Quantifying non-tariff measures in international agricultural trade: a tariff equivalent of technical barriers to trade on African horticultural exports to the European markets

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Abstract— **Fresh food and agricultural products from sub-Saharan Africa meet few tariff barriers because of preferential market access granted to ACP countries through Lomé and Cotonou Act. However, non-tariff barriers are still serious impediments to trade. This paper focuses more specifically on technical barriers to trade (TBT) and sanitary and phytosanitary measures (SPS) on horticultural exports from Kenya and Zambia to France, Germany, the Netherlands and United-Kingdom. Using an extension of price-wedge method that takes into account imperfect substitution (on demand side) and differences in factor endowments (on supply side), we provide a tariff-equivalent of a wide range of TBT. Preliminary results show that the tariff-equivalent of TBT is very high for Kenyan green beans exports (more than 56%) while it is low for Kenya's exports of peas and avocados and Zambian exports of peas (less than 10%). However, there are no large differences between EU importing countries.**

Keywords— **Armington elasticity of substitution, price-wedge method, tariff-equivalent**

I. INTRODUCTION

Fresh food and agricultural from African countries meet less customs duties because of preferential market access granted to them in the framework of ACP-EU partnership. On the other side, concerns around non-tariff barriers[1] are becoming more important. International agricultural markets are currently more complex and fast moving as standards are promulgated in multiple spheres at national and international, public and private levels. The main concern associated with non-tariff barriers and especially technical barriers to trade (TBTs) is their double facet. Their prima facie objective is to correct for market failures stemming from externalities associated with the supply chain [1]. On the other hand, TBT can also act as trade impediments and be used for protectionist purposes when they are more stringent than necessary.

This paper focuses more specifically on TBT and SPS measures on the horticultural exports of Kenya and Zambia to the European markets[2]. We choose horticultural products in the trade relations between Kenya and Zambia and the four EU members for two reasons. First, fresh food products constitute important opportunities to exports diversification because they are luxury, i.e. high income elasticities and meet few tariff barriers. Second, fresh agricultural and food products face stringent food safety standards and regulations in developed countries markets.

Regulations are not always based on science, non-discriminatory or least-trade-restrictive alternatives as they must under the SPS and TBT agreements. A lack of adequate scientific evidence and differing interpretations have led to disputes about regulations applied by particular countries. Moreover, private standards are not dealt with WTO bodies. This is the reason why there is an evident need to measure the effects of those technical regulations and standards to clarify any claim, quantify and contribute to resolve trade disputes and define more efficient regulations [2].

The remaining of the paper is organized as follows. The second section surveys the main studies that have used price-wedge method to quantify TBT and SPS measures. The third section presents the analytical framework. The fourth section provides and interprets the empirical results while the last section concludes.

[1] The literature on NTBs defines them as the world of government measures, other than tariffs or customs taxes, which restrict or distort international commerce between domestic and imported goods and services

[2] Technical barriers to trade are the most important of the food safety standards in international agricultural trade: the notifications of new technical measures to WTO have grown from 300 in 1980 to 3000 in 2000 [8].

II. PRICE WEDGE METHOD AND TARIFF EQUIVALENT OF TECHNICAL REGULATIONS

The price wedge method estimates the degree to which NTBs raise domestic prices above international prices in the countries imposing them. The main use of this method is to provide a tariff equivalent [3],[2] which is the tariff rate that would restrict trade to the same level as the technical barrier [3]. The tariff equivalent of a regulation is measured as a residue when the price difference between the imported good and the comparable product in the domestic market is corrected for tariff, handling and transportation costs [2].

The well-known application of the price wedge method to compute a tariff equivalent is the study on phytosanitary barriers in the US-Japanese apple trade [3]. The gap of price is the difference between the domestic Japanese price p^{jj} and the price of similar U.S. apples delivered to Japan which is taken as a proxy for the world price p^{W}.[3] Then, the tariff equivalent of the Japanese phytosanitary protocol is expressed as:

$$TE_{TBT} = p^{jj} - p^{W} - IT_R - Tariff \qquad (1)$$

where IT_R represents the transaction and international transport costs while $Tariff$ designs custom duties.

