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Effects of non-tariff measures on European horticultural and fish imports from African countries

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Dedicated to my wife Lydia Gakima and our kids Jean-Aurel Muco and Douce Délicia Iteka for their tremendous support including deprivation throughout this research process

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PREFACE

"Europe is by far the most significant trading partner for Southern Africa…this means that decisions made in Brussels transform lives in the region, controlling whether factories close and jobs are lost, whether farmers grow maize or roses, families can earn enough to send their children to school" (ACTSA, 2001).

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List of acronyms and abbreviations

ACP:	African, Caribbean and Pacific countries
ACTSA:	Action for Southern Africa
AGOA:	African Growth and Opportunity Act
BRC:	British Retail Consortium
CAP:	Common Agricultural Policy
CES:	Constant Elasticity of Substitution
CET:	Common External Tariff
CIF:	Cost Insurance Freight
COMESA:	Common Market for Eastern and Southern Africa
COMTRADE:	Commodity Trade of the United Nations
DCFSS:	Developed Countries Food Safety Standards
DSK:	Dixit Stiglitz Krugman
EAC:	East African Community
EBA:	Everything But Arms
EC:	European Community
EPA:	Economic Partnership Agreement
ETI:	Ethical Trading Initiative
EU:	European Union
FAO:	Food and Agriculture Organization
FLO:	Fair trade Labelling Organization
FOB:	Free On Board
FSBL:	Food Safety Basic Law
FTA:	Free Trade Agreement
FUNDP:	Facultés Universitaires Notre Dame de la Paix
GAP:	Good Agricultural Practises
GATT:	General Agreement on Tariffs and Trade
GDP:	Gross Domestic Product
GLS:	Generalized Least Squares
GMM:	Generalized Method of Moments
GMO:	Genetically Modified Organisms
GNI:	Gross National Income
GSP:	Generalized System of Preferences
GTAP:	Global Trade Analysis Project
HACCP:	Hazard Analysis-Critical Control Points
HCDA:	Horticultural Crop Development Authority
HS:	Harmonized System
IFSS:	International Food Safety Standards
IMF:	International Monetary Fund

IOE:	International Office of Epizootics
IPPC:	International Plant Protection Convention
ISO:	International Organization for Standardization
KEPHIS:	Kenya Plant Health Inspectorate Service
KRA:	Kenya Revenue Authority
LDC:	Least Developed Countries
LSDV:	Least Squares Dummy Variable
LVBC:	Lake Victoria Basin Commission
LVFO:	Lake Victoria Fisheries Organisation
MFN:	Most Favoured Nation
MRL:	Maximum Residue Limits
MRPL:	Minimum Required Performance Level
NBP:	Nash Bargaining Product
NTMs:	Non-Tariff Measures
OECD:	Organization for Economic Co-operation and Development
OLS:	Ordinary Least Squares
ROW:	Rest Of the World
RTA:	Regional Trade Agreement
SA:	Social Accountability
SAN:	Sustainable Agricultural Network
SIC:	Standard Industrial Classification
SITC:	Standard International Trade Classification
SPS:	Sanitary and Phyto-Sanitary
SSA:	Sub-Saharan Africa
SUR:	Seemingly Unrelated Regressions
TARIC:	Tarif Intégré des Communautés Européennes
TBT:	Technical Barriers to Trade
TRA:	Tanzania Revenue Authority
UK:	United Kingdom
UNCTAD:	United Nations Conference for Trade And Development
URA:	Uganda Revenue Authority
USA:	United States of America
WDI:	World Development Indicators
WEO:	World Economic Outlook
WHO:	World Health Organization
WTO:	World Trade Organization
ZEGA:	Zambian Exporters and Growers Association

Chapter 1

Introduction

Context

Tariff barriers are decreasing in international agricultural trade following the multilateral liberalization initiated under the auspices of the General Agreement on Tariffs and Trade (GATT) and World Trade Organization (WTO). Throughout this trade liberalization process, developing countries have been experiencing non reciprocal trade preferences under the Generalized System of Preferences (GSP) since 1963. In addition, African, Caribbean, and Pacific (ACP) countries enjoy market access to the European markets through the Cotonou Act including the Everything But Arms (EBA) initiative. However, statistics show that their trade performances do not improve accordingly (Manchin, 2005). Emerging countries such as China, Argentina, India, and Brazil are the major beneficiaries of the generalized system of preferences. Trade liberalisation pursued under Doha round is likely to be negative for a significant number of developing countries (Bureau *et al.*, 2005). Some studies suspect non-tariff barriers to be at the core of the poor trade performance of developing countries (Gaisford and Kerr, 2001; Bureau *et al.*, 2005).

The governance of standards and regulations is assured by three international institutions: the Codex alimentarius commission of the World Health Organization (WHO) and the Food and Agriculture organization (FAO) for food safety, the International Office of Epizootics (IOE) and the secretariat for International Plant Protection Convention (IPPC) (Gaisford and Kerr, 2001; Reed, 2001). However, article 20 of the General Agreement on Tariffs and Trade (GATT) authorises governments to set their own standards and regulations to protect human, animal, and plant life, or health, provided they do not discriminate among countries or use them for concealed protectionism.

Following these safety and security concerns, several studies show that the absence of quality signalling should raise the lemon problem where bad products will drive out good products in a context of asymmetric information (Akerlof, 1970; Achterbosch and van Tongeren, 2002). The absence or regulation could lead to market closure especially in the case of credence goods (Bureau *et al.*, 2001; Marette *et al.*, 2000) even though instruments in place to correct for these externalities steaming from market inefficiencies could undermine liberalisation and variety of goods (Gozlan and Marette, 2000).

Statement of the problem

Theoretically speaking, standards are in place to protect consumers from harmful products and offensive products and producers against diseases and pests from abroad. However, standards and regulation may cloak protectionism intentions (Fischer and Serra, 2000; Gaisford and Kerr, 2001; Reed, 2001). However, developing countries lack administrative and financial resources required for an effective participation in the Sanitary and Phytosanitary measures (SPS) and Technical Barriers to Trade (TBT) agreements and which comply with standards that are duplicative, increasingly changing, and stringent. Furthermore, in response to consumer concerns there is actually a proliferation of private food safety and quality standards in industrialised countries that fall beyond the scope of the WTO. International food safety standards are seen as obstacles to exports from developing countries despite tariff preferences guaranteed to them. The integration of developing countries in the world trading system is undermined if the overall trade effect of non-tariffs barriers is negative. There is a need for modelling these non-tariff measures and evaluate their role inform public authorities about the trade effect of SPS measures.

Research questions

This doctoral dissertation investigates three central questions. First, what is the tariff rate that would restrict the imports of horticultural and fish products from African countries to the same level as the panoply of non-tariff measures prevailing in the European importing countries? Second, to what extent these non-tariff measures matter on trade flows? What is the impact of the emergence of new and stringent standards in terms of decision making and possible exclusion of small-scale farmers in developing countries?

Hypotheses

Three hypotheses are put forward and will be tested on the basis of empirical data.

(i)- The tariff equivalent of non-tariff measures is high and comparable to the tariff rate level prevailing before trade liberalisation. This assumption suggests that despite the tariffs preferences guaranteed to developing countries, export promotion is not possible due to non-tariff measures that are replacing tariffs to distort trade.

(ii)- Non-tariff measures negatively affect developing countries' exports to the European markets. That is why these countries do not improve their trade performance regarding the European Union barriers on African fish and horticultural exports to the European markets.

(iii)- Poor and small-scale farmers are more likely to exit certified quality export supply following the emergence of stringent food standards.

Methodology

We make first a review on the quantification methods of non-tariff barriers in international agricultural trade. We conceptualise the analytical framework. We pursue the study through investigation made in the area of study on the institutional environment on NTMs issues.

We focus on case studies to assess the potential adverse trade impact of non-tariff barriers on developing countries attempting to exploit potentially lucrative developed countries markets for high-value agricultural and food products. Four African exporting countries (Kenya, Uganda, Tanzania, and Zambia) and eight European importing countries (Belgium-Luxembourg, France, Germany, Italy, the Netherlands, Portugal, Spain, and United Kingdom) are considered in this study. Fish and horticultural exports (green beans, fresh peas, and avocados) are considered.

Last, we use statistical data on trade and production from NEW CRONOS, COMEXT and EUROPROMS databases of EUROSTAT, FAOSTAT database of Food and Agriculture Organization (FAO) of the United Nations and UN-COMTRADE database of United Nations Conference for Trade and Development (UNCTAD). Macroeconomic data are obtained from the World Development Indicators (WDI) database of the World Bank and the World Economic Outlook (WEO) of the International Monetary Found (IMF). Additional data come from national databases in African exporting countries (Kenya, Uganda and Tanzania Revenue Authorities and COMESA databases) and a survey database at the farm-level in Kenya.

Structure

This doctoral dissertation is organised into three chapters. Our results contribute to the discussion of the impact of changing food safety standards and other non-tariff measures on the competitiveness of developing countries in agricultural international trade.

The first essay constitutes an econometric analysis to estimate the parameters of consumer preferences and Armington short-run and long-run elasticities. The values found are used in the computation of an *ad valorem* tariff equivalent of a set of non-tariff measures including the international food safety standards (IFSS) using the price-wedge method. The final results show that the NTB act as trade barriers. Their price effect is comparable to import tariff of the pre-trade liberalization. For some periods of time, this tariff is prohibitive to trade. This is the case for instance for frozen fish fillets during the EU ban period, i.e. 1997-2000.

The second essay uses econometric estimation to assess the trade effect of the non-tariff measures on European horticultural and fish imports from African countries. We use the theoretically derived gravity model from Anderson and van Wincoop (2004) appropriate for analyzing disaggregated trade data. In this essay, we use the results from the computation of the *ad valorem* tariff equivalent as a proxy of non-tariff measures and a component of the trade costs between trading countries. Results from gravity model specifications show that thesenon-tariff measures negatively reduce the European imports of frozen fish fillets but they do not affect significantly trade NTMs is negative on European imports imports of frozen fish fillets fish and horticultural products to the European markets. An increase of one percent in the stringency of standards and regulations decreases trade from about one to two percent. The EU ban on fish reduces trade by 68 per cent causing losses in annual trade value of about US$2.5 million.

The third essay combines analytical and empirical approaches. The analytical approach provides a stylized model using the Nash bargaining theory to analyze strategic responses of Kenyan horticultural farmers to the emergence of more stringent international food safety standards. We consider an exporter and a representative member of producers' association, who bargain over the product quality level and producer price and contract if the bargain succeeds. The comparative statics analysis shows the effects of exogenous parameters on endogenous variables at equilibrium. Unlike the compliance costs, the monitoring and enforcement costs have, *ceteris paribus*, a positive effect on the equilibrium quality level. Results also show that number of contracting farmers decreases when the compliance costs with food safety standards increase, suggesting a possible exclusion of farmers following the inception of stringent standards. A complementary econometric analysis using a bivariate probit estimation shows that wealthier and more educated farmers are more likely to remain in the green beans sector while contracting decision and credit are strongly each other suggesting that this access credit plays a particular role in the compliance with food standards.

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Chapter 2

A tariff equivalent of non-tariff measures on European horticultural and fish imports from African countries

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Abstract

In the context of the Partnership Agreements between the European Union (EU) and the African, Caribbean and Pacific (ACP) countries, this study estimates ad valorem tariff equivalents of European food safety standards on imports of key horticultural and fish products from Kenya, Tanzania, Uganda, and Zambia. The study uses an extension of the price-wedge method to account for imperfect substitution and factor endowment in monopolistic competition. The estimated tariff equivalent is about 40 per cent for avocados and ranges from 40 to 60 per cent for green beans, 50 to 90 per cent for fresh peas and 10 to 200 per cent for frozen fish fillets. We also observe large variations in the tariff equivalents for the horticultural and fish products over time and EU importing countries.

JEL Classification: F12, F14, Q17, O13, O55

Key words: *price-wedge method, tariff equivalent, food safety standards, non-tariff measures, ACP countries, European Union*

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1. Introduction

The African, Caribbean and Pacific (ACP) countries benefit from preferential market access to the European Union (EU) thanks to EU-ACP Partnership Agreements. Like other developing countries, these countries are also eligible to the Generalized System of Preferences (GSP) of the EU and the least developed of them are eligible to the European Everything But Arms (EBA) initiative. Despite these trade preferences, ACP countries have not improved their trade performance into the EU with respect to other countries accordingly. Their share in EU total imports declined from 7 per cent in 1976 to 3.5 per cent in 2008 while that of the Brazil-Russia-India-China (BRIC) group increased from 18 to 30 per cent in the last 15 years (Eurostat, 2009).

Against the overall decreasing share of the ACP in EU total imports, some ACP countries such as Ethiopia, Gambia, Kenya, Senegal, Tanzania, Uganda, and Zambia have been particularly successful in exporting high-value horticultural products into the EU over the last two decades. For instance, the main Kenyan exports to the EU nowadays consist of flowers and vegetables instead of tea and coffee. Kenya actually supplies nearly 25 per cent of total EU-15 imports of green beans (Eurostat, 2009). However, there is a concern that non-tariff measures could handicap in the future the development of these exports from ACP countries. Following the food scandals of the last two decades European countries and companies have set increasingly stringent food safety standards and other non-tariff measures that pose major challenges for the development of high-value fresh food exports from developing countries (World Bank, 2005; Bureau *et al.***,** 2005; Gioè, 2008).

Hillman (1996) defines non-tariff measures or barriers (NTB) as all government measures, other than tariffs or customs taxes, that restrict or distort international commerce between domestic and imported goods and services. Non-tariff measures or barriers can be classified into technical NTB when they relate to quality product attributes and non-technical NTB otherwise (Nardella and Bocaletti, 2004).[2] Technical requirements are governed by the technical barriers to trade (TBT) agreement that was negotiated in the 1974-79 Tokyo Round of

[2] The Trains database of the United Nations Conference on Trade and Development (UNCTAD) provides a detailed coding system of trade control measures.

multilateral trade negotiations to cover technical requirements resulting from food safety and animal and plant health measures, including pesticide residue limits, inspection requirements and labelling. Within those technical NTB the Sanitary and Phytosanitary (SPS) measures have received a special attention from the protagonists at the previous World Trade Organisation (WTO) trade negotiations due to the political sensitivity of health and sanitary issues in developed countries (Gaisford and Kerr, 2001). For these sensitive issues a set of specific rules were consigned in the so-called SPS agreement that entered into force with the establishment of the WTO on 1 January 1995. While this agreement binds governments to notify changes in sanitary and phytosanitary requirements and related regulations, the increasing number of more stringent private standards tends to undermine this transparency as they fall beyond the scope of the WTO (Jaffee and Henson, 2004).

The double facet of non-tariff measures makes them interesting to study. On the one hand, their *prima facie* objective is to correct for market inefficiencies stemming from externalities associated with the production, distribution and consumption of agro-food products (Roberts and DeKremer, 1997). Hence, non-tariff measures can act as trade catalysts when they reduce asymmetry of information in the markets allowing easier comparison of quality attributes and turning food credence attributes into search attributes (Marette *et al.*, 2000). On the other hand, they can act as trade deterrence when they diverge from the general WTO principles of non-discrimination, scientific evidence, risk assessment, and least-trade-restrictive alternatives. For instance, a lack of adequate scientific evidence and divergence in interpretations have led to disputes about SPS regulations applied by particular countries (Colyer, 2006). Non-tariff measures can also restrict the number of varieties available in a market and, hence, limit consumer choice and welfare (Tothova and Oehmke, 2008).

Non-tariff measures are particularly challenging for developing countries. These countries often lack the administrative, technical and scientific capacity required not only to participate effectively in the TBT and SPS agreements (Henson and Loader, 2001) but also to comply with changing standards set in developed countries (Otsuki *et al.*, 2001). There is a growing concern that institutional weakness coupled with rising compliance costs may contribute to further marginalization of developing countries in trade of high-value exports (Jaffee and Henson, 2004).

The objective of this study is stemming from the need to quantify these international food safety standards in the trade of agricultural and food products from developing countries. This measurement could provide a reliable representation of non-tariff measures that can be used to assess their trade impact. Accordingly, this study measures the *ad valorem* tariff rate that could have the same distorting trade effect as the set of non-tariff measures considered.

Among the methods for modelling non-tariff measures (see Beghin and Bureau, 2001), we choose the price-wedge method that is commonly used to provide the tariff equivalent of a set of non-tariff measures observed in a market. Indeed, there is a perception that non-tariff measures originate from differences in compliance costs between trading partners. Henson *et al.* (1999) and Lacovone (2005) argue that the heterogeneity of non-tariff measures is rooted in legitimate determinants of comparative advantage such as endowment, technology and preferences. Chand (2003) underlines that compliance and certification with technical standards are capital-intensive processes and, therefore, place labour-intensive products such as those from developing countries at a disadvantageous position. Despite a symmetric treatment of standards between foreign and domestic suppliers, trade impact can be highly asymmetric because costs of compliance can differ among countries (Wilson, 2008).[3] Roberts *et al.* (1999) emphasize that when a SPS measure asymmetrically increases the compliance costs of foreign suppliers, it has a "tariffication" effect.

This study addresses two main limitations of the price-wedge method. First, the price-wedge method generally provides a tariff equivalent of a set of non-tariff measures without, however, identifying what those non-tariff measures precisely are (Beghin and Bureau, 2001). In this study, our field investigations in some key African exporting countries reveal that the Global good Agricultural Practices (GAP) standards

[3] Non-tariff barriers are not always used in a symmetric way among trading countries. Maertens and Swinnen (2009) report three cases in which food standards are used in a discriminatory way at the advantage of domestic or selected foreign suppliers.

that cover food safety, environment, hygiene and social protocols are the most stringent among the private standards, in particular its conditions on hygiene and its restrictions on pesticides residues. They also reveal that the British Retail Consortium (BRC) food standards, the Hazard Analysis Critical Control Points (HACCP) standards, the farm to fork standards and the Ethical Trading Initiative (ETI) standards are important. FAO (2004) also reports other voluntary standards such as those of Social Accountability (SA) of the International Labour Organisation (ILO), the International Organization for Standardization (ISO) and the Fair Trade Labelling Organization (FLO). Despite of being voluntary, private standards can affect trade in some niche markets.

Second, several applications using the concept of the price-wedge method adopt the law of one price considering imports and domestic goods as homogenous goods. To overcome this limitation, Yue *et al.* (2006a) account for imperfect substitution into the price-wedge method using the Armington (1969) assumption that distinguishes foreign and domestic products by the place of production. We extend further the price-wedge method by differentiating foreign products according to their origin and considering supply conditions in addition to demand conditions.

We measure tariff equivalent of non-tariff measures using data of EU imports of horticultural and fish products from specific African countries. Unlike traditional exports of coffee, tea, cacao and sugar whose international trade is still largely governed by prices, standard quality requirements and common forms of trade protection and preference (Jaffee and Henson, 2004), exports of these high-value food products to developed countries face stringent safety standards (Unnevehr, 2000; World Bank, 2005).

The next section surveys the use of the price-wedge method to quantify the equivalent of food safety standards in international agricultural trade and sets up the analytical framework. The third section describes the data. The fourth section provides the econometric method and interprets the empirical results. The last section gives some concluding remarks.

2. Tariff equivalent of non-tariff barriers

In this section, we provide the principle of the price-wedge method and examples of its application. We then present the analytical framework involving both demand and supply conditions.

2.1. The price-wedge method: principle and applications

The price-wedge method consists in providing an implicit tariff or tariff equivalent of trade restrictions that result from non-tariff measures (Beghin and Bureau, 2001), that is the tariff rate that would have the same distortion effect on trade as the set of non-tariff measures. The method assumes that non-tariff measures can alter relative prices between foreign and domestic markets and thus create a price wedge between potential trading countries. This method estimates the level to which non-tariff measures raise domestic prices above international reference prices in countries using them (Ferrantino, 2006). A more appropriate measure would be to compare the domestic price that prevails in presence of non-tariff measures to the domestic price that would prevail without the non-tariff measures, *ceteris paribus* (Deardorff and Stern, 1998, in Beghin and Bureau, 2001). However, because this latter price is usually unobservable, actual measures of non-tariff measures instead focus on a comparison of the domestic and foreign costs, insurance and freight (c.i.f) prices in the presence of the non-tariff measures. Hence, the tariff rate of non-tariff measures is measured as a residue when the price wedge is corrected for tariff, transaction and transport costs between the trading partners (Beghin and Bureau, 2001).

Krissoff *et al.* (1997) use the price-wedge method to calculate the tariff equivalent of phytosanitary requirements related to fire blight, codling moth, apple maggot, and other pests for the Japanese, South-Korean and Mexican imports of apple from the United States (U.S.) using monthly c.i.f. and wholesale prices between 1994-95 and 1995-96. These authors consider the Fuji apple variety for Japan and South-Korea and the Red and Golden Delicious apple varieties for Mexico. Assuming that the price gap consists of the tariff and tariff equivalent of the technical barriers, the authors find that the tariff equivalent varies between 0 and 58 per cent depending on the apple variety and importing country. Japan and Mexico show a higher tariff equivalent than South-Korea.

Calvin and Krissoff (1998) apply the same price-wedge method to calculate the tariff equivalent of a fire blight protocol on imports of Fuji apple from the U.S. between 1994-95 and 1996-97. They find that the tariff equivalent of Japanese technical requirements is 27 per cent compared to an *ad valorem* tariff rate of 19 per cent. Calvin and Krissoff (2005) use the price-wedge method by considering additionally the transaction and transport costs to compute the tariff equivalent of the Japanese requirements related to fire blight in the U.S.-Japan apple trade between 1998-99 and 2003-04. They find that the tariff equivalent substantially varies over time between 2 and 113 per cent with an average of 43 per cent for the Fuji apple variety and between 57 to 503 per cent with an average of 222 per cent for other apple varieties.

The authors of these studies, however, acknowledge that their estimated tariff equivalents are overstated since quality differences between domestic and imported apples are not considered to explain price differentials. As a result, Yue *et al.* (2006a) drop the law of one price that applies for homogeneous traded commodities to address these quality differences in the estimation of the tariff equivalent of Japanese phytosanitary requirements on apple imports from the U.S. between 2001 and 2003. These authors use a constant elasticity of substitution (CES) utility function to account for imperfect substitution between foreign and domestic apples. Transaction costs from the harbour to the internal wholesale market are also included in the price wedge. The authors find an *ad valorem* tariff equivalent of 60 per cent.

Instead of the price-wedge method, Henry de Frahan and Vancauteren (2006) use a gravity model of international trade to estimate the tariff equivalent of costs stemming from the non-harmonised EU food regulations. These authors model the non-harmonised food regulations as one of the variables of the trade cost factor of the gravity model. Their results show that the *ad valorem* tariff equivalent varies significantly across food sub-sectors, from about 10 per cent for the meat and dairy sub-sectors to more than 220 per cent for fruits and vegetables. Given that their trade costs are very sensitive to their assumption on the CES, these authors suggest calculating the CES that emerges from the theoretically based gravity equation.

This paper uses the price-wedge approach as in Yue *et al.* (2006a) but introduces two extensions. First, imports are differentiated by origin while Yue *et al.* (2006a) consider total imports. Second, differences in marginal costs of production across suppliers are integrated in the estimation of the price wedge as suggested by Ferrantino (2006).

2.2. The analytical framework

The analytical framework of this study accounts for both demand and supply conditions. On the demand side, this study relies on the Armington (1969) assumption where goods are differentiated by their place of origin but the number of varieties supplied by each country is fixed to one. This implies that countries trade simply because foreign and domestic goods are imperfectly substitutable. Private and public quality standards increase substitution between these differentiated goods (English *et al.,* 2004). Even with identical quality standards, European consumers could consider domestic products as safer than products imported from developing countries because of their perception of a greater potential of compliance for domestic products.

