



**UNIVERSITÀ DEGLI STUDI DI MILANO**

**FACOLTA' DI SCIENZE AGRARIE E ALIMENTARIA**

*Dipartimento di Economia, Management e Metodi Quantitativi*

**SCUOLA DI DOTTORATO DI RICERCA IN**

*Innovazione tecnologica per le scienze agro-alimentari e ambientali*

(XXVI ciclo)

**Non-Tariff Measures and Trade Flows:**

**The Case of EU Agri-food Standards**

**Docente Tutor: Prof. Alessandro OLPER**

*Dipartimento di Economia, Management e Metodi*

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**Tesi di Dottorato di :**

**Marsela LUARASI**

**Matr. n. R09176**

**Anno Accademico 2012-2013**



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*My doctoral dissertation is lovingly dedicated to my mother **Bardha Sako Selenica**, the most beautiful and strongest woman I have ever seen. I want to thank my mother for learning me everything, and giving me strength to carry on with the life. She has always been there for me in the most loving and beautiful way throughout my life. Without her greatest influence, I don't know how I would have survived. All I am, I owe to my mother. I attribute all successes in my life to the moral and intellectual education I received from her. It is because of the love and strength that both my Mother and God gave to me*

***I will always love you***

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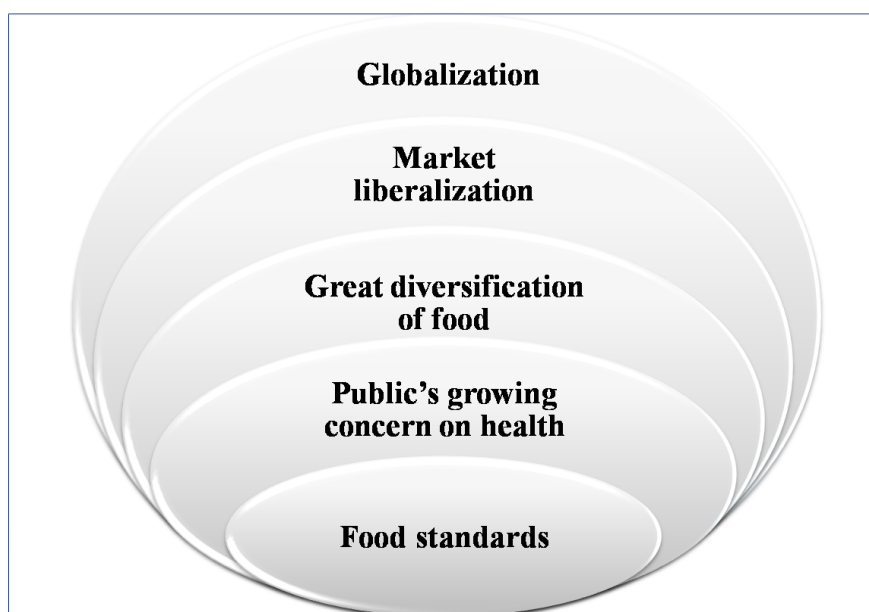
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## **Abbreviations**

WB	World Bank
SE	Small Enterprises
ME	Medium Enterprises
LE	Large Enterprises
MRA	Mutual Recognition Agreement
AICA	Association for International Collaboration of Agriculture
POLS	Pooled Ordinary Least Square
ZIM	Zero Inflated Model
NBR	Negative Binomial Regress
PPML	Poisson Pseudo Maximum Likelihood
AVG	Average Strictness
MAX	Maximum Strictness

## **Introduction**

The phenomenon of the globalization is having the most important impact on food system around the world. From one hand, the food system is changing quickly, ensuing a greater availability and diversity of food due to market liberalization. Many of these changes in food system are straightly associated with a public increasing concern on health and the suitable sanitary and phytosanitary standards (SPS), internationally diffused and affecting the global supply chain nowadays (FAO 2004), as shown in the following figure.



**Figure 1.** Agri-food system

Trade may increase or decrease by imposing food standards. Thus there is not yet a clear trend about the effects of stringent food standards, whether they promote or hinder

trade. The dual effect of standards on trade is explained as follows.

Many authors suggest the idea that standards have a “catalyst” role on trade. For example, according to Henson (2006), standards might have positive effects by reducing asymmetry of information for producers and consumers. In additions, Maertens and Swinnen (2007) show that standards might grow the consumer demand for product quality and safety. From political point of view according to Vandemoortele (2011), standards may improve market access and reduce transaction costs

Other others protect the idea that standards may act as “barriers” to trade. For example, Charnovitz (2005) emphasizes that stringent standards may aggravate the inconsistencies to comply with, between rich and poor countries. According to Henson *et.al.*, (2006), stringent standards impede export trade of firms in developing countries. Moreover, according to Otsuki *et.al.*, (2001) and Anderson *et.al.*, (2009), the trade cost effects of stringent standards can significantly reduce imports and even drive some foreign suppliers out of market.

From political point of view standards are considered as trade protectionist tool. Developed countries apply stringent standards as “*trade protectionist*” instrument to hinder imports from developing countries, in order to shelter domestic producers rather than protecting their health.

But according to Vandemoortele (2011), it is significantly important to be careful when classifying the standards as “*protectionist instrument*” because standards may be welfare optimal, while negatively affecting trade

Protectionism in agricultural trade takes the form of the so-called *non-tariff measures* (Beghin *et.al.*, 2012).

Non-tariff measures (NTMs) can be classified in 16 categories, including among of them:

- Sanitary and Phytosanitary (SPS) measures
- Technical Barriers to Trade (TBT) measures
- Price control measures
- Quality control measures (labelling)
- Maximum Residue Levels (MRLs), ect.

Maximum Residue Level (MRL) is an index which represents the maximum concentration of a pesticide residue (expressed as mg/kg) legally permitted in food commodities and animal feeds (Beghin 2012)

MRLs on food imports are set by each respective country and they are imposed as regulatory standards at the border. MRL standards are also known as quantitative standards.

Thus, the objectives of this research work are to quantify the protectionism of MRLs standards relative to the stringency of international standards of Codex Alimentarius; to evaluate the protectionist nature of MRLs and to provide insights into the potential protectionist effects of the stringency for the European MRL standards on trade versus US and other countries

Previous empirical strategies to measure the effects of MRLs on trade have been carried out. For example, Scheepers *et.al.*, (2007) examined the effects of MRLs which are more stringent than MRLs set by Codex, on trade of South Africa avocados. Further, Drogue and Demaria (2011) explained the impact of MRLs on bilateral trade of fresh apples and pears on seven export countries. In addition, Xiong and Beghin (2012) explained the implications of stringency of MRLs on trade performance of US and Canada. More recently, Li and Beghin (2014) established an index to quantify the protectionism of MRL standards.

This research work is organized as follows: in the *first* chapter we introduce a review of agri-food trade effects of standards. In particular we focused the attention on the role and the importance of international food standards in trade flow. We first gave explanations on the various definitions of agri-food standards, the influence of technical regulation as mandatory standards acquired by the law and the private standards which are theoretically considered as voluntary standards. In this part of the work we try to classify the agri-food standards and the standard setting organizations. We gave an overview of the evolution of private standards versus public ones in food supply chain and in particular which are the consequences of implementing public or private standards in developing countries' economies.

In addition, the trade theory and the empirical approach of the effects of international agriculture standards is presented. More specifically, the "state of the art" and the trend of the effects of standards in agricultural trade is explained from theoretical and political point of view. Moreover, empirical based approaches and analytical measuring systems of the effects of agri-food standards on trade are given by the explanations of gravity model, equilibrium model and cost-benefits analysis. To conclude with the first part of this research work, we analyzed the implications of data collection and measurement, especially the transparency intensity of data collected on international standards and regulations and the role of respective institutions on measuring the effects of agri-food standards.

In the *second* chapter, gravity modeling is introduced, as one of the most applied empirical methods to model and explain international trade flows. We focus the attention on the economic theory approach of gravity model in international trade. First, we give an introduction to gravity model based

on Isaac Newton's Law of Gravity (1687), as one of the most significant laws of natural sciences. Based on several empirical tests, the economists have noticed that the Newton's formula can be equivalently applied on international trade to explain the economic phenomena between different locations. This is the first justification of the formulation of gravity equation, but it still has a long history on research science. As a result, we further continue with a brief overview of the theoretical foundation milestones of this model, and the developments that have brought gravity modeling into mainstream economics.

One of the most important issues is to perceive the leap from the theoretical approach to the empirical one, in order to better understand the further implications of gravity model on international trade analysis. The development of multilateral resistance terms by Anderson and Van Wincoop (2004) allow a new interpretation of gravity modeling with international economics. Following Anderson and Van Wincoop (2004), the constitution of gravity equation is a step towards a more comprehensive, holistic and sensitive analysis of international trade flows

In the *third* chapter, we first introduce a review on the current trade and MRLs evidences. In addition we describe the both USDA MRL pesticides and veterinary drugs databases, followed by the data and the methodology used. The attention is intensified on the protectionism of agri-food standards in international agricultural trade and in particular in the quantification of the protectionism of MRLs standards and comparing them respective to Codex international standards, other countries and US. For the quantification of the protectionism we implement the aggregation index of NTMs established by Li and Beghin (2014).



# **Chapter 1. Agri-food trade effects of standards: A review**

## **1.1. Introduction**

### **1.1.1. Definition of agri-food standards**

There are thousands of food product standards employed in agri-food sector nowadays. According to the general classical understanding, based on a holistic approach, some food standards describe *food products attributes* such as food nutritional value labels, ingredients, energy, additives and organoleptic properties (colour, appearance, size, taste, texture, odour and other sensory characteristics), all of those considered as food hygiene sanitary standards to ensure that foods are not harmful to human health, while others describe *processes attributes* and production methods used in creating the characteristics of those food products (end-point), covering such things as organic production, animal welfare conditions, GMO-free, environment preservation and healthy workplace conditions standards, which are considered as safety standards. Many scientific authors, in the existing literature, have defined the *food* and *process* standards in different ways. According to Giovannucci (2008) a food standard generally indicates the typical features of the output (end product) and not potentially the instruments and tools applied to get there. Some food product standards can apply *first* to safety issues even the absence of biocide residues or harmless bacterial levels and *second* to specific quality matters for a particular characteristic of product such as size, colour, uniformity, sugar percentage content, etc. On the other hand, as described by Vigani (2010), the food product standards commonly correspond to the maximum allowed levels of residuals, food additives,

herbicides, pesticides, drugs, or other contaminants, or to the minimum levels of nutritional properties components such as fats or proteins. Moreover, agri-food process and production methods (PPM) standards typically refer to the norms related to how a product or good should be produced. These standards are applied before and during all the steps of the production processes such as cultivation, farming, packaging, harvesting, manufacturing and transportation. Some well-known process standards, such as International Organization for Standardization (ISO), Good Agriculture Practices (GAP), Good Manufacturing Practices (GMP), and Hazard Analysis at Critical Control Point (HACCP) are becoming progressively more important. They are also known as “sustainability standards” in literature, since they are considered as a reference point for the best management of resources such as agrochemical inputs, energy, water and wastes.

The following section introduce very briefly the most important food standards which make a significant contribution to most aspects of human’s life because they affect not only the producers of food products, but also the entire value chains, supply chains, agribusiness firms, consumers, and the agri-food trade sector as a whole, whose the aim of this study is mainly focused on.

The role of food standards is particularly focused on two directions. From one hand they specify and guarantee essential requirements of products such as quality and safety - by establishing minimum of standards or posing the safety requirements, they develop public consumer health, as the essential social goal. From the other hand, many evidences have shown that food standards have an important impact also on trade - by defining clear characteristics of products,

they can facilitate trade exchange and can improve the quality required by import or export partners.

Thus, it is fundamental to understand what are the “food standards”; to distinguish other food standards-related concepts such as international, public, private, voluntary or mandatory standards; to know who is developing them and how do they effect the agri-food trade sector, according to scientific researchers in the existing literature ?

*First*, it is basic to understand which products fall under the concept of “food” ? Having regard to Article 2 of Regulation (EC) No178/2002 of the European Parliament and of the Council of 28 January 2002, on the general principles and requirements of the Food Law, a “food” or “foodstuff” means “*any substance or products whether processed, partially processed or unprocessed intended to be, or reasonably expected to be, ingested by humans*”. This rule guarantees not only the required quality of foodstuffs for the human consumption and animal feed, but also the free trade flow of safe and secure food and feed in the European market.