The main drawbacks of their approach are on one hand the strong assumption that no other significant factors contribute to the price wedge [3]. According to the literature not yet published, there are other factors among which marginal costs that increase the price gap between domestic and c.i.f prices. On the other hand, authors assume that imports and domestic product are homogenous goods. In the case of imperfect substitution, their method is useless.

An interesting study has done to drop the law of one price under a homogenous commodity assumption to calculate the tariff equivalent of technical barriers in Japan on apple imports [4]. The authors use a constant elasticity substitution (CES) utility function assuming that local and imported apples are imperfect substitutes and provide the tariff equivalent of Japanese technical regulations as follows:

$$TE_{TBT} = p_{jj}\frac{1-\alpha}{\alpha}\left(\frac{q_{jj}}{q_{ij}}\right)^{\frac{1}{\sigma}} - p^{W} - IT_R - Tariff - T_R \qquad (2)$$

where σ is the elasticity of substitution between imports and domestic varieties; α is the parameter of preferences respectively; q_{ij} and q_{jj} are marshallian demand for imports and domestic products respectively; p^{W} is again a proxy of world apple price, but it is exactly the price/unit cost of U.S. apple that is exported to other markets than Japan. However, even if they deal with endogeneity bias, authors do not include supply aspects in the determination of tariff equivalent but rather on the welfare analysis.

III. ANALYTICAL FRAMEWORK

The model takes into account both demand and supply aspects. In the specific case of horticultural exports from Kenya and Zambia (country i) to the European markets (country j), we assume that a European representative consumer allocates his expenditures between a local product and his foreign imperfect substitute to maximize his utility function as follows [4]:

$$\text{Max } U = Q_j = \left[\alpha_{jj} q_{jj}^{\frac{\sigma-1}{\sigma}} + (1-\alpha_{jj}) q_{ij}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \qquad (3)$$

$$s.t.\ p_{ij}q_{ij} + p_{jj}q_{jj} = Y_j$$

The ratio of marshallian demand obtained from (3) as in [4]provides an expression similar to that used by [5] to compute short-run and long-run Armington elasticities in the U.S. manufactured sector (equation 4).

$$\frac{q_{jj}}{q_{ij}} = \left[\frac{\alpha_{jj}}{(1-\alpha_{jj})}\frac{p_{ij}}{p_{jj}}\right]^{\sigma} \qquad (4)$$

The double-log transformation on relation (4) yields the following equation where the subscript t indicates time series:

$$Y_t = \beta_O + \beta_1 X_t \qquad (5)$$

We follow [4] to determine three main equations according to the results of the unit root tests on relation (5). First, when series Y_t and X_t are log-

[3] [3] assume that the US apple price can serve as reasonable proxy for the world price since United States is the leading Western hemisphere producer and exporter. Furthermore, the authors assume that prices of apple from the State of Washington represent world prices as most U.S. apple exports originate from that state and nearly year-round. We adopt index i for exporting country and j for country of destination.

level stationary, a parsimonious geometric model (PGM) is specified; second, when both Y_t and X_t are cointegrated, a single-equation error correction model (ECM) according to Engle and Granger (1987) in [6] is estimated and provides short and long-run elasticities; third, when Y_t and X_t are not cointegrated, a first-differenced model (FDM) is estimated. As q_{ij}, q_{jj} and p_{ij}, p_{jj} are respectively quantities and prices of equilibrium, we suspect a simultaneous bias in the regression relations (5). This is the reason why we rely on the supply side to get pertinent instrumental variables (IV) of relative prices.