By adopting the Armington (1969) assumptions of weak separability among foreign sources and homotheticity of the utility function, we specify a CES utility function for a representative consumer located in a domestic country j as in Yue *et al.* (2006a). This consumer allocates his expenditures between quantity q_{jj} of domestic product and quantity q_{ij} of a foreign imperfect substitute originating from source $i = 1,...,M$ with $i \neq j$. Let p_{jj} and p_{ij} be the consumer prices of the two goods, α_{jj} and α_{ij} the preference parameters of the consumer in the domestic country j for the domestic and foreign products respectively, and σ the CES between the domestic product and the foreign imperfect substitute. Instead of adopting total imports $\sum_{i=1, i\neq j}^{M} q_{ij}$ in the CES utility function as in Yue *et al.* (2006a), note that we use a CES aggregator of imports $\sum_{i=1, i\neq j}^{M} \alpha_{ij} q_{ij}^{\frac{\sigma-1}{\sigma}}$ as in Davis and Kruse (1993) with $\alpha_{ij} \in [0,1]$ and $\sum_{i=1, i\neq j}^{M} \alpha_{ij} = 1$. However, for simplicity, we assume that the CES of the nested CES utility function take the same values. This CES utility function is to be maximized under budget constraint R_j as follows:

$$Maximize \ \ U_j = \left[\alpha_{jj} q_{jj}^{\frac{\sigma-1}{\sigma}} + (1-\alpha_{jj}) \left(\sum_{i=1, i\neq j}^{M} \alpha_{ij} q_{ij}^{\frac{\sigma-1}{\sigma}} \right) \right]^{\frac{\sigma}{\sigma-1}} \tag{1}$$

$$subject \ to \ \ p_{jj} q_{jj} + \sum_{i=1, i\neq j}^{M} p_{ij} q_{ij} = E_j$$

The solution to problem (1) leads to the Marshallian demands for the domestic good and each of its foreign imperfect substitutes whose ratio is expressed as follows:

$$\frac{q_{jj}}{q_{ij}} = \left[\frac{\alpha_{jj}}{(1-\alpha_{jj})\alpha_{ij}} \frac{p_{ij}}{p_{jj}} \right]^{\sigma} \quad \forall i \neq j \tag{2}$$

The foreign parity price p_{ij} can be decomposed into the world price p_w that is the free on board (f.o.b.) price in the leading world exporter of the same product but going elsewhere than in the country j adjusted for the per-unit insurance and freight costs IFC_{wj}, the per-unit internal transport costs IT_j from the harbour to an internal wholesale market, the custom tax CT_{ij} and the tariff equivalent TE_{ij} of non-tariff measures as follows:

$$p_{ij} = p_w + IFC_{wj} + IT_j + CT_{ij} + TE_{ij} \tag{3}$$

The substitution of relation (3) into expression (2) yields a solution for the tariff equivalent of non-tariff measures that is:

$$TE_{ij} = p_{jj} \frac{(1-\alpha_{jj})\alpha_{ij}}{\alpha_{jj}} \left(\frac{q_{jj}}{q_{ij}} \right)^{\frac{1}{\sigma}} - \left(p_w + IFC_{wj} + IT_j + CT_{ij} \right) \tag{4}$$

On the supply side, we also consider product differentiation on the basis of monopolistic competition and increasing returns to scale as a source of trade following Krugman (1990). We account for supply conditions because trade effects are sensitive to the incidence of the relative costs of compliance with regulations among trading countries (Roberts *et al.*, 1999). These supply conditions are captured into the marginal costs of production that cannot be discounted from the gap between foreign and domestic prices (Ferrantino, 2006).

We follow Krugman (1990) and Chand (2003) to specify a profit function for a foreign country i and a domestic country j. We consider three inputs that represent key resources, i.e., farm land, labour and capital that are used to produce agricultural and food products instead of the solely labour adopted by Krugman (1990) and Chand (2003). The following analytical development relates to the foreign country i but the corresponding expressions for the domestic country j are obtained by replacing the subscript i by j in the expressions below. The profit function Φ_i is simply specified as follows:

$$\Phi_i\left(p_{ij}, q_{ij}, f_i, w_i, r_i\right) = p_{ij} q_{ij} - \psi\left(f_i, w_i, r_i, q_{ij}\right) \quad (5)$$

where Φ_i is the profit function of the supplier located in the foreign country i, p_{ij} and q_{ij} are prices and quantities as already defined, f_i is the land rental rate, w_i is the agricultural wage and r_i is the interest rate in country i.

Assuming a constant marginal cost as in Krugman (1990) to give a simplified structure to the model for making the analysis easier, the first-order condition of profit maximization is null:[4]

$$p_{ij} + q_{ij} \partial p_{ij} / \partial q_{ij} - \zeta\left(f_i, w_i, r_i\right) = 0 \quad (6)$$

Thus, the price p_{ij} can be derived as follows:

[4] This model also assumes a linear function of output expressed in terms of inputs with fixed costs incorporating decreasing average costs. However, these fixed costs disappear within the profit maximization.

$$p_{ij} = \frac{\varepsilon_{ij}}{\varepsilon_{ij}+1}\zeta(f_i, w_i, r_i) = \xi(f_i, w_i, r_i) \tag{7}$$

where ε_{ij} is the cross-price elasticity of demand in domestic country *j* for a product from the foreign country *i*.

We assume that foreign and domestic suppliers comply asymmetrically with the set of non-tariff measures imposed by the domestic country j. As highlighted by Roberts *et al*. (1999), the difference in these compliance and transaction costs is represented by the tariff equivalent TE_{ij}. If foreign suppliers bear higher compliance costs to the agro-food standards, we follow Chand (2003) to specify their profit function as follows:

$$\Phi_i(p_{ij}, q_{ij}, f_i, w_i, r_i, TE_{ij}) = p_{ij}q_{ij} - (1+TE_{ij})\psi(f_i, w_i, r_i, q_{ij}) \tag{8}$$

The expression (8) assumes that the tariff equivalent of technical regulations raises all input costs required for production by $(1+TE_{ij})$. From profit maximization, we derive the unitary price as follows:

$$p_{ij} = \frac{\varepsilon_{ij}}{\varepsilon_{ij}+1}(1+TE_{ij})\zeta(f_i, w_i, r_i) = \nu(f_i, w_i, r_i, TE_{ij}) \tag{9}$$

In sum, the unitary foreign price is a function of the foreign prices of farm inputs and the *ad valorem* tariff equivalent of non-tariff measures. Likewise, similar expression holds for the price of domestic good.

3. Data description and preliminary analysis

We apply the price-wedge method to EU imports of horticultural and fish products from ACP countries of the last two decades. Based on data availability, we consider trade of green beans and fresh peas between 1988 and 2008, trade of avocados between 1988 and 2006 and trade of frozen fish fillets between 1995 and 2006. However, because data to derive the world prices are unavailable before 1990 for green beans, 1996 for avocados and frozen fish fillets and 1997 for fresh peas, we cannot calculate the tariff equivalents before these dates. Green beans from Kenya are imported in Belgium-Luxembourg, France, Germany, the Netherlands, and the United

Kingdom (UK); fresh peas from Kenya are imported in Germany, the Netherlands, and the UK; fresh peas from Zambia are imported in the Netherlands and the UK, and avocados from Kenya are imported in France. Frozen fish fillets are imported in Belgium, France, Germany, Italy, the Netherlands, Portugal, and Spain from Kenya, Tanzania, Uganda taken together to obtain continuous time series of imports and prices between 1995 and 2006. We name this latter source of imports the East African Community (EAC) as these three countries are the founding states of this regional trade agreement. In addition to these African sources of imports, we consider imports from the other first fifteen Member States of the EU (EU-15) and the rest of the world (ROW).

Kenya was a pioneer in exports of high-value fresh horticultural products to the European markets that date back to the middle to late 1950s during the colonial era. Kenya began developing infrastructure and organisations involving smallholders actually well before the inception of private food safety standards and traceability guidelines. In contrast, Zambia became an exporter of such products later in the last two decades when stringent standards were already in place (Okello *et al.*, 2007). As a result, Kenyan growers were able to comply proactively with non-tariff requirements while Zambian growers were complying reactively according to the World Bank (2005).

In this section, we first describe the time series with a focus on trends and data sources. Second, we test the panel data for non-stationarity and endogeneity.

3.1. Data description

For the last two decades, Kenya has been a leading exporter of green beans to the EU. About 90 per cent of the Kenyan exports of green beans into the EU-15 are concentrated in the six selected European countries. Figure 1 shows that Kenya is the most important import source of green beans in the UK accounting for 60 to 70 per cent of the UK total imports of this commodity. Imports of green beans in France and Belgium-Luxembourg (Bel-Lux) from Kenya represent about 30 per cent in earlier 1990 but decline over time while imports in the Netherlands and Germany expand from less than 5 per cent in 1988 to more than 20 per cent 20 years later.

About 93 per cent of the EU-15 imports of fresh peas from Kenya are concentrated in the three selected European countries. About 97 per cent of the EU-15 imports of fresh peas from Zambia are concentrated in the two selected European countries. Figure 2 shows that Kenya accounts for a major source of fresh peas of the UK increasing from near 1 per cent in 1988 to more than 50 per cent of the UK imports of this commodity 20 years later. This share decreases to 23 per cent between 2000 and 2003 and increases again between 2004 and 2008.

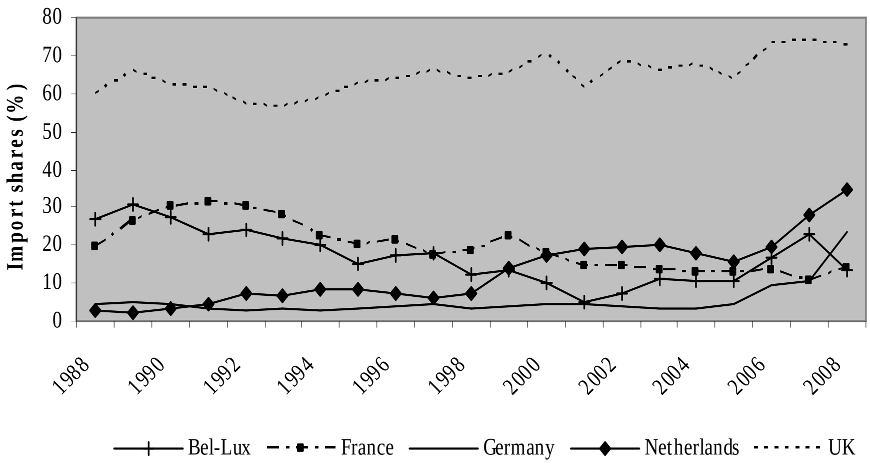

Figure 1. Import shares of green beans from Kenya in imports of green beans for each selected European country between 1988 and 2008 (Source: Eurostat)

Kenya accounts for less than 1 per cent in 1988 to more than 50 per cent of the imports of fresh peas of the Netherlands 20 years later. Similarly, its share in imports of fresh peas of Germany increases from less than 1 per cent in 1988 to 30 per cent in 2008. The share of Zambia in imports of fresh peas of the Netherlands and the UK fluctuates over time between less than 1 per cent and nearly 10 and 20 per cent respectively.

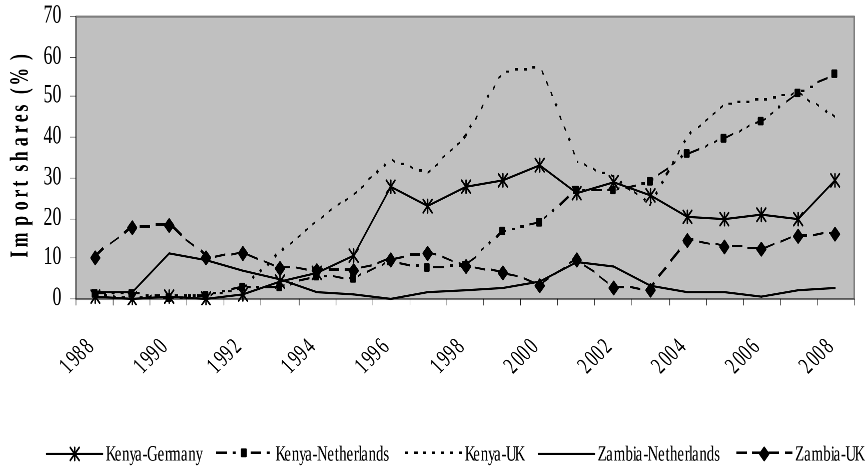

Figure 2. Import shares of fresh peas from Kenya and Zambia in imports of fresh peas for each selected European country between 1988 and 2008 (Source: Eurostat)

Kenya is one leading African exporter of avocados to France. Kenya exports about 50 to 80 per cent of its total exports of avocados to France. Figure 3 shows that the share of Kenya in imports of avocados of France has been increasing from less than 3 per cent in 1988 to 14 per cent in 2001 and then decreasing to 8 per cent in 2006.

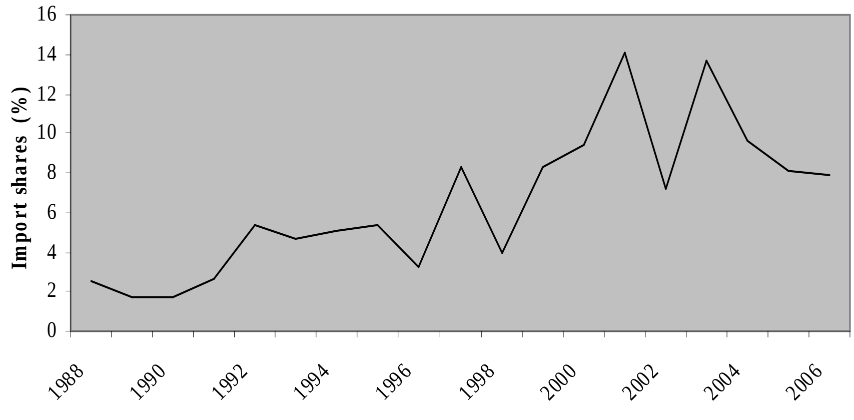

Figure 3. Import shares of avocados from Kenya in imports of avocados for France between 1988 and 2006 (Source: Eurostat)

The EU-15 fish imports from the EAC area are dominated by the Nile perch (*Lates niloticus*) from the Lake Victoria accounting for more than 80 per cent of exports. The EU accounts for nearly 60 per cent of total exports of frozen fish fillets from Kenya, Tanzania and Uganda prior to the introduction of food safety restrictions in 1997. Following these restrictions EAC exporters pursue alternative markets such as in Israel, Japan, Singapore, and the United Arab Emirates (Henson *et al.*, 2000) resulting in a sharp decline in the share of frozen fish fillets imported from EAC in the seven selected European countries from 1997 and 1999. The EU adopts a series of bans on fish imports from Kenya and its neighbours in November 1997, January 1998 and April 1999 following the claims on the presence of salmonellae and reports of a cholera outbreak and fish poisoning with pesticides in the Lake Victoria. Among the three EU bans on fish imports from the Lake Victoria Abila (2003) finds that the last ban was the most damageable for Kenyan fish exports resulting in a decline of 62 per cent in foreign exchange earnings.

Data of EU imports in volume and c.i.f. value from African countries and the rest of EU-15 come from the Comext database of Eurostat. Imports in volume and c.i.f. value from the rest of the world are calculated as the differences between imports from non EU-15 and imports from the selected African countries. We use the unit c.i.f. import values to represent the c.i.f. import prices.

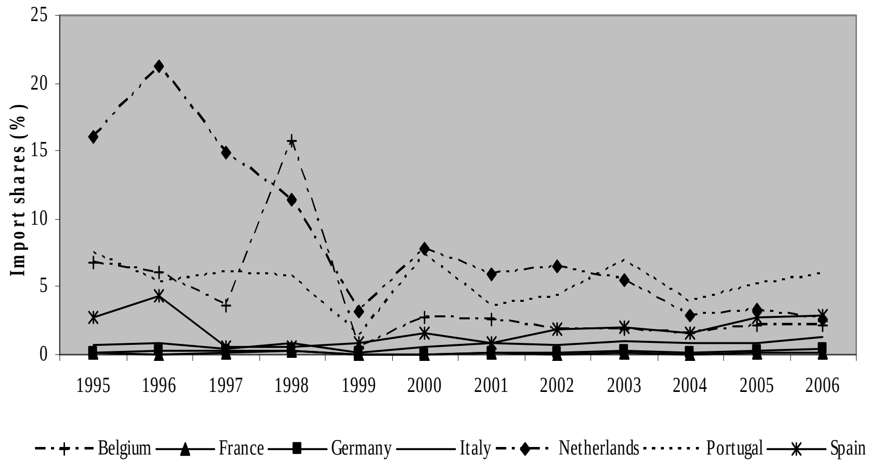

Figure 4. Import shares of frozen fish fillets from EAC in imports of frozen fish fillets for each selected European country between 1995 and 2006 (Source: Eurostat)

Data of domestic production and prices of green beans (C1910), fresh peas (C1890) and avocados (C2253) in the selected EU countries are taken from the New Cronos database of Eurostat for the period between 1988 and 2008. Data of domestic production and prices of frozen fish fillets (PRCCODE: 15201270) in the selected EU countries are taken from the Europroms database of Eurostat for the period between 1995 and 2006. Domestic sales of horticultural and fish products in the EU countries are calculated as the differences between domestic production and total exports. The consumer price index obtained from the World Development Indicators (WDI) of the World Bank is used to convert nominal into real values.

World prices in the selected EU importing countries consist of two terms that are the unit f.o.b. values of the world leading exporters (Kenya for horticultural products, Mexico for avocados and China for frozen fish fillets) and the per-unit insurance and freight costs. [5] These unit f.o.b. values are calculated from trade data of total exports in value and volume available from United Nations Commodity Trade Statistics (UN-Comtrade) since 1996 for avocados and frozen fish fillets and 1997 for fresh peas. The unit f.o.b values for green beans are calculated since 1990 from the FAOSTAT database of the United Nations Food Agriculture Organization (FAO). The international insurance and freight costs between these leading exporters to each of the EU-15 importing countries are calculated by the difference between the unit c.i.f. and f.o.b. values. The nominal exchange rate provided by the New Cronos database of Eurostat is used to convert data expressed in US$ into Euro. Data on EU custom tariffs at the Harmonised System at 6 digits for imports from ACP countries are obtained from the on-line custom tariffs database “The common customs tariff and integrated tariff of the European communities” (Taric).

Land rent provided by the New Cronos database is only available for the EU countries. Per capita gross national income (pcGNI) adjusted by the purchasing power parity (PPP) obtained from the WDI database

[5] Taking instead directly the unit c.i.f. values would introduce a measurement bias because these c.i.f. values may include the effects of the non-tariff measures prevailing in the EU importing country on the marginal costs in the world leading exporter.

is used as an indicator of the agricultural wage in both exporting and importing countries. The real interest rate obtained from the WDI database is used as an indicator of the cost of capital in both exporting and importing countries. For some import sources such as EU-15 and the ROW, we do not use specific input costs because land rent, per capita income or interest rate can hardly be aggregated.

3.2. Preliminary data analysis

For trade in green beans, fresh peas and frozen fish fillets, we use the dynamic panel data unit root test. Importing countries are taken as cross-section units to construct panel data over the same product and origin. We follow Maddala (1994) and Wu (1996) to test the stationarity of the relative quantities and prices derived from the log-linearization of relation (2). The approach of Maddala (1994) and Wu (1996) accounts for the shortcomings of other studies that have focused on testing for unit roots in dynamic panels (Banerjee, 1999). These two authors propose a test combining the p-values π_j obtained from the Dickey-Fuller (DF) and Augmented-Dickey-Fuller (ADF) unit root tests for each cross-sectional unit $j = 1,...,N$ as follows:

$$t_{Maddala\ \&Wu} = -2\sum_{j=1}^{N}\ln(\pi_j) \rightarrow \chi^2_{2N} \tag{10}$$

The Maddala (1994) and Wu (1996) test is a Chi-square distributed test with $2N$ degrees of freedom under the assumption of cross-sectional independence, N being the number of cross-sectional units, i.e., the number of EU importing countries. For trade in avocados we use the usual DF and ADF unit root tests.

Table A.1. in the Appendix gives the Chi-square statistics of the time series and panel unit root tests. We find that 20 ratios of quantities and prices out of 24 are integrated of order 0. The null hypothesis of non-stationarity is not rejected for relative quantities of imports of green beans and frozen fish fillets from the rest of EU-15, relative quantities of imports of avocados from the ROW, and relative prices of imports of fresh peas from Zambia. Fresh peas from Kenya, EU-15 and ROW are withdrawn from the subsequent analysis because the corresponding relative quantities and prices are not stationary.
To detect a possible bilateral causal relationship between relative quantities and relative prices, we run panel estimation and test the

random *versus* the fixed individual effects with the Hausman test. The use of instrumental variables to deal with the endogeneity bias is detailed in section 4.

Because the majority of the series of ratios of quantities and prices series are log-level stationary, we can specify a parsimonious geometric lag model as in Gallaway *et al.* (2003) to obtain long-run elasticities in addition to short-run elasticities.

$$y_{ijt} = a_{0ij} + a_{1i}x_{ijt} + a_{2i}y_{ijt-1} + \varepsilon_{ijt} \tag{11}$$

where $y_{ijt} = \ln\left(\frac{q_{jjt}}{q_{ijt}}\right)$, $x_{ijt} = \ln\left(\frac{p_{ijt}}{p_{jjt}}\right)$ and $a_{0ij} = \sigma \ln\left[\frac{\alpha_{jj}}{(1-\alpha_{jj})\alpha_{ij}}\right]$ while ε_{ijt} is an error term assumed to be independent and identically distributed.

The short-run elasticity is $\hat{a}_{1i}$ and the long-run elasticity can be calculated as: $\hat{a}_{1i}/(1-\hat{a}_{2i})$ if $0 < \hat{a}_{2i} < 1$.

Tests of homogeneity of constants and slopes and test of endogeneity of the individual effects are performed on equation (11). Table A.2 in the Appendix indicates the sequence of the Chi-square and Fisher tests on panel data. We follow Hurlin (1999) to test the presence of individual effects with a Fisher test. This test uses the testing rule related to F_3 and H_O^3. In six cases out of nine, the null hypothesis of absence of individual effects is rejected given the homogeneity of the slopes. For cases for which this null hypothesis is rejected, we use the Hausman test to discriminate fixed and random individual effects. This test compares results from two estimators: the generalized least square (GLS) estimator from random effects and the least square dummy variable (LSDV) estimator from fixed effects. In the absence of endogeneity bias, the GLS estimator is used because it is the best linear unbiased estimator. Otherwise, the LSDV estimator is used because it is always unbiased even though not best.

Table A.3 in the Appendix gives the results of the Fisher and Hausman tests on individual effects. These results show that whenever the individual effects are not rejected, they are always fixed effects. The results from the Hausman test indicate that a correlation between the right-hand side variables and the disturbance makes GLS estimator biased. As a result, we use instrumental variables to yield unbiased and consistent estimates (Thomas, 1997; Castiñeira and Nunes, 1999).

4. Econometric estimation of the tariff equivalent

We first estimate the Armington elasticities from the maximization of the nested CES utility function under budget constraint using the seemingly unrelated regressions (SUR) on the geometric lag model (11). The parameters of the consumer preferences are derived from the constant terms. Both Armington elasticities and consumer preferences are integrated in relation (4) to provide the tariff equivalent of non-tariff measures. The following two sub-sections detail the procedure for obtaining these two components of the tariff equivalent.

4.1. The Armington elasticities

We define the SUR over the equations corresponding to the three import sources across which we impose common parameters $a_{1i} = a_1, \forall i$ and $a_{2i} = a_2, \forall i$ of model (11) to estimate the Armington elasticities. The SUR estimation yields asymptotically consistent and more efficient estimates than the single equation defined on individual import source (Cheng, 2001). Each of the set of equations in the SUR estimation is panel fixed effects estimation. We obtain these panel fixed effects using ordinary least squares (OLS) on series deviated from their respective mean values (Hurlin, 1999; Sevestre, 2003).