*Second*, following the general concept of “food standards”, it is necessary also to know how a “standard” is defined and who has developed them? World Trade Organisation is known as an international competent standard-setting institution. In fact WTO does not really set standards but it strongly encourages member countries to use internationally accepted science-based standards whenever available (Beghin 2014).

From juridical point of view, we chose to follow the definition of standards defined according to WTO on Technical Barrier to Trade Agreement, because it addresses product standards and their “related” process and production methods. Pursuant to paragraph 2 of Annex I of WTO Agreement on Technical Barrier to Trade – TBT (2003), a “standard” is

## *Chapter 1 – Agri-food trade effects of standards*

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defined as “a document approved by a recognised body that provides, for common and repeated use, rules, guidelines or characteristics for products or related processes and production methods, with which compliance is not mandatory. It may also include or deal exclusively with terminology, symbols, packaging, marking or labelling requirements as they apply to a product, process or production method”. For example, the information on chemicals in food and water is a compositional standard, while “suitable for vegan/vegetarian”, “organic” or dietary information are examples of labeling and advertising claims. Thus, a standard might be simply defined as “a set of rules for guaranteeing quality”. It can be a mechanism to improve the supply chains, particularly regarding to the high commodity prices when there are few opportunities for large productivity improvements and limited chances for agriculture development Giovannucci (2008).

“International standards” are another group of standards classification that has been noticed in the previous literature. Different studies define the terms of “international” and “standard”, in many various senses. The term “international standard” has a broad variety of understandings in traditional usage. Some might reflect that a standard is only “international” if it meets the requirements with a standard published by International Organisation for Standardization (ISO) - the world’s largest developer and publisher of international standards. Other parts of the literature provide a wider interpretation: a standard can mean a global regulation indicated by a compulsory agreement. Charnovitz (2005) emphasises that a standard might be also naturally a common or a dominant tendency in the marketplace. As used by Charnovitz (2005), an international standard has two crucial characteristics:

*first*, it has been described or approved by an institution set up or an organisation for that purpose, and *second*, the institution or the organisation must be international in the sense that it includes membership from more than two countries. Similarly, such a judgement is reinforced by Swann (2010) who confirms that a standard is considered as “international” if it is just common to a group of countries or regions, for example the European Union countries – regardless of whether it is “international” according to the classical general definition. Several other studies of bilateral trade flows between two countries use the same insight that a standard is treated as “international” if it is harmonized in these two countries – again, regardless of whether it is “international” by the definition. If not, then it is treated as “national” standard, which is more specifically expressed as a standard adapted by national standardization body and made available to the public.

#### **1.1.2. Technical regulations (public) and standards (private): mandatory or voluntary?**

Much of the previous evidences have tended to discuss some efforts of trade officials and regulators towards a clear and strict distinction between food standards and food regulations, mainly in developed countries. Officially, pursuant to paragraph 1 of Annex I of the TBT Agreement of WTO (2003), a “technical regulation” is “*a document which lays down product characteristics or their related processes and production methods, including the applicable administrative provisions, with which compliance is mandatory...*”.

By the definition, it is very clear that the main contrast between the concept of “technical regulation” and “standard” is essentially based on their compliance. Compliance with a

technical regulation is mandatory according to the legislation, while compliance with a standard is voluntary. Henson (2006) further explained that combinations of public and private organizations are involved in standard setting within the European Union. Regulatory standards, also known as “technical regulations” by the definition of WTO’s TBT Agreement, are standards set by public institutions, by international government authorities such as WTO and Codex and in particular by regulatory agencies, with which compliance is mandatory within the law. These standards are equivalently known as purely *public*. Alternatively, Henson (2006) emphasized that standards might be established by the consensus of all bodies concerned, i.e. voluntary agreements, which do not in themselves impose obligations upon the potential users or anyone else to apply them. They can choose whether to comply or not, since the agreement of voluntary standards is a formal process, which employs participants in a market with or without the participation of public institutions and governmental stakeholders. Both public and private institutions can be engaged in the management of the voluntary standards. For this reason, the voluntary standard system is also known as “soft law”, because the voluntary standards are generated by non-governmental organisations, private bodies or agencies. Thus, in the same line *voluntary* standards are equivalently defined as purely *private*. But, in practice the difference between voluntary and mandatory standards may often become unclear. Beside of the fact that regulations may mention the standards in an suggestive way, standards are then *voluntary* and in a restrictive way, standards are then *mandatory*, there is also a view that private standards, though sometimes called voluntary, they are occasionally *de facto* entry requirements to trade Smith (2009).

This judgment is in accordance also with the findings of Swann (2010), where he emphasizes in his review that many theoretically supposed *voluntary* standards are not in reality voluntary, even if they are not lawful requirements, they are business requisitions.

For example, the government may present voluntary standards and it may aim for compliance with such standards, particularly with quality and Sanitary and Phytosanitary (SPS) standards, but from the other hand, the government must be still organized to introduce mandatory standards if food quality compliance is not accomplished by voluntary standards. Specifically, when production and processing methods can have serious effects on the consumers' welfare, governments take preventive action to prohibit and to avoid such risks and in addition the governments enforce the application of mandatory standards.

Table 1, shows the differences of the procedural aspects between technical regulations, known as mandatory standards and the standards themselves known as voluntary standards.

**Table 1.** Differences between technical regulations and standards

<b>Technical regulations</b> <i>(Mandatory standards)</i> <i>acquired by law</i>	<b>Standards</b> <i>(Voluntary standards) known</i> <i>as “soft laws”</i>
Public standards	Private standards
Legislative rules	Recommendations
Set by public institutions international government authorities: WTO, Codex	Set by private agencies with the consensus of all parties concerned
Regulatory agencies	International non-governm. organisation (ISO, HACCP)
Approved in accordance with all the respective governmental institutions	Approved by recognized Standardization Body (Organic, Fair-Trade)
<b>Compliance with technical regulations: mandatory</b>	<b>Compliance with standards: voluntary</b>
Applied to products, processes or production methods	Focused on: processes methods, packaging requirements, social and environmental concerns
Food safety standards: governmental competence	Food quality standards: consumers’ subjective preferences

From economic point of view, the voluntary and mandatory standards theoretically have different objectives. Mandatory standards, promote sustainable trade and economic development, encourage competition and protect consumers against the consumption of products traded unfairly. Voluntary standards gain access to new markets and they have impact on the relationship between successful export and environmental performance. As we see, the objectives started gradually to presents overlaps. Moreover, Swann



(2010) follows the fact that the researchers and the economists are quite convinced that the economic impact of standards and regulations, based on the previous evidences in literature, is not as different (see next sections). However, the synergies between public and private agri-food standards continue to progress. Public and private standards practically are predisposed to be complementary and in harmonization. Even complex, the collaboration between private and public sectors has one main objective - focusing on food quality and safety matters because of consumers' awareness and increasing concern in global trade.

### **1.1.3. Classification of agri-food standards and standard - setting organizations**

“Quality and safety standards” are considered as the most important food standards. Quality standards are established to provide a minimum quality of food products traded in a market, such as nutritional level. This category of standards, apart from labelling requirements, is particularly important to decrease consumers' insecurity for the quality of products and to increase people's willingness to pay even more for premium products Chen (2008). Usually, food quality is complicated to be determined, as it relies considerably on objective attributes of food commodities as well as on subjective preference. International Organisation of Standardisation (ISO) has defined the quality as “*the totality of features and characteristics of a product that bear on its ability to satisfy stated or implied needs*” Smith (2009). Thus, food quality standards (voluntary standards) involve the set of food product and process characteristics required by consumers and community, as well as food safety (mandatory standards). In addition, food safety is obviously

an essential part of food quality relatively up to the level that food safety is a basic precondition for any quality feature. However, food safety has different requirements than food quality. It can be argued that food safety provides a public good since secure food is a central condition to provide confidence in the food supply chain. It is usually assumed that food safety issue is a competence of the government to provide mandatory food safety standards. Moreover, as mentioned above, Codex standards are focused to develop the commodity (food) standards or so called “vertical standards” *applied to a restricted number of manufactories and businesses*. Vertical standards are typically provisioned for *specific features* of products such as composition including the use of food additives, antioxidants, preservatives, maximum residue levels for pesticides and veterinary drugs and the maximum levels for the contaminants and *specific characteristics* such as presentation, including labelling, processed or semi-processed food products. Those specific features and characteristics were seen as necessary if Codex standards were to incorporate all foods that were moving to international trade and to provide general guidance and recommendations to promote safe food handling and processing (Rees and Watson 2000). To the response of this fact, the standard-setting activity of Codex, shifted its attention from the development of commodity standards to the development of general standards or so called “horizontal standards” for the use of food additives *applied to all manufactories and businesses*, which serve as suggestive guidelines for basic inputs generally, shared by various types of foods or relate to specific aspects of manufacturing. Moreover, besides of the phytosanitary standards, food quality and safety standards, recently organic standards,

quality testing, market trade requirements related to certification and accreditation procedures are considered as central issues of agri-food sector. The denominations “organic”, “biological” or “ecological” have become first popular in Europe and North America to differentiate organic from conventional agriculture commodities and production methods and techniques. The first organic regulation was adopted in United States in 1974, while the organic standards were developed by USDA in 2002 as a part of National Organic Program (NOP), (see FAO, 2003). While in 1991, European Union introduced the first standard for organic food products.

The certificate required in market trade proves to the buyer that the vendor complies with certain standards which might be more persuasive than confidential. The organisation carrying out the certification processes is called certification body or certifier. To assure that the certification bodies carry out correctly the certification processes, they are monitored, evaluated and accredited by an authorized and recognized body. Certification bodies might be accredited by a legislative institution which has to assess the compliance with regulations and standards set by International Organisation for Standardisation (ISO), European Standardisation Body or some other entities for the performance of the inspection bodies. Furthermore, International Federation for Organic Agriculture Movements (IFOAM) funded in Bonn, Germany in 1972, has established first International Basic Standards (IBS) so called “generic standards”, which allowed public and private standard-setting organisations to promote more specific organic standards. Regarding to the national standard bodies important for international trade, Japanese Agriculture Standards (JAS) refers to the combination of the JAS standard system and quality and labelling standard

system for food and agriculture products. Likewise, British Standards Institution (BSI), the United Kingdom's national standard body - is worldwide recognized as an unbiased multinational business service provider which helps both private and public sectors to simplify the production of British, European and international standards. Table 2, shows other committed agri-food standard-setting organisations having different levels of government and private oversights such as: Organisation for Economic Cooperation and Development (OECD), American National Standards Institute (ANSI), South Africa Bureau Standards (SABS), Standard Council of Canada (SCC), Brazilian National Standard Organisation (ABNT), German Institute for Standardisation (DIN), Swedish Standards Institute (SSI), Standards Norway (SN), Swiss Association for Standardisation (SNV), etc. There are also multinational bodies, in particular remarkably in Europe such as European Committee for Standardisation (CEN), (see OECD, 2010). While, fair-trade movements try to provide better access in the market and to facilitate trading conditions for small-scale farmers' business.

**Table 2.** Agri-food standard-setting organizations

<b>National standard setting organisations</b>		<b>International standard setting organisations</b>	
<i>Public</i>	<i>Private</i>	<i>Public</i>	<i>Private</i>
BSI (UK organic)	NGOs Associations	<b>EU regulation</b>	ISO standards
NOP (US organic)	ABNT (Brazil)	<b>CODEX regulation</b>	IFOAM
JAS (Japan organic)	DIN (Germany)	<b>USDA regulation</b>	CEN
ANSI (US)	SIS (Sweden)	OECD	Fair-trade movement
SABS (South Africa)	SN (Norway)	WTO	Internat. NGOs
SCC (Canada)	SNV (Switzerland)	NSF	Global GAP (British)

In summary, apart from all food standards explained in this section, there also exist other standards such: “performance standards” embody requirements in terms of outcomes in different sectors; “environmental or ecological standards” focus on maintaining environment components and function; “labour and social standards” often normative standards seek fair working conditions of human rights and sustainable networks; “industrial standards” recently established for the relevant technologies, etc. All the above standards explained in this part of the work have been established to achieve specific objectives. They are significantly important for consumers’ health aspect, the global trade issues and for the competitiveness.

