regional aggregation level, we only analyze the effect in an Armington CES system, neglecting any trickle-down effects in the overall CGE.

We use three equations representing the usual Armington equations in a trade models. The equation exhausts the demand budget *armVal* for imports of a product by the total value of the imports (quantity *tradeFlows* times import price *impP*):

(1) $\overline{armVal} = \sum_r tradeFlows_r \overline{impP_r}$

The second equation exhausts that value by the product of the Armginton aggregator *ArmQuant* and the related price *armP*:

(2) $armQuant\ armP = \overline{armVal}$

Finally, behavioral equations drive the trade flows as a function of relative prices

(3) $tradeFlows_r = \delta_r armQuant \left[\frac{armP}{impP_r} \right]^{\sigma}$

As seen from above, we take the prices and budget for total imports as given. By shocking selected import prices, we simulate the impact of introducing a FTA. Specifically, we model three importers of which the first is assumed to be not part of the new FTA. The second and third importers belong to the same trade block – say the EU.

Set-up of experiments and main findings

We assume in our experiments that the analyzed FTA will reduce import prices from the trade block by 20%. We draw 20 times from uniform [1,10000] to get starting values for the trade flows, assuming that all import prices in the calibration point are equal to unity.

For each of these outer draws, we construct a benchmark by aggregating the trade flows for region 2 and 3 to a trade block and lower its import prices to 0.8. That would be equivalent of an analysis where we have only two exporters in our analysis: the trade block for which import tariffs are lowered and ROW with unchanged tariffs. Next, we perform 20 inner draws where we draw both import shares for the two regions of the block between [0,1] and new prices for these regions between [0.6,1.0]. The trade shares are scaled to unity such the sum of imports of the trade block does not change and the new prices scaled such that the average price at trade block level in the simulation would be again 0.8. Each draws thus represent a possible consistent break down of the trade block in terms of quantities and ad-valorem bi-lateral tariffs towards our importing region for which *armVal* is given. For the example with the EU, bi-lateral tariffs of an importer – say South Korea - for one product might differ between EU Member States as each Member State might have a specific composition of that product with respect to HS6 tariff lines.

The model is then calibrated against the trade flows at prices before the shock (=1) by adjusting the share parameters. Afterwards, the price shock is introduced the resulting changes in trade flows and the Armington aggregator quantities and prices simulated and stored. The table below gives an idea how the experiments look like by reporting the first five draws for one out draw:

		d1	d2	d3	d4	d5
R1	.TradeFlows, drawn	173	173	173	173	173
R1	.TradeFlows, sim	1	0.948	0.909	0.466	0.795
R1	.Price	1	1	1	1	1

R2 .TradeFlows, drawn	1394	708	1293	514	1116
R2 .Price	0.8	0.772	0.786	0.971	0.764
R3 .TradeFlows, drawn		687	101	880	278
R3 .TradeFlows, sim		633	16	2155	57
R3 .Price	0.8	0.829	0.981	0.7	0.946
SubAgg.TradeFlows, drawn	1394	1394	1394	1394	1394
SubAgg.AvPrice	0.8	0.8	0.8	0.8	0.8
SubAgg.TradeFlows, sim	1927	1951	1960	2203	2012
Arm .Price, sim	1	0.994	0.99	0.919	0.975
Arm .Quant, sim	1	1.006	1.011	1.088	1.026

The first columns D1 report the benchmark case. Imports from regions 2 and 3 are aggregated such that the model does only comprise two regions; the aggregated results are reported as region 2. In subsequent draws (D2, D3 etc.), the sum of the imports from region 2 and 3 (subAgg. Trade Flows, drawn) and the trade flows for ROW (R1) will not change in the new calibration point of the model. Equally, in each draw, the price shocks for regions 2 and 3 differ (R2.Price, R3.Price), but the average shock for the trade block at unchanged trade flows is always equal to 20% (subAgg.AvPrice). Changes for the ROW imports are shown in relative terms (R1, TradeFlows, sim), the same holds for the Armington price and quantity.

Our analysis finds firstly, which is reassuring, that if tariffs do not differ inside the trade block, i.e., between regions R2 and R3, the simulated trade generation effect on the block as a whole is independent on how large the exports share of block members are. That also means that trade diversion effects and aggregator prices and quantities are not affected.

But if, as it will be usually the case, tariffs inside the block differ, simulation results will depend on the chosen regional dis-aggregation. In the unlike case of an Armington elasticity below unity, tariff differences between exporters inside a trade block will lead to lower trade effects. In the usual case of Armginton elasticities above unity (see table below), these tariffs differences will increase the simulated trade generation and diversion effects compared to an aggregated analysis, while lowering the Armington aggregate prices and thus increasing the Armington aggregate quantity. The later can be interpreted as a welfare gain, such that also overall simulated welfare effects for the importer are larger. The differences between aggregated and dis-aggregated analysis increase with the size of the substitution elasticities. The table below reports the findings for different substitution elasticities.

Substitution elasticity	**2**	**5**	**10**
Min simulated trade diversion effect	0.960	0.632	0.141
Mean simulated trade diversion effect	0.994	0.935	0.766
Min simulated Armington price	0.960	0.892	0.805

Mean simulated Armginton price	0.994	0.983	0.965
Max simulated Armington quantity	1.042	1.121	1.243
Mean simulation Armington quantity	1.006	1.018	1.038

Note: Benchmark, i.e. aggregated analysis = 1

Discussion

We find these results disturbing. Obviously, it is possible to increase trade and welfare effects in an analysis with Armington based models by increasing the dis-aggregation. The effects found with the very same version of GTAP from a policy experiment will therefore depend on the regional aggregation chosen. Similar findings can probably be generated by changing the product dis-aggregation. The results above show sizeable average effects at reasonable Armington elasticities in the range reported for GTAP (see Hertel et al. 2008, Table 14.2, Sourcing of Imports), the minimum and maximum values reported hint at the possible range of errors which depend on the specific data constellation.

The results can be seen in the context of the discussion around a consistent aggregation of tariffs (cf ….). Obviously, simply adding regional data on imports flows in cif and fob values and deriving the ad-valorem tariff is an aggregation rule which does not match an Armington system at unchanged substitution elasticities.

4. **Comparison of simulation results of an EU-Korea FTA using GTAP model and CAPRI model**

5. **Concluding remarks**

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