However, the Hausman test on the geometric lag model (11) detects an endogeneity bias to be addressed with instruments. Because instruments should not necessarily remain the same across equations since these equations correspond to three import sources where supply constraints and opportunities differ, we use instruments that differ from one equation to another. This approach requires the use of generalized method of moments (GMM) estimation. For horticultural products, we use equation-specific instruments from the supply conditions of relation (9). For frozen fish fillets, we have poor instruments because by aggregating imports from Kenya, Tanzania and Uganda we do not have valid wages, real interest rates and nominal exchange rates for this country aggregation. We, therefore, consider the elasticities derived from the SUR estimation only.

A suitable set of instrumental variables is both sufficiently uncorrelated with the stochastic disturbance terms and sufficiently correlated with the relevant explanatory variables (Castiñeira and Nunes, 1999). To select them, we pursue an iterative process. From a SUR or GMM estimation using all the available instruments, we extract the residuals. These residuals are thereafter regressed on the selected instruments. The instruments that are significant at 10 per cent level of probability are abandoned. This process is iteratively repeated until no more significant instruments are left.

Table 1 gives the estimates of the short-run and long-run Armington elasticities using starting values from a 3-SLS. We follow Casella and Berger (2002) to establish the sampling distribution of the long-run elasticities using the Delta method that is based on the Taylor series approximation. Using the GMM estimators, we obtain a short-run elasticity of 0.15 and a long-run elasticity of 8.9 for imports of green beans. We obtain a long-run elasticity of 5.4 for imports of avocados. We obtain no significant elasticities for imports of fresh peas. Using the SUR method on imports of frozen fish fillets, we obtain short-run and long-run elasticities that are both inferior to one. The values of the long-run Armington elasticities found for imports of the horticultural products are roughly comparable to those found in similar applied studies using both static and dynamic models. Yue *et al.* (2006a, 2006b) find an elasticity of substitution of 7.1 between total imports of apple and domestic supply in the Japanese market using a two-stage least square (2-SLS) to address the endogeneity bias in a non-dynamic model. Our SUR estimates of short-run and long-run elasticities for frozen fish fillets are lower than the respective values of 1.3 and 2.0 found by Cheng (2001) using a SUR estimation on U.S. scallops imports from Canada, Japan and China.

Table 1. Estimates of the short-run and long-run Armington elasticities of European imports of horticultural and fish products from foreign sources

Product	Import source[c]	Estimate[d]				R^2	DW test
		a_1	a_2	$a_1/(1-a_2)$	Adj. rate		
Green Beans[a]	Kenya EU-15 ROW	0.15* (1.68)	0.98*** (27.99)	8.93*** (4.05)	0.02	0.74 0.40 0.81	2.14 2.14 2.16
Fresh peas[a]	Zambia EU-15 ROW	0.25 (1.34)	0.96*** (36.34)	5.87 (1.24)	0.04	0.18 0.27 0.94	2.44 2.72 2.12
Avocados[a]	Kenya EU-15 ROW	2.68 (1.28)	0.50** (2.48)	5.41* (1.60)	0.50	0.40 0.72 0.16	2.74 1.40 1.96
Frozen Fish fillets[b]	EAC EU-15 ROW	0.31** (2.01)	0.49*** (8.56)	0.61*** (2.69)	0.52	0.60 0.41 0.58	2.61 1.60 1.18

(a): GMM estimates.
(b): SUR estimates.
(c): EU-15: the first fifteen Members States of the European Union; ROW: Rest of the World; EAC: East African Community.
(d): The symbols *, ** and *** denote statistical significance at 0.10, 0.05 and 0.01 probability level respectively; the t-statistics are indicated in parentheses beneath the estimated coefficients.

The adjustment rates are calculated as the ratio of the short-run to the long-run elasticities. They measure the proportion of any discrepancy between the desired and previous relative quantities that is eliminated in the current period. As the rate approaches one, the adjustment becomes complete. We find an adjustment rate of 0.02 for imports of green beans, 0.04 for imports of fresh peas and about 0.50 for imports of avocados and frozen fish fillets. The value for the imports of frozen fish fillets is about the same magnitude as 0.67 of Cheng (2001). The low adjustment rates for green beans and peas could be explained by the fact that some of their imports are off-season and, hence, are not competing directly with domestic sales as they reach the European markets during the winter season.

4.2. The consumer preferences

The constants a_{0ij} of equation (11) need to be calculated as they are removed with the *within* data transformation in the deviations from individual means except for the case of avocados where we use standard OLS estimation of equation (11) with time series on untransformed data. We calculate the constants a_{0ij} of relation (11) using the GMM or SUR estimates of $\hat{a}_1$ and $\hat{a}_2$ as follows:

$$\hat{a}_{0ij} = \overline{y}_{ijt} - \hat{a}_1 \overline{x}_{ijt} - \hat{a}_2 \overline{y}_{ijt-1} \qquad i = 1,..., M;\ j = 1,..., N \tag{12}$$

where $\overline{y}_{ijt}$, $\overline{x}_{ijt}$ and $\overline{y}_{ijt-1}$ represent the mean values of relative quantities, relative prices and lagged relative quantities respectively in each cross-sectional unit, that is, importing country *j*, from each of three import sources mentioned above, and $\hat{a}_1$ and $\hat{a}_2$ the GMM or SUR estimates of Table 1.

We use the calculated constant $\hat{a}_{0ij}$ for each cross-sectional unit j and each import source i to solve for the parameters of consumer preferences α_{jj} and α_{ij} of expression (4). With the additional constraint consisting in $\sum_{i=1, i\neq j}^{M} \hat{\alpha}_{ij} = 1$, we have a system of four equations with four parameters to solve. Table 2 lists the short-run and long-run values of the parameters of preference that are derived from the estimates reported in Table 1.

With higher preference parameters for imports from the ROW for green beans and fresh peas in the short run, European consumers tend to prefer imports form the ROW than those from the other origins. In the long run, European consumers are generally indifferent in the origin of these two horticultural products. In the short and long runs, French consumers tend to prefer the foreign origins of avocados. In the short and long runs, European consumers tend to prefer frozen fish fillets from domestic and EAC origins than the other two foreign origins.

Table 2. Short-run and long-run values of parameters of European consumer preferences in the trade of horticultural and fish products

Product	Importing country	Consumer preference							
		Short-run parameter $\hat{\alpha}_{ij}$				Long-run parameter $\hat{\alpha}_{ij}$			
		Domestic	ACP[a]	EU-15	ROW	Domestic	ACP[a]	EU-15	ROW
Green beans	Belgium	0.05	0.07	0.17	0.76	0.25	0.33	0.33	0.34
	France	0.03	0.08	0.20	0.72	0.24	0.33	0.33	0.34
	Germany	0.09	0.35	0.35	0.30	0.25	0.33	0.33	0.33
	Netherlands	0.03	0.12	0.40	0.48	0.24	0.33	0.33	0.34
	UK	0.00	0.09	0.29	0.62	0.24	0.33	0.33	0.34
Fresh peas	Netherlands	0.00	0.00	0.00	0.99	0.10	0.11	0.26	0.63
	UK	0.00	0.00	0.01	0.99	0.21	0.27	0.33	0.40
Avocados	France	0.12	0.39	0.28	0.33	0.18	0.36	0.31	0.33
Frozen fish fillets	Belgium	1.00	0.98	0.01	0.01	0.99	0.84	0.08	0.07
	France	1.00	1.00	0.00	0.00	0.99	1.00	0.00	0.00
	Germany	1.00	1.00	0.00	0.00	1.00	0.92	0.02	0.06
	Italy	1.00	1.00	0.00	0.00	1.00	0.95	0.03	0.02
	Netherlands	1.00	0.29	0.05	0.67	1.00	0.34	0.14	0.52
	Portugal	1.00	0.99	0.01	0.00	1.00	0.88	0.09	0.04
	Spain	1.00	0.89	0.01	0.10	1.00	0.69	0.08	0.23

(a)**:** The ACP source is Kenya for green beans and avocados, Zambia for fresh peas, and Kenya, Tanzania and Uganda taken together for frozen fish fillets.

4.3. Tariff equivalent of non-tariff measures

To calculate the *ad valorem* tariff equivalent rates TER_{ijt} of non-tariff measures prevailing at the border of importing countries, expression (4) is transformed into the following expression:

$$TER_{ijt} = \frac{1}{p_{ijt}} \left[p_{jjt} \frac{\left(1-\hat{\alpha}_{jj}\right)\hat{\alpha}_{ij}}{\hat{\alpha}_{jj}} \left(\frac{q_{jjt}}{q_{ijt}} \right)^{\frac{1-\hat{a}_2}{\hat{a}_1}} - \left(p_{wt} + IFC_{wjt} + CT_{ijt} \right) \right] \qquad (13)$$

Because long-run parameters are more appropriate for trade-policy analysis (Gallaway *et al*., 2003), we use the long-run estimated parameters of consumer preference and substitution elasticities to calculate the tariff equivalent rates. Because no custom tariff applies to imports from the four ACP countries, CT_{ijt} are null for the calculation of the tariff equivalent rate for imports from these countries.

Table 3 gives the rates of the *ad valorem* tariff equivalent to the non-tariff requirements of imports of EU countries from the four ACP countries. The mean tariff equivalent rates range between 39 and 92 per cent for trade in green beans, peas and avocados. While the mean tariff equivalent rates for imports of green beans do not vary much across the five EU importing countries, the mean tariff equivalent rate for the UK imports of fresh peas is almost the double than the rate for the Dutch imports. This large difference could result from tighter private standards such as those of the BRC that apply to the UK imports. For instance, Jaffee (2003) highlights pressures from UK supermarkets for requesting HACCP and BRC certifications on African suppliers of fresh food products.

The generally higher tariff equivalent rates for the imports of fresh peas from Zambia than for the imports of green beans from Kenya could reflect that the latecomer Zambian growers have not accumulated as much as experience than their competitors in Kenya to comply with the European non-tariff requirements. Among the three horticultural products, the tariff equivalent rates are the lowest for the French imports of avocados from Kenya.

Over time, the variation in tariff equivalent rates for horticultural imports corroborates the pressure from the external regulatory environment in the form of maximum residue limit of pesticides requested for HACCP, GlobalGAP and BRC certifications as well as ethical audits for selected customers in the period between 2001 and 2003 (Jaffee, 2003). Figure 5 reflects the stringency of the regulatory environment where the tariff equivalent rates of imports of both green beans and fresh peas take a parabolic shape with a maximum rate in the period between 2001 and 2003. However, the tariff equivalent rates of imports of avocados take an inverse parabolic shape with a minimum rate in the same period.

Large differences in the tariff equivalent rates are observed for imports of frozen fish fillets from the EAC across EU importing countries. Imports in Spain, France and, to a lesser extent, Italy and Germany show the highest tariff equivalent rates with a mean value of 206, 198, 96 and 75 per cent respectively. On the other hand, imports in Portugal, Belgium and the Netherlands show the lowest values of the tariff equivalent rates with a mean value of 51, 42 and 11 per cent respectively. Differences in the tariff equivalent rates across these EU countries during the three ban periods of 1997, 1998 and 1999 reflect that EU countries apply differently the EU bans on fish imports from the Lake Victoria. For instance, the tariff equivalent rates of imports of Spain and Italy are high during the three ban periods of 1997, 1998 and 1999 reflecting that when Spain and Italy banned fish imports from Kenya, claiming the presence of salmonellae in November 1997, other EU countries continued to import fish from Kenya and its neighbours on bilateral agreements (Abila, 2003).

Figure 6 shows that the equivalent tariff rates of European imports of frozen fish fillets from the EAC are the highest in 1999 during the third EU ban on imports of fish from the Lake Victoria. The decline in equivalent tariff rates after the 1999 ban suggests that suppliers of fish in Kenya and neighbouring countries have successfully met the European standards. Henson *et al.* (2000) and Okello (2006) report that following the EU bans, several strategies including public and private partnerships were put in place to modernize the export supply sector.

In general, the tariff equivalent strongly varies over time with, however, a recent decline for imports of green beans, fresh peas and frozen fish fillets and a recent rise for imports of avocados. These recent declines in the tariff equivalents may reflect greater adaptation of African growers and exporters to the EU non-tariff requirements.

The rates of *ad valorem* tariff equivalent calculated in this study are comparable to those in other empirical studies. The *ad valorem* tariff equivalent rates for imports of horticultural products found in this study are of the same magnitude as the *ad valorem* tariff equivalent rates ranging between 39 and 60 per cent for the U.S.-Japan apple trade found in Yue *et al.* (2006a). They are, however, higher than the rate of 27 per cent measured by Calvin and Krissoff (1998) for Japan-U.S. apple trade but lower than the *ad valorem* tariff equivalent of border effects measured by Olper and Raimondi (2005) for agricultural markets in the OECD countries ranging from 17 to 889 per cent.

Table 3. *Ad valorem* tariff-equivalent (%) of non-tariff measures on European horticultural and fish imports from ACP countries

Product and origin	Green beans from Kenya					Fresh peas From Zambia		Avocados from Kenya	Frozen fish fillets from the EAC						
Destination	BE	DE	FR	NL	UK	NL	UK	FR	BE	DE	ES	FR	IT	NL	PT
1990	9	13	23	8	19	-	-	-	-	-	-	-	-	-	-
1991	14	20	36	20	29	-	-	-	-	-	-	-	-	-	-
1992	32	27	40	30	35	-	-	-	-	-	-	-	-	-	-
1993	25	24	35	17	31	-	-	-	-	-	-	-	-	-	-
1994	35	32	50	31	41	-	-	-	-	-	-	-	-	-	-
1995	33	39	47	50	41	-	-	-	-	-	-	-	-	-	-
1996	29	30	59	49	44	-	-	60	5	21	11	1162	12	5	124
1997	37	51	59	47	40	22	75	46	13	15	382	21	139	6	47
1998	40	57	63	48	38	41	107	68	1	9	302	4	27	7	9
1999	43	53	61	39	23	70	123	38	236	558	634	127	725	52	243
2000	67	80	83	53	49	69	138	29	23	119	228	305	43	11	11
2001	61	85	81	61	53	52	100	27	2	23	375	47	17	12	46
2002	61	97	74	58	37	84	94	43	23	30	173	263	25	13	29
2003	47	92	63	51	46	81	124	23	31	9	59	105	15	6	5
2004	52	11	66	73	37	59	107	44	33	25	53	108	21	8	21
2005	54	3	68	77	41	49	101	44	26	9	32	16	14	7	14
2006	66	90	42	62	47	49	76	53	-	7-	21	14	13	9	8
2007	56	91	39	71	39	26	35	-	-	-	-	-	-	-	-
2008	35	71	35	71	55	52	29	-	-		-	-	-	-	-
		79													
Mean	**42**	**60**	**54**	**45**	**39**	**55**	**92**	**43**	**42**	**75**	**206**	**198**	**96**	**12**	**51**

BE: Belgium-Luxembourg; DE: Germany; EAC: East African Community; ES: Spain; FR: France; IT: Italy; NL: The Netherlands; PT: Portugal; UK: The United Kingdom;

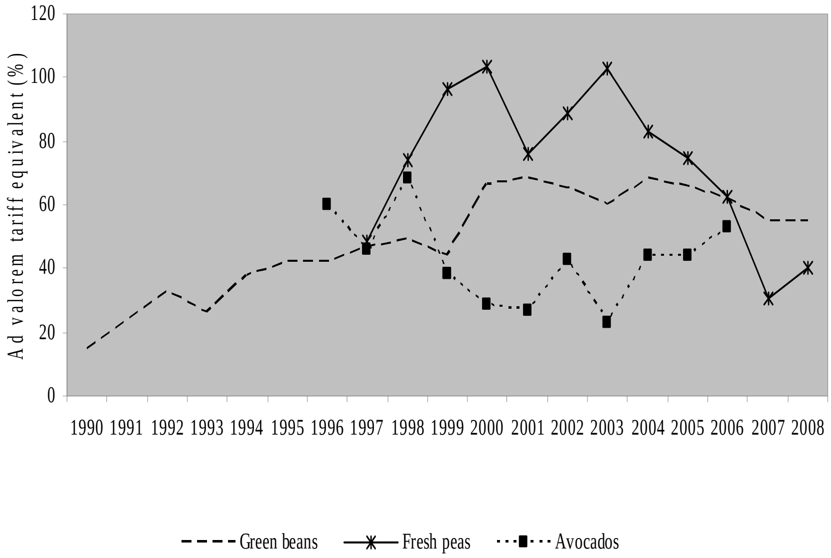

Figure 5. Annual mean rates (%) of *ad valorem* tariff equivalent of non-tariff measures on EU-15 horticultural imports from selected ACP countries between 1990 and 2008

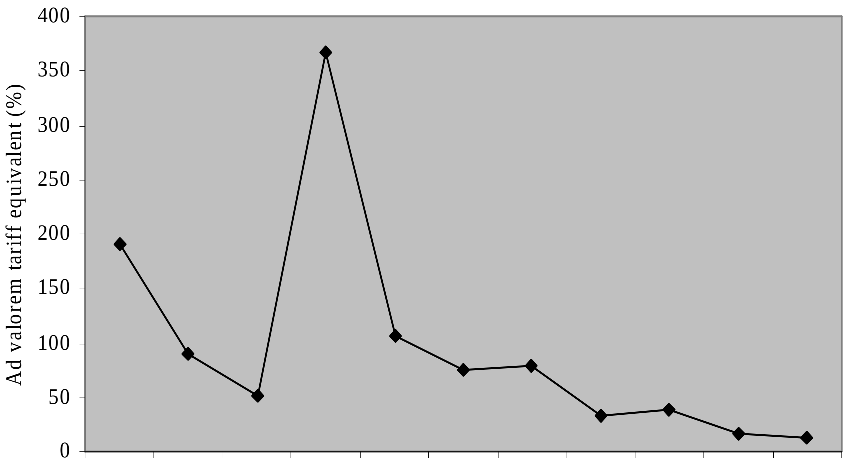

Figure 6. Annual mean rates (%) of *ad valorem* tariff equivalent of non-tariff measures on EU-15 imports of frozen fish fillets from EAC countries between 1995 and 2006

5. Concluding remarks

The main objective of this analysis is to quantify the tariff equivalent of a set of food safety standards and other non-tariff measures prevailing in the trade of horticultural and fish exports from some ACP countries to their major European trading partners. We provide the measurement of these requirements using the price-wedge method and considering differences in factor endowment and technology between trading partners and imperfect substitution according to the place of production of these high-value food products. Past empirical studies have also attempted to correct differences between domestic and import prices for tariffs, international and internal transport costs and more recently for quality differences but few of them have accounted for differences in supply conditions among trading countries and weak separability among import sources.

From the results of this empirical investigation, we draw the following conclusions. First, the magnitudes of the estimated tariff equivalents of a set of public and private food safety standards and other non-tariff measures bring evidence that these measures act asymmetrically among trading countries. One possible reason is that African suppliers face higher costs of compliance with these measures compared to European suppliers. If this is the case, then these measures have a tariffication effect as suggested by Roberts *et al.* (1999). Consequently, complete trade liberalization between ACP and EU countries in the framework of the Economic Partnership Agreements (EPA) should also consider non-tariff measures as it has been the case of the free trade agreement between Japan and South Korea (Fukao *et al.*, 2003). Increasing private or public technical assistance to help alleviate compliance costs through physical and human capacity building in African countries could, for instance, stimulate trade in high-value products from these countries.

Second, estimates reveal strong differences in the *ad valorem* tariff equivalence among EU importing countries, especially for fresh peas and frozen fish fillets despite the functioning of a single EU market. Hence, ACP countries would need to focus on the origins of these differences in discussing trade issues with their EU partners. Nardella and Bocaletti (2004) reach a similar conclusion following their assessment of trade impact of the EU and U.S. non-tariff measures on agro-food exports from developing countries.

This study does not examine the trade and welfare effects of the public and private food safety standards. Despite considerable compliance costs as reported to us by the Plant Health Inspectorate Service in Kenya, exports of horticultural products from Kenya and Zambia have expanded over the last two decades. To test to what extent these standards are actually trade distorting, we suggest using a gravity model that would include our estimates of tariff equivalents to these non-tariff measures. To consider the full welfare effects, we would also need to discuss the intangible favourable effects from these public and private food safety standards. Among these intangible effects, the health effect from the compliance to food safety standards for the benefit of workers and consumers in developing countries is an important side effect to consider.

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Appendix

Table A.1. Unit root test statistics on relative quantities and prices (in logarithm) for horticultural and frozen fish fillets imports in selected European countries

Product	EU importing country	Import source[c]	Variable	Test statistic
Green beans[a]	Belgium-Luxembourg France Germany Netherlands United Kingdom	Kenya	Relative quantities	23.43***
			Relative prices	8.92**
		EU-15	Relative quantities	14.81
			Relative prices	19.13**
		ROW	Relative quantities	27.12***
			Relative prices	31.64***
Fresh peas[a]	Netherlands United Kingdom	Zambia	Relative quantities	7.74*
			Relative prices	7.13
		EU-15	Relative quantities	13.78***
			Relative prices	9.72**
		ROW	Relative quantities	15.54***
			Relative prices	7.65*
Avocados[b]	France	Kenya	Relative quantities	-3.37**
			Relative prices	-4.07**
		EU-15	Relative quantities	-3.33**
			Relative prices	-4.33***
		ROW	Relative quantities	-1.86
			Relative prices	-4.70***

(a): Maddala and Wu unit root test statistic has a χ^2 distribution

(b): Augmented-Dickey-Fuller unit root test statistic has a Dickey-Fuller distribution

(c): EU-15: European Union of the fifteen, ROW: rest of the world; EAC: East African Community

The symbols ***, **** and ******* denote statistical significance at 0.10, 0.05 and 0.01 probability level respectively.

Table A.1. *(Continued)*

Product	EU importing country	Import source[c]	Variable	Test statistic
Frozen Fish fillets[a]	Belgium France Germany Italy Netherlands Portugal Spain	EAC	Relative quantities	52.17***
			Relative prices	43.65***
		EU-15	Relative quantities	20.64
			Relative prices	38.61***
		ROW	Relative quantities	27.59**
			Relative prices	41.18***

(a): Maddala and Wu unit root test statistic has a χ^2 distribution

(b): Augmented-Dickey-Fuller unit root test statistic has a Dickey-Fuller distribution

(c): EU-15: European Union of the fifteen, ROW: rest of the world; EAC: East African Community

The symbols ***, **** and ******* denote statistical significance at 0.10, 0.05 and 0.01 probability level respectively

Table A.2. Sequence of Chi-square and Fisher tests on panel data using the geometric lag model (11)

Hypothesis	Chi-square and F-statistical tests[a]	Testing rules
1. Global homogeneity test: $H_0^1 \equiv a_{1ij} = a_{1i}; a_{2ij} = a_{2i}; a_{0ij} = a_{0i}$ $\forall j \in [1, N]$ $H_a^1 \equiv \exists (j,l) \in [1, N]: a_{1ij} \neq a_{1il}, a_{2ij} \neq a_{2il}$ *or* $a_{0ij} \neq a_{0il}$	$F_1 = \dfrac{(SSRR_1 - SSRU_1)/[(N-1)(K+1)]}{SSRU_1/[NT - N(K+1)]}$	Reject H_0^1 if: $F_1 > F_{\alpha\%}[(N-1)(K+1), [NT - N(K+1)]$. If not rejected, the panel is homogenous in all the parameters.
If hypothesis H_0^1 is rejected, we perform the following tests:		
2. Homogeneity test on the slopes a_{1ij} and a_{2ij}: $H_0^2 \equiv a_{1ij} = a_{1i}; a_{2ij} = a_{2i}$ $\forall j \in [1, N]$ $H_a^2 \equiv$ $\exists (j,l) \in [1, N]: a_{1ij} \neq a_{1il}$ *or* $a_{2ij} \neq a_{2il}$	$F_2 = \dfrac{(SSRR_2 - SSRU_2)/[(N-1)K]}{SSRU_2/[NT - N(K+1)]}$	Reject H_0^2 if: $F_2 > F_{\alpha\%}[(N-1)K, [NT - N(K+1)]]$. If rejected, there is no panel structure and it is better to specify different equations for each individual

(a): $SSRR$ and $SSRU$ are residual sums of squares in the restricted and unrestricted models respectively; N is the number of cross-sectional units in the panel structure; K is the number of regressors; T is the time dimension and $\alpha\%$ is a probability threshold, generally 10 per cent.