#### **1.1.4. Expansion of private standards versus public standards in food supply chain**

This part of the work provides a theoretical framework to better understand the raise of private standards in agri-food chain. Contemporary agri-food systems are increasing private quality standards that have emerged in a context of increasing consumer concerns about the sustainability of food, including communication of product quality, food safety considerations, nutritional aspects, environmental and social aspect, product authenticity, required labelling and private logo such as “Barilla”, “Lavazza”, “Nutella” (Italian), “Marlboro”, “Cocca-Cola”, “McDonalds”, “Starbucks” (US), “Colman’s”, “Twinings”, “Dickinson & Morris” (UK), “Knorr”, “Pilsner” (German), “Godiva” (Belgian), “Roquefort”, “Bleu d’Auvergne” (France), ect

According to the terminology of Henson and Humphrey, (2010), the implementation of the private voluntary standards is individual in nature. In this framework, specification required to the traders, which are often more restrictive than public regulations, may require considerable investments to upgrade agriculture production practices (handling and hygiene practices, equipment, spaces for storage, temperature controlled, technical skills etc). However the issue is not the compliance cost itself, but rather the cost in relation to the profitability of the business that also depends on market opportunities. Hence these strategies may also influence the decisions of traders to adapt in a competitive environment

A large body of agri-food literature focuses the attention on the way in which the agri-food sector is being transitioned and in particular it examines in which framework international food standards have been evolved in both industrialized and developing agri-food markets’ countries.

If food products are exported to European Union countries, it is necessary to take into consideration the fact that food safety and quality are the most important matters for European Union authorities, businesses, companies and consumers. In order to guarantee healthy food, European Union member states have imposed stringent safety and quality standards for all the types of food products which are imported into the European Union countries. Both, public and private sectors are involved in food standard-setting performance and they play a fundamental role to address the food safety and quality concerns in wide public community. However, even though the agri-food sector is increasingly governed by a combination of public and private standards both of which considered pragmatically mandatory for trading agri-food products, an extensive literature stresses the fact that there is a common tendency focused on the implementation of private food standards, as a driving force for the current agri-food system, particularly in developing countries.

This brief review in this part of the work has merged the most relevant papers to bring some specific insights on the evolution of private standards versus public counterparts in international agri-food sector. For example, to some extent, the literature demonstrates that a wide tendency of implementing private standards have emerged mainly as a response to the consumer concerns about food safety and quality attributes (Henson *et.al.*, 2005; Fulponi, 2006). The consumers have become more challenging and selective in their choices, by shifting currently the agri-food markets from price-based to quality-based competition for high nutritional value products.

Further, Henson *et.al.*, (2005) explain on the institutional context the implementation of private food standards versus

public ones. *First*, private standards have emerged in the framework of inadequate or missing public standards (see also Fulponi, 2006; Herauld *et.al.*, 2010). International food quality and safety standards are essential requirements to meet the consumers' demands and they are basic tools for food processing companies to differentiate products in order to protect and expand the market share. But those international standards do not exist in developing countries. Even when public food standards for differentiation of food products exist, they are insufficient to meet consumers' requirements regarding to the quality and safety. In this aspect, public standards are not appropriate and relevant to support the firms' competition in national and international markets. Therefore, private food standards operate as a substitution of public standards (Henson,2006; International Trade Centre III, 2011). Instead, the *second* justification for the implementation of private standards rather than public ones is the case where effective public standards exist but they need to correspond with the private standards, which go even beyond the strict legal requirements (REF). This consideration is strongly reinforced by Fulponi (2006) who analyses the institutional aspect that has led food traders to use international private standards. In food safety and quality region many retailers describe the private standards as more significant than those established by governments. The reasons behind this fact are, from one hand the profits of OECD countries governments through the bilateral trade, and from the other hand the public insufficient budget which hinder regulatory activities. Thus, the governments appreciate the important role of international private standards in regulating the agri-food sector.

Further, it is important to emphasize the establishment of a management system – the so-called “quality meta-systems”



such as Hazard Analysis and Critical Control Point (HACCP), Good Agriculture Practicing (GAP), ISO 9000, Good Manufacturing Practicing (GMP)- to monitor and evaluate the performance of production processes and the way in which supply chain operates (Fulponi 2006; Henson 2006). This is mainly a particular attribute of international private standards schemes. In addition, regarding to food quality and safety, the adaptation of international private standards ensures fair competition, reduces the possibility of consumer complaint and increase the amount of high value products in trade. Moreover, according to the economists, the role of information, quality and reputation, which means providing consumers with products that meet quality and safety standards that go beyond the minimum requirements, constitute the basic elements for understanding the importance of implementing international private standards in agri-food system. Alternatively, some other authors seem to be unbiased in the way of analysing this particular issue. Giovannuci (2008) supports the idea that both sectors evolve simultaneously as a result of the collaboration with complementary and facilitating roles in developing agri-food standards. In parallel, Heraudet *et.al.*, (2010) think that the reinforcement of minimum quality standard (MQS) set by public system may affect the firms to develop more stringent private standards, which might have positive effects by promoting the market access for producers and the consumer welfare. Thus, public and private sector are always interrelated in their evolution.

To conclude, Roberts and Josling (2011) highlight the fact that developing countries are still concerned about the law adaptation rate of international standards to encourage and to implementing successful policies for market access, since these standards have a particular role in facilitating the

trade. However, despite of all those positive effects of private standards, it is important to know that public standards still matter. In many agri-food products markets, public standards remain one of the principal structure of governance and exporters are still required to comply with public mandatory requirements at national and international level. Hence, private standards are becoming the leading driving forces in agri-food system

#### **1.1.5. Consequences of implementing public or private standards in developing countries' economies**

The phenomenon of globalization has ensured a wide and diverse range of foods from many nations which are now available to most of the markets in the world. Most developed and developing countries implement national regulations and private standards which regulate the minimum quality and safety of food produced and traded within their territories. Generally, developing countries apply less stringent food standards than those adapted by developed countries, which drive the companies and businesses to be confronted with different requirements to trade in the domestic and international markets. For example, a food can be denied access in market of country destination when it does not comply with food requirements applicable in this country. This influences firms' decision whether to export food and particularly to which market. Many studies have been carried out whether these differences among national regulatory requirements and standards of different countries can help or hinder export trade perspectives for fragile economies such as those of developing countries.

This part of the paper is largely focused on the opinion of the authors who highlight the consequences of implementing

internationally harmonised standards and regulations in developing countries' economies. For example, Charnovitz (2005) has raised the question in his study whether the adaptation of international standards established by World Trade Organisation (WTO) member nations, to some extent may aggravate the inconsistencies between rich and poor countries, because the developing countries do not have sufficient capacity to reap all the benefits of international standards. Further, it has been considered that “developing countries are typically *standards takers*, rather than *standards makers*” (Maskus *et.al.*, 2006) because adapting international food standards of the developed countries seems to be more economic than establishing their own national standards. Moreover, (Henson *et.al.*, 2006) highlights the conditions under which the complexity of food standards and regulations impede the export trade of firms in developing countries. Developed countries apply high food standards and stringent regulatory requirements as “protectionist” instruments to hinder importation of agri-food products from developing countries, which do not comply with their food standards. As a consequence, the lack of harmonization of food requirements between different foreign companies and businesses denies the developing countries firms access into the markets of more industrialized economies. For example, the government set the standards based on the characteristics of firms' products, which lead to high export costs of developing countries firms to comply with standards. In addition, the difference in standards across markets lead to the payment of each individual fixed compliance cost, while the difference in regulations across markets limit the capacity of productivity of firms which affect the decision in the number of export markets (Chen *et.al.*, 2006). Besides complying with

standards and regulations, firms experience also time delays because of the inspection procedures, which can be translated as a barrier to exporting firms. A case study presented by Jayasariya *et.al.*, (2006) show despite of the large potential, the most important factors constraining Indian export growth are difficulties in complying with stringent food standards because of the low quality of raw material, high cost of laboratories which requires investments in expensive technologies, testing, certification and other costly financial issues (Faria *et.al.*, 2010). Another case study shows that, according to the Chinese official governmental sources, SPS and TBT standards impact, imposed by developed countries - Japan, EU and US, to restrict agriculture imports from developing countries, have resulted in massive losses for China's agriculture exports (Chen *et.al.*, 2008)

Otsuki (2011) in his study found that export firms of developing countries in EU and in Central Asia, inspected by external auditors, are tended to be required for the international standards certification, which is a great obstacle for those firms.

Overall, it is important to understand to what extent these internationally harmonized food standards has been used in developing countries. Roberts *et al.*, (2011) emphasizes that developing countries are still concerned about the law adaptation of international standards, to provide effective policy for market access, even after fifteen years since when SPS Agreement was established

The trade effect of standards is an important issue, especially in the agri-food sector and especially for developing countries. Understanding the impact of food standards on developing countries is imperative, as

agricultural and food exports are a fundamental component of developing countries' growth.

SPS and TBT are likely to affect both consumers and producers' incentive structures. From the perspective of producers and processors, the cost of complying with SPS and TBT might be high. The fixed costs may include the upgrade of practice codes and facilities, the acquisition of certificates, and conformity in marketing requirements. In addition, inspection and testing procedures may cause prolonged delivery time, rejection of certain shipments, or even denial of entry completely. Therefore, the proliferation of SPS measures and TBT can significantly reduce a country's imports from its trading partners and even drive some foreign suppliers out of market. This is the trade-cost effect, which corresponds to the "standards as barriers" argument in international development literature (Otsuki *et.al.*, 2001; Anders *et.al.*, 2009)

On the other hand SPS and TBT may enhance a country's demand for imports if the regulations address market imperfections. For example, mandatory labeling requirements in meat products can boost meat demand by conveying quality information to consumers (Bureau, Murette, Schiavina 1998). Alternatively, SPS policies can promote social well-being, in the form of better public health, higher animal welfare or more sustainable environment. In economies of developed countries where the consumer awareness of food safety, animal welfare and plant health is high, the SPS measures could stimulate more demand for products under regulation (Josling, *et.al.*, 2004). This is the demand-enhancing effect of SPS and TBT corresponding to the "standards as catalyst" arguments in the literature. Therefore, SPS measures and TBT either facilitate or hinder international trade depending on whether the demand-

enhancing effect, if any, outweighs or fall short of trade costs effects. This dual effect calls for a different analytical framework from those used to analyze the conventional trade taxes.

## **1.2. Trade theory and the empirical approach of the effect of international agriculture standards**

### **1.2.1. “State of the art” and the trend of the effects of standards on agri-food trade**

A broad literature exists on the welfare and trade effects of standards and regulations. The general literature shows that welfare and trade may increase or decrease by imposing the food standards and many actors in supply chain, such as consumers or producers may be affected differently. This part of the work is focused on the positive effects of standards on agri-food trade.

Steve Charnovitz (2005) has described four potential ways in which the application of standards can increase particularly the welfare of developing countries. *First*, an international standard can help to avoid the inefficiency of segmented markets by replacing different national standards. This benefit can be useful especially for developing countries with small domestic markets. *Second*, an international standard can prevent conflicts caused by differences in standards. Developing countries have always been in a difficult position because of trade disagreements among countries, in an international food standards system, where there is much opportunity for all to gain. *Third*, an international standard might raise the economic conditions of countries. Hence, low-income countries might be more willing to borrow an appropriate international standard. *Forth*, the shift to international standards may lead to greater efforts at capacity building for developing countries. However,

international standards do not guarantee for sure to increase welfare (Henson *et.al.*, 2006). Another assumption is developed by Henson *et.al.*, (2006) about the potential opportunities of food standards on trade. The public and private standards are viewed as a bridge between consumers' demand and participation of international suppliers.

In addition, food standards may serve as a “common language” in supply chain to reduce transaction costs. In this aspect, food standards are considered as “catalysts” to have access in international agri-food market. Indeed, the recent evidences of stringency of food standards, in particular of food safety and quality standards, are generating new basis for competitive positions of developing countries on trade export performance. SPS and TBT Agreements are of particular importance for developing countries, which most of them are primary agriculture exporters and depend economically on access to foreign markets for their agriculture (WTO report 2003). For example, SPS and TBT measures have significantly affected the Chinese farmers and exporters who had a large positive impact on domestic production Chen *et.al.*, (2008). Another case study presented by Alpay *et.al.*, (2000) investigates the impact of quality and safety standards on export performance of Turkish firms in developed countries. The findings show that quality standards have significant positive impact on export performance of those firms. Complying with voluntary standards can stimulate export, because the firms gain the quality. Producers are likely to pay higher prices for certified products. Standards can reduce the asymmetry of information between sellers and buyers by increasing the quality of products and improving the image of the firm Faria *et.al.*, (2010). The importance of international food standards in developing countries is obvious. Introducing

international standards, probably, encourage the integration of developing countries into the international trade system Roberts *et.al.*, (2011). It is important for the firms of developing countries in EU and Central Asia to meet international standards when they trade food products to EU markets. Standard certification enhances also the reputation of the companies and attracts buyers in export markets Otsuki (2011). Based on the literature, from political point of view, it is noticed that consumers rely significantly on public standards (set by government) but also on private standards (set by firms) in their decision making to consume. Producers as well rely on standards to improve their production or to increase the transparency or consumers' reliability Vandemoortele (2011). Those examples emphasize the potential effects of standards, but from the other hand, standards may also have positive or negative welfare impact on different actors in the market.

### **1.2.2. Understanding political and economic theory of trade effects of standards**

The understanding of the political context of agriculture trade has directed the economists to try to model the political behavior Josling *et.al.*, (2010). Economists have been mainly based on the domestic framework of political economy and on the rational behavior of political actors to understand trade policy. Many authors have carried out a considerable work on the political economy of international agri-food trade. For example, Swinnen *et.al.*, (2009) present a model of political economy of public standards, where both the consumers and producers are satisfied, because the characteristics of products satisfy the consumers' preferences and the producers increase the production cost by implementing public standards. However, a key result is that, both consumers and producers may either gain or lose from a



change in the standard. Further, the authors examine if food safety standards are different from food quality standards and other in the aspect of political economy. The findings of Swinnen *et.al.*, (2009) shows that the level of standards does not suggest the fact that most stringent standards act as trade barriers or as protectionist instrument, because it depends not only on the type of food standards but also on the interaction between them. It is important to be careful in classifying the standards as protectionist instrument, because standards may be welfare optimal while negatively affecting trade Vandemoortele (2011). In addition, on the basis of a situation which suggests that more stringent standards provide benefits to domestic producers, it is expected for food safety standards to be more important trade protectionist instrument than food quality standards. This opinion is consistent with the outcomes of Vandemoortele (2011) who highlights that public standards may be used as trade-protectionist tools to shelter domestic producers. Another question investigated by Vigani (2010) explains why a retailer is willing to set its private standards at a higher level than the public ones? The model shows that a retailer is willing to set its private standards at a higher level than public one, if the retailer has sufficient market power to pass the complying cost of standards to producers. Since the producers face most of this cost, they lobby in favor of low public standards. If the retailers do not have market power, private standards cannot be at a higher level than public standards. These conclusions are consistent also with the results of Vandemoortele (2011). Overall, the economists need to understand the domain of politics and to be rational in determining the international trade policies.

### **1.2.3. Empirical based approach**

In scientific use, the empirical approach is largely used by researchers to obtain results from direct observations as a way of answering specific empirical questions, which can be analyzed by a combination of quantitative and qualitative method. The paper summarizes some of the existing empirical evidence and it explains the empirical approach used to investigate the effect of agri-food standards on international trade. Many researchers have used different empirical approaches in their econometric studies to measure the effects of agri-food standards on trade.

The comprehensive empirical evidence of many researchers is obtained as a result of analyzing a variety of specific econometric models such as linear regression analysis, tobit estimations etc. In addition, in order to define the legality of empirical research , accurate analysis of data are produced by using statistical methods, standard equations and formulas, variables, parameters, indexes and other coefficients which have been useful to form logical conclusions. For example, through the *quantitative approach*, Alpay *et.al.*, (2000) have constructed an index for the compliance with quality and safety standards estimated by *Parametric and Non-Parametric Linear Least Squares Regression*. Through quantitative analysis approach, the majority of studies using *Perinorm database* (Shepherd 2006; Shepherd 2008) have shown that the effect of standards tend to be trade-creating rather than trade-reducing. Further, (Otsuki 2011) has applied *Control Function (CF) with endogenous variables* based on *Heckman's model* in his study to control the results on the effects of international standards on firms' export performance. Moreover, (Swann 2010) after analyzing only *qualitatively* a wide variety of econometric models in his empirical literature review, he

presents a “*black box*” model that disguise the “backstages” of a complex relationship between agri-food standards and trade. In addition, based on both *quantitative and qualitative approach*, Swinnen *et.al.*, (2009) have analyzed the political economy of food standards not only theoretically but also on the basis of analytical framework by using *linear utility functions and equations* and *Grosman-Helpman model* as well.

Even though, many researchers have widely analyzed the effects of agri-food standards on trade on empirical framework from different point of views, however the findings from empirical studies are flexible, depending on the models and methods used. In the next section, we have explained in more details the gravity-type approach, equilibrium model and cost benefits analysis as parts of the analytical measuring system of the effects of standards on trade

As we understood, many researchers have empirically analyzed the effects of agri-food standards on trade from different point of views; however the general conclusions are as follows.

The overall impression of econometric studies that use information on mutual recognition agreements (MRAs) (Chen *et.al.*, 2008; Ann *et.al.*, 2009; Swann 2010) is that the impact of MRAs and the harmonization of domestic regulation with international standards have a significant export promoting effect. Further, in analytical framework of the non-tariff measures impact (NTMs) (Schlueter *et.al.*, 2009; Swann 2010; Demaria *et.al.*, 2011) the evidences have generally shown that NTMs are more strictly than tariffs. However NTMs tend to commonly have mixed trade effect.

Following Swann (2010), in his empirical literature review on the effects of international standards on trade, he

concludes that there is often, but not always a positive relationship between international standards and exports or imports. The findings from econometric models show that it is widely supportive that international standards help trade, while for national (i.e. country-specific) standards studies find positive as well as negative effects on trade. In sum, there are many possibilities how a standard impacts on an economy. Some effects are positive but others are negative, which may explain the diversity of the results of the empirical literature reviewed here.

Thus, a key finding of the literature reviewed does not provide a single answer to the question of trade effects, and the explanation for this appears to have to do with how the multiple economic effects of standards interact. Part of the reason is that the different studies have referred to different countries, different industries and different measures of standards.

### **1.3. Analytical measuring system of the effect of standards on trade**

#### **1.3.1. Gravity model**

Quantitative analysis has taken a variety of approaches in global trade. Gravity-type model is recently one of the most prevalent approaches of empirical and statistical analyses in economics (Chaney 2011), used by many economists and researchers to evaluate the trade patterns. Application of this model on international trade, and in particular on bilateral trade flows between different countries, has also remarkably demonstrated constancy across different illustrations of methodologies. Numerous applications of gravity approach have analyzed different measures, types of trade costs and their impacts on bilateral trade flows such as transport costs, export and import, tariff and non-tariff

barriers, regional agreements and other trade facilitations. For example, Jayasariya *et.al.*, (2006) have applied gravity model to estimate the effect of food safety standards measures in specific importing countries on Indian's firms processed food exports. In addition, Chen *et.al.*, (2008) aimed to measure the effect of food safety standards on vegetables and aquatic products China's export by using regression analysis on gravity model. Moreover, econometric studies empirically analyzing the impact of NTMs are also based on gravity model of bilateral trade flow (Schlueter *et.al.*, 2009) and in particular one main point of interest is how NTMs are captured in gravity model (Demaria *et.al.*, 2011). Further, Vigani (2010) has econometrically analyzed the trade effects of GMO regulations and standards on developing and developed countries, by using a gravity model and by controlling for sample selection bias on zero trade flow. While, Shepherd (2011) has developed a gravity model and through the analytical work, he examines more carefully the trade impacts of internationally harmonized standards. Gravity model of trade is considered as one of the most successful econometric models (Anderson 2011) in international economics. Gravity model has led the literature on the evaluation of trade policy with numerous publications and working papers.

Gravity model is explained in details in the next chapter.

### **1.3.2. Equilibrium model**

Developing countries' economies are regularly integrated in the world economy, thanks to the globalization process, as a result of international trade flows, cross-border investments, migrations, participations in international agreements etc. Through the globalization process, the global economy has particularly influenced the development of trade

liberalization and market equilibrium. According to the economists' view, the way how the trade is modeled is very significant for the development of the countries' economy. The general equilibrium model created by the French economist *Leon Walras* is one of the greatest success and it is considered a benchmark model to analyze market economy (Tsfatsion 2005). The model explains the behavior of supply, demand and prices in a whole economy and the determination of the commodity prices and quantities in perfect competitive markets to reach the general equilibrium. Essentially in accordance and closely related to Walrasian equilibrium theory, Pareto states that "no consumer can be made better off, without another being made worse off". Thus, any "Walrasian equilibrium is Pareto optimal" (Levin 2006).

Hence, the general equilibrium analyzes a range of economic variables and their interactions to understand the whole economic system. In particular this is very suitable and typical model to investigate the trade policy effect, the impact on production, trade flows and of course the overall welfare. As result, the international trade is basically considered a general equilibrium phenomenon. Instead, the partial equilibrium model developed by Marshal, considers particular markets by analyzing only one variable and keeping unchanged all the other variables. Tariffs preference level and tariff rate quotas are some examples of trade policies that are better addressed in a partial equilibrium context.

The following scientific sources are selected to explain in which aspect equilibrium and partial equilibrium models are usefully applied to examine the international trade patterns. For example, an interesting contribution was made by (Bautista *et.al.*, 1998) who have employed general

equilibrium model to present the impacts of trade policy interventions on agriculture, the outcomes of which are compared with the previous works in partial equilibrium model. Further, Coque *et al.*, (2006) have analyzed the impact of bilateral liberalization of agri-food trade in Mediterranean counties by looking into the performance of specific trade policy tools such as tariffs and non-tariff measures in both general and partial equilibrium models. In addition, Francoise *et.al.*, (2009) have implemented a multi-country and multi-sector general equilibrium model to assess the influence of free trade agreements for the liberalization of agriculture trade and tariffs between European Union and third countries. Moreover, Disdier *et.al.*, (2010) indicate how to combine both gravity model and partial equilibrium model to better understand the positive impact of non-tariff measures. In these contexts, the general and partial equilibrium models are appropriate analytical frameworks for such analysis.

### **1.3.3. Cost benefits analysis**

The cost-benefits analysis (CBA) is an evaluation process which analyses all the potential costs and benefits that may be generated before taking an economic decision. The cost benefits analysis has emerged as an economic instrument to somehow overcome the regulatory divergences among the countries. For example, from one hand, successful efforts have been made to reduce the trade tariffs at relatively low levels, in the major part of the developed countries, as a result of several rounds of multilateral trade negotiations. From the other hand, non-tariff barriers are still the remaining barriers to be addressed, since they are considered as the most prominent impediments in international trade for a wide variety of products. In this

context a great attention is consistently focusing on the impact of non-tariff measures in international agri-food trade, which is even a broader level than just non-tariff barriers.

This part of the review is synthetically focused on the cost benefits analysis of the effects of NTMs in agri-food trade - designed to ensure that products meet import/export countries requirements. It examines briefly the potential economic benefits and costs that could result for example, from the mitigation of stringent food products regulations and standards.