Imports q_{ij} from Kenya and Zambia are considered as imperfect substitutes varieties domestically supplied q_{jj} in France, Germany, The Netherlands or United Kingdom. By referring to [9], we can specify a profit function:

$\pi_{(.)} = F\left(p_{(.)}, q_{(.)}, f_{(.)}, w_{(.)}, r_{(.)}\right)$ (7) which generates through its maximization the marginal cost as follows:

$$\frac{\partial \pi_{(.)}}{\partial q_{(.)}} \equiv Rm_{(.)} = p_{(.)}(1-\frac{1}{\varepsilon_{(.)}}) = \zeta\left(f_{(.)}, w_{(.)}, r_{(.)}\right) = Cm_{(.)}$$

$$\Rightarrow p_{(.)} = \xi^{*}\left(f_{(.)}, w_{(.)}, r_{(.)}\right) \qquad (i) \qquad (6)$$

$$\Rightarrow \frac{p_{ij}}{p_{jj}} = \zeta^{**}\left(f_i; f_j; w_i, w_j, r_i, r_j\right) \quad (ii)$$

where $\left(f_{(.)}, w_{(.)}, r_{(.)}\right)$ is a vector of inputs prices: the land lease for agricultural land, the wage for labour and real interest rate for the capital factor respectively; $Rm_{(.)}$ is the marginal revenue and $\varepsilon_{(.)}$ the own-price elasticity of demand.

To correct for the simultaneous bias, we run a 2SLS regression as indicated in relations (7).

$$\ln\left(\frac{q_{jjt}}{q_{ijt}}\right) = \beta_0 + \beta_1 \ln\left(\frac{p_{ijt}}{p_{jjt}}\right) + u_t \qquad (7i)$$

$$\ln\left(\frac{p_{ijt}}{p_{jjt}}\right) = \alpha_0 + \alpha_1 w_{it} + \alpha_2 w_{jt} + \alpha_3 r_{it} + \alpha_4 r_{jt} + v_t \qquad (7ii)$$

$$l \ln\left(\frac{q_{jjt}}{q_{ijt}}\right) = \gamma_0 + \gamma_1 \ln \frac{\hat{p}_{ijt}}{\hat{p}_{jjt}} - \lambda res(-1)_{(i)} + w_t \qquad (7iii)$$

The tariff-equivalent formula then becomes:

$$TE_{TBT} = \hat{p}_{jj} \frac{1-\alpha}{\alpha}\left(\frac{q_{jj}}{q_{ij}}\right)^{\frac{1}{\gamma_1}} - p^W - IT_R - Tariff - T_R \quad ^{4}(8)$$

IV. DATA SOURCES AND EMPIRICAL RESULTS

A. Data sources

Three horticultural products at 6 digits of harmonised system (HS1996): peas (070810), greens beans (070820) and avocados (080440) are considered in this study. Annual time series from 1988 to 2006 of their imports in tons and in value are provided by COMEXT database of Eurostat**.** Data on Kenyan and Zambian exports are provided by national databases. The unit value of exports is taken as the proxy of f.o.b. prices.

Demand for domestically produced goods in EU countries is the difference between domestic production and exports and the related data are respectively available from NEWCRONOS and COMEXT databases of Eurostat. Tariffs are obtained from the integrated tariff for European Communities (TARIC). The real interest rate and the agricultural wage, proxied by the real income per capita, are provided by the World Development Indicators (WDI) database of the World Bank. Data on land lease are not available.

Moreover, we make investigations in Kenya and in Zambia to know the kind of technical regulations and food and safety standards that impede horticultural exports. They are of three main groups: regulation (EC) n°1148/2001 of 12 June 2001, Eurep-GAP protocol and British Retail Consortium (BRC) technical food standard. Contrarily to the critics of [2] on the practical validity of the price wedge method, it in our case well indicated to assess the trade effect of all this array of NTBs.

B. Empirical results and discussion

Table1 reports results on short-run and long-run Armington elasticities of substitution obtained from our three main equations: PGM, ECM and FDM. Error correction models are predominant in the results. Adjusted R-square is high enough to conclude in favour of well-specified models. We observe large

[4] The world price p^W in our empirical estimates is proxied by the f.o.b price of Kenya for each of the three horticultural exports.

elasticities for avocados and peas and small elasticities for green beans.