Table A.2. *(Continued)*

Hypothesis	Chi-square and F-statistical tests[a]	Testing rules
If hypothesis H_0^2 is not rejected, we perform the following tests:		
3. Homogeneity test on constants a_{0ij}: $H_0^3 \equiv a_{0ij} = a_{0i}\ \forall j \in [1, N]$ $H_a^3 \equiv \exists\,(j,l) \in [1, N] : a_{0ij} \neq a_{0il}$	$F_3 = \dfrac{(SSRR_3 - SSRU_3)/(N-1)}{SSRU_3/[N(T-1)-K]}$	Reject H_0^3 if: $F_3 > F_{\alpha\%}[(N-1), [N(T-1)-K]]$. If not rejected, there are no individual effects and we have a pooled model.
If hypothesis H_0^3 is rejected, we perform the Hausman test to discriminate fixed and random effects:		
4. Hausman test on individuals effects: $H_0^4 \equiv \chi_K^2$ where K is the number of explanatory variables	$F_4 = (\hat{\beta}_{GLS} - \hat{\beta}_{LSDV})'[\mathrm{var}(\hat{\beta}_{GLS} - \hat{\beta}_{LSDV})]^{-1}(\hat{\beta}_{GLS} - \hat{\beta}_{LSDV})$	Reject H_0^4 if: $F_4 > \chi^2(df = K)$. If rejected, there is a misspecification and we prefer the fixed- to random-effects specification. If not rejected, the model is well specified and the random effects are then adopted

(a): $SSRR$ and $SSRU$ are residual sums of squares in the restricted and unrestricted models respectively; N is the number of cross-sectional units in the panel structure; K is the number of regressors; T is the time dimension and $\alpha\%$ is a probability threshold, generally 10 per cent.

Table A.3. Fisher and Hausman tests from the geometric lag model (11) applied to panel data of European imports of horticultural products and frozen fish fillets in selected European countries

Product	Import Source	Test on individual effect $F[(N-1),(NT-K-N)]$	Hausman test (χ^2_2)	Conclusion
Green beans	Kenya	F(4,93) = 2.87 (0.028)	7.29 (0.026)	Fixed effects
	EU-15	F(4,93) = 4.76 (0.002)	9.97 (0.007)	Fixed effects
	ROW	F(4,93) = 1.56 (0.193)	3.08 (0.214)	No individual effects
Fresh peas	Zambia	F(1,36) = 0.03 (0.869)	0.02 (0.988)	No individual effects
	EU-15	F(1,36) = 5.23 (0.029)	4.42 (0.035)	Fixed effects
	ROW	F(1,36) = 1.74 (0.196)	1.45 (0.228)	No individual effects
Frozen fish fillets	EAC	F(6,67) = 7.34 (0.000)	19.52 (0.000)	Fixed effects
	EU-15	F(6,67) = 3.78 (0.003)	14.66 (0.000)	Fixed effects
	ROW	F(6,67) = 1.39 (0.231)	5.35 (0.069)	Fixed effects

EU-15: European Union of the fifteen; ROW: rest of the world; EAC: African Community.
The p-value is indicated in parentheses beside the value of the Fisher and Chi-square test statistics

Chapter 3

Trade effect of non-tariff measures on European imports of horticultural and fish products from East African countries

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Abstract

This paper assesses the trade effect of non-tariff measures prevailing in European markets on imports of horticultural products from Kenya and fish products from East African countries. Using an ad valorem tariff equivalent of non-tariff measures in gravity equations, we find that these non-tariff measures do not significantly affect trade in green beans for the 1990-2008 period but they negatively affect trade in frozen fish fillets during the 1996-2006 period. The establishment of regional trade agreements in East Africa does not divert trade in green beans and frozen fish fillets from the European destinations while the successive three European Union bans on fish imports from East African countries between 1997 and 1999 have the expected detrimental impact on these imports.

JEL classification: F12, F14, Q17, O13, O55

Keywords: tariff equivalent, food safety standards, gravity model, East African countries, European Union.

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1. Introduction

Non-tariff measures such as the sanitary and phyto-sanitary (SPS) measures but also private standards can play an important role in trade of food products. Either they can facilitate trade by guaranteeing safety and quality for processors and improving confidence of retailers and consumers on imported products. Or, they can impede trade when they diverge from the general principles of the World Trade Organisation (WTO) governing technical barriers to trade (TBT) which are (i) non-discrimination, (ii) scientific evidence, (iii) risk assessment, and (iv) adoption of least-trade-restrictive alternatives (OECD, 1999). In either case, these non-tariff measures are particularly challenging for developing countries because these countries often lack the administrative, technical and financial capacity to comply with food safety standards that are prevailing in developed countries markets (Otsuki *et al.,* 2001; Jaffee and Henson, 2004). Trade and welfare losses stemming from these non-tariff measures can actually be considerable for developing countries (Otsuki *et al.,* 2001; Gebrehiwet *et al.,* 2007; Disdier *et al.,* 2008).

Studies show that trade impacts of TBT vary across countries and sectors. Harrigan (1993), Head and Mayer (2000) and Chen (2004) provide evidence that non-tariff measures across sectors do not impede trade flows among developed countries and Lee and Swagel (1997) show that they do not reduce imports from developed and developing countries. In contrast, Nogués *et al.* (1986) show that these measures affect relatively more imports of industrial countries from developing countries than from other industrial countries. On the basis of trade involving 81 countries and territories which notified their SPS measures and TBT to the WTO (Fontagné, Mimouni and Pasteels, 2005) and 14 countries selected among OECD members (Moenius, 2004 and 2006) find a predominance of negative impacts of TBT and SPS on trade flows of fresh and processed food but insignificant or even positive impacts for most of the manufactured products. It is therefore unclear what the effects of non-tariff measures on trade flows are. [7] Hence, this constitutes an important empirical question to investigate.

[7] On this ambivalent role of non-tariff measures, Disdier *et al.* (2008) state: “We are confronted here with the dual effect of SPS and TBTs in agriculture: they can have no impact on trade or even facilitate it as they carry information and confidence on

According to Beghin and Bureau (2001) assessing the trade and welfare effects of non-tariff measures can be useful to (i) inform public authorities about the trade and welfare effects of SPS measures, (ii) provide determinants necessary for defining more efficient regulations, (iii) help solving trade disputes and serve as a basis for calculating compensation claims and, more generally, (iv) specify treatment of non-tariff instruments and barriers in current and future trade agreements. In particular, this study investigates to what extent European food safety standards affect imports of key high-value food products from African countries. Because of data availability, the study focuses on imports of green beans from Kenya and fish products from Kenya, Tanzania and Uganda in the main European markets.

Most available empirical studies that quantify trade and welfare effects of non-tariff measures use the gravity approach. They mainly distinguish themselves by how they represent non-tariff measures into the gravity equation. A first set of studies uses the level of non-tariff measures themselves. For instance, Otsuki *et al.* (2001) and Gebrehiwet *et al.* (2007) use the level of standards on aflatoxins in their gravity equation to estimate the trade effect of a European harmonised standard on aflatoxins that is more stringent than the international Codex standards on African groundnut exports. A second set uses data from inventory such as numbers of regulations or pages of domestic regulations, numbers of complaints and notifications to international bodies, frequency indices of non-tariff measures, and ratios of import coverage.[8] For instance, Nardella and Bocaletti (2004) use the total number of non-tariff measures faced by product groups in a gravity equation to evaluate the incidence of these measures on agro-food imports in the European Union (EU) and United States (U.S.) from developing countries. Metha *et al.* (2005) use a frequency index ratio of weighted SPS parameters adopted in

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the imported products, assuming that exporters can cope with the associated technical requirements and paperwork; but they can also be trade-impeding when countries are unable to meet the standard."

[8] Frequency indices represent the number of product categories subject to a non-tariff measure as a proportion of the total number of product categories in the classification while the import coverage ratios compare the value of imports of each commodity subject to a non-tariff measure to the value of imports in the corresponding product category (Beghin and Bureau, 2001).

seven selected OECD importing countries to the corresponding weighted SPS parameters adopted by Codex in 2000 to assess the restrictiveness of a set of food safety standards on Indian processed food exports. Henry de Frahan and Vancauteren (2006) use export-weighted coverage ratios of trade by food sub-sectors that is subject to EU harmonized regulations in a gravity equation to provide a tariff equivalent of the trade costs arising from non-harmonised food regulations in the EU single market. A third set of studies uses dichotomous variables to represent non-tariff measures. Chevassus-Lozza *et al.* (2005) use dichotomous variables in gravity model to assess the role of non-tariff measures for agro-food exports from the new EU Members to the single market. Nguyen and Wilson (2009) also use dichotomous variables to assess the effects of food safety standards on sea food exports from 123 countries to the EU, the U.S. and Japan. Anders and Caswell (2009) use a dichotomous variable to assess the trade impact of mandatory Hazard Analysis Critical Control Points (HACCP) on U.S. seafood imports using various specifications of gravity model.

The use of dichotomous variables is only valid for setting in which the economic outcome we seek to model is a binary choice among two alternatives (Greene, 2003) while data from inventory poorly represent non-tariff measures and bring some drawbacks when they are used in gravity equations (Beghin and Bureau, 2001; Disdier *et al.* 2008). To avoid the measurement bias associated with the use of poor indicators of non-tariff measures this paper uses the *ad valorem* equivalents (AVE) of non-tariff measures estimated in Nimenya *et al.* (2009) using the price-wedge method. Few studies use AVE to represent non-tariff measures. Disdier *et al.* (2008) use *ad valorem* equivalents of non-tariff measures obtained from Kee *et al.* (2006) to estimate the impact of TBT and SPS regulations on bilateral agricultural trade in OECD countries using a gravity model.

The remaining of the paper is structured as follows. The next section specifies the gravity model. The third section describes the data and discusses the empirical results. The last section provides concluding remarks.

2. The gravity model

2.1. Model specification

The gravity model is a popular formulation for statistical analyses of bilateral flows between different geographical entities. Several theoretical foundations have been used to derive it (Anderson, 1979; Bergstrand, 1985, 1989 and 1990; Helpman and Krugman, 1985; Baier and Bergstrand, 2001; Feenstra *et al.*, 2001; Anderson and van Wincoop, 2003 and 2004). Among them Anderson and Wincoop (2003) develop a consistently and efficiently estimated gravity model from a constant elasticity substitution (CES) expenditure system. Their approach assumes imperfection substitution among goods from different origins but a single good by trading country. It also allows preference parameters to vary across countries subject to the constraint of market clearing. We use their approach because it fits well in our case as we use tariff equivalents of non-tariff measures that have been estimated under the Armington (1969) assumption of imperfection substitution between domestic and foreign varieties. Under that assumption, all goods are differentiated by place of origin and each country is specialized in the production of one substitutable good while the parameter of consumer preference is allowed to vary across countries as in the Anderson and van Wincoop (2003) framework. This framework, however, holds for a one-sector economy where expenditure equals to output.

For disaggregated data, Anderson and van Wincoop (2004) generalise their 2003 framework emphasizing the use of trade separability where the allocation of trade across countries can be analyzed separately from the allocation of production and consumption within countries under the assumption of separable preferences and technology. From the maximization of a CES utility function subject to budget constraint and market clearance, these authors derive a standard gravity equation represented by the following system:

$$X_{ij}^{k} = \frac{Y_i^k E_j^k}{Y^k}\left(\frac{t_{ij}^k}{\Pi_i^k P_j^k}\right)^{1-\sigma_k} \tag{1}$$

$$\left(\Pi_i^k\right)^{1-\sigma_k} = \sum_j \left(\frac{t_{ij}^k}{P_j^k}\right)^{1-\sigma_k} \frac{E_j^k}{Y^k} \tag{2}$$

$$\left(P_j^k\right)^{1-\sigma_k} = \sum_i \left(\frac{t_{ij}^k}{\Pi_i^k}\right)^{1-\sigma_k} \frac{Y_i^k}{Y^k} \tag{3}$$

where X_{ij}^k is the value of exports from country i to country j for a product class k; Y_i^k the output or value of production in country i for a product class k; E_j^k the expenditure in country j for a product class k; Y^k the world output for a product class k; t_{ij}^k equal to one plus the bilateral *ad valorem* trade costs between countries i and j for a product class k; Π_i^k the outward multilateral trade resistance in country i for a product class k, that is the resistance to shipments from country i to its trading partners other than country j; P_j^k the inward multilateral trade resistance in country j for a product class k, that is the trade costs from suppliers other than country i to country j; and the parameter σ_k the elasticity of substitution for a product class k.[9] In the rest of this paper, we adopt the combined subscripts $t \in [1, T]$ and $j \in [1, N]$ for a given import source i to show the two dimensions of the panel data we are using.

Following Péridy (2005) and Anderson and van Wincoop (2004), we hypothesize that t_{ijt}^k is a logarithmic linear function of observable variables including bilateral distance D_{ij}, linguistic identity $Lang_{ij}$, colonial tie Col_{ij} as in Otsuki *et al.* (2001), and membership to a regional trade agreement RTA_{it} as in Pishbahar and Huchet-Bourdon (2007) to assess occurrence of trade creation or diversion. We extend

[9] See Anderson and van Wincoop (2004) for more details on the complete derivation of this model

these trade costs to factors which play an important role in explaining international trade such as *ad valorem* tariff to imports TAR_{ijt}^{k} and *ad valorem* tariff equivalent of non-tariff measures to trade AVE_{ijt}^{k}.

Following Head and Ries (2001) for modelling tariff and non-tariff components and Hummels (2001) and Péridy (2005) for the multiplicative functional form of the whole trade costs, we therefore model the bilateral trade resistance variable t_{ijt}^{k} of relation (1) as follows:

$$t_{ijt}^{k} = (1+TAR_{ijt}^{k})^{\theta_0}(1+AVE_{ijt}^{k})^{\theta_1} D_{ij}^{\theta_2}\psi\left(Lang_{ij}, Col_{ij}, RTA_{it}\right) \qquad (4)$$

Because variables pertaining to $\psi(.)$ are dichotomous, the relation (4) is then written as follows:

$$\begin{aligned} t_{ijt}^{k} &= (1+TAR_{ijt}^{k})^{\theta_0}(1+AVE_{ijt}^{k})^{\theta_1} D_{ij}^{\theta_2} \\ &\exp\left(\theta_3 Lang_{ij} + \theta_4 Col_{ij} + \theta_5 RTA_{it}\right) \end{aligned} \qquad (5)$$

The log-linearization of relation (1) after substituting relation (5) into relation (1) yields the following gravity equation:

$$\begin{aligned} &\ln X_{ijt}^{k} = \ln Y_{it}^{k} + \ln E_{jt}^{k} - \ln Y_{t}^{k} + (1-\sigma_k)\theta_0 \ln(1+TAR_{ijt}^{k}) + \\ &(1-\sigma_k)\theta_1 \ln(1+AVE_{ijt}^{k}) + (1-\sigma_k)\theta_2 \ln D_{ij} + (1-\sigma_k)\theta_3 Lang_{ij} + \\ &(1-\sigma_k)\theta_4 Col_{ij} + (1-\sigma_k)\theta_5 RTA_{it} - (1-\sigma_k)\ln\left(\Pi_{it}^{k} P_{jt}^{k}\right) \end{aligned} \qquad (6)$$

From this theoretical specification of the gravity equation, we need to derive a specific expression that can be used in an empirical way. Changes in the theoretical specification are mainly due to data on trade flows, the location and the sample of the trading countries considered in the empirical estimation, the modelling of the unobservable multilateral trade resistance factor and other econometric issues.

2.2. The econometric model

From the gravity equation (6), we remove the *ad valorem* custom tariff TAR_{ijt}^{k} since the EU imports of horticultural and fish products from Kenya, Tanzania, and Uganda do not face custom tariffs thanks to the EU-ACP Lomé & Cotonou agreements partnership. The *ad valorem* equivalent of non-tariff measures AVE_{ijt}^{k} are approximated by those calculated by Nimenya *et al.* (2009) using the price-wedge method, that is, an *ad valorem* tariff that would have the same trade effect as the set of non-tariff measures that region j imposes on imports from region i.

The linguistic identity variable $Lang_{ijt}$ is a dichotomous variable taking the value of 1 when both regions i and j share the same language and the value of 0 otherwise. Likewise, the colonial tie variable Col_{ijt} is a dichotomous variable taking the value of 1 when the regions i and j have a colonial tie and the value of 0 otherwise. Because these two dichotomous variables are perfectly collinear due to the countries considered in this study, we drop the first dichotomous variable in the empirical estimation. The dichotomous regional trade agreement variable RTA_{it} takes the value of 1 when the exporting region i belongs to a regional trade agreement and the value of 0 otherwise. Due to the exporting countries considered in this study, we consider membership to the Common Market for Eastern and Southern Africa (COMESA) and the East African Community (EAC).

Hence, the general form of the estimating equation using the import value M_{ijt}^{k} instead of the export value as the dependent variables because of its greater statistical reliability is written as follows:

$$\ln M_{ijt}^{k} = \alpha_0 + \alpha_1 \ln Y_{it}^{k} + \alpha_2 \ln E_{jt}^{k} + \alpha_3 \ln Y_{t}^{k} + \alpha_4 \ln\left(1 + AVE_{ijt}^{k}\right) + \alpha_5 \ln D_{ij} + \alpha_6 Col_{ij} + \alpha_7 RTA_{it} + \alpha_8 \ln\left(\prod_{it}^{k} P_{jt}^{k}\right) + \varepsilon_{ijt} \tag{7}$$

where $\alpha_4 = (1-\sigma_k)\theta_1$.; $\alpha_5 = (1-\sigma_k)\theta_2$; $\alpha_6 = (1-\sigma_k)\theta_3$; $\alpha_7 = (1-\sigma_k)\theta_4$; $\alpha_8 = (1-\sigma_k)$

The econometric estimation of the gravity equation (7) arises two main issues. The first issue concerns the need to account properly for the unobservable multilateral trade resistance factors, $\prod_{it}^{k}$ and P_{jt}^{k} implied by the theory. Among the three approaches outlined in Anderson and van Wincoop (2004) and Péridy (2005), we first approximate these factors with consumer prices in the exporting and importing markets respectively for simplicity following Baier and Bergstrand (2001) and Fontagné *et al.* (2005) who use aggregated price indexes. This approximation has been, however, criticised for not measuring properly the theoretical implicit prices because of missing some of the trade costs such as home market preferences, time and currency risks involved in international trade, etc. (see Feenstra, 2002). Nevertheless Anderson and van Wincoop (2004) conclude that "This does not mean that prices of individual tradable goods are entirely uninformative about trade costs". A second approach used by Anderson and van Wincoop (2003) would have been to estimate the structural equation with nonlinear least squares after solving for the multilateral trade resistance factors as an implicit function of the trade cost observables and their parameters using non-linear least squares. The implementation of this approach is, however, more complex even though more efficient (Feenstra, 2002) and does not guarantee that residuals are uncorrelated with any of the independent variables, in particular the trade costs (Péridy, 2005). We therefore use a third approach common in many empirical studies as in Rose and van Wincoop (2001), Péridy (2005), Hummels (2001), Feenstra (2002), and Disdier *et al*. (2008) that consists in replacing the multilateral resistance terms with region-specific dummies. Not only the fixed effects specification can capture the unobserved price effects but also potential trade resistance variables omitted in the trade cost function (4). As in Péridy (2005), Feenstra (2002) and Rose and van Wincoop (2001), we assume that these effects are time-invariant in equation suggesting that the aggregate prices do not vary too greatly during the time period under consideration. We use additionally an alternative approach from Emlinger *et al.* (2008) combining the use of export free on board (f.o.b.) price in exporting country and the internal price in importing country to account for differences in price competitiveness between suppliers along with the exporting and importing countries fixed effects to account for remaining trade resistance not included in those prices and in the trade cost variables of relation (4).

The second issue concerns the restrictions on output and expenditure elasticities of exports. To allow for a more flexible export response, in particular in presence of trade costs as noted by Péridy (2005) or incomplete specialization as shown by Haveman and Hummels (2004), we consider in addition an unrestricted specification where the coefficients α_1, α_2 and α_3 differ from one. As in Henry de Frahan and Vancauteren (2006) we test the econometric validity of imposing unitary elasticities on the basis of a Fisher test.

The estimation the unrestricted specification is prone to the endogeneity of the output and expenditure variables. Omitted variables can cause estimation bias if the error term reflects these omitted variables which are also correlated with the included explanatory variables (Anderson and van Wincoop, 2004). For the unrestricted specification many studies use an instrumental variable approach for these two variables (see Anderson and van Wincoop, 2004). We follow Henry de Frahan and Vancauteren (2006) to replace these two variables with their predicted values from a regression on several and valid instruments. [10] Alternatively, one common solution consists in using restricted model obtained by shifting the output and expenditure variables as well as the world output variable from the right to the left side of equation (7) as in Anderson and van Wincoop (2003) and Emlinger *et al.* (2008). This simplified specification has the additional advantage of being parsimonious in estimated parameters leading to a higher power test and, hence, best estimates. As a result equation (7) for the restricted specification becomes:

$$\ln M_{ijt}^{k^*} = \beta_0 + \beta_1 \ln\left(1 + AVE_{ijt}^k\right) + \beta_2 \ln Dist_{ij} + \beta_3 Col_{ij} + \beta_4 RTA_{it} + \beta_5 \ln\left(\Pi_{it}^k * P_{jt}^k\right) + \eta_{ijt} \tag{8}$$

where $M_{ijt}^{k^*} = \left(M_{ijt}^k / E_{jt}^k\right) / \left(Y_{it}^k / Y_{wt}^k\right)$ corresponds to the index of relative bilateral intensity of Gaulier and Zignago (2002) and Emlinger *et al.* (2005). This index compares the market share of the exporting country i on the domestic market of importing country j to the share of country i in the world production market. The value of this index in

[10] To test the validity of the instruments, we use the tests of Sargan' (1958) and Basmann'(1960) chi-squared tests performed after instrumental variables 2SLS estimation.

the trade of green beans and frozen fish fillets between African and European countries is smaller than 1 denoting trade resistance between these countries. [11]

Considering that Z_{ijt} represent the dependent variable and $W'_{ijt} = \lfloor W_{it}, W_{jt}, W_{ij}, ... \rfloor$ the transpose vector of independent variables in the unrestricted and restricted models and including a time dimension as in Nouve and Staatz (2003), Cheng and Wall (2005) and Péridy (2005) to account for changes in openness across countries, we represent the gravity equation as follows:

$$Z_{ijt} = \lambda_0 + \lambda_i + \lambda_j + \varphi_t + \gamma'_{ijt} W_{ijt} + u_{ijt} \qquad (9)$$

with $\sum_i \lambda_i = 0$; $\sum_j \lambda_j = 0$; $\sum_t \varphi_t = 0$

where the intercept is split into four components: one common to all years and countries λ_0; one specific to exporting country i and common to all years λ_i; one specific to importing country j and common to all years λ_j; and the last one specific to year t and common to all country pairs φ_t; γ_{ijt} being the vector of estimates and u_{ijt} an independent and identically distributed (i.i.d.) error term with zero mean and constant variance for all observations.

Opting for country fixed effects for both the unrestricted and restricted models to account for the multilateral trade resistance constitutes in the same time a usual way for dealing with another form of endogeneity bias that may appear in these gravity equations when the disturbance of the random effects model is correlated with the explanatory variables. Hence, the Hausman test that compares the Least Squares Dummy Variables (LSDV) estimator of panel fixed effects and Generalized Least Squares (GLS) estimator of panel random effects is an endogeneity test (Hurlin, 1999). However, the fixed-effect specification of the panel estimation becomes inappropriate when time-invariant explanatory variables such as the geographical distance and colonial tie are included in the model. Indeed, the within or LSDV estimator eliminates all the time-invariant

[11] For the interpretation of the plausible values taken by the index of relative bilateral intensity, see Gaulier and Zignago (2002) and Emlinger *et al.* (2008).

variables. Yet, it is uncommon and even awkward to estimate a gravity equation without geographical distances.

Some methods enable to take advantage of the fixed-effects specification and keeping time-invariant variables in the gravity equation. Mundlak (1978) and Hausman and Taylor (1981) use instruments taken from the independent variables of the model to remove this endogeneity problem. Assuming that all the time and individual-varying variables are correlated with the individual random effects, Mundlak (1978) suggests controlling for this correlation by adding the mean values of the time- and individual-varying variables as instruments. Hausman and Taylor (1981) use the individual means of uncorrelated time-varying variables and the deviations from the individual means of both correlated and uncorrelated time-varying variables as the instruments for endogenous time-invariant variables. We follow the approach suggested by Mundlak (1978) instead of Hausman and Taylor (1981) for two reasons. First, the Hausman and Taylor (1981) approach would impose the analyst the delicate task to split right side variables into exogenous and endogenous variables (Verheyden, 2009). Second, the inclusion of many additional regressors (mean values and deviations from mean values) reduces the degree of freedom and then the quality of the estimates when using small sample size, especially in the time dimension. For instance, Péridy (2005) and Adja (2007) follow the approach of Hausman and Taylor (1981) because they use large sample size.

Considering the same dependent variable and vector of independent variables of equation (9), the random fixed effects model is represented as follows:

$$Z_{ijt} = \mu + \delta'_{ijt} W_{ijt} + v_{ijt} \text{ where } v_{ijt} = \alpha_{ij} + \xi_{ijt} \qquad (10)$$

where δ'_{ijt} is the transpose vector of the k parameters to be estimated, μ the constant term common for all individuals and time periods, and v_{ijt} the residuals. The residuals v_{ijt} are split into the random individual effects α_{ij} correlated with explanatory variables, that is, $E(\alpha_{ij} / W_{ijt}) \neq 0$, and an error term ξ_{ijt} assumed to be independent and identically distributed.

Let $\overline{W_{ij}}$ be the vector of the mean values of the right side variables W_{ijt} in relation (9). Mundlak (1978) assumes that the random effects α_{ij} are a linear combination of the mean values $\overline{w}_{ij}$ and an orthogonal term α_{ij}^{*} as follows: $\alpha_{ij} = \lambda'\overline{W}_{ij} + \alpha_{ij}^{*}$.

The final Mundlak (1978) specification is then written as follows:

$$Z_{ijt} = \mu + \alpha_{ij}^{*} + \delta' W_{ijt} + \lambda' \overline{W_{ij}} + \xi_{ijt} \qquad (11)$$

When the disturbance of the random effect model is not correlated with the explanatory variables, GLS estimator of equation (10) is used because it is the best linear unbiased estimator (BLUE).

Given that distance is commonly used in gravity models as a proxy for transport costs, we alternatively use data on these transport costs in the form of *ad valorem* freight rate $F_{ijt}^{k} = \left(IFC_{ijt}^{k} / p_{it}^{k}\right)$, where IFC_{ijt}^{k} is the actual insurance and freight costs and p_{it}^{k} being the fob price in the exporting countryas indicated in Harrigan (1993), Baier & Bergstrand (2001), Head & Ries (2001), Hummels (2001), Limao & Venables (2001), and Anderson and van Wincoop (2004). Hence in the alternative specifications of equations (7) and (8), we replace distance D_{ij} by the term $\left(1 + F_{ijt}^{k}\right)$.

3. Data description and empirical results

The equations (10) and (11) are estimated for imports of green beans in Belgium-Luxembourg, France, Germany, Netherlands, and United Kingdom from Kenya and frozen , and, Spain from Kenya, Uganda, and Tanzania taken together to obtain continuous series of trade flows and prices. We name this source of EU imports East African Community (EAC) as these three countries are the founding states of this regional trade agreement. Leguminous vegetable (green beans and fresh peas) are along with cut flowers, coffee, and tea the top four Kenyan exports to EU representing more than 86 per cent of its total exports to EU in 2000 (Odek, 2003). In addition, according to the UN-COMTRADE database, the selected EU-15 countries account for more than 96 per cent of the total value of Kenyan exports of green beans. Likewise, the imports of green beans from Kenya in EU-15 have been increasingly economically important as its value in the total value of imports has increased from an average of 17 per cent in 1988 to 24 per cent in 2008. The mean *ad valorem* tariff equivalent of non-tariff measures is particularly important in the period 200-2004 where it averages 60 per cent. Frozen fish fillets exports from Kenya, Uganda and Tanzania earn less than horticultural products and EU-15 imports of frozen fish fillet from the EAC have decreased economically over time as its value in the total value of imports has declined from an average of 2.30 per cent in 1996 to 1.15 per cent in 2006. However, annual landings of fish from the Lake Victoria is actually varying from 8,000 to 1,000,000 tons and generate US$ 350 to 400 millions at the shore and near US$ 250 millions from exports. This commodity constitutes an interesting case of study because its trade faces high values of *ad valorem* tariff equivalent exceeding 200 per cent for some countries especially during the period 1997-1999 covered by the three successive EU-15 bans on fish imports from EAC (Nimenya *et al.*, 2009).

3.1. Data description

We limit our investigation on trade flows of green beans between 1990 and 2008 and trade of frozen fish fillets between 1996 and 2006 from three Eastern African countries because of data availability. Among the EU countries the United Kingdom is by far the main destination of Kenyan exports of green beans with annual imports averaging € 34 millions between 1990 and 2008 and corresponding to about 60 per cent of the total imports of these five EU countries (Table A.1 in the Appendix). The Netherlands is by far the leading destination of frozen fish fillets from the EAC with annual imports averaging € 12.4 millions between 1996 and 2006 and corresponding to 49 per cent of the total imports of these seven EU countries (Table A.2 in the Appendix).

For trade flows we prefer to use data on imports from the Comext database of Eurostat than data on exports from the Revenue Authorities of the three Eastern African countries because of their greater reliability. Large variations in export unit values are observed for consecutive years. For green beans we use the 070820 disaggregated category and for frozen fish filets the 030420 disaggregated category of the Harmonised System. For production in value of green beans and frozen fish fillets we use production volumes and prices from the FAOSTAT database. On average Kenya production of green beans represents 1.8 per cent of the world production while EAC production of frozen fish fillets represents 2.1 percent of the world production (Tables A.1 and A.2. in the Appendix). We approximate expenditures on human consumption of green beans and frozen fish fillets in the EU countries with the apparent consumption in value calculated from domestic supply, imports and exports taken from the FAOSTAT and Comext databases. On average expenditures on green beans are the highest in France (€million 478) and the lowest in the Netherlands (€million 49) (Table A.1 in the Appendix). On average expenditures on frozen fish fillets are the highest in Germany and France where they exceed € million 470, e lowest in Portugal where they are lower than € million 27 (Table A.1 in the Appendix). We use the nominal exchange rate from the New Cronos database of Eurostat to convert price data expressed in US$ per ton into Euro.

We use the *ad valorem* tariff equivalent rates (AVE) of non-tariff measures for European imports of green beans and frozen fish fillets from the Eastern African countries from Nimenya *et al.* (2009). These authors estimate these tariff equivalents by adapting the price-wedge method to account for imperfect substitution and factor endowment in monopolistic competition. Table A.1 in the Appendix shows that the average AVE of non-tariff measures for imports of green beans from Kenya between 1990 and 2008 are the lowest for the UK (39 per cent), the first leading destination among the EU-15, and the highest for Germany (60 per cent). Table A.1 in the Appendix reports that the average AVE of non-tariff measures for imports of frozen fish fillets from the EAC between 1996 and 2006 are the lowest for the Netherlands (12 per cent), the first leading destination among the EU-15, and the highest for France (198 per cent) and Spain (206 per cent). This large variation in the tariff equivalents for frozen fish filets among EU countries is due to different implementation of regulations among EU member states regarding fish imports from East African countries. According to Abila (2003), when Spain and Italy banned fish imports from Kenya, claiming the presence of salmonellae in November 1997, other EU countries continue to import fish from Kenya and its neighbours on the basis of bilateral agreements. The AVE of non-tariff measures for trade in frozen fish fillets is higher than for green beans with a large standard deviation. Table A.1 in the

Appendix provide the descriptive statistics for the continuous variables used in the gravity equations of the trade flows for green beans and frozen fish fillets respectively.

Data on bilateral distances are taken from http://www.indo.com/distance where the distance is measured using the "great circle" formula as in Anderson and Wincoop (2003). Insurance and freight costs are approximated by the difference between the export and import unit values taken from the FAOSTAT database and the Comext database of Eurostat respectively.

The dichotomous colonial variable is constructed according to the colonial historical tie of the three East African countries. Kenya and Uganda were indeed British protectorates from 1896 to 1920 and then became British colonies untill 1962. Tanzania was part of the German East Africa until 1922 when it was declared a Trust Territory of the United Nations, with Britain's role to ensure its progress towards self-government and eventual independence (Christopher, 1984). The colonial variable equals unity if the destination of exports is the United Kingdom and zero otherwise. For the trade flows of frozen fish fillet, we add a dichotomous variable taking the value of one during the period of the successive EU bans (1997 to 1999) on fish imports from EAC and zero otherwise.

For the trade of green beans, two dichotomous variables for regional trade agreements named 'COMESA' for the Common Market for Eastern and Southern Africa and 'EAC' for the East African Community are constructed according to the date of membership of Kenya to these two regional trade agreements. The treaty for the establishment of the COMESA was signed in October 1994 to replace the former Preferential Trade Agreement. Under this treaty food safety standards are being harmonized to increase intra-COMESA trade. The treaty for the establishment of the EAC was signed on 30th November 1999 and entered into force on 7th July 2000 following its ratification by the three founding states, i.e., Kenya, Uganda and Tanzania (EAC, 2010). Shared investments to comply with EU food standards are being made under this treaty. For instance, the Lake Victoria Basin Commission (LVBC) and the Lake Victoria Fisheries Organisation (LVFO) are among the institutions of the EAC involving especially the three founding states of the EAC. These two institutions intend in particular to guide, support and implement the building of capacity of communities to participate in the management of the basin. Increased harmonisation of laws, regulations and standards and increased public awareness on environmental and socio-economic issues are among the expected benefits. The 'COMESA' variable takes the value of zero prior to 1995 and one since 1995 in the specification of trade flows of green beans. Likewise the 'EAC' variable takes the value of zero prior to 2001 and one since 2001 for the specifications of trade flows of green beans and frozen fish fillets.

The export free on board in the exporting country is taken from FAOSTAT database while the internal consumer price in domestic market of the importing country is proxied by the unit expenditures on human consumption.

3.2. Preliminary data analysis

We follow Hurlin (1999) and Sevestre (2003) to estimate the gravity equations (7) and (8) Table A.2 in the Appendix indicates the sequence of the Chi-square and Fisher tests on panel data referring to equation (7). This sequence of tests also applies to equations (8). The Fisher test on the homogeneity of the slopes systematically rejects the panel structure of equations (7) and (8). In such case, Hurlin (1999) suggests estimating the different equations separately using individual time series. We, however, do not follow this recommendation because the rejection of the panel structure is not reliable when the time dimension is closed enough to the dimension of the vector of the coefficients. This is the case for both trade flows, in particular for trade flows of frozen fish fillets. Because $(K+1)$ tends to T, K being the number of regressors and T the time dimension, the calculated Fisher test statistic is always greater than the theoretical Fisher test corresponding to $(N-1)K$ and $NT-N(K+1)$ degrees of freedom. According to the second testing rule of Table A.2 in the Appendix, the Fisher test would then lead to the incorrect rejection of the panel structure. Hence, the use of time series when the time dimension is closed enough to the number of regressors yields a spurious regression.

Destinations of the African exports are taken as cross-section units to construct panel data for the same product and origin. We follow Maddala (1994) and Wu (1996) to test the stationarity of the variables involved in the gravity equations with the exception of the distance and dichotomous variables. These two authors propose a test combining the p-values π_j obtained from the Dickey-Fuller (DF) or Augmented-Dickey-Fuller (ADF) unit root tests for each cross-sectional unit $j = 1,..., N$ as follows:

$$t_{Maddala\ \&Wu} = -2\sum_{j=1}^{N} \ln(\pi_j) \rightarrow \chi^2_{2N} \tag{12}$$

The Maddala (1994) and Wu (1996) test is a Chi-square distributed test with $2N$ degrees of freedom under the assumption of cross-sectional independence, N being the number of cross-sectional units. Table A.3. in the Appendix gives the Chi-square statistics of unit root tests on continuous variables involved in equations (7) and (8). Most of the variables are log-level stationary except for imports of frozen fish fillets and the related insurance and freight costs, and expenditures on human consumption on green beans and frozen fish fillets. The dependent variable of equation (8), unlike that of equation (7) is always stationary.

3.3. Empirical results and discussion

For each food product, we present and compare results from both the restricted and unrestricted models. We then test whether imposing unitary elasticities of output and expenditures is appropriate with a Fisher test. For both unrestricted and restricted models, we perform six estimations because we test three approaches of dealing with the unobservable multilateral trade resistance factors: (i) the use of consumer prices, (ii) the use of country and time specific effects, and (iii) the combination of consumer prices and country and time specific effects. We only present the results from the best econometric estimation. Since the continuous variables are transformed in their natural logarithms, their coefficients are interpreted as elasticities. The interpretation of the partial elasticities of dichotomous variables is based on the contribution of Halvorsen and Palmquist (1980) who provide an interpretation of dummy variables in semi-logarithmic equations.

Table 1 gives the gravity estimates of the trade effect of non-tariff measures on the European imports of green beans. For this food product, the unrestricted model is estimated with the combination of the country and time fixed effects, consumer prices to cope with the unobservable multilateral trade resistance and the use of *ad valorem* freight rate instead of distance. We choose these fixed effects specification because the Hausman test rejects the null hypothesis of consistency of GLS estimators at a Chi-square test statistic of 68.52 significant at 1 per cent level of probability. Time and individual-invariant variables such as exporting country and world output are dropped with the adoption country and time-fixed effects. In addition, the variable "colonial" tie is no included in the model because it is correlated with the fixed effect of the United Kingdom. Finally, robust score Chi-square ($\chi^2(1) = 0.41,\ p = 0.5206$) and robust regression Fisher tests ($F(1{,}63) = 0.27,\ p = 0.6010$) performed after a 2 SLS instrumental variables regression do not reject the null hypothesis stipulating that the importing country expenditures are exogenous. As in Emlinger *et al.* (2008), the estimation is performed without using instruments.

The estimation of the unrestricted gravity model is robust with an R-squared amounting to 0.99 (Table 1). All the explanatory variables included in the model are jointly relevant to explain the imports value according to Fisher test statistic of global fitness. Likewise, the significance of the Fisher test statistic shows a joint significance of country and time-dummies.

We follow other several studies (Péridy (2005), Henry de Frahan and Vancauteren (2006), Olper and Raimondi (2008) to make an econometric interpretation of the whole estimates of the variables included in the trade costs of relation (4). We are however aware of the sensitivity of these coefficients to the value of elasticity of substitution as shown in Hummels (2001). The best way would be to first estimate this elasticity and then infer the size of the trade costs variables. We should follow Hummels (2001) and Head and Ries (2001) to compute the elasticity of substitution by estimating an additional regression between *ad valorem* freight and distance. However, because of our limited panel, we find that the distance has always a significantly positive coefficient. Indeed, despite that the UK is the farthest country from Kenya; it remains the leading EU importer of green from this country. Consequently, this would lead to a negative elasticity of substitution.

Table 1 - Gravity estimates from panel data estimation on European imports of green beans from Kenyan (1990-2008)

Variable	Unrestricted model (equation 7) Fixed effects specification		Restricted model (equation 8) Random effects specification	
	coefficient	p-value	Coefficient	p-value
Ln (expenditures E_{jt}^{k})	- 0.73*** (-4.19)	0.000	-	-
Ln (1+ AVE_{ijt}^{k})	0.37 (0.61)	0.546	0.38 (0.41)	0.684
Ln (1+ F_{ijt}^{k})	- 2.01*** (-3.26)	0.000	-0.92 (-0.99)	0.324
$COMESA_{it}$	- 0.48 (-1.25)	0.214	0.61 (0.85)	0.398
EAC_{it}	0.46 (1.61)	0.112	- 0.01 (-0.01)	0.999
Ln ($p_{it}^{k}.p_{jt}^{k}$)	0.48*** (2.39)	0.002	-0.21 (-1.02)	0.308
Importing-country effects				
Belgium-Luxembourg	-1.29*** (-5.86)	0.000		
France	0.92** (2.18)	0.033		
Germany	-2.88*** (-16.16)	0.000		
Netherlands	-1.69*** (-8.76)	0.000		
Constant	18.18*** (9.36)	0.000		
Number of observations	95		95	
R-squared	0.99		0.401	
Specification tests: - F-test (7) *vs* (8)	F(1,68) = 98.97***			
- Tests of endogeneity	Robust Score $\chi^2(1) = 0.41$ Robust regress. F(1,63) = 0.27			
- Haus. test: FE *vs* RE	$\chi^2(21)$ = 68.52***		$\chi^2(21)$)= -	
- Country effects	$F(4,68)$) = 160.28***		$\chi^2(21)$ = 394.53***	
- Time specific effects	$F(16,68)$ = 2.71***		$\chi^2(16)$= 34.47***	
- Global fitness test	$F(26,68)$ = 34.32***		$\chi^2(21)$= 1.91***	

The symbols *, ** and *** denote statistical significance at 0.10, 0.05 and 0.01 probability level respectively; the t-statistics are indicated in parentheses beneath the estimated coefficients.

The estimate of the *ad valorem* tariff equivalent rate for non-tariff measures is not statistically significant suggesting that non-tariff measures do not affect significantly trade flows in green beans. This result corroborates the opinion of the personnel of the Kenya Plant Health Inspectorate Service (KEPHIS) and the Horticultural Crop Development Authority (HCDA) according to which sufficient resources have been committed to overcome the challenges posed by food safety standards in the horticultural sector. This personnel indicates that both the private domestic standards (Kenya good agricultural practises, Horticultural crop trading initiatives) and the public standards (Kenya Bureau of standards, HCDA code of practices, etc.) in Kenya are as much stringent as the European food safety standards. According to the data from the European centre for fruits and vegetables also reported by the Belgian federal service of food safety "*Agence fédérale de la sécurité de la chaine alimentaire*", there was no border rejection for 123 Kenyan shipments of horticultural products between 2001 and 2004 where these data are available. This information seems to confirm the point of view of the Kenyan institutions involved in the horticultural crop development.

The coefficient of the expenditures on human consumption of green beans in EU importing countries is unexpectedly significantly negative. The results for the *ad valorem* freight rate, colonial and the product of consumer prices are however in line with our expectations.

The expected positive sign of the estimate of the product of consumer prices in trading countries show that when the average trade costs that face a given country i with its trading partners except for country j goes up, the bilateral trade between countries i and j increases. However this increase in trade is lesser than proportionate as an increase of 1 per cent in the multilateral trade resistance increases bilateral trade by 0.48 per cent.

Table 2 gives the estimates of the interaction between the ad valorem tariff equivalent and the importing-country fixed effects using multiplicative dummies. The impact of *ad valorem* tariff equivalent on trade differs significantly among European importing countries. For instance imports of green beans from Kenya are very sensitive to the non-tariff measures prevailing in Belgium-Luxembourg, France and Netherlands domestic markets. However for this latter country, non-tariff measures are trade catalysts rather than barriers. Hence this country may constitute a promising market in a perspective of Kenyan exports' expansion. These results corroborate the findings from Nimenya *et al.* (2009) showing considerable variations among EU countries despite the single market.

For trade of frozen fish fillets in both unrestricted and restricted models, the best results are obtained using the random-effects specification on an equation including time specific dummies and distance rather than *ad valorem* freight rate (Table 3). Indeed, the Hausman test favours the GLS estimator rather than the *Within* estimator. In addition the Breusch-Pagan Lagrange Multiplier (LM) confirms the presence of significant random differences across importing countries suggesting that the random effects specification is appropriate while the Chi-square test confirms the joint significance of time specific dummies.

With this specification, the individual-invariant variables such as world and exporting country output are dropped because of collinearity. Using the combined tests of Durbin (Score) and the Wu-Hausman on the expenditures to consumption of frozen fish fillets, we dot not reject the null hypothesis according to which this variable is exogenous. The estimation is then performed without using instruments.

Table 2. Interaction between *ad valorem* tariff equivalent and importing –country fixed effects

Variable	Coefficient	t-statistic	p-value
Ln (expenditures E_{jt}^{k})	0.08	0.38	0.708
Ln (1+ F_{ijt}^{k})	-1.86***	-2.78	0.007
$COMESA_{it}$	0.03	0.18	0.856
EAC_{it}	0.31**	2.48	0.015
$p_{it}^{k}.p_{jt}^{k}$	0.17	1.46	0.148
Importing - country effects			
Belgium-Luxembourg	-1.23**	-2.13	0.036
France	0.55	0.70	0.485
Germany	-3.11***	-5.24	0.000
Netherlands	-3.00***	-4.91	0.000
Importing-country effects* *ad valorem* tariff equivalent			
Ln(1+ AVE_{ijt}^{k})*Bel.-Luxemb	-2.38**	-2.34	0.022
Ln (1+ AVE_{ijt}^{k})*France	-3.25***	-3.08	0.003
Ln (1+ AVE_{ijt}^{k})*Germany	-0.31	-0.52	0.604
Ln (1+ AVE_{ijt}^{k})*Netherlands	3.01***	3.04	0.003
Ln (1+ AVE_{ijt}^{k})*UK	0.02	0.01	0.991
Constant	9.57***	4.00	0.000
Number of observations	95		
Adjusted R-squared	0.89		
Global fitness	F(14,80) = 60.22***		

The symbols *, ** and *** denote statistical significance at 0.10, 0.05 and 0.01 probability level respectively

Here also the estimation of both gravity models is robust. The R-squared of the unrestricted and restricted models amount to 0.86 and 0.84 respectively and the Wald Chi-square test show a global fitness of the model.

Results from Table 3 show that the *ad valorem* tariff equivalent rate for non-tariff measures is here statistically significant and negative with an import elasticity of -1.11. The successive European bans on fish imports from that region additionally reduce imports by 68 per cent *[100(exp (0.52)-1]*. This estimate is within the same range as the decline of 13, 32 and 62 per cent in foreign exchange earnings following the EU bans on frozen fish fillets estimated for 1997, 1998 and 1999 respectively by Abila (2003). The other control variables are not significant.

Table 3 - Gravity estimates from panel data estimation on European imports of frozen fish fillets from East African Community (1996-2006)

Variable	Unrestricted model (equation 7) Random effects specification coefficient	p-value	Restricted model (equation 8) Random effects specification Coefficient	p-value
Ln(expenditures E_{jt}^{k})	0.35* (1.64)	0.101	-	-
Ln (1+ AVE_{ijt}^{k})	-1.11*** (-11.33)	0.000	-1.05*** (-10.44)	0.000
Ln D_{ij}	33.62 (0.41)	0.679	54.61 (0.53)	0.593
EAC_{it}	0.069 (0.29)	0.772	0.61** (3.42)	0.001
BAN_{ijt}^{k}	-0.52** (-2.22)	0.026	0.13 (0.68)	0.495
Ln ($p_{it}^{k}.p_{jt}^{k}$)	0.15 (0.39)	0.694	0.55 (1.51)	0.131
Constant	-71.71 (-0.41)	0.684	- 126.90 (-0.57)	0.567
Number of observations	77		77	
R-squared	0.86		0.84	
Specification tests				
- F-test: (7) *vs* (8):	$\chi^2(1) = 8.8$***			
- Haus. test: FE *vs* RE	$\chi^2(11)$ = -		$\chi^2(12)$ = 0.06	
- Random effects	LM $\chi^2(1)$ = 309.23***		LM $\chi^2(1)$ = 327.13***	
- Time fixed effects	$\chi^2(8)$ = 14.49*		$\chi^2(8)$ = 57***	
- Global fitness test	Wald $\chi^2(14)$ = 84.27***		Wald $\chi^2(13)$ = 333.54***	

The symbols *, ** and *** denote statistical significance at 0.10, 0.05 and 0.01 probability level respectively; the t-statistics are indicated in parentheses beneath the estimated coefficients.

Table 4 displays results from the interaction between the *ad valorem* tariff equivalent and the importing-country specific effects. Results show that except for the Netherlands where non-tariff measures encourage trade, Italy and Spain where the estimate of the ad valorem tariff equivalent of NTMs is not significant, non-tariff measures set in other European importing countries undermine trade. In addition, the EU bans on fish imports from Kenya, Tanzania and Uganda are significantly trade reducing in France and Spain.

Results from the econometric specification of the gravity model of Table 4 show that the main control variables are not significant. An increase in the value of production in exporting country and expenditures in importing country are theoretically assumed to increase the imports value. This insignificant sign can, however, be explained given the development of new outlets for exports of frozen fish fillets towards non-European countries such as Israel, Japan, Singapore and the United Arab Emirates, in particular after the successive European bans on fish imports from Eastern African countries between 1997 and 1999. For instance, the European share of fish exports from Kenya drops from 62 per cent in 1996 to 21 per cent in 2003 while the Israeli and Far Eastern share of fish exports from Kenya rise to 42 and 26 per cent in 2003 (Abila, 2003). Countries of the EAC increase their production of frozen fish fillet while reducing their exports to European countries.

Table 4. Effect of interaction between *ad valorem* tariff equivalent and importing country specific effects on imports of frozen fish fillets in selected EU countries from East African countries

Variable	coefficient	t-statistic	p-value
Ln (output Y_{it}^{k})	-0.14	-0.31	0.755
Ln (expenditures E_{jt}^{k})	-0.15	-1.28	0.205
Ln (output Y_{t}^{k})	-0.88	-0.71	0.482
Ln D_{ij})	33.55**	2.27	0.027
EAC_{it}	-0.01	-0.01	0.995
Ln ($p_{it}^{k}.p_{jt}^{k}$)	0.89*	1.73	0.090
Importing-country effects* *ad valorem* tariff equivalent			
Ln (1+ AVE_{ijt}^{k})*Belg.-Lux	-1.60**	-2.04	0.046
Ln (1+ AVE_{ijt}^{k})*France	-2.04***	-8.13	0.000
Ln (1+ AVE_{ijt}^{k})*Germany	-1.63***	-3.23	0.002
Ln (1+ AVE_{ijt}^{k})*Italy	-0.82	-1.03	0.307
Ln (1+ AVE_{ijt}^{k})*Netherlands	4.39*	2.00	0.051
Ln (1+ AVE_{ijt}^{k})*Portugal	-2.69***	-3.59	0.000
Ln (1+ AVE_{ijt}^{k})*Spain	0.23	0.74	0.462
Importing-country effects* *BAN effecs*			
BAN*Bel. Luxembourg	-0.51	-0.71	0.479
BAN*France	-1.36**	-2.44	0.018
BAN*Germany	-0.14	-0.20	0.843
BAN*Italy	-0.58	-0.50	0.622
BAN*Netherlands	-0.53	-0.73	0.468
BAN*Portugal	-0.11	-0.15	0.879
BAN*Spain	-1.46*	-1.99	0.052
Constant	-49.16	-1.44	0.156
Number of observations	77		
Adjusted R-squared	0.69		
Global fitness	F(20,56) = 9.56***		

The symbols *, ** and *** denote statistical significance at 0.10, 0.05 and 0.01 probability level respectively;

4. Concluding remarks

This study is a contribution to the continuing challenge of modelling the trade impact of non-tariff measures. While poor proxy variables for these measures are commonly used in the empirical literature, this study uses tariff equivalent rates of a set of non-tariff measures in the gravity equation proposed by Anderson and van Wincoop (2004) for product-specific trade flows. As the imposition of unitary elasticities of output and expenditures is still debated in the theoretical literature, this study brings an additional empirical evidence that such restriction is not appropriate for our panels.

Allowing for non-unitary elasticities of output and expenditures in a gravity equation, our estimations show that the impact of non-tariff measures on trade flows of food products from some representative African countries depends on the product considered. The inception of European food safety standards does not affect significantly European imports of green beans from Kenya. In contrast, similar European standards affect significantly European imports of frozen fish fillets from East African countries by an import elasticity of the ad valorem tariff equivalent of -1.11 suggesting that an increase of 1 per cent in the *ad valorem* tariff rate of non-tariff measures induces a decline in trade value of about 1.1 per cent; The three European bans on fish imports from these countries between 1997 and 1999 reduce yearly these imports by 68 per cent compared to the rest of the sample period corresponding to average losses of about € million 2.5.

It seems that Kenya has been successful to convert the challenges posed by non-tariff measures into opportunities by modernising its export supply chain of its horticultural sub-sector and maintain its import share in the European countries. However, Kenya, Tanzania and Uganda seem to have been less successful to overcome these challenges. Why Kenya is successful in horticultural supply chain while the fish exports to the EU still face significant trade impediments from non-tariff measures? [12] There are two main reasons

[12] Even though both the three EAC members had comparable shares to exports of Nile Perch prior to EU bans and both suffered dramatically from these bans, they react differently after the year 2000. By 2003, Tanzania recovered its exports and even increases its share to 60 per cent, Uganda reaches about 30 per cent while Kenya' export share declined considerably to 10 per cent in the post-ban period (Frohberg, Grote and Winter, 2006).

to this. First, food safety standards might be particularly stringent for fish products which are prone to rapid pathogenic contamination. According to some estimates, the consumption of unwholesome fish and fishery products accounts for as much as 30 per cent of all food-borne illnesses in the world and consequently, nearly 10 per cent (13 million metric tons) of the world's total fish production is lost as a result of spoilage (Abila, 2003). Second, while "proactive compliance" with European public and private-sector standards (Frohberg, Grote and Winter, 2006) thanks to an active private sector engaged in horticulture (UNCTAD, 2008) and considerable financial support and technical assistance from the donor community (FAO, 2006) have lead the horticultural sector to improve its competitiveness in spite of relatively high freight costs, "*reactive compliance*" and "*reactive exit*" (Henson and Mitullah, 2004) coupled with an increasing competition from modern processing plants in Tanzania and Uganda hampered the recovery of the fish export sector in Kenya (Frohberg, Grote and Winter, 2006).

Our results may have some policy implications. As the effect of non-tariff measures on East African countries exports to European countries differs from one importing country to another, these African countries need to focus to the origins of these differences in discussing trade issues with their European partners. Given that some importing countries constitute promising markets able to stimulate African exports while others are limiting trade, these trade debate we suggest should be done on bilateral rather multilateral framework.

This study however, suffers from some drawbacks. First, the panel size particularly in its time dimension is very limited. Some unexpected signs of coefficients are inherent to this shortcoming. For instance, UK is the destination of about 60 per cent of the EU-15 total imports of green beans from Kenya even though it is the furthest European country from this African country. Hence, the variable 'distance' is very likely to have a positive sign. This constitutes a serous handicap in the derivation the elasticity of substitution which is essential in the economic interpretation of the results related to trade costs variables.

Second, even though the exporting and world output are dropped due to the adoption of time and country specific effects and given hat the expenditures in the importing country is exogenous, there is still an endogeneity problem that need to be overcome. Given that we use *ad valorem* tariff equivalent generated from an econometric estimation using quantity of trade, elasticity of substitution and consumer preferences (see Nimenya *et al.*, 2009), this could have some econometric implications (Disdier *et al.*, 2008). To improve the econometric results, these authors suggest the use of the Full Information Maximum Likelihood (FIML) method, where all the equations of the structural model are estimated simultaneously by maximizing the likelihood function subject to restrictions on all the parameters in the model. In addition the theoretical gravity equation from Anderson and van Wincoop (2004) assumes identical preferences and technology across countries. Hence, the use of elasticity of substitution among goods produced in foreign countries that differ from the elasticity of substitution between home and foreign goods and the assessment on the extent to which these differences in preferences affect trade costs may constitute an area of future research.

This study has only focused on trade effect of non-tariff measures. Limiting the analysis of non-tariff measures to their trade effect would be equivalent to treat them as tariffs. Focusing their study on the effect of the level of chloramphenicol residues on imports of crustacean products, Disdier and Marette (2010) show that stricter standards of non-tariff measures can be trade distorting and welfare improving. Extension of their approach by dropping the assumption of homogenous goods is another interesting field for future research on this topic.

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Appendix

Table A.1. Summary statistics of the continuous variables used in the econometric estimation

Product, origin and period	Country	Variable	Mean	Std dev.	Min.	Max.
Green beans (070820) from Kenya (1990-2008)	BE-LU	Imports (€ million)	3.78	2.67	1.49	12.38
		Consumption (€ million)	127.47	51.86	46.25	236.87
		AVE (%)	42.05	16.87	8.88	67.67
	FR	Imports (€ million)	11.85	1.46	9.49	14.44
		Consumption (€ million)	478.44	102.11	310.60	706.78
		AVE (%)	53.95	16.94	23.22	82.93
	DE	Imports (€ million)	1.56	1.83	0.59	8.11
		Consumption (€ million)	92.70	27.88	66.50	160.71
		AVE (%)	60.17	30.62	13.25	112.83
	NL	Imports (€ million)	5.66	4.90	0.67	19.01
		Consumption (€ million)	48.78	15.19	24.65	73.75
		AVE (%)	48.24	19.78	8.45	77.41
	UK	Imports (€ million)	34.00	21.42	8.74	69.86
		Consumption (€ million)	57.59	20.57	32.61	95.65
		AVE (%)	39.21	9.26	19.43	55.45
	KE	Output (€ million)	13.89	5.55	3.92	21.75
	WD	Output(€ million)	763.04	191.61	451.53	1023.39
Frozen Fish filets (030420) from the EAC (1996-2006)	BE	Imports (€ million)	3.99	3.72	0.54	14.82
		Consumption (€ million)	74.20	11.54	51.31	86.68
		AVE (%)	41.47	65.66	0.72	236.38
	FR	Imports (€ million)	0.47	0.39	0.04	1.25
		Consumption (€ million)	470.15	81.86	326.47	610.74
		AVE (%)	197.48	335.50	4.00	1162.23
	DE	Imports € million)	1.38	0.96	0.14	3.57
		Consumption (€ million)	97.80	134.82	412.63	818.43
		AVE (%)	74.80	163.22	6.86	557.55
	IT	Imports (€ million)	1.48	0.78	0.22	3.20
		Consumption (€ million)	202.71	31.50	156.13	270.41
		AVE (%)	95.43	211.83	12.31	724.60
	NL	Imports (€ million)	12.42	3.80	4.56	18.37
		Consumption (€ million)	97.81	37.12	35.30	168.16
		AVE (%)	12.34	13.44	4.79	52.18
	PT	Imports (€ million)	1.33	0.77	0.28	2.64
		Consumption (€ million)	26.54	9.12	14.28	40.78
		AVE (%)	50.73	72.36	5.49	243.29
	ES	Imports (€ million)	4.18	3.02	0.73	10.23
		Consumption (€ million)	232.58	57.93	145.66	318.29
		AVE (%)	206.27	200.18	11.39	633.56
	EAC	Output (€ million)	0.05	0.01	0.04	0.07
	WD	Output (€ million)	2.55	0.26	2.24	3.03

Source: Comext database of Eurostat for trade, FAOSTAT database for production, and Nimenya *et al*. (2009) for *ad-valorem* equivalent (AVE) of non-tariff measures

Table A.2. Sequence of Chi-square and Fisher tests on panel data analysis using the gravity equation (7)

Hypothesis	Chi-square and F-statistical tests[a]	Testing rules
1. Global homogeneity test: $H_0^1 \equiv \alpha_{0j} = \alpha_0; \alpha_{kj} = \alpha_k$ $\forall j \in [1, N]; \forall k \in [1, K]$ $H_a^1 \equiv \exists (j,l) \in [1, N] / \alpha_{0j} \neq \alpha_{0l}$ $or\, \alpha_{kj} \neq \alpha_{kl}$	$F_1 = \dfrac{(SSRR_1 - SSRU_1)/[(N-1)(K+1))]}{SSRU_1 / [NT - N(K+1)]}$	Reject H_0^1 if: $F_1 > F_{\alpha\%}[(N-1)(K+1), [NT - N(K+1)]]$. If not, the panel is homogenous in all the parameters.
If hypothesis H_0^1 is rejected, we perform the following tests		
2. Homogeneity test on the slopes α_{kj}: $H_0^2 \equiv \alpha_{kj} = \alpha_k \;\; \forall j \in [1, N];$ $\forall k \in [1, K]$ $H_a^2 \equiv \begin{array}{l} \exists (j,l) \in [1, N]; \\ \exists k \in [1, K] / \alpha_{kj} \neq \alpha_{kl} \end{array}$	$F_2 = \dfrac{(SSRR_2 - SSRU_2)/[(N-1)K]}{SSRU_2 / [NT - N(K+1)]}$	Reject H_0^2 if: $F_2 > F_{\alpha\%}[(N-1)K, [NT - N(K+1)]]$. If the null hypothesis is rejected, there is no panel structure and it is better to specify different equations for each individual.

(a): $SSRR$ and $SSRU$ are residual sums of squares in the restricted and unrestricted models respectively; N is the number of cross-sectional units in the panel structure; K is the number of regressors while T is the time dimension and $\alpha\%$ a probability threshold, generally 10 per cent.

Table A.2. *(Continued)*

Hypothesis	Chi-square and F-statistical tests[a]	Testing rules
3. Homogeneity test on constants α_{0j}: $H_0^3 \equiv \alpha_{0j} = \alpha_0 \ \forall j \in [1, N]$ $H_a^3 \equiv \exists\ (j,l) \in [1, N]; \exists k \in [1, K] / \alpha_{0j} \neq \alpha_{0l}$	$F_3 = \dfrac{(SSRR_3 - SSRU_3)/(N-1)}{SSRU_3 / [N(T-1) - K]}$	Reject H_0^3 if: $F_3 > F_{\alpha\%}[(N-1), [N(T-1)-K]]$. If not, there are no individual effects and we have a pooled model.
If hypothesis H_0^3 is rejected, we perform the Hausman test to discriminate fixed and random effects:		
4. Hausman test on individuals effects: $H_0^4 \equiv \chi_K^2$ where K is the number of explanatory variables	$F_4 = (\hat{\beta}_{GLS} - \hat{\beta}_{LSDV})' [\mathrm{var}(\hat{\beta}_{GLS} - \hat{\beta}_{LSDV})]^{-1} (\hat{\beta}_{GLS} - \hat{\beta}_{LSDV})$	Reject H_0^4 if: $F_4 > \chi_K^2(df = K)$. This means that there is a misspecification. We prefer the fixed to random effects specification. If the null hypothesis is not rejected, the model is well specified and the random effects are then adopted

(a): $SSRR$ and $SSRU$ are residual sums of squares in the restricted and unrestricted models respectively; N is the number of cross-sectional units in the panel structure; K is the number of regressors while T is the time dimension and $\alpha\%$ a probability threshold, generally 10 per cent.

Table A.3. Tests statistics of panel data unit root tests on continuous gravity variables (in logarithm) for imports of green beans and frozen fish fillets in selected EU countries

Product and origin	EU importing country	Variable	χ^2_{2N} test statistic
Green beans from Kenya	Belgium-Lux. France Germany Netherlands United Kingdom	M_{ijt}^{k}	22.91**
		$M_{ijt}^{k\,*}$	29.42***
		Y_{it}^{k}	25.90***
		E_{jt}^{k}	7.50
		Y_{wt}^{k}	20.82**
		$1+AVE_{ijt}^{k}$	20.25**
		$1+F_{ijt}^{k}$	31.82***
		$p_{it}^{k} \cdot p_{jt}^{k}$	38.12***
Frozen fish fillets from EAC	Belgium France Germany Italy Netherlands Portugal Spain	M_{ijt}^{k}	20.13
		$M_{ijt}^{k\,*}$	22.99*
		Y_{it}^{k}	27.14**
		E_{jt}^{k}	14.95
		Y_{wt}^{k}	80.42***
		$1+AVE_{ijt}^{k}$	89.34***
		$1+F_{ijt}^{k}$	15.59
		$p_{it}^{k} \cdot p_{jt}^{k}$	36.07**

The symbols ***, **** and ******* denote statistical significance at 0.10, 0.05 and 0.01 probability level respectively.

Chapter 4

Compliance with international food safety standards as an outcome of a Nash bargaining process: a case study on Kenyan horticultural farms

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Abstract

This paper first provides a stylized model using the Nash bargaining theory to analyze strategic responses of Kenyan horticultural farmers to the emergence of more stringent international food safety standards. We consider an exporter and a representative member of producers' association, who bargain over the product quality level and producer price. The comparative statics analysis shows the effects of exogenous parameters on endogenous variables at equilibrium. Unlike the compliance costs, the monitoring and enforcement costs have, ceteris paribus, a positive effect on the equilibrium quality level. The effects of these exogenous parameters have an ambiguous effect on the equilibrium producer price. Second, the study provides empirical results from bivariate probit model estimation with survey data at farm level in Kenya. Wealthier households with highly educated members are more likely to participate in the certified supply chain. Education and credit access could play an important role in the capacity-building of small-scale farmers' association through public-private partnership.

Keywords: *bargaining, small-scale farm, voice, bivariate probit model*

JEL codes: D18, O17, O33, Q13, Q17

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1. Introduction

Food safety standards in developed countries become an important concern for global trade in agricultural and food products (Henson and Jaffe, 2008). Food safety scandals and the ensuing consumer concerns with food contamination by microorganisms and pesticides in the European Union (EU) over the 1990-2000 decade have led governments and retailers to enact stringent food safety regulations (Jaffee, 2003; Mungai, 2004). Food safety standards set in the developed countries becomes particularly challenging when the export supply chain involves actors from developing countries who often lack financial and skilled human resources required for compliance (Otsuki et al., 2001). For instance, large retailers in Europe play an important role in structuring the production and processing of fresh vegetables exported from Africa (Dolan and Humphrey, 2001). These European retailers have been developing their own standards such as GlobalGAP and British Retailers Consortium (BRC) standards and passing them via importers and exporters to foreign suppliers in developing countries who are often *"standards takers"*. Accordingly, there is a concern emerging through the literature that small-scale farms could be marginalized and excluded from the agri-food export supply chain. Some studies argue that farms too small to benefit from economies of size could be the victims of the development of stricter food safety standards in developed countries while the benefits go to multinational companies and developing countries elites (Dolan and Humphrey, 2000; Farina and Reardon, 2000).

This study focuses on the exclusion of Kenyan small-scale farmers from the export supply of green beans to the United Kingdom (UK) retailers. According to the Comext database of Eurostat, 60 to 70 per cent of imports of green beans in the UK originate from Kenya between 1988 and 2008. Until 1990s, the production of green beans in Kenya was dominated by small and medium-scale family farms, mainly because of its labour intensity (Okello, 2005). [14] At that time, the major quality requirements for Kenyan farms were physical attributes such as size, shape and spotlessness that were met by

[14] Collins (1995) mentions additionnal factors that create, or may create, biases against small-scale farms. These factors include working capital intensity, human capital intensity, access to certification, future markets and insurance, vertical coordination, etc. However, the quality of labor that is sometimes referred to as «interactive labor intensity» acts at the disadvantage of large-scale farms.

applying large quantities of pesticides without however adequate protection of the users of sprayers (Okello, 2006). After 1990, significant events took place in the external regulatory environment. For instance, the Food Safety Act in the UK and EU directives on pesticide residues and food hygiene were developed in 1990 while GlobalGAP and BRC food technical standards were set in the middle of the 1990s. Due to the pressure from this new regulatory environment, among other things, the share of Kenyan small-scale farms in the total volume of green beans declines from 55 per cent in the middle of the 1980s to about 11 per cent in 2001 (Dolan and Humprey, 2000; Jaffee, 2003). Hence, the exclusion of Kenyan small farms from the horticultural export supply constitutes the central question that this study addresses both analytically and empirically.

To study analytically this exclusion of small farms from the supply chain, we rely on the Hirschman (1970)'s framework of *'exit'*, '*voice'* and *'loyalty'*. This framework was initially developed to examine the economic and political behaviour following the decline in quality among firms, organizations and states. It has been since extended to different contexts especially in agricultural applied studies by the World Bank (2005), Okello (2006) and Henson and Jaffee (2008) where "*loyalty*" refers to "*compliance*". The emergence of more stringent food safety standards exits less efficient farmers from the certified quality export sector and drive them to alternative markets. More efficient farmers are able to *voice* with their customers on price and quality level following a Nash (1950) *bargaining* process. This analytical framework highlight the pay-offs of the farmers and exporters involved in negotiation and displays the main related comparative statics

On the empirical side, we aim to determine factors that influence the farmer's participation in contract using a bivariate probit estimation underling interdependence between contracting decision and access to credit. We use farm-level survey data collected from the major green bean growing areas of Kenya between October 2003 and June 2004.

The next section presents the analytical model. The third section presents the data. The fourth section presents and discusses the empirical results. The fifth section gives the concluding remarks and outlines some policy implications.

2. The analytical model

This section uses the Nash bargaining theory to conceptualise a simple two-player game where a representative Kenyan small-scale horticultural farmer pertaining to association and an exporter bargain over the producer price and the quality level of the exportable green beans to UK supermarkets. In the Nash bargaining game, two players demand a portion of some good. If the two proposals sum to no more than the total good, then both players meet their demand. Otherwise, both get nothing. In our case, following the inception of more stringent private standards, retailers in developed countries and producers in developing countries are involved in bargaining interactions. These actors can both gain by remaining in the certified quality supply if the formers offer an incentive price and the later efficiently provide an acceptable quality level of their product. If the two players cannot come to an agreement, each of them switches to outside alternatives. We first highlight the assumptions under which the model development is valid and hence present the bargaining model and the resulting comparative statics.

2.1. The assumptions

We consider farmers organised into associations because the data used in the empirical analysis are collected from farmers' associations. Kenyan small-scale horticultural farmers do not work individually. They rather resort to farmers associations to overcome idiosyncratic market failure and attain economies of scale (Okello, 2006). This collective action is beneficial for both producers and buyers. The farmers can attain economies of scale by sharing the fixed costs of compliance and certification while the exporter is motivated to contract with farmers associations to reduce transactions costs of monitoring and enforcement (Okello and Sindi, 2007). However, as this Nash bargaining is a bilateral game, one representative farmer instead of the whole group negotiates with the exporter.

In addition, the upstream and downstream market structure is not easy to characterize. Despite that the presence of more than one exporter operating in the growing green beans areas of Kenya, there is no perfect competition. Indeed the exporter still has a market power as he can decrease the producer price without loosing all his customers. A given farmer unable to contract with one exporter switches to alternative markets with less stringent requirements instead of contracting with a second exporter. For simplicity of analysis, we assume that there is no strong competition among exporters who send their product to the same UK supermarkets. In the remaining of this study, we consider the upstream niche market is a monopsony where one exporter buys all the certified produce from the compliant farmers.

We assume that this exporter is acting as a delegate of the UK supermarkets and passes their requirements to Kenyan horticultural farmers. Even though we focus only on two actors, we know from Dolan and Humphrey (2000) that there are other actors such as importers, retailers and consumers who are not however directly involved in the bargaining game. More capable horticultural farmers comply with the supermarkets food safety standards and sign a contract linking them to the exporter to supply the required quality.

Okello and Swinton (2007) highlight the risk that is linked to such contractual relationship through the principal-agent theory. The buyer-exporter is the principal as he is the less-informed partner while the farmer, the well-informed partner, is the agent. The principal faces uncertainty due to asymmetric information about the effort and performance of the agent that cannot be completely observed. The most prevalent risk arises from the opportunistic behaviour, that' is the risk of deviating from the contractual terms. Authors conclude that partial monitoring combining with performance-based pricing keeps the agent behaviour aligned with the principal objectives. Hence, the exporter bears monitoring and enforcement costs to reduce the information asymmetry. These costs are assumed to increase with the number of compliant farmers. Hence, compliant farmers are "monitored" while non-compliant farmers are not. However, both farmer and exporter still face the opportunistic behaviour risk except when they resort to a third-party authority to avoid loose and informal contracts.

2.2. Pay-offs of the players

To define the pay-offs of the horticultural farmer and exporter, we use the theoretical model for assessing the welfare implications of the adoption of developed countries quality standards in developing countries of Fontaine *et al.* (2009). This model simplifies the assumptions of Mussa and Rosen (1978) on the coexistence of different varieties to consider only one level of certified quality sold to consumers. Fontaine *et al.* (2009) follow Tirole (1988) to represent the quality level using the symbol s instead of q used in Musa and Rosen (1978) to avoid a possible confusion with quantity supplied. As in Mussa and Rosen (1978), the same consumer price is paid by the consumers of a given certified product. Because of certification, the commodity is taken as *search* good, i.e. the buyers are informed on the quality level prior to purchase. On the demand side, the model of Fontaine *et al.* (2009) is summarised by the consumer utility function (1), the demand (2) and the inverse demand (3) for certified quality product as follows:

$$u_\theta^c = \theta . s - p_c^c \geq 0 \text{ with } \theta \in [\underline{\theta}, 1] \tag{1}$$

$$q = 1 - \underline{\theta} = 1 - \frac{p_c^c}{s} \tag{2}$$

$$p_c^c = (1 - q)s \tag{3}$$

where u_θ^c is a linear and monotone consumer utility function in quality level s as follows; θ being the consumer valuation of the quality; p_c^c the consumer price of the certified quality product; the subscript designs an actor (consumer) while the exponent traduces the participation in certified quality market; q the demand for this certified product derived by normalising the mass of consumers at unity as in Mussa and Rosen (1978).

From the equations above, we derive the utility function of the exporter of green beans. The buyer-exporter x purchases green beans from compliant farmer for a price p_p^c and sells them to consumers for a unitary price p_c^c. Theoretically, the price received by the producer should be taken as a premium price to remunerate the quality level s of his product. However, Okello and Sindi (2006) show that the price outside the contract is not necessary lower than that received in the certified quality supply. Sometimes it is even higher but it is very unstable over time. Hence, contract could be considered as a form of insurance for price volatility. More details on the reasons of adopting contract are provided in the third section.

Let δ be the monitoring and enforcement costs, we follow Fontaine *et al.* (2009) to specify the exporter utility function u_x^c in the contract as follows:[15]

$$u_x^c = \left(p_c^c - p_p^c\right)q - \delta q = \left[(1-q)s - p_p^c - \delta\right]q \tag{4}$$

Let u_x^o be the utility of the exporter outside the contract, in order words, his margins when the bargaining fails. We don't know much about u_x^o but it is lower than the utility under contract. If the bargaining process fails indeed, the exporter could bear additional transaction costs to identify other farmers' associations ready to contract and then ensure reliability of supply. For simplicity of modelling the bargaining process, we assume that $u_x^o = 0$.

On the supply side, Fontaine *et al.* (2009) consider a discrete *continuum* of suppliers characterized by producer efficiency' index i restricted to one dimension and defined in the interval $[0,1]$; however only producers with larger values of i participate in the export supply chain as follows:

$$u_i^c = p_p^c - s^{a+1}(1-i) - \frac{C}{n^*} \geq 0 . \tag{5}$$

where u_i is the producer utility function; a is a parameter exacerbating changes in s and is such that $a > 1$; C the group certification costs; n^* the number of compliant producers, that is, the size group of producers whose type $i \in [\underline{i};1]$. Non compliant farmers obtain a price p_p^o outside the contract, that is, in alternative markets. Once again, for simplicity, we assume the grower's utility outside the contract is $u_i^o = 0$.

[15] Authors acknowledge a helpful comment from the 11th PhD ABER/BLVE symposium for mentioning this kind of costs that were not well addressed in our previous draft

As utility functions of the representative farmer (4) and exporter (5) are defined in contract and outside the contract, let specify the corresponding Nash bargaining game and the solution.

2.3. The Nash bargaining game

As highlighted in Dowding *et al.* (2000), the strategic responses of Hirschman (1970) are not mutually exclusive alternatives since they should be used in several combinations. For instance, Dong *et al.* (2010) point out a positive dependence between the contract decision and exit expectations when the grower faces uncertainty about the business survival. We follow Dowding *et al.* (2000) to represent the three strategic responses as a stylized decision tree that begins with the decision on whether or not to voice following dissatisfaction. The voice strategy here referred to the Nash bargaining could be understood as a particular case of this approach of Hirschman because depending on the outcome of voice, the decisions on whether or not to exit should then be taken. The exporter and a representative farmer are involved in cooperative bargaining to reach to an agreement of supplying a given quality product on a contractual basis specifying the price remunerations. Less efficient farmers are likely to exit when standards become more stringent while more efficient able to remain in the export oriented supply sector.

We thus specify a game involving these two players following the Nash (1950) bargaining theory. The corresponding game tree is represented graphically in Figure 1. In the first stage, the representative farmer i and the exporter x bargain over the producer price p_p^c and the quality level s. In the second stage, the exporter sets the consumer price p_c^c depending on market conditions. In the last stage, the farmer decides whether or not to contract. Adopting a backward-induction resolution for this game, solutions of the last two sub games are included in the first stage.

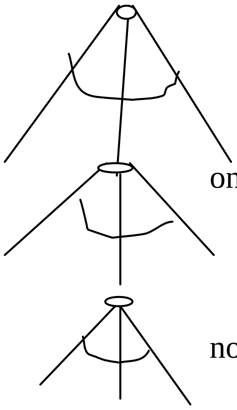

Figure 1: Game tree of a Nash bargaining involving the representative farmer and an exporter of horticultural products

As we are interested in a bilateral bargaining process and given that unlike *exit* which a dichotomous variable, *voice* or *bargaining* is a continuous variable (Dowding *et al.*, 2000), it is relevant to consider one value of the farmer efficiency i. For the purposes of representation, we consider the median grower of the compliant group as the representative farmer type among the discrete continuum of suppliers who negotiates with the exporter. His efficiency is given by $i = \underline{i} + \frac{1-\underline{i}}{2}$. As the parameter $\underline{i}$ represents the farmer type who is indifferent whether or not to supply on a contractual basis, the quantity $1-\underline{i}$ approximates the total production q for the farmers association. Relations (6) and (7) display the pay-offs of the exporter and a representative contracting farmer:

$$u_i^c\left(p_p^c, q, s, C, n^*\right) = p_p^c - \frac{q}{2}s^{a+1} - \frac{C}{n^*} \tag{6}$$

$$u_x^c\left(p_p^c, s, q, \delta\right) = \left[(1-q)s - p_p^c - \delta\right]q \tag{7}$$

Clearly two endogenous variables that are the producer price p_p^c and the quality level s are the key elements of the pay-offs of the two players as shown in relations (6) and (7). This is in accordance with the assertions of Okello and Sindi (2006) on the contents of formal contracts linking Kenyan producers of green beans to exporters.

For agents assumed to be rational and well informed will maximize the product of the differences between the values of the game and the utilities of the situation where the players do not cooperate (Nash, 1953). Nash (1950) provides a solution to the bargaining problem by maximizing the arguments of the product of excess utility, referred to as the Nash bargaining product (NBP) Ω is written as follows (Nash, 1953):

$$\Omega = Log\left[\left(u_i^c - u_i^O\right)\left(u_x^c - u_x^O\right)\right] \tag{8}$$

Despite this general symmetric Nash solution, the procedure of Binmore *et al.* (1986) points to an assymetric Nash solution when there is an assymetry in the bargaining procedure or in the parties' beliefs. This assymetry could include the case of different beliefs from the players concerning the probability of breakdown in the risk model. Indeed, as noted in section 2.2, the partial monitoring coupled with the performance-based pricing do not remove all the opportunistic behaviour risk. Hence, considering $\beta \in [0,1]$ is the bargaining power of the representative farmer while $1-\beta$ is the bargaining power of the exporter, the Nash bargaining product becomes:

$$\Omega = Log\left\{\left[u_i^c\left(p_p^c, s, q, C, n^*\right) - u_i^o\right]^{\beta} . \left[u_x^c\left(p_p^c, s, q, \delta\right) - u_x^o\right]^{1-\beta}\right\} \tag{9}$$

where the expression Ω is the function to optimize with respect to the producer price p_g^c and the quality level s at a given volume of output q.

Only an implicit solution of the maximization of the Nash bargaining with respect to the producer price is available and derived as follows:

$$\left(p_p^{c^*}, s^*\right) = \text{argmax}\,\Omega \text{ subject to } q = 2\frac{p_p^c - \frac{C}{n^*}}{s^{a+1}} \tag{10}$$

This implicit function denoted h is given by the following expression:

$$p_p^{c^*} = h(s, q, C, \delta, \beta) \tag{11}$$

with $p_p^{c^*} \equiv \frac{\partial \Omega}{\partial p_p^c} = 0$; $\frac{\partial^2 \Omega}{\partial p_p^{c\,2}} < 0$. Details on the function h and the first and second order conditions of the maximization of the Nash bargaining product with respect to the producer price are provided in Appendix 1.

The use of Mathematica does not permit an algebraic solution in s. Either more efficient algorithms are required or non-algebraic ways should be used to yield complete solution s^*. Hence, in the statics comparative analysis, we use the implicit function theorem to overcome the unavailability of explicit solutions with respect to the endogenous variables of the model.

2.4. Comparative statics

We focus on the effects of the compliance costs C, monitoring and enforcement costs δ, the number of compliant farmers n^* and the bargaining power β on the endogenous variables at equilibrium. Because we do not have an analytical solution for the quality level and an explicit solution for the producer price, we cannot make direct comparative statics analysis. To overcome this obstacle, we follow Ferrier (2003) and apply the implicit function theorem on the first order condition to maximization of the Nash bargaining product with respect to quality level.

Let the function F be this first order condition of the maximization of the NBP with respect to the quality level s. It is expressed in terms of all the endogenous variables and exogenous parameters of the model as shown in Appendix 1. In relation (12), we only report his simplified form as follows:

$$F\left(p_p^{c^*}, s, q, C, \delta, n^*, \beta\right) = F\left(h(s, q, C, \delta, \beta), s, q, C, \delta, n^*, \beta\right) = 0 \equiv \frac{\partial \Omega}{\partial s} = 0 \tag{12}$$

Let z represent any exogenous parameter in the function F while s is quality level which is an endogenous variable of the same implicit function. The comparative statics are derived from the differential of a constant function as follows:

$$dF = \frac{\partial F}{\partial s^*} ds^* + \frac{\partial F}{\partial z} dz = 0 \Rightarrow \frac{ds^*}{dz} = -\frac{\frac{\partial F}{\partial z}}{\frac{\partial F}{\partial s^*}} \tag{13}$$

These comparative statistics display the total effects of an exogenous parameter on an endogenous variable at equilibrium. As we are using implicit functions, we can only determine the sign but not the magnitude of these comparative statics. The denominator is obviously negative as it is the second order condition of the maximization of the Nash bargaining product with respect to the quality level. The sign of the comparative statics is then reduced to the sign of the first derivative of the implicit function F with respect to the exogenous parameter z .

To extend this comparative statics analysis to $p_g^{c^*}$, we need to account for both direct and indirect effects of exogenous parameters on this endogenous variable at equilibrium. Direct effects are computed from the relationship h while indirect effects come from the implicit functions F as shown in relations (14) - (17):

$$\frac{dp_p^{c^*}}{dC} = h'_C + h'_s \frac{ds}{dC} \tag{14}$$

$$\frac{dp_p^{c^*}}{d\delta} = h'_\delta + h'_s \frac{ds}{d\delta} \tag{15}$$

$$\frac{dp_p^{c^*}}{dn^{**}} = h'_{n^*} + h'_s \frac{ds}{dn^*} \tag{16}$$

$$\frac{dp_p^{c^*}}{d\beta} = h'_\beta + h'_s \frac{ds}{d\beta} \tag{17}$$

Table 1 synthesizes the results of the comparative statics. The details of the mathematical development are reported in Appendix 1. The whole sign of the effects of the compliance costs, monitoring and enforcement costs, the number of producers and the bargaining power on the equilibrium producer price is ambiguous even though the sign of individual components in relations (14) – (17) is unambiguously determined (see Appendix 1 for more details). Okello and Swinton (2006) highlight the complexity of the determination of the producer price is complex in the context of imperfect information. The contract linking farmers to exporter is such that the later shares the risk with farmers by paying a price that is variable.

Table 1. Synthesis of the results on the total effects of exogenous parameters on endogenous variables of the bargaining game

Exogenous parameter	Endogenous variable	
	p_p^c	s
C	$\frac{dp_p^{c^*}}{dC}: ambiguous$	$\frac{ds^*}{dC} < 0$
δ	$\frac{dp_p^{c^*}}{d\delta}: ambiguous$	$\frac{ds^*}{d\delta} > 0$
n^*	$\frac{dp_p^{c^*}}{dn^*}: ambiguous$	$\frac{ds^*}{dn^{**}} > 0$
β	$\frac{dp_p^{c^*}}{d\beta}: ambiguous$	$\frac{ds^*}{d\beta} < 0$

Regarding the quality level, the total effect of the compliance costs C on this endogenous variable s is negative suggesting that a quality level for which compliance requires high costs is not easily met. The inverse is also true. In the period prior to developed countries food safety standards, the major quality concerns were physical attributes of green beans such as size, shape and spotlessness. These physical attributes were easily met by applying large quantities of pesticides without however adequate protection of farmers (Okado, 2001) *in* Okello, 2006. When the compliance costs with a certain quality level are too high, there may be a strong likelihood of exit. The literature related to agricultural international trade issues shows that the quality level is rarely met when it involves stringent requirements and hence high compliance costs. Instead, trade disputes occur accordingly (Calvin and Krissoff, 1998; Yue *et al.,* 2006).

The sign of the total effect of the parameter β on this endogenous variable is negative implying that the farmer bargaining power has a negative effect on the quality level at the equilibrium. In other words, producers with sufficient room manoeuvre exit rather than comply with requirements that are perceived to be stringent. A stronger bargaining power reflects for instance best outside alternatives such as higher prices in domestic or regional markets where quality level is not as stringent as in export supply. Alternatively, when farmers have a limited bargaining power such as in monopsony, they need to copy with a "*do or die*" scenario. Dowding *et al.* (2000) argue that *compliance* does not necessarily mean satisfaction. *Exit* may not occur because either its costs are too high or when there are no alternatives.

The total effect of the monitoring and enforcement costs δ on the quality level s is positive as expected. These costs are indeed in place to limit asymmetric information between the players involved in the bargaining game. The exporter who is less-informed bears the monitoring and enforcement costs to monitor the effort made by farmer. Consequently, these costs enhance the quality of the product by preventing opportunistic behaviour after achieving contractual terms.

The total effect of the number of compliant farmers on the equilibrium quality level is positive. According to this comparative statics analysis, changes in the quality level and the size group of compliant farmers are of the same sign. This result does not suggest an exit movement following an increase in quality level. The result corroborates instead the collective action highlighted by Okello (2006). This author underlines the fact that Kenyan small-scale farmers can avoid being marginalized by stringent food safety standards by banding together into farmers associations. As the comparative statics of the compliance costs and the size group of compliant farmers on the quality level have opposite signs, their ratio is negative suggesting that when compliance cots arise, the number of compliant farmers falls. This relation is crucial to respond to the research question investigated in this study that small-scale farmers should exit when they face increasingly compliance cots with food safety standards.

With the data availability, we cannot test empirically the whole bargaining model. In the following section, we focus instead on its last stage in accordance with the back-ward induction resolution. Whether or not a farmer decides to contract depends on his efficiency that is however unobservable. We follow Okello (2005) to identify the determinants of the farmers' efficiency among a set of observable characteristics including socio demographic and institutional variables, physical, human and social capital.

3. Data description

Given that the producer efficiency is unobservable, this empirical model focuses on the observable farmer contracting decision in the last stage of the game tree of Figure 1. Contracting farmers being assumed to be the more efficient as developed in the previous section. Because we use cross-sectional data, we cannot provide an empirical test of the whole bargaining model. In addition because the participation decision is a dichotomous variable, we apply econometric estimation appropriate to qualitative dependent variable. Before developing the econometric model, we present variables and data description.

3.1. Variables and data description

We use farm-level survey data collected between October 2003 and June 2004 in the major green bean growing areas of Kenya. From a list of major green bean growing villages was drawn and 30 villages that have both contracting and non-contracting farmers were randomly selected. Six farmers were randomly sampled from each of the 30 villages giving a total of 180 farmers.

To select the select the relevant variables that could explain the contracting decision, we follow Okello (2005) and Asfaw *et al.* (2007) and use institutional variables (extension, distance to markets and bean collection centre and access to credit), household characteristics (gender and age), physical capital (wealth, farm assets, farm size and green beans plot size), human capital (education and farmer's experience in growing green beans). Contracting farmers have access to credit, training, and provision of information provided the exporter. Non contracting farmers

The dependent variable is a dichotomous variable equalling one if the farmer contracts with an exporter to supply certified quality green beans and zero otherwise. The selected explanatory variables encompass the institutional variables, household characteristics, human and physical capital presented above. Table A1 in Appendix 2 describes the variables used in the model. The highest level of education is a discrete variable opening to 9 levels is split into 9 corresponding binary variables.

3.2. Summary descriptive statistics

Table A2 in Appendix 2 displays the summary descriptive statistics using the central limit theorem on mean values of continuous variables. Table A3 in Appendix 2 gives the summary statistics descriptive using χ^2 test on variances of dichotomous variables.

Table A2 in appendix 2 shows that that monitored household heads are in average slightly older (40 years) than unmonitored ones (38 years). The mean values of the age squared and the household head's education level do not differ significantly between monitored and monitored households. The farm size does not differ significantly between monitored and unmonitored households but monitored households have larger plot sizes (acres 0.55) than unmonitored households (acres 0.47). In addition, we find no significant difference in the mean values of main assets, aggregated assets and off-farm income between these unmonitored and monitored households but monitored households are wealthier than unmonitored households. We do not find significant differences between monitored and unmonitored households in terms of access to services in terms of distance in walking minutes to markets and green beans collection centres.

Unmonitored farmers receive higher prices for both fine and extra fine beans, respectively Ksh 43.7 and Ksh 46.8 per kilogram against Ksh 28.8 and Ksh 38.4 per kilogram for monitored households. This suggests first that high prices are not the only objective that farmers pursue in producing under contract. Table 2 highlights the relative importance the mains reasons evoked in supplying certified product. For about 58 per cent of the respondents the main first reason for concluding a contract with an exporter is to benefit from an assured market. This reason is particularly important for farmers enjoying an experience in growing green beans who may have specific investments. The share of farmers who expect to get stable prices is about 13 per cent while those who hope to benefit from high prices through contract represents only 12 per cent. However high prices constitutes one of the main second reasons for adopting a contract

The relative importance of *market* and *payment guaranteed* coupled with *stable* and *high prices* as reasons for contracting show that farmers face a strong uncertainty in selling green beans to brokers. However; even within contracts, unstable prices remain a considerable concern. Okello and Sindi (2007) argue that prices could vary because of brokers' activities generating sometimes price speculation. Out of the contract, the prices vary more substantially. They can rise to six times higher especially in the period of high demand for beans in the United Kingdom. The fact that farmers pay loan received from the exporter could also explain low prices prevailing under contract.

Table 2. Relative importance of the main reasons for producing under contract

Possible reasons for contracting	Frequency of the main reasons as a percentage of respondents		
	first reason	second reason	third reason
Market guaranteed	58	18	7
Stable prices	17	17	10
High prices	12	23	19
Loss of money with	4	1	12
brokers	3	3	7
Access to new pesticides	2	23	29
Payment guaranteed	2	10	5
Access to quality seeds	2	-	-
Information access			

Source: Survey data at farm-level in Kenya, October 2003- June 2004

The experience in growing green beans measured in times the farmer grew green beans between 2000 and 2004 does not differ significantly between monitored and unmonitored households.

Table A3 in Appendix 2 presents the descriptive statistics for binary variable using chi-square test analysis. The main significant differences between unmonitored and monitored households relate mainly to credit access and at lesser extent to the highest level of education in the household and mechanization. Monitored households are very likely to receive credit and access to mechanization even though they face high likelihood of illiteracy. It is worthy to point out the bilateral casual relationship between the dichotomous variables "contract" and "credit". In These variables are codetermined because the socio demographics household's characteristics determine simultaneously contract participation and credit access. This feature is of particular importance on econometric estimation as shown in section 4.

4. Econometric estimation and empirical results

We investigate the determinants of contracting decision in growing green beans to explore the unobservable producer efficiency i in relation (6). In deed our theoretical model assumes that efficient farmers are likely to supply exportable green beans to UK supermarkets by signing a contract linking them to the exporter while inefficient farmers are very likely to exit the business following the inception of rigorous food safety standards.

As the dependent variable "contract" is a dichotomous variable, we would adopt a univariate probit or a logit model following Greene (2003) provided there are no autocorrelation between some variables. These two models yield comparable results as the standard normal and the logistic distributions belong to the same group of exponential laws (Thomas, 2000). However, there is an important empirical concern about the autocorrelation between variables "contract", "credit". There is a risk of endogeneity bias as the most important sources of credit are the farmer's associations and the exporter. As we are working with farmers who are producing within associations, those who contract have *ceteris paribus* more access to credit. Alternatively, farmers producing on a contractual basis benefit from services offered by the exporter such as training and access to credit. Contract is and endogenous variable in the credit equation and this later is also an endogenous regressor in the contract equation. Hence, a simple probit or logit estimation involving these variables would yield inconsistent estimates. We do not have relevant instrumental variables to address this endogeneity bias as credit and contract are codetermined, i.e. every variable explaining one of them is automatically relevant to predict the other one. To cope with this issue we follow Greene (2003) to set up a seemingly unrelated bivariate probit estimation as follows:

$$\text{contract:} \quad \begin{array}{l} y_1^* = w'\alpha_1 + u_1 \\ y_1 = \begin{cases} 1 \; if \;\; y_1^* > 0 \\ 0 \;\; otherwise \end{cases} \end{array} \qquad \text{credit:} \quad \begin{array}{l} y_2^* = w'\alpha_2 + u_2 \\ y_2 = \begin{cases} 1 \; if \;\; y_2^* > 0 \\ 0 \;\; otherwise \end{cases} \end{array}$$

(18)

where y_1^* and y_2^* are, respectively, latent variables for contract choice y_1 and credit access y_2, w the transpose vector of explanatory variables, α_1 and α_2 the parameters and u_1 and u_2 the error terms for contract and credit equations. Here we adopt the same explanatory variables for contract decision and credit access equations but these variables from one equation to another if these binary variables were not codetermined.

The errors terms are assumed to be bivariate normal to satisfy:

$$\begin{aligned} &E[u_1/w] = E[u_2/w] = 0 \\ &Var[u_1/w] = Var[u_2/w] = 1 \\ &Corr[u_1, u_2/w] = \rho \end{aligned} \qquad (19)$$

For the two standard-distributed variables u_1 and u_2 the joint density probability is given by the bivariate normal distribution ϕ as follows:

$$\phi(u_1, u_2) = \frac{1}{2\pi\sigma_{u_1}\sigma_{u_2}\sqrt{1-\rho^2}} \exp\left[-\frac{1}{2}\left(\frac{u_1^2 + u_2^2 - 2\rho u_1 u_2}{1-\rho^2}\right)\right] \qquad (20)$$

where ρ is a correlation parameter denoting the extent to which the two error terms independent to each other. Under the null hypothesis of $\rho = Cov[u_1, u_2 / w] = 0$, the model consists of independent probit equations which can be estimated separately and ϕ reduces to two separate standard normal distributions. Otherwise, the two error terms are correlated as the probability of one dependent on the probability of another and a seemingly unrelated bivariate model is more appropriate to yield consistent estimates.

Prices are not included as explanatory variable of contracting decisions because they do not reflect intrinsic farmer' characteristics; they are rather determined within the bargaining process. Furthermore, variables such as "mechanization" and "specific investments" are omitted to avoid multicollinearity bias as the main use of credit is to improve agricultural practises and put in place specific investments required to meet the requirements of the certified quality supply. Some variables such as *high education 0*, *high education*s 5 - 9 are withdrawn from to biprobit estimation to preserve global fitness of the model.

Table 2 gives the results of the bivariate probit estimation. In addition, using the Wald test on joint significance, we reject the restricted model where all the slopes in the model are co-restricted to have zero value. This means that all the explanatory variables taken together are relevant in the bivariate probit model. The estimated value of the coefficient of correlation between the two structural disturbances is $\rho = 0.82$ with a t-statistic value of 0.056 (Table 3). On the basis of the likelihood-ratio statistic for the null hypothesis $\rho = 0$, we reject this null hypothesis at 0.01 significance level of probability using a chi-square test. This result econometrically suggests that a probit estimation instead of two separate probit estimations is appropriate. Economically, this suggests that participation to contract can not be analyzed independently from access to credit. This result confirms the observation from FAO (2006) that smallholder compliance to private-sector standards set by European retailers is feasible, but « only with large financial support and technical assistance from the donor community, which other countries of less importance to European markets may not be in a position to attract ».

According to Thomas (2003), we cannot directly make a reliable interpretation on the estimates $\hat{\alpha}_1$ and $\hat{\alpha}_2$ because they do not really reflect the parameters of the latent variable. The absolute scale of the coefficients in a binary choice model gives a distorted picture of the response of the dependent variable to a change in one the explanatory variable because the model is actually of a probability (Dong *et al*., 2010). The only useful information provided by these estimates provide is the sign of the change of an explanatory variables on the probability of contracting decision.

Marginal effects are required to obtain the sensitivity of the probability of supplying certified quality with respect to each explanatory variable. We make interpretation on the basis of both the sign and the magnitude of explanatory variables from computed marginal effects presented in Table 4.

Some socio demographic variables such as the age the household's head and the highest level of education in the household play an important role in enhancing the likelihood of a contractual supply. An additional one-year of the farmer raises the probability of contracting by 0.04. There is no strong prior expectation concerning the sign of this variable. Indeed, age may be an indicator of experience or represent a reluctance to take up new technologies (Asfaw *et al.*, 2007; Gebremedhin *et al.*, 2009). In this study, older farmers might be more willing to produce under contract than younger ones because of their specific investments in green beans business that they want to safeguard. If the age reflects experience, its effects could be similar to that of the time of growing beans. But we realize that there is no strong correlation between the two variables. If we omit "timegro" in the model, the marginal effects of the variable "age" on the likelihood of producing under contract becomes 3.7 per cent that is closer to 4 per cent.

Table 3. Results of the seemingly unrelated bivariate probit estimation on the dependence of contract decision and credit access

variable	estimate	t-value	p-value
contract equation			
age	0.102*	1.71	0.087
age squared	-0.001*	-1.61	0.107
education	-0.029	-0.44	0.660
high education 1	6.607***	7.41	0.000
high education 2	0.078	0.14	0.889
high education 3	0.141	0.36	0.715
high education 4	0.198	0.34	0.733
distance to market	-0.092	-0.62	0.535
distance to green bean collection centre	0.204**	1.99	0.047
farm size	0.060	0.41	0.680
plot size	-0.005	-0.03	0.974
off-farm income	-0.000	-0.18	0.858
assets-value	-0.000	-1.13	0.259
timegro	0.006	0.91	0.363
records	0.360	1.53	0.125
wealth	0.239**	1.95	0.051
constant	-8.195**	-2.42	0.015
credit equation			
age	0.039	0.67	0.505
age squared	-0.000	-0.75	0.454
education	-0.016	-0.24	0.811
high education 1	6.983***	7.88	0.000
high education 2	-0.035	-0.06	0.950
high education 3	0.008	0.02	0.983
high education 4	0.689	1.13	0.258
distance to market	-0.072	-0.49	0.621
distance to green bean collection centre	0.014	0.15	0.883
farm size	0.195	1.38	0.167
plot size	0.016	0.10	0.918
off-farm income	0.000	1.07	0.285
assets-value	-0.000	-0.35	0.730
timegro	-0.008	-1.29	0.198
records	0.399*	1.68	0.094
wealth	-0.031	-0.24	0.812
constant	0.268	0.08	0.937
ρ	0.821	0.056	

Number of observations = 171

Likelihood-ratio test of $\rho = 0$: $\chi^2(1) = 44.53^{***}$

Test of global fitness: Wald $\chi^2(32) = 2573.44$ with prob>chi2 = 0.000;

Log pseudolikelihood = -189.05

Table 4 Computation of marginal effects from bivariate probit estimation

variable	Marginal effetcts	t-value	p-value pr>/t/
age	0.04*	1.71	0.08
age^2	-0.00	-1.61	0.11
education	-0.01	-0.44	0.66
high education 1	0.48***	12.17	0.00
high education 2	0.03	0.14	0.89
high education 3	0.06	0.37	0.71
high education 4	0.08	0.35	0.73
distance to market	-0.04	-0.62	0.53
distance to green			
bean collection	0.08**	1.99	0.05
centre	0.02	0.41	0.68
farm size	-0.00	-0.03	0.97
plot size	-0.00	-0.18	0.86
off-farm income	-0.00	-1.13	0.26
assets	0.00	0.91	0.36
timegro	0.14	1.57	0.12
records	0.09**	1.95	0.05
agricultural wealth			

A level of education in the household corresponding to an incomplete primary increases the probability of supplying green beans through contract with exporters by 47 per cent. While a minimum level of education is required to comply with food safety standards through better farming capacity and access to information (Gebremedhin *et al.*, 2009), we do know why this specific level of education plays the most important role compared to the other three levels of education included in the model. However, the education of household's head is not statistically different from zero. Asfaw *et al.* (2007) find similar results using an adoption decision model. These authors conclude as in Basu *et al.* (2001) that an educated member in the household "confers a positive externality on the illiterate agents in the household by sharing the benefits of his (her) literacy".

The distance of the nearest bean collection centre from the farm in walking minutes has the unexpected sign because it increases by 8 per cent the probability of concluding a contract with an exporter. Indeed, distance to market institutions acts as marketing costs (Key *et al.*, 2000; Omamo, 1998) and then lower the likelihood of market participation. The only interpretation to this unexpected sign is that there should be a bias in measuring this distance as all the farmers do not have the same speed in walking. Additionally, farmers could easily overstate or understate the duration of walking the distance to markets from their farms.

The total wealth of the horticultural farms increases the probability of contracting by 9 per cent. Wealthier farmers can easily make required investments to comply with new food safety standards. Expensive improved seeds and new chemicals should still affordable to households with high total wealth.

5. Conclusions

This paper makes three interesting contributions to the emerging literature on non-tariff measures and small-scale horticultural farmers in developing countries. The first contribution is to base the analytical framework on Nash bargaining theory as a particular case of the "exit, voice and loyalty" framework of Hischman (1970). The existing literature does not point out the possible relation between these two frameworks.

The second contribution of this paper is to confirm the strong dependence between contracting decision and credit access in developing countries using the seemingly unrelated regression. The existence of a high coefficient of correlation between the structural disturbances of contract decision and credit access equations suggest that the use of a simple probit estimation is not appropriate to this situation.

The third contribution of this study is to make an attempt in testing empirically the Nash bargaining model even though only one stage of the model is tested, the contracting decision. The data availability does not permit to test the whole bargaining game giving a perception of disconnected analytical and empirical parties. To overcome this limit and fully test the whole bargaining game, longitudinal or cross-sectional time series data enabling time variation of producer prices, compliance costs and farmers' intrinsic characteristics would be required.

Our stylized bargaining process is built on two complementary analytical and empirical approaches. In the analytical model, we have considered that compliance with private food standards follows a kind of voice, here understood as a cooperative and bilateral Nash bargaining process. The main results from the comparative statics analysis show that the compliance costs and the bargaining power have a negative effect on the quality level, an ambivalent effect on the volume of the product and an ambiguous effect on the producer price. Transaction monitoring costs have on the other hand positive effects on the quality level both in proactive and reactive scenarios, a negative effect on the volume of output and ambiguous effect on the producer price. The average costs have a negative effect on the quality level while these exogenous parameters have ambiguous effects on the producer price.

In this analysis, we consider only static bargaining. We have of course taken into account monitoring costs to prevent opportunistic behaviour from farmers who should deviate from contractual terms. However, this risk of opportunistic behaviour is not thoroughly avoided. Hence, a dynamic bargaining model with anticipations should bring more additional useful information.

We thereafter make an empirical analysis using survey data collected at farm-level for 180 households in Kenya to provide proxies of the producer's efficiency that is governing participation in certified quality supply chain. However, it is worthy to note that the empirical analysis is not a test of the analytical model. Rather, it is a complementary analysis made to know better what influence the producer efficiency before entering in a voice process.

These results may have some policy implications. There is an evident need of institutional support in the favour of horticultural farmers to promote their participation in certified supply chain. Training and credit access facilities could play an important role in strengthening the capabilities of these horticultural farmers and maintaining them in the business. Both public and private actors who intend to participate in the capacity-building of green beans growers to remain in the green bean business must focus on such aspects. In addition, private standards set by retailers of developing countries should not be only analyzed in terms of possible exclusion from agribusiness. Positive externalities in the favour of the small farmers could emerge from the adoption of voluntary standards such as the ethical trading initiative (ETI) by the leading UK retailers to compete each other (Freidberg, 2004).

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Appendix 1- Mathematical developments of Nash bargaining product, implicit solution with respect to producer price and comparative statics

1. Analytical expression of the Nash bargaining product

$$\Omega = Log\left\{\left[p_p^c - \frac{q}{2}s^{a+1} - \frac{C}{n^*}\right]^{\beta} . \left[\left((1-q)s - p_p^c - \delta\right)q\right]^{1-\beta}\right\}$$

2. First and second-order conditions of the maximization of the Nash bargaining product with respect to the producer price

$$p_p^{c^*} = h\left(s,q,C,\delta,n^*,\beta\right) = \frac{\left(2C + n^* q s^{a+1}\right)(1-\beta) + 2n^*\beta\left((1-q)s - \delta\right)}{2n^*}$$

$$\frac{\partial^2\Omega}{\partial p_p^{c\,2}} = -\frac{(1-\beta)}{\left((1-q)s + p_p^c + \delta\right)^2} - \frac{4\beta n^{*2}}{\left(n^*\left(qs^{a+1} - 2p_p^c\right) + 2C\right)^2} < 0$$

3. Analytical expressions of the comparative statics using the implicit function F

a). Implicit function F

$$\begin{aligned} F\left(p_p^{c^*}, s,q,C,\delta,n^*,\beta\right) &= F\left(h\left(s,q,C,\delta,n^*,\beta\right), s,q,C,\delta,n^*,\beta\right) \\ &= \frac{-2\left(C - n^* p_p^c\right)(1-q)(1-\beta) + n^* q s^a\left((q-1)s(1+a\beta) + (1+a)\beta\left(p_p^c + \delta\right)\right)}{\left(2C - 2n^* p_p^c + n^* q s^{1+a}\right)\left(p_p^c + (q-1)s + \delta\right)} \\ &= 0 \end{aligned}$$

b). Comparative statics on variable s using the function F

$$\frac{ds^*}{d\beta} \equiv \frac{\partial F}{\partial \beta} = \frac{-2\left(C - n^* p_p^c\right)(q-1) + n^* q s^a\left(a(q-1)s + (1+a)\left(p_p^c + \delta\right)\right)}{\left(2C - 2n^* p_p^c + n^* q s^{a+1}\right)\left(p_p^c + (q-1)s + \delta\right)} < 0$$

$$\frac{ds^*}{dC} \equiv \frac{\partial F}{\partial C} = -\frac{2(1+a)n^* q s^a \beta}{\left(2C - 2n^* p_p^c + n^* q s^{a+1}\right)^2} < 0$$

$$\frac{ds^*}{d\delta} \equiv \frac{\partial F}{\partial \delta} = \frac{(1-q)(1-\beta)}{\left(p_p^c - (1-q)s + \delta\right)^2} > 0$$

$$\frac{ds^*}{dn^*} \equiv \frac{\partial F}{\partial n^*} = \frac{2(1+a)C q s^a \beta}{\left(2C - 2n^* p_p^c + n^* q s^{a+1}\right)^2} > 0$$

4. First derivatives on the producer p_p^c using the function h:

$$h_s' = \beta(1-q) + \frac{1}{2}(a+1) q s^a (1-\beta) > 0\,;$$

$$h_C' = \frac{1-\beta}{n^*} > 0$$

$$h_\delta' = -\beta < 0$$

$$h_{n^*}' = \frac{C(\beta-1)}{n^{*2}} < 0$$

$$h_\beta' = (1-q)s - \delta - \left(\frac{1}{2} q s^{a+1} + \frac{C}{n^*}\right) > 0\,;$$

Table A.1. Variables definition

Variable name	Variable definition
***<u>Dependent variable</u>*:**	
Contract	1 when the household produces
<u>Explanatory variables:</u>	under contract and 0 otherwise
<u>Household's characteristics</u>	
Age	The age of the household head in years
Age squared	The square of the age of the household head
Gender	1 for male and 0 for female
Education	The education level of household head in years spent to school
High-education	The highest education level in the household
High-education 0	No body in the household goes to school
High-education 1	Incomplete primary school
High-education 2	Completed primary school
High-education 3	Completed junior secondary school
High-education 4	Completed O level
High-education 5	Completed A level
High-education 6	Completed college diploma
High-education 7	University graduate and above
High-education 9	Incomplete O level
<u>Household's assets & wealth</u>	
Farm-size	The size of the farm in acres
Plot-size	The size of the plot of green beans in acres
Assets-value	Aggregated value of assets by type in Kenyan
Off-farm-income	shillings
Total-wealth	Off-farm household income in Kenyan shillings
<u>Access to services</u>	Total wealth of the household in Kenyan shillings
Market	Distance of the nearest market from the farm in walking minutes
Green bean-collection	Distance of the nearest green bean collection centre from the farm in walking minutes
Credit access	1 if the household receives credit and 0 otherwise
<u>- Prices incentives</u>	
Price-fine-beans	Price of fine beans in Kenyan shillings per kilogram
Price-extra-fine-beans	Price of extra fine beans in Kenyan shillings per
<u>- Good hygienic and agricultural practises</u>	kilogram
Records	1 if the household keeps records of his farm's operations for the last crop and 0 otherwise
<u>Experience in growing beans</u>	
Timegro	Number of times the farmer grows green beans in the five past years
Mechanization	1 if the farmer has an ox-plough, oxen or tractor and 0 otherwise
Specific investments	1 if the farmer has a chemical store or a grading shed and 0 otherwise

Source: Survey data at farm-level in Kenya, October 2003- June 2004

Table A2 Descriptive statistics and test statistic on means of continuous explanatory variables

Variable name	Mean: Monitored households	Mean: Unmonitored households	Test statistic	p-value
Households' demographic characteristics				
Age	39.7	37.5	1.9*	0.16
Age squared	1702	1548	1.5	0.13
Education	8.3	8.9	-1.6	0.11
Households' assets & income				
Farm-size	3.4	2.7	1.6	0.11
Plot-size	0.5	0.5	2.1**	0.04
Assets-value	10180	90,70	1.1	0.27
Off-farm-income	38,62	33,08	0.7	0.49
Total wealth	235,38	186,10	2.6***	0.01
Access to services				
Market	34.0	35.5	-0.7	0.47
Bean-collection	30.4	30.0	0.2	0.88
Prices incentives				
Price-fine-beans	28.8	43.7	-9.1***	0.00
Price-extra-fine-beans	38.4	46.8	-4.1***	0.00
Experience in growing green beans				
Timegro	1.5	12.01	1.4	0.17

Legend: ***, **** and ******* denote statistical significance at 0.10, 0.05 and 0.001 probability level respectively

Table A3 Descriptive statistics and chi-square test analysis on variances of dichotomous explanatory variables

Variable name	Monitored households		Unmonitored households		χ^2 statistic test	p-value
	Sample size	%	Sample size	%		
Gender (Male)	77	80.21	68	80.00	0.12E-02	0.97
High-education 0 (Yes)	2	2.08	0	0.00	1.79*****	0.07
High-education 1 (Yes)	26	27.08	23	27.06	$1.37.10^{-5}$	0.99
High-education 2 (Yes)	39	40.62	34	40.00	0.01	0.99
High-education 3 (Yes)	4	4.17	4	4.71	0.03	0.97
High-education 4 (Yes)	17	17.71	19	22.35	0.61	0.54
High-education 5 (Yes)	1	1.04	0	0.00	0.89	0.37
High-education 6 (Yes)	7	7.29	4	4.71	0.53	0.59
High-education 7 (Yes)	0	0.00	1	1.18	1.14	0.26
Credit-access (Yes)	77	80.21	20	23.81	57.35*******	0.00
Records (Yes)	30	31.25	20	23.81	1.24	0.27
Mechanization (Yes)	51	53.12	34	40.00	3.12*****	0.08
Specific investments (Yes)	9	9.37	7	8.25	0.07	0.79

Legend: *, ** and *** denote statistical significance at 0.10, 0.05 and 0.01 probability level respectively

Chapter 5

Summary, Conclusions and Recommendations

For developing countries (DCs), integration into global markets offers the potential of more rapid growth and poverty reduction. African Caribbean and Pacific (ACP) countries are benefiting from trade access to the European Union (EU) markets in the framework of the ACP-EU partnership agreements and the least developed among them benefit from the European Everything But Arms (EBA) initiative. These countries also are eligible to the EU's Generalized System of Preferences (GSP) granted to developing countries since the 1960s.

Despite these trade preferences however, ACP countries did not improve their trade performance into the EU. They are rather among the most vulnerable countries in the global trading system. Global trends from several analyses on the agricultural and food trade between ACP and EU countries show that regarding the EU, the trade with ACP countries remains marginal. Indeed, less than to 2.5 per cent of the EU imports come from the ACP region. In contrast, ACP countries are strongly dependent on European countries because they represent the destination of nearly 30 per cent of all ACP exports.

For these countries, tariffs barriers do not play anymore a hampering role against the development of their exports. The lack of their performance is stemming from other forms of trade barriers. Several studies mention that among these « other forms of trade barriers » non-tariff measures may undermine food and agricultural exports of developing countries to developed countries markets. The lack of skilled human resources and financial capabilities to comply with non-tariffs measures may explain this situation.

However, few studies model the wide range of non-tariff measures set in the international food and agricultural markets. Rather, most researches focus on a single kind of standards. This dissertation is a contribution to the challenging task of modelling non-tariff measures. We first identify trading countries and commodities traded and the sample period. Due to data availability, we consider three horticultural products (green beans, fresh peas and avocados) and fish frozen fish fillets. Green beans are imported in Belgium-Luxembourg, France, Germany, Netherlands and the United Kingdom from Kenya between

1988 and 2008. Fresh peas are imported in the Netherlands and United Kingdom from Kenya and Zambia between 1988 and 2008 ; avocados are imported in France from Kenya for the same time period while frozen fish fillets are imported in Belgium, France, Germany, Italy, Netherlands, Portugal and Spain from Kenya, Uganda and Tanzania taken together between 1988 and 2006.

The first essay (chapter 2 of the thesis) quantifies all the non-tariff measures that are likely to affect the European imports of horticultural and fish products from selected African countries. We choose these non-traditional exports because they face significant non-tariff measures unlikely the traditional African exports such as coffee, tea, cotton and sugar that are subject to classical trade barriers. In this essay, we use the price-wedge method to provide a tariff equivalent of non-tariff measures, that is, a level of custom tariff that may distort trade to the same extent as the set of non-tariff measures under evaluation. In this approach we account for (i) production differentiation following the assumption of Armington (1969) according to which products are distinguished by their place of production and (ii) factor endowments among trading countries.

The main contribution of this essay is that unlikely previous studies in this area, it considers a CES aggregator index on imports that compete with domestic supply. Our results show tariffs equivalent values averaging between 40 and 60 per cent for trade of horticultural products and oscillating between 10 and more than 300 per cent for frozen fish fillets especially during the EU bans periods. In addition, we observe strong variations in the values of tariff equivalents among importing countries and over time. One possible explanation of this inter-importing countries variation of the tariff equivalent is that the NTMs are not implemented equally among EU countries while over time there are changes in rules within the regulator environment.

The first limit of this essay is that it does not succeed to match demand and supply conditions into a unique analytical framework. Rather it considers price inputs as plausible instruments to deal with endogeneity bias raised from demand side analysis. The second limit of this essay is that it keeps the assumption of identical preferences among trading countries especially in considering one value of elasticity of substitution among any countries pair.

While the essay just provides a measure of non-tariff measures, the second essay (chapter 3 of this dissertation) goes beyond and assesses the trade effect of these NTMs using the results from the previous analysis. Considering a gravity approach which is appropriate to analyze disaggregated data, the tariff equivalents are used as one component of the unobservable trade costs between trading countries. The use of a tariff equivalent generated from the price-wedge method in gravity equations is the main contribution of this essay regarding the existing empirical literature. Our results show that non-tariff measures set in the selected European importing countries do not affect the trade in horticultural products but significantly reduce the imports of frozen fish fillets. Differences in empirical results between these two products are on the one hand due to their intrinsic characteristics. Fish products are indeed prone to rapid pathogenic contamination. Hence, a considerable volume of fish production around the world is loosed due spoilage. Hygiene measures in the form of microbiological contaminants are of high importance in the markets channels of frozen fish fillets while the exports of horticultural products are especially sensitive to the Maximum Residues Levels (MRL) in pesticides. On the other hand, literature underlines an important foreign direct investment in the Kenyan horticultural sector that could ease compliance with non-tariff requirements. Once again the trade effect varies across importing countries suggesting that the African exporting countries would gain in targeting these differences and dealing with them in bilateral negotiations on trade issues.

Apart that it is possible to improve the results in dealing with the endogenous tariff equivalent, the essay should also consider evolving extensions on the gravity equations regarding the relaxation of its classical assumptions.

The third essay (chapter four of the dissertation) combines two complementary approaches: an analytical and an empirical investigation to understand the decision marking at farm-level following the mergence of stringent standards. On the analytical side, we confront the strategic responses outlined in Hirschman (1970) with the Nash bargaining theory to conceptualize a stylized bilateral game. A representative farmer and exporter bargain over the price and the quality level of exportable horticultural product. This study particularly shows a possible exclusion of small scale farms from the lucrative export supply following the high compliance costs inherent to stringent standards. While the essay constitutes an original approach to deal with non-tariff measures and especially food safety standards, it suffers from the several assumptions adopted about pay-offs (utility functions) of the two players involved in the bargaining game. Its complementary empirical approach, even though unable to test the whole theoretical model largely contributes to show, using a bivariate probit model, that contracting decision made at Kenyan farm-level is strongly dependent to credit access. This result corroborates the observations from several studies stating that the success of Kenyan horticultural sector supply strongly requires significant financial support and technical assistance from the donor community.

Non-tariff measures constitute a huge topic that can not be only undertaken in the form of price and trade effects and contracting choices. Farmers are also consumers and constitute frequently the main workforce in African family farms. Hence, they need to consume safer food and work in good social and environmental conditions. This is to mean that additional investigations could hence focus on the social welfare considerations, at both domestic and international levels, as recent studies show that stringent food safety could be in the same time trade distorting and welfare enhancing.