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Technical Annex

The Doha Round and Food Security in the Dairy Sector in Cameroon: A Global Simulation Model (GSIM) Approach

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This document is the technical annex to the full paper "The Doha Round and Food Security in the Dairy Sector in Cameroon: A Global Simulation Model (GSIM) Approach" which is available separately.

Table A.1 Proposals in December 2008 for the Reduction of Agricultural Tariffs

Products	Developed countries		Developing countries		Small and vulnerable economies (SVEs)	
	Tariff bands	**Reduction (%)**	**Tariff bands**	**Reduction (%)**	**Tariff bands**	**Reduction (%)**
Products in general	] 0% ; 20% [ ] 20% ; 50% [ ] 50% ; 75% [ ] 75% ; → [	50 57 64 70	] 0% ; 30% [ ] 30% ; 80% [ ] 80% ; 130% [ ] 130% ; → [	33.33 38 42.66 46.66	] 0% ; 30% [ ] 30% ; 80% [ ] 80% ; 130% [ ] 130% ; → [	23.33 28 32.66 36.66
Sensitive products	] 0% ; 20% [ ] 20% ; 50% [ ] 50% ; 75% [ ] 75% ; → [	16.66 19 21.33 46.7/35/23.33	] 0% ; 30% [ ] 30% ; 80% [ ] 80% ; 130% [ ] 130% ; → [	11.11 12.66 14.42 31.11/23.33/15.56	] 0% ; 30% [ ] 30% ; 80% [ ] 80% ; 130% [ ] 130% ; → [	7.77 9.33 10.88 24.44/18.33/12.22
	(including sensitive, tropical & tariff escalation products)	minimum average: 54	(including sensitive, tropical & tariff escalation products)	maximum average: 36	(including sensitive, tropical & tariff escalation products)	maximum average: 36
Special products	not applicable	not applicable	12% of total tariff lines 5% maximum	11% on average 0	12% of total tariff lines 5% maximum	Tiered formula for products in general 0

Source: Author's construction from the December 2008 draft modalities in agriculture.

Table A.2 Tariff Reduction Scenarios

Country groups	Tariff bands	Scenario 1	Scenario 2	Scenario 3
Developing countries	] 0% ; 30% [ ] 30% ; 80% [ ] 80% ; 130% [ ] 130% ; → [	33.33% 38% 42.66% 46.66%	11.11% 12.66% 14.22% 15.56%	0% 0% 0% 0%
Developed countries	] 0% ; 20% [ ] 20% ; 50% [ ] 50% ; 75% [ ] 75% ; → [	50% 57% 64% 70%	16.66% 19% 21.33% 23.33%	16.66% 19% 21.33% 23.33%

Note: we have not considered the case of vulnerable countries less ambitious than the status of developing countries.

Source: Author's analysis.

Mathematical Formulation of GSIM

GSIM is a static, deterministic, single commodity bilateral trade model driven by export supply and bilateral import demand equations. Exports and imports are a function of the world price plus or minus the relevant bilateral trade tax or subsidy. Because taxes are bilateral and possibly different from country to country, the change in tariffs or a quota leads to a change in relative prices that drives differential changes in imports from various sources. This is essential where bans are imposed on some countries but not on others. An elasticity of substitution determines the extent to which changes in relative prices lead to a switch in the source of imports. The model solves numerically to a specified tolerance using Excel's Solver to find a market clearing price such that global imports equal global exports.

The crux of the model is the import-demand equations. Import demand in country *v* for commodity *i* from country *r* is a function of prices and total expenditure on the commodity:

(1) $M(i,v),r = f(P(i,v),r ,P(i,v),s\ r , Y(i,v))$

where $M(i,v),r$ is imports; $P(i,v),r$ is internal prices; $P(i,v),s\ r$ is external prices; and $Y(i,v)$ expenditure on imports is *i* in country *v*.

The response of imports to changes in relative prices depends on an expenditure–share weighted sum of the composite demand elasticity, Em, and the supply elasticity, Es:

(2) $N(i,v),r,s = \theta(i,v),s\ (Em + Es)$, and

(3) $N(i,v),r,r = \theta(i,v),r\ Em - \Sigma sr\ \theta(i,v),sEs = \theta(i,v),r\ Em – (1-\theta(i,v),r\ Es)$.

The price linkage equations relate internal prices to export prices:

(4) $P(i,v),r = (1-t(i,v),r)P^*\ i,r = T(i,v),rP^*\ i,r$

where $T = (1+t)$, the power of the tariff. Quotas, or outright bans, can be expressed as a tariff equivalent.

On the export side, exports are a function of world prices:

(5) $X(i,v),r = f(rP^*\ i,r)$.

These equations are in levels. By differentiating the import, export and price equations, it is possible to obtain expressions for the changes in imports and exports according to changes in tariffs and world prices:

(6) $M'i,r = \Sigma v\ M'\ (i,v),r = \Sigma v\ N(i,v),r,r\ P'\ (i,v),r + \Sigma v\ \Sigma sr\ N(i,v),r,s\ P'\ (i,v),s = \Sigma v\ N(i,v),r,r\ [P^*\ r+T'\ (i,v),r] + \Sigma v\ \Sigma sr\ N(i,v),r,s\ [P^{*\prime}\ s+T'\ (i,v),s]$.

The model is solved numerically by finding a set of prices such that the change in global imports (equation 6) equals the change in global exports (the derivative of equation 5). Once we have solved for world prices, it is possible to work backwards to

solve for export quantities and import quantities. Changes in government revenues are simply determined by the trade flows times the tariff rates. Producer and consumer surplus effects can then be determined from changes in prices and quantities:

(7) $\Delta PSi,r = R0\ i,r\ P'\ i,r + 0.5\ R0\ i,r\ P'\ i,r\ Xi,r$

where R0 i,r is the initial export revenue.

Consumer surplus is more complex because consumption is a composite of imports from different sources.

(8) $\Delta CSi,r = (\Sigma v\ R0\ (i,v),r\ T0\ (i,v),r\ ) * (0.5\ Em(i,v)\ P'\ i,v\ 2 * sign\ (P'\ i,v) - P'\ i,v)$

where $P'\ i,v = \Sigma r\ \theta(i,v),r\ P^{*\prime}\ r + T'\ (i,v),r.$

P′ i,v represents the price for composite imports, and R0 T0 the initial expenditure.

Total welfare is the sum of producer and consumer surplus and the change in government revenue. Data required for the model are bilateral trade flows (in values), bilateral trade taxes, and elasticities of supply, demand and substitution between imports (the so-called Armington elasticities). One limitation of the model is the (log) linear demand and supply relationship. Linearity implies that large shocks to the model may induce some errors in the size of the quantity changes. For example, it is reasonable to expect that as prices rise consumers become less responsive. Other limitations are that there is no storage in the model, nor time-related effects nor uncertainty. These limitations need to be kept in mind when interpreting the results.