So far, most of the literature has presented a descriptive analysis of costs and benefits of economy based on the rationality of classical theory regarding marketplaces and trade. Few empirical studies have been carried out to support theoretical outcomes analyses. For example Tongeren *et.al.*, (2009) have explained a very detailed application of cost and benefits analysis for all the stakeholders in the food supply chain, in a partial equilibrium context. The main issue analyzed is “what are likely costs and benefits from changing the current policy?” The study compares the previous empirical works’ outcomes which allow identifying the potential appropriate alternative choice (such as standards, *testing, certification, border inspections and labeling* - as the most frequently mentioned classification of NTMs) for a better trade and welfare in the international context (Tonereng *et.al.*, 2009; Beghin *et.al.*, 2011). In this sense, this approach gives a more comprehensive analysis of NTMs, because it goes beyond the evaluation of the trade impact operating alone. Evidently, Tonereng *et.al.*, (2009) and Beghin *et.al.*, (2011) suggest that usually NTMs do not necessary represent economic deficiencies in terms of trade barriers, besides the case when



NTMs may be in the form of trade restricting policies of market imperfections. Therefore, it is not clear that the trade impacts of regulations are efficient or inefficient or that the removal of non-tariff measures would achieve benefits in that level that could exceed the losses, for example, from weaker regulations. Further, in the same logical line, Tongeren *et.al.*, (2010) have presented three illustrative case studies to show how a cost benefits analysis can help to identify least-cost solutions of mandatory NTMs set up by OECD for agri-food sector. The *first* case study is specifically related to production and importation requirements for raw milk cheese. It estimates *consumers'* willingness to pay in order to avoid human health contamination with *Listeria*. From trade point of view, some OECD countries impose stricter production and importation requirements than the others, which lead to some cheese varieties being non tradable between those countries. In this case, NTMs are considered as import bans on certain varieties of cheese. The empirical analysis of the first case study, suggests that consumption of cheese can be costly for both: consumers and community, as it brings *Listeria* disease. The *second* case study is focused on the use of antibiotics in shrimps. Hence, it examines the compliance cost of production requirements on shrimps. Non-OECD *suppliers*, such as India, Indonesia and Vietnam are also concerned to human health. In this case NTMs are import bans but also free trade in combination with requirements to adopt improved production methods, which could benefit both: producers in exporting countries through higher profits, and the importing OECD countries given the lower risk of antibiotic residues in the product. Restricting the consumption of shrimps that contain antibiotics and the implementation of such production standards can be welfare

enhancing, both nationally and internationally. The *third* case study is focused on market access. It is related to *producers'* concerns about invasive species of cut flowers imported from Kenya, Israel and Ecuador to the EU, which affect the output quality of local producers. In this case, NTMs are considered as strict border inspection, which affect foreign suppliers from non-OECD countries. The study suggests that the cost of strict border inspection and the cost due to the changes in the production methods tend to be large, respective to the profits of avoiding contamination for EU flower production. As it is noticed, the three cases analyse different cost benefits analysis. In continuation of the above study, Beghin *et.al.*, (2011), was further focused only on the shrimp case study, who examines the impact of technical barriers and SPS regulations on trade and welfare. The authors conclude that the optimum of NTMs is often not zero. The illustration outcomes show that the reinforcement of food safety standards is socially more preferable (see also Tonereng *et.al.*, 2009). As suggested by the researchers, the relationship between trade, welfare and NTMs is complex.

#### **1.4. Implications of data collection and their measurements**

##### **1.4.1. Transparency intensity of data collected on international standards and regulations**

Standards and technical regulations can be considered as “the real 21<sup>st</sup> century trade issues” (Chen *et.al.*, 2012). Thus it is fundamental to measure better the standards and regulations. Based on previous literature and the governmental sources have made known that there are gaps in data about regulations and standards such as: where they are used, how often and gaps in the analysis of impact of such use. Theoretically, most of the previous studies

according to a logical way of thinking, have suggested that use of standards and regulations should help trade, but these studies have failed to produce evidences. Different approaches such as direct and indirect methods have been used to collect data on standards and regulations and to measure them. The direct approach collects evident data on trade costs from different sources such as Perinorm database. For example in the study presented by Shepherd (2006), one of the principal difficulties in analyzing the trade impact of Technical Barrier to Trade (TBT) and Sanitary and Phytosanitary (SPS) measures remain the lack of availability of adequate and reliable data. In addition, a difficult issue remain also the mapping the standards to products in a regular way, because the classification schemes used for standards (ICS) and goods (HS, SITC) were based on different approaches. Identification of standards and regulations is another source to measuring the trade costs. For example, a pilot review study developed by Fliess *et.al* (2010) illustrates the complexity of data and the difficulty of identifying which standards are used for each regulatory objective for a given sector. An analytical framework was developed for classifying and recording data: what products, which objectives are addressed to technical regulations, how to achieve those objectives and which standards are accepted as basis for compliance with regulations. This information demonstrates the potential transparency. In this context, the research illustrates how the transparency of data collected on the use of standards can be improved. Improved transparency can improve harmonization which can help to remove trade barriers. Another benefit of transparency is that the information of the use of standards in technical regulations provide a rich and accurate data source to be further used in empirical

work on how use of standards affect international trade. However, the findings of Fliess *et.al.*, (2011), in study, have shown a negative conclusion: there is a lack of data transparency, which complicate the measurement process. Further, notifications of changes in regulations from WTO which could influence the trade are currently another good source of information referring to direct approach of measuring effects of standards in global food trade and particularly to explore to what extent the use of these international standards has been successful Roberts *et.al.*, (2011). In addition, Josling *et.al.*, (2011) go even in more details besides the use of international standards. They highlight that there is no information to what extent is the impact of Sanitary and Phytosanitary (SPS) standards on trade. Most of the analyses of the case studies have been relied on indirect approach such as comparison of prices or trade flow's quantities, to measuring the SPS effects on trade. Recently, some econometric analysis resulted that SPS measures have a significant influence on agriculture markets, but still much remains unknown about the full economic effect of these measures in international trade. For this reason, Josling *et.al.*, (2011) emphasized the need of new data on SPS measures, which would present a more complete picture of regulatory barriers to trade, would facilitate analyses across countries and products, would increase transparency, and would observe improvements in market access. To conclude, a common suggestion by researchers to be considered in the future studies is the fact that without transparency of data, it is impossible to evaluate the trade impact on trade of international standards and regulations.

**1.4.2. Role of international institutions on measuring effects of standards**

Some efforts done by some international institution on measuring the effects of standards are clearly described by Josling *et.al.*, (2011). Regarding to some previous initiatives, The United Nations Conference on Trade and Development (UNCTAD) have managed a database that has included non-tariff trade barriers. The Trade Analysis and Information Systems (TRAINS) database has also provided information for such barriers, since it is based in large part of notifications of WTO of new measures, but it had a partial description and a classification system which is not conform to the regulatory system. In addition, Josling *et.al.*, (2011) described some approaches (projects) used to investigate qualitative and quantitative methods used in trade studies. First, the establishment of Multi-Agency Study Team (MAST) was done to organize the work on collecting information on non-tariff measures, which resulted in a new classification system of NTMs in 2007. After that, MAST has created a website to enable the agri-food private sector to report problems in market access. Another effort is NTM-IMPACT research project to measures the impact of regulatory heterogeneity, carried out to develop the basis for a NTM database. In a further project, Josling *et.al.*, (2011) have explained that one of the outcomes of Economic Research Service (ERS) of United States Department of Agriculture (USDA) was the creation of a new database combining it with the Phytosanitary Regulation of the entry of fresh fruits and vegetables into the United States. Through a simple classification of measures and by applying a specific gravity model, the researchers were able to analyze the relationship between SPS system and the trade impact. USDA emphasized the bilateral nature of SPS regulations.

The last approach explained by Josling *et.al.*, (2011), is the Composite Indicator of Market Access (CIMA) which was focused on the need to collect information about the cost of meeting the mandatory requirements set by importing countries. It would combine tariffs, subsidies and other market tools with the compliance cost of meeting importer regulations. Adding SPS measures to tariffs through the compliance cost would reduce the constraints on market access. To conclude, Josling *et.al.*, (2011) suggested that better notifications and more systematic reporting through SPS Trade Policy Review (TPR), would help to provide information to make clearer the grey issues of international trade. Besides the above approaches, a considerable number of international institutions including World Bank, International Monetary Fund (IMF) and General Agreement on Tariffs and Trade (GATT), World Trade Organization (WTO) ect, have also played an important role in promoting free trade instead of protectionism phenomenon.

**Table 3.** General Review on food international standards

<b>Author(s)</b>	<b>Objective</b>	<b>Data collection</b>	<b>Data analysis</b>	<b>Results</b>	<b>Conclusions</b>
<b>Alpay <i>et.al.</i>, 2001</b>	Exp vertical integration	100 Turkish exporting firms	Linear & Non Linear Reg	Stronger vertical integ	EU market: food quality & safety
<b>Steidle <i>et.al.</i>, 2005</b>	Analysis of food regulat.	EU,NOP JAS, Codex, IFOAM	Qualitative analysis	Consumers' trust required	New ISO 65 needed organic
<b>Chen <i>et.al.</i>, 2006</b>	Standards on export	619 firms in 17 develop. countr	General. Linear Model	Adverse effect of standards:	Export & market diversif.
<b>Henson <i>et.al.</i>, 2006</b>	Standards on export	World Bank Literat. review	Theoretical & strategic app	Stan:"barrier" & "catalyst"	Food standards: holistic perspec.
<b>Henson, 2006</b>	Private stan. in food sector	SPS, TBT,ISO, GMP, HACCP,	Qualitative analysis	Private stand: lack of public	Reduce+enhance food trade
<b>Jayasariy <i>et.al.</i>, 2006</b>	Difficulties of exp: India	71 Indian firms in 7 countries	Quantit. app Gravity model	Low quality & high costs	India, 18% loss in exp: SPS reg.
<b>Shepherd, 2006</b>	ISO stand. & 'isosyncratic'	CE Norm & EU Perinorm data	Quant.analyse Gravity model	More ISO than idiosyncratic	Better stand. impact on trade

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<b>Chen <i>et.al., 2008/a</i></b>	China's exp food stand.	COMTRADE, FAO, UNCTAD	Gravity & LS Reg.analysis	Higher stand: negat. effects	SPS & TBT: barrier Chn exp
<b>Chen <i>et.al., 2008/b</i></b>	Standards in export	619 firms in 17 develop. count	Theoretical & emp. analysis	"Quality": pos "Certific": neg	Certific. needed across countries
<b>An, <i>et.al., 2009</i></b>	Harmonisation of stand.	421 exp firms in 5 dev. count.	Econometric analy & Tobit	MRAs: sig exp promot. effect	Attention on MRA: grow exp
<b>Mitra <i>et.al., 2009</i></b>	Export restrictions	Agric. Ministry of Japan &	Theoretic & empiric analy.	Export restric: loss of market	Exp restriction: loss of welfare
<b>Pierre, 2009</b>	3 types of exp. restrict.	60 low-income countries: FAO	Qualitative analysis app.	Food security or exp. restr?	Restrictions: negat. impact
<b>Schlueter <i>et.al., 2009</i></b>	NTM impact quantificat.	MAST 2008 & MADB data	Quant. analys Gravity model	Comparison reg. & stands	Welfare enhancing
<b>Swinnen <i>et.al., 2009</i></b>	Trade&polit equilibrium	WTO notificat: SPS & TBT.	Theoretical & empirical app	Stand: barrier & catalyst	Right level of stands: profits
<b>Faria <i>et.al., 2010</i></b>	Voluntary stand & export	117 Brazilian food firms.	Reg analys Empirical lit.	Stand positive effect on exp	Positive impact of standard



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<b>Fliess <i>et.al.</i>, 2010</b>	Standards: basis for reg	PERINORM & ANSI database	Qualitative app. analysis	Gaps in data reg & stand	Standard in regulation
<b>Shepherd <i>et.al.</i>, 2010</b>	Voluntary standards	EUSDB, Euro-stat, CEPII	Emp. analysis Gravity, PPML	ISO: different. trade effects	ISO: promote. Non-ISO: inhib.
<b>Swann, 2010</b>	Stan. help or hinder trade	Perinorm, MRA, SPS, TBT	‘Black box’ model	Int standards: + trade effect	Trade-promot than reducing
<b>Tongeren, <i>et.al.</i>, 2010</b>	NTM least-cost solution	Legislation & COMEXT data	Cost-benefit analysis	NTMs: bans, free trade, ins	Inspection: neg. benefits
<b>Vigani &amp; Olper, 2010</b>	Stan. political economy	GMOs regulat for 60 countr.	OLS, GMO index, Gravity	Retailer: high private stand.	Stand. stringen affecting trade.
<b>Demaria <i>et.al.</i>, 2011</b>	GM’s econo-metric estim.	TRAINS, UNCTAD, WTO	Quant. analys, Gravity Model	NTMs: more restrictive	Costs & benefits of import
<b>Fulponi <i>et.al.</i>, 2011</b>	55 RTA on agriculture	WTO, IDB & 158 tariffs	Theoretical analysis app.	AP, LA & SS del. tariffs	Progress: MRAs & harmonisat.
<b>Josling <i>et.al.</i>, 2011</b>	SPS reg. on market	Surveys on exp & importers	Qualitative & quantit. app	Compliance cost US reg.	SPS & TBT data needed

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<b>Navarett <i>et.al.</i>, 2011</b>	EU export performance	15,000 manuf-actures in 7 EU	Qualitative & quantitat. app	Size, product. work force	Firm: influence than country
<b>Otsuki, 2011</b>	Int. standard on export	25 countries: WB Survey	CF model, Heckman	Stan.help only large firms	Inces. exp 44% & declin. effects
<b>Roberts <i>et.al.</i>, 2011</b>	Privat. stand on trade	WTO through SPS Committee	Notifications: effect of IS	57%:IS no use 59%:no exist	Private stand.: as benchmarks
<b>Vandemoortel e, 2011</b>	Political & econ. theory	Theoretical literat. review	Partial equilib. model	Stand: trade-protectionist	Welfare & neg. effect on trade

## Chapter 2. Gravity model on international trade: an economic theory approach

### 2.1. Introduction to gravity model

#### 2.1.1. Newton's Law of gravity

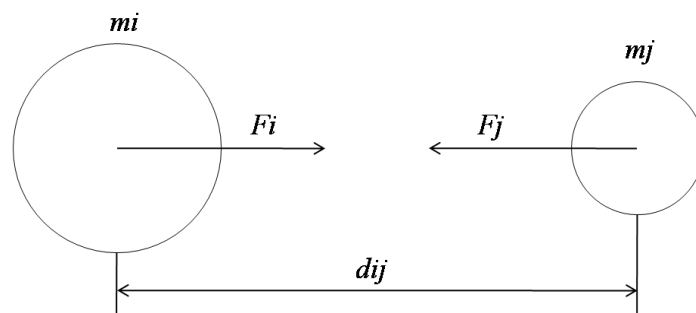
Isaac Newton's Law of Gravity (1687), as one of the most significant laws of natural sciences, states that *"All physical bodies attract each other with a force proportional to the product of their masses and inversely proportional to the squared of the distance between them"* (Rooij 2008).

In symbols it is expressed as follows:

$$F_{ij} = G \frac{m_i \cdot m_j}{d_{ij}^2}$$

where  $F_{ij}$  is the attractive force between objects  $i$  and  $j$ , the  $G$  is the gravitational constant depending on the units of measurement for mass and force,  $m_i$  and  $m_j$  are the masses of the objects  $i$  and  $j$  and  $d_{ij}^2$  is the squared distance between the objects.

A graphical presentation of the gravity law is shown as follows:



**Figure 2.** Newton's law of gravity

where, the masses  $i$  and  $j$  are presented by the area of circles which attract each other with a force that acts along the line joining them and  $d_{ij}$  is the distance between the centers of the two objects.

In simple words, the gravity law means that the attraction between any two objects in the universe is equal to the product of their masses and that the attraction between two objects diminishes as the distance between them increases. Based on several empirical tests, the economists have noticed that this simple idea of gravity has been widely and successfully applied in previous theoretical and empirical analysis to describe different economic and even social phenomena on research sciences. In particular, the economic phenomena between different locations can be empirically described by the so called *gravity equation*, which does not arise from other models, but simply from Newtonian physics notion, as explained above. This is the first justification of the formulation of gravity equation, but it still has a long history on research science.

### **2.1.2. Brief overview of theoretical foundations milestones of the gravity model**

The list of applications of gravity equation concept is long; therefore, numerous theoretical models based-approach and empirical contributions have followed the evolution of various definitions and functions derivations of gravity equation in literature, based on different conditions and under different assumptions. In particular, the studies of Krugman and Helpman (1985), Bergstrand (1985, (1989) and (1990), Deardorff (1995), Evenett and Keller (2002), Anderson and Wincoop (2003) have significantly contributed in the efforts to establish a theoretical foundation for gravity model, by demonstrating that the gravity equation can be derived from a variety of different trade models (Olper *et.al.*, 2008; Bernardini 2010). Numerous papers on literature, using basically gravity model have tried to explain econometrically different economic trade issues such as, the migration (Greenwood 2005; Emannule *et.al.*, 2009; Bodvarsson *et.al.*, 2013), the economic integration agreements (Marchetti 2009; Bergstrand *et.al.*, 2013), the foreign direct investment (FDI) patterns (Bos *et.al.*, 2004; Ichiro *et.al.*, 2013), the regional trade agreements (Jayasinghe *et.al.*, 2004; Cipollina *et.al.*, 2007), the direct effects of national borders (Anderson and Wincoop 2000; Olper *et.al.*, 2008), the currency unions (Adam 2009; Katayama *et.al.*, 2011), the travel demand forecasting (Fridstrom *et.al.*, 1989; Makoto 2005), the tourism (Santeramo *et.al.*, 2008; Massidda *et.al.*, 2010), the common languages (Egger *et.al.*, 2012; Jan *et.al.*, 2014), and many other measures of trade costs (Anderson and Wincoop 2004), on bilateral international trade flows.

Specifically, the British geographer E.G Revenstein (1885) and the American sociologist G. Zipf (1946) have made

important contributions through the gravity concept to the study of migration. In the early twentieth century Revenstein (1885), the editor of “Laws of Migration”, used the gravity equation for the first time to describe the early hypothesis of individual migration patterns and spatial mobility (Siddle, 2000). In analogy with Newton’s law of gravity, the application of Revenstein (1885) on migration, assumes that the number of individuals  $M_{ij}$ , that move between locations  $i$  and  $j$  per unit time, is proportional to some power of the population of the source  $m_i$  and destination  $n_j$  and decreases with the distance  $d_{ij}$  between them (Simini *et.al.*, 2012). Revenstein (1885) has demonstrated a key finding that the migration occurs in small geographical steps, by recognizing the *relevance of distance* as a factor of migration. Furthermore, Zipf’s theory (1946) built upon Revenstein’s laws, hypothesized that the level of migration between two spaces is directly proportional to the product of population of the origin and destination, and indirectly proportional to the distance – referring to the miles of two places (Bodvarsson *et.al.*, 2013). This understanding clearly emphasizes that the gravity model of migration flows is a function of distance. In particular, the importance of *distance variable* will be better explained in the next sections. However, in terms of popularity, the *gravity model of bilateral migration* has received very little research attention compared to the so called *the gravity model of international trade* (Howe *et.al.*, 2011), whose objective of this work is mainly focused on.

In this part of the work, we discuss the literature with reference to chronological development of gravity equation on international trade. At present, let us explain how the physics’ notion of gravity is related to international trade.

## Chapter 2 – Gravity model on international trade

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The gravity equation was applied for the first time on international trade, by a Dutch economist, Jan Tinbergen (1962), who described the patterns of bilateral trade flows in the absence of trade impediments (free trade situation), in which the prices are not specified (all countries have identical prices), where the trade is determined by supply potential (exporters' GDP), the market demand potential (importers' GDP) and where the transportation costs are based on the distance between countries (Benedictis *et.al.*, 2011). Tinbergen (1962) suggested that the same function equation of Newton's law (1687), could be equivalently implemented on the international trade to explain the volume, rather than the composition, of bilateral trade among countries in the world, given as follows:

$$F_{ij} = R_j \frac{m_i^\alpha \cdot m_j^\beta}{d_{ij}^\theta}$$

where, in trade economy  $F_{ij}$  is the volume of trade (monetary flow) between countries  $i$  and  $j$  (import and export);  $R_j$  is the remoteness coefficient measure (important to capture the average distance of countries from their trading partners or as alternative way of a country to obtain commodities);  $m_i$  and  $m_j$  are the economic size of the exporting and importing countries (GDPs - Gross Domestic Production or GNI - Gross National Income) or countries' populations;  $\alpha$  and  $\beta$  are often estimated in the log-linear form of the model;  $d_{ij}^\theta$  is the bilateral distance between countries  $i$  and  $j$  (usually measured center to center as shown in the figure) as indicator of trade transportation costs and other obstacles to trade, where  $\theta$  is the exponent econometrically estimated.

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Continuing, in basic economic interpretation of gravity equation the above explanation is translated into:

$$\text{Trade flow}_{ij} = R_j \frac{\text{GDP}_i \cdot \text{GDP}_j}{\text{Distance}_{ij}^2}$$

Through empirical analysis, the gravity equation on trade states that the bilateral trade flow  $F_{ij}$  (volume of import/demand and export/supply between countries) is estimated by the multiplication of the remoteness coefficient  $R_j$  and the economic development levels of two countries  $m_i$  and  $m_j$ , divided by the bilateral distance  $d_{ij}^0$  between those countries. Theoretically, under the gravity equation, the bilateral trade between two countries is proportional to their respective economic sizes, measured by the GDP and inversely proportional to the geographic distance between them (Chaney 2011). As a result, the basic idea of the application of gravity equation on trade flows demonstrates that the trade between two countries depends mainly on their economic levels and the distance between them. In its intelligible form, it means that the trade volume between two countries is presumed to increase with the size of their economies and to decrease with the trading costs (Fenster 1998; Kandogan 2004). In other words, gravity says that from one side we predict larger countries to trade more between them, but from the other side we suppose countries that are further apart to each other to trade less, possibly because the transport costs between them might be higher for a longer distance (Shepherd 2013).

Independently but a similar approach to the first study of trade flows based on gravity run by Jan Tinbergen, was also employed by a Finnish economist, Pentti Poyhonen (1963),



for which both authors gave simply intuitive justifications in their respective studies regarding to trade. Tinbergen (1962) and Poyhonen (1963) concluded that exports are positively affected by income of trading countries and that the distance can negatively affect exports (Tayyab *et.al.*, 2012). Quoting Benedictis and Taglioni (2011), many studies used the derived forms of “traditional” gravity equation, as “empirical benchmark” for the bilateral trade flows, but what was missing, in the early version of gravity equation for describing international trade patterns, was a convincing theoretical microeconomic foundation.

In this context, another Dutch economist, Hans Linneman (1966) moved toward a more theoretical justification for gravity equation rather than intuitive arguments shaped previously by Tinbergen and Poyhonen (Deardorff 1998; Hilbun 2006). Distinctively, Linneman (1966) added a certain number of explanatory variables in his model such as the size of a *country’s population* simply to incorporate economies of scale and analyzed Gross National Product (GNP) to evaluate the tendency of import for each trade flows (Kristjansdottir 2005)

For the formulation of the trade flow equation, Linneman (1966) was based on the Walrasian General Equilibrium Theory, which seeks to explain the behavior of supply, demand and price in a whole economy. More specifically, Linneman (1966) explained the trade flows (exports) between any pairs of countries  $i$  and  $j$ , based on a combination of three main indicators: the potential supply of export of country  $i$ , the potential demand of import from country  $j$  and the resistance of trade flows between country  $i$  and  $j$  (from potential supplier  $i$  to potential buyer  $j$ ). The resistance of trade flows intends the trade barriers such as geographical distance as a proxy of transportation costs, tariffs, quotas

etc. This approach demonstrates that the potential export supply of any country to the world market is a positive function of the income level of the exporting country, which can be interpreted as a proxy for product variety (Caporale *et.al.*, 2008). The potential demand of the importing country also depends positively on the income level of the importing country. While, barriers to trade are a negative function of transport costs and tariffs. In other words, the national incomes of two countries  $i$  and  $j$ , transport costs, populations, geographical distance and the regional agreements are the fundamental indicators of Linneman's (1966) model (Rault 2007).

Nevertheless, Leamer and Stern (1970) extended the analysis proposed by Linneman (1966), but based on Savage and Deutsch (1960) contribution. They lead the economists to the non-economic concept of *resistance to trade*, as a synonym for distance - a proxy of transportation costs and other trade impediments (Deardorff 1998; Benedictis *et.al.*, 2011). The proxy variable "resistance" was inserted in the formulation of Leamer and Stern (1970) model and with the log-linear form for all the functions they developed their version of gravity equation (Anderson 1979). Leamer and Stern (1970) spotted relatively the variables of demand (importer income and population) and variables of supply (exporter income and population) on gravity equation. As a matter of this fact, Leamer and Stern (1970) explained the factor determinants of the trade flow, as a function of importer's and exporter's features (countries' economic sizes of trading partners) by underlying the importance of distance variable in the equation, as mentioned above. In addition, the interpretation of Leamer and Stern (1970) was based on probability model of transactions. They computed

the trade flow from country  $i$  to country  $j$  by the following equation:

$$F_{ij} = T_n \cdot t_s \cdot p_i \cdot q_j \cdot g \cdot (R_{ij}) + \varepsilon_{ij}$$

where,  $F_{ij}$  is the value of trade flow for products from exporter  $i$  to importer  $j$ ;  $T_n$  is the transactions number;  $t_s$  is the transactions size;  $p_i, q_j$  usually determined by GDPs and populations in specific countries;  $R_{ij}$  estimates the trade resistance;  $\varepsilon_{ij}$  is the error term.

They principally pointed out that the volume of bilateral trade cannot be determinate in the absence of transport costs and so they believed that countries basically tie in competition their trading partners suddenly and surprisingly, based on different probabilities that these partners meet on the world market (Bergeijk *et.al.*, 2010). This interpretation tried to give explanation for the multiplicative functional structure of gravity equation as a pragmatic and flexible tool of trade economy. Subsequently, Leamer (1974) continued to employ theoretically a “hybrid” version of the *gravity model* but in combination with the *Heckscher-Ohlin (HO) model* (Deardorff 1998) to explain the aggregate imports of goods by countries in order to give more credibility to the explanatory variables in his regression analysis of trade flows.

The classical assumption of the Heckscher-Ohlin model that the traded goods’ prices are unchanged in all countries has demonstrated to be inadequate due to the presence of what the trade economists call “regional or national border effects” (see next section). In fact, taking into account the border effects requires prices of traded goods to differ among the global countries. In this context, the Heckscher-Ohlin model

of international trade was incapable of providing such a foundation, and probably even that the HO model was theoretically incoherent with the gravity equation. However, the dilemma with either the interpretation of Leamer or Stern (1970) or the hybrid version of Leamer (1974) is that even though the argument of probability question on gravity equation might be considered as reasonable, it still required a clear persuasive economic rationalization.

The further contribution was followed by the work of Anderson (1979), which seemed to be one of the first economists providing a sound micro theoretical foundation for the improved derivation of gravity model basically focused on the product differentiation. Anderson (1979) raised a theoretical set up for the gravity model relying first on Cobb-Douglas preferences function, and then followed by the Constant Elasticity Substitution (CES) preferences for all the countries (Deardroff 1989; Baldwin *et.al.*, 2007), both on the basis of Paul Armington (1969) assumption, which quotes that the final products and services traded globally are differentiated depending on the country of origin (Lloyd *et.al.*, 2006) and the consumers' preferences are already defined for the differentiated products. This means that goods are distinguished not only by their type but also by their production place. For this reason, the country's destination of the supplier for a given product is fundamental for the characteristics and features of this product. This structure assumes that two products produced in different countries have imperfect substitution rate in the demand. Thus, a country will be willing to consume at least one product from every other country, whatever is the price. In this way, all countries trade products between them. In a tale situation of economic equilibrium, the national income is equal to the total of home and foreign demand for the unique

good that each country produces. In the framework of the gravity model, this assumption is reasonable, due to the fact that the production place of a given product is also essential regarding to the trade costs. Larger countries trade (import and export) more, but taking into account that from the other side the transport costs constrain the trade flows by reducing the volume.

The theoretical derivation of alternative gravity equation proposed by Anderson (1979) estimates the *economic distance* - “proximity” between two national economies  $i$  and  $j$  or *countries’ expenditure* on traded goods, which is known as RED (Mazurek 2012) - towards the expenditures of global trade. Then it estimates economic distance among a group of countries (known as GREG) (Mazurek 2012), towards the expenditure of global trade (direction of the trade flows).

The combination of the two above estimations specifies the economic distance from country  $i$  to  $j$  (bilateral trade) towards the economic distance of country  $i$  to all the potential trading partners (multilateral trade). Anderson (1979) modified the gravity equation from one sector into multiple sectors (Bergstrands 2010), estimating the bilateral trade flows taking into account all the other feasible trade flows.

Anderson’s (1979) gravity equation can be written as follows:

$$F_{ij} = \frac{\text{GDP}_i \cdot \text{GDP}_j}{\left( \sum_{j=1}^N \text{GDP}_j \right)} \left[ \frac{1}{f(d_{ij})} \right] \left( \sum_j \frac{\text{GDP}_j}{\left( \sum_{j=1}^N \text{GDP}_j \right)} \left[ \frac{1}{f(d_{ij})} \right] \right)^{-1}$$

↓

Economic distance  
from (i) to (j) towards  
to world

↓

Economic distance from (i) to all  
potential trading partners  
towards world trade

where,  $F_{ij}$  is the value of trade flow from  $i$  to  $j$ ;  $\text{GDP}_i$  is the nominal GDP of  $i$  and  $\text{GDP}_j$  is the nominal GDP of  $j$ ;  $\sum_{j=1}^N \text{GDP}_j$  is the world GDP, constant across any country pairs;  $f(d_{ij})$  is the trade cost, as a function of distance between  $i$  and  $j$ .

Further on, Anderson (1979) in his derivation analyzed independently the prices based on Constant Elasticity Substitution (CES) preferences function, as mentioned above. Along these lines, the main concept of Anderson’s gravity model derivation relies on trade share expenditures systems of countries, concluding that the world trade expenditure are in balance with the world trade income as revealed in the above equation (Starck 2012).

The following approach of theoretical foundations of gravity equation was developed by Bergstrand (1985) based on the old trade theory. In particular, Bergstrand (1985) developed a theoretical connection between factors endowments and

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bilateral trade. His gravity model was based on monopolistic competition developed by Paul Krugman 1980

The theoretical equation of the gravity model by (Anderson and Van Wincoop 2004) takes the form as follow:

$$X_{ij} = \frac{Y_i \cdot Y_j}{Y} \left( \frac{t_{ij}}{\Pi_i P_j} \right)^{1-\sigma}$$

where,  $X_{ij}$  is the GDP of the world;  $t_{ij}$  cost in ( $j$ ) for importing a good from ( $i$ );  $Y_i$  and  $Y_j$  are the GDPs of county ( $i$ ) and ( $j$ );  $\sigma > 1$  means elasticity of substitution;  $\Pi_i$  and  $P_j$  ease of importers' and exporters' to access markets (countries' inwards and outwards).

## **Chapter 3. Maximum Residue Levels (MRLs) and Trade**

### **3.1. Introduction**

### **3.2. The current Trade and MRL empirical evidences: A review**

The authors define the NTM as protectionist when it lowers global real income. According to Beghin (2012), a standard is a protectionist if its optimum level is higher under a local social planner (local government authorities), than under a global social planner, treating all firms competing for domestic market. However the issue of “appropriate level of protectionism” is still under discussion and the WTO has not yet demonstrated what this means practically.

Many NTMs researches presume that NTMs hinder trade and implicitly the welfare as well. However, NTM policy interventions could be trade-impeding or trade-enhancing while increasing welfare. NTMs may be also protectionist

The level of chosen measures may be excessively stringent, hence, protectionist by creating unnecessary disharmonies in trade. This is an increasing preoccupation during the NTMs policy discussions. Nevertheless, there is not yet any clear trend between NTMs and trade and welfare in the presence of market imperfection (Li and Beghin 2012). Several studies have been made to understand the effects of NTMs /MRLs on trade and of course welfare.

For, example, the study of Scheepers, Joste and Alemu (2007) investigates the effect of MRLs that are more stringent than the MRLs set by Codex on trade of South African avocados. In addition the study identifies the level to which MRLs may influence the avocado exports by SA. First, Scheepers, Joste and Alemu (2007) used Gini coefficient to



measure the concentration of trade to foreign markets. Gini coefficient which is equal to 0, means that the trade is equally distributed. Gini coefficient which is equal to 1, means that the trade is restricted to one region or country. The choice of MRLs used in this study is done on the basis of the most frequent chemical called Prochloraz (out of 523 chemicals) imposed by importing countries. However, the trade flows of avocados from SA to EU countries are examined by using the gravity model. Different methods have been proposed for the objective of this study such as Pooled Ordinary Least Square (POLS) regression, Fixed effect (FE) model, Random effect (RE) model. To select the most efficient estimator among the above methods, the measure of heterogeneity was tested by using F-test. Based on the results found by Scheepers, Joste and Alemu (2007), it was considered that POLS was the most efficient estimator for this study. The results show that the more stringent MRL have significant negative impact on avocado export to EU. This means that Prochloraz MRLs should be up to Codex levels, taking into account that the contribution of avocado industry to the GDP value of agriculture products would increase significantly.

Furthermore, Droque and DeMaria (2011), investigate the impact of MRLs of pesticides on bilateral trade of fresh processed apples and pears for seven exporters (Arg, Br, Chl, Chn, EU, NZ, SA) and seven importers (AUS, Can, Jap, Ko, Mex, Rus, US). These countries have been chosen on the basis of their share in the international trade of apples and pears, their consumption level, their stringency in regulations and on their MRLs on pesticides data availability. MRLs data were taken from COMTRADE, CEPII and WTO databases. If MRL data does not exist, the MRL default values have been used. Differently from

Scheepers, Joste and Alemu (2007), who have been focused on a particular pesticide, Drogue and DeMaria (2011) have considered in the study the entire list of pesticides appeared in different regulations, for different countries involved in this study. The objective is to compare the “closeness” of standards in order to understand the effects of similarities of these pesticides on trade. The level of standards set by importers is not taken into consideration. The difference in the tolerance level of both importing and exporting countries is done by computing the similarity index to compare the regulations, associated to Pearson’s coefficient correlation. The application of the similarity index is done also in GMO regulations by Vigani, Raimondi and Olper (2010). The value equal to 0, means that the two compared samples are similar. The index of similarity which is lower than 1 (such as for Arg, EU, NZ) means high level of similarity with the regulations of other partners. While, the index of similarity which is greater than 1 (such as for Bra, Chl, Chn, SA) means lower level of similarity. Then, Drogue and DeMaria (2011) introduce this index into the gravity model, for a time period from 2000 to 2008. The 6-digit level 1996 harmonized system. Aggregation level is not a problem since apples and pears are homogenous products. Drogue and DeMaria (2011) suggested to use Poisson Pseudo Maximum Likelihood (PPML) method which can help dealing with heteroskedasticity. In addition Zero-inflated model (ZIM) may help dealing with zeros. These two main estimators were applied on pooled data. The results show that increasing similarity may impact trade positively. In addition, the results suggest that the impact of food safety standards is more significant than the impact of tariffs on trade.

Following Xiong and Beghin (2012), their study examines the implications of stringency of MRLs on trade performance of US and Canada, by implementing the previous protectionist score indices established by Li and Beghin (2012), and by using the same database of USDA MRL pesticides and veterinary drug. More concretely, Xiong and Beghin (2012) investigate the impact of stringency MRL score indices on trade performance. Xiong and Beghin (2012) focused, first, on the stringency of MRL scores of importing country, which highlight the impact of MRL stringency on country's imports. Second, they focused on stringency MRL score of the exporting country to investigate the impact of a country's own stringency standards on its export performance. The higher the score index is, the more stringent are the countries MRLs towards products. The scores equal up to 1, indicates that standards defer to Codex. The score above 1 indicates that country adopts stricter MRL standards than Codex. To complement the score indices with bilateral trade records by country and by commodity, Xiong and Beghin (2012) use data from United Nations Comtrade database, having finally 60 countries potentially trading with US or Canada in 135 plant and animal products (HS4 and HS6 digit level), classified in 9 sectors. Using the gravity equation approach to trade, Xiong and Beghin (2012) conducted four regressions: US imports from the rest of the world, US exports to the rest of the world, Canadian imports from the rest of the world, Canadian exports to the rest of the world. Then the countries were analyzed as importers and exporters which allow US and Canada to have different MRL responses. In both cases, Xiong and Beghin (2012) used Poisson Pseudo Maximum Likelihood (PPML) estimator to manage zero outcomes and they constructed the heteroskedasticity resistant standard error to check the

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robustness. The results show that the MRLs of US which are not more stringent than Codex do not significantly impede US imports from the rest of the world, while the exports are constrained from the MRLs of the world. Canada with more stringent MRLs than Codex, has gained further competitiveness in the world market.

In addition, Farnsworth (2012) examines whether MRLs of pesticides residues on agriculture products are considered as barriers to trade or consumer protection regulations, protectionisms or food safety? Farnsworth (2012) has contributed with a literature of regulation and trade protectionism, by investigating the motivations for stringent MRLs. To understand the link between MRLs and trade protectionism, data were used from FAS MRLs database, FAOSTAT, World Bank, Agricultural Marketing Service's Pesticides Data Program (PDP) including 73 countries, 300 commodities and 178 pesticides. In total there are 1594 pesticides commodity combinations. Different types of regressions on literature are used to understand the driving forces behind the strictness of MRLs, performed at three levels of aggregation: OLS regressions with a country-level MRL index, OLS regression with a commodity-level MRL index, MRL level regression using ordered logit and probit regressions for each MRL. Farnsworth (2012) constructed two indices for the restrictiveness of the MRLs: AVG – the average strictness and MAX – maximum strictness. Results found by Farnsworth (2012) show that the MRLs are influenced by both protectionist and socioeconomic forces. The countries with high income level and high volume of imports prefer to have stricter MRLs, as indicator of protectionism. However MRLs tend to indicate also the health priorities and the consumer awareness for high quality food products.

The literature continues to provide mixed evidences on the idea that MRLs distort the international trade in agriculture commodities. In the next study, Xiong and Beghin (2013) emphasize that the same MRLs affect differently the trading partners. Thus, Xiong and Beghin (2013) try to disentangle (separate) the dual effect of MRLs, on imports of plant products in high income OECD countries. More concretely, they try to identify the trade cost effect of MRLs stringency on import demand and foreign exporters' supply of plant products.

In particular, a generalized gravity equation was applied in an equilibrium situation where the model capture how both sides of the market react to MRLs. First, Xiong and Beghin (2013) estimated the demand-enhancing effect or quality improvement effect, associated with the parameter that captures the degree to which the stringency of MRLs affects the import demand. As it is known, the import demand depends on consumer preferences characterized by Constant Elasticity of Substitution (CES), budget constraint of one country and price of products. Second, producer have to decide which market to target and how much to sell in each destination. Cross-section databases are used: MRL database developed by USDA, UN Comtrade database, Macmap database of UNCTAD/WTO and Homologa database developed by DEFRA in UK. Xiong and Beghin (2013) found that MRLs enhance the import demand by ensuring higher food safety, and reduce exporter's supply by imposing additional costs. High MRL costs put the exporters of less developed countries in a difficult position on the market in comparison with their competitors from developed world; however, MRL does not hinder creation of a trade partnership.

Moreover, Li and Beghin (2014) establish indices of Non-Tariff Measure (NTM) to quantify the protectionism of Maximum Residue Limits (MRL) standards, considering international standards such as Codex Alimentarius, as benchmark, since the appropriate level of protectionism is still under discussion by WTO. The data used by Li and Beghin (2014) come from a large international USDA FAS dataset on veterinary drug and pesticides MRLs for 83 countries on 341 products, completed by trade data from United Nations Comtrade database.

MRLs have different scales, which could vary from 0.01 ppm (parts per million) to 10 ppm or even more. Concretely, Li and Beghin (2014) define an importer's Maximum Residue Limits (MRL) as protectionist when the stringency of MRL standards (less than value 1), exceeds the levels of Codex's MRL. Importer's MRL lower than international MRL means that the importer's MRL is protectionist. This means that the more stringent is a standard (measured by the lowest value of MRL), the more protectionists it is considered. Otherwise, If an importer's MRL is higher than the international MRL, the MRL is considered as non-protectionist. Importer's MRL higher than international MRL means that the importer's MRL is non-protectionist. Li and Beghin (2014) calculated two types of results: country-by-product level protectionism scores with non-established MRL, substituted with default levels; and country-by-product levels protectionism scores with non-established MRL deleted. For each of two methods, they aggregated country-by-product scores to country level and product level with trade weights and then equal weights as complementary information between them. Information on country-level protectionism over all goods helps to compare the rank countries' differences by their relative MRL

protectionism. Country level results of Li and Beghin (2014) show that Australia ranks the most protectionists one. While the information on product-level protectionism make us understand the sectors or commodities' difference in MRL protectionism. Li and Beghin (2014) find that meat and dairy products have lower protectionism scores compared to other goods.

A more recent research is completed on the potential protectionist effects of maximum residue limits (MRLs) for 19.486 pairs of pesticides and products and 9.000 veterinary drugs established by 83 countries in international agriculture and food trade, data used from USDA Foreign Agriculture Service. As mentioned above in the previous research studies, (Beghin 2014) has computed the aggregated indices, based on the deviation of a country's MRL from the Codex standards, in order to provide insights on the potential protectionist effects of the MRL standards. A very important characteristic is that the indices increase more than proportionally with increasing protectionism in MRLs. In this case, the difficulty to meet more stringent standards becomes larger. The index, in this research work, signifies protectionism effect (value  $>1$ ), in case when a country's MRL (Codex) for pairs of chemicals and products is set to be more stringent than international standards. On contrary, the index indicates anti-protectionisms effects when index value  $<1$ . The research did not consider MRLs for which Codex does not set international standards. The research work of (Beghin 2014) limited the discussion to country level protectionism indices. The results show that Australia, Japan and Taiwan come out as the most protectionist countries, due to the stringent default values, which replaced the non established MRLs. In addition, Australia and Taiwan have stringent established MRLs,

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while Japan is slightly anti-protectionist (index <1) based on established MRLs. Russia and Brazil comes out as systematically protectionist because of stringency on established MRLs, and less protectionist because of the default MRLs. EU, Turkey and Canada are also among protectionist countries since they have both established and default MRLs stricter than Codex. Countries such as South Africa, Sri Lanka and Albania have MRL values much below Codex MRLs, which means under protection level with the health consumer consequences.



Table 4. Current review of MRL and Trade

Author(s)	Countries / Data sources	MRL indices	Gravity specifications	Key results
<b>Scheepers <i>et.al.</i>, 2007</b>	South Africa EU countries	MRL choice: most frequent chemical	POLS, fixed effect (FE) model, F-test	MRL: negative impact on avocado export
<b>Drogue <i>et.al.</i>, 2012</b>	Develop. countries COMTRADE data	MRLs index of standards	6-digit level, HS'96 PPML, ZIM & NBR	Similarity: positive impact on trade
<b>Xiong &amp; Beghin, 2012</b>	60 countries, USDA MRL, COMTRADE	MRL stringency for imp & exp	Pooled regressions, Pseudo R2 & PPML	US MRL: help import Can MRL: competitiv
<b>Farnsworth, 2012</b>	73 countries, WB MRL, FAOSTAT,	MRL: AVG, MAX; OLS; Logit & Probit	Literature review No gravity	High-income count. stricter MRLs
<b>Xiong &amp; Beghin, 2013</b>	USDA,MRL,CEPII COMTRADE, UK,	MRLs stringency indices	Import D & Export S, costs effects.	High MRL: high imp high food safet
<b>Li &amp; Beghin, 2014</b>	83 count.,USDA MRL, COMTRADE	3 indices of NTM protectionism	No specification of gravity model	EU countries: most protectionist

### **3.3. Description of the USDA MRL pesticides and veterinary drug databases**

The USDA FAS International MRL database exclusively refers to the Maximum Residue Levels (MRL) – the maximum allowable level for the use of pesticides in plants and the veterinary drugs in animal products.

The Maximum Residue Levels (MRL) database used for this work is freely available online at:

<http://www.mrldatabase.com/>.

This international MRLs database is frequently updated but to a certain point, we decided to refer to the data of 2011-2012. The global MRLs database developed by USDA for a large set of countries is composed by basically two main separated databases: pesticides MRLs database and veterinary drugs MRLs database, which both of them have different structure.

#### **3.3.1. Pesticides MRLs database**

The pesticides MRLs database covers 698 products, 359 pesticides and 85 countries (markets), including United States. Internationally, US, Codex and EU are three main classification groups of MRLs, which the countries refer to. In total there are 44,739 pairs of products by pesticides, taking into account the fact that some products are classified with more than one HS6 code (Harmonized System for Products Classification in 6 digits). The overall database contains 3,802,815 records. Among 85 countries presented in pesticides MRLs database, 22 countries set their own standards, 2 countries refer to US standards, 29 countries apply Codex standards, 18 countries defer to EU standards, 5 countries comply with Gulf Cooperation Council (GCC) standards and 7 countries adapt exporting countries standards.

However, this extensive and comprehensive database has quite a few imperfections such as: *redundancy of the listed products* due to the fact that some countries specify the MRLs of the general commodity groups and some other countries specify particular kinds of commodities; *the presence of US pesticides only, the non-established MRLs values and the variant units of measurements of both MRLs database*

*Redundancy issue:* Basically, two types of redundancy in the listed products are noticed in pesticides MRLs database, due to the different names of products that countries use. This issue might have quit a major impact when computing the protectionism indices established by Li & Beghin 2012.

The first type of redundancy is related to the same products which are presented with alternative names, but with similar MRL values. For example, the general commodity group of “squashes” products in MRLs database includes: “Squash winter (acorn)”, “Squash winter (butternut)”, “Squash winter (calabaza)”, “Squash winter (hubard)”, “Squash winter (sphagetti)” and even “Squash summer (crookneck)”, “Squash summer (scallop)”, “Squash summer (straightneck)”, “Squash summer (vegetable marrow)” and “Squash summer (zucchini)”. It is noticed that all the above products names of “squash” category, in reality, show to be basically the same products and to have exactly the same MRLs values and the same HS6 products code, even though they are presented with different names and they are itemized separately in pesticides MRL database. To resolve this type of redundancy, we manually select only one product as representative of this group. In this way, we significantly reduce the excessiveness of this type of redundancy.

The second type of redundancy is more complex. It has to do with some specific products listed separately, which are found to have, in some cases, the same MRLs and HS6

products codes and in other cases different MRLs and different HS6 products code inside the same commodity group. For example, the category of “Beans” includes 27 products names such as “Bean broad (fava) succulent”, “Bean dry (adzuki)”, “Bean dry (field)”, “Bean dry (kidney)”, “Bean dry (lablab)”, “Bean dry (lima)”, “Bean dry (moth)”, “Bean dry (mung)”, “Bean dry (navy)”, “Bean dry (pinto)”, “Bean dry (rice)”, ect. In contrast from Li and Beghin 2012, who kept the redundant products for this type of commodity, we tried to solve this problem in another way, since the commodities in our database are not listed precisely in the same way like in Beghin’s database, where some specific products commodities belong to a general commodity group. Some few products name are missing in our database, and some new others are added, compared to Li and Beghin database. Thus, we first classify the commodities of “beans” in groups according to the same MRLs values. For each group of beans products with the same MRLs, we choose only one product as representative, but which is also in consistency with the same HS6 products codes, classified by Li and Beghin 2012. This is the same logical way that we used for the first type of redundancy. While for some other groups, we keep all beans commodities with the same MRLs but different HS6 products codes.

*US pesticides-only issue:* The MRLs of database have been established on a permanent basis under domestic US legislation according to the US Code of Federal Regulation (CFR). For this reason, the second issue of MRLs database is the presence of United States pesticides only. This means that USDA pesticides MRLs database does not contain any foreign markets’ MRLs which is not applied in US. Foreign markets’ MRLs are included only when the US chemical is in place for the same commodity.

*Default values for non-established pesticides MRLs:* The third problem of MRLs database is related to the non-established MRLs. In these cases, we manually substitute the non-established pesticides MRLs with the countries' general default MRLs values – an application needed when the substances are not included in any of the annexes of EU regulation and Codex. As explained by Li and Beghin (2012), the key problem is that we cannot distinguish when a non-established MRL means a default value or just a missing data. Thus, the missing data is an unavoidable issue and it remains a concern to handle with, like in every research work.

*Variant units of measurements of MRLs database (part per million and part per billion):* MRLs databases have different measurements of units: pesticides MRLs databases data are measured in parts per million and the veterinary and drug MRLs database data are presented in parts per billion. Finally, to complement the data for this work, we extract EU 15 trade data of 2012 from EUROSTAT database, produced by the statistical office of the European Union, available online at:

<http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/>

### **3.3.2. Veterinary drugs MRLs database**

The veterinary drug MRLs database covers 7 products groups, classified in three categories: mammal group which includes cattle, hogs and sheep products; poultry group, which includes chickens, eggs and turkeys products and the dairy group which includes milk product. In addition, it contains 89 active ingredients, 310 commodity terms