Table 1 Short-run and long-run Armington elasticities of substitution between Kenyan, Zambian and European varieties of green beans and peas

Legend: *, **, ***: significant at 10 percent, 5 percent and 1 percent levels, respectively; coef: estimated coefficient; SE: standard-error; DW: Durbin-Watson test; n: number of observations; student statistic ratios are indicated in parentheses beneath the estimated coefficient

Product	Reporter	Trade Partner	Equation	Short-run elasticity			Long-run elasticty			Adj. R^2	DW	n
				Coef.	S.E	p-value	Coef.	S.E	p-value			
Green beans (070820)	France	Kenya	PGM				.126 (.653)	.194	.525	.774	2.30	17
	Germany	Kenya	ECM	0.047 (.694)	.068	.502	0.293*** (3.07)	.095	.008	.509	2.45	16
	Netherlands	Kenya	ECM	0.218 (1.36)	.159	.194	.215 (1.12)	.191	.274	.493	1.78	18
	United Kingdom	Kenya	FDM	-.163* (-1.95)	.083	.071				.158	1.64	16
Peas (070810)	Netherlands	Kenya	ECM	0.455 (1.42)	0.320	0.177	-3.76*** (-4.62)	0.815	.000	.479	1.80	17
	United Kingdom	Kenya	ECM	.209 (.823)	.254	.428	-1.361*** (-4.33)	.314	.000	.425	2.07	17
	Netherlands	Zambia	ECM	.282 (.982)	.286	.344	-3.768*** (-4.623)	.815	.000	. 427	1.55	17
	United Kingdom	Zambia	ECM	-.296 (-1.69)	.174	.114	-1.361*** (-4.33)	.314	.000	.519	1.49	18
Avocados (080440)	France	Kenya	ECM	.984* (2.117)	.464	.060	1.571** (2.50)	.627	.023	.704	1.35	16

Our results are similar to the findings of [5]. Long-run elasticities are four to six large than short-run elasticities and there is strong variability of both short-run and long-run elasticities between products. Non significant and negative elasticities could be inherent to misspecification. Even if real interest rate and the proxy of wage explain well the unitary prices according to equation (6i), the results on instrumental variables (IV) estimates are not better than those on ordinary least squares (OLS) as shown in table 2.[5] When wage proxy and interest rate are included in PGM, ECM and FDM as additional variables, Armington elasticities of short-run and long-run are not significant except for substitution between Britannic and Kenyan varieties of green beans. With these instrumental variables, we are not able to detect endogeneity bias. Remember that Hausman statistic tests equality of the instrumental variables (IV) and OLS estimates [7].

Table 3 provides the tariff-equivalent of technical barriers to trade applied to the exports of Kenya and Zambia to the EU markets. The highest tariff equivalent is observed for green beans trade between Kenya and Germany (56.11%) and Netherlands (37.38%). Specific tariff equivalent is middle (from 6.10 to 10.87% in average) in peas and avocados trade and low in the remaining cases. For pea's trade in general, tariff equivalent is increasingly important in time, becoming then three times greater since 1997 than before. Negative tariff-equivalents mean that technical regulations are catalyst to promote exports. This could confirm our results of qualitative inquiries that we made in COMESA area in 2006. Kenya Plant Health Inspectorate Service (KEPHIS)'s staff states Kenyan exporters comply with regulations in the EU markets. However, the export sector has taken many resources to the detriment of other sectors.

V. CONCLUSIONS

Our instrumental variables do not permit to provide better estimates of short-run and long-run Armington elasticities. Other data like land lease, investments in quality and agricultural internal support in the EU and large sample are needed to get best estimates. However, the frequent negative value of tariff equivalent suggests that the marginal costs should be included in the price gap.

[5] The results on estimates of marginal costs by product and pair of trading partners are not reported in this document but are available on request. They show that interest rate elasticity is roughly lower than wage elasticity in both EU countries and the two African countries.

Table 2 OLS and IV estimates of short-run and long-run Armington elasticities
Legend: PGM: Parsimonious geometric model, ECM: Error correction model, FDM: First differenced model

Product	Reporter	Trade partner	Equation	Short-run elasticities			Long-run elasticities		
				OLS	IV		OLS	IV	
					Coef.	p-value		Coef.	p-value
Green beans	France	Kenya	PGM	-	-	-	.126	-.500 (-1.632)	.147
	Germany	Kenya	ECM	.047	-.0454 (-.498)	.668	0.293	-.039 (-.693)	.514
	Netherlands	Kenya	ECM	.218	.097 (.285)	.787	.215	.132 (.900)	.391
	United Kingdom	Kenya	FDM	-1.63	-.168* (-1.98)	.078	-	-	-
Peas	Netherlands	Kenya	ECM	0.455	0.368 (1.276)	.249	-3.76	.0214 (.045)	.965
	United Kingdom	Kenya	ECM	-.209	.075 (.124)	.907	-1.361	-.443 (-1.28)	.230
	Netherlands	Zambia	ECM	.282	-1.140 (-.794)	.573	-3.76	-.540 (.576)	.996
	United Kingdom	Zambia	ECM	-.296	-.919 (-1.23)	.342	-1.361	-.617 (-.992)	.367
Avocados	France	Kenya	ECM	.984	-.116 (-.105)	.923	1.571	.813 (1.110)	.296

Table 4.Specific tariff-equivalent (%) of Technical barriers applied to horticultural exports of Kenya and Zambia to some leading EU-15 importing countries Legend: FR: France; DE: Germany; NL: Netherlands; UK: United Kingdom; aberrant results are indicated in italic.

Year	Kenya							Zambia	
	Green beans				Peas		Avocados	Peas	
	FR	DE	NL	UK	NL	UK	FR	NL	UK
1988	0.14	-	9.87	-3.07	2.20	-0.87	18.05	-0.61	-1.50
1989	0.42	-	164.30	-3.06	0.48	-0.02	33.37	0.20	-0.30
1990	0.26	56.63	15.40	-3.15	0.04	0.82	22.27	-0.21	0.91
1991	-0.22	40.89	82.38	-3.36	3.94	0.50	5.63	0.31	0.62
1992	-0.93	138.04	260.29	-3.24	2.60	-0.41	3.05	-0.37	-0.81
1993	-1.15	76.49	43.42	-3.45	-0.77	-0.11	6.91	0.11	-0.43
1994	-0.52	13.49	17.16	-3.53	2.74	2.25	6.46	-0.55	1.95
1995	0.23	78.94	14.45	-3.46	3.10	3.05	4.32	-0.01	3.31
1996	-0.09	99.64	17.48	-3.56	3.55	3.31	2.76	-0.04	2.93
1997	-0.40	62.73	39.39	-3.85	12.24	12.19	1.50	-0.38	12.27
1998	-0.26	122.33	8.66	-3.73	11.34	10.56	3.28	-0.22	11.20
1999	-0.21	85.31	6.01	-3.58	16.07	6.82	1.47	-0.16	7.26
2000	-0.72	100.82	6.04	-1.66	22.99	13.64	1.33	-0.31	14.67
2001	-0.42	5.73	5.32	-2.07	22.01	11.52	0.46	0.28	11.19
2002	-0.65	14.22	1.51	-3.31	23.18	6.63	1.83	-0.07	8.50
2003	-0.47	21.81	11.74	-3.31	*-2.51*	9.68	-0.32	0.62	10.97
2004	-0.59	18.98	9.48	*204.87*	24.51	21.74	0.64	1.49	21.00
2005	-0.44	11.64	1.53	-4.64	26.04	25.12	1.43	2.42	24.50
2006	-3.41	6.17	-4.10	-4.71	32.82	27.65	1.50	2.79	25.57
Mean	**-0.50**	**56.11**	**37.38**	**-2.22**	**10.87**	**8.11**	**6.10**	**0.28**	**8.10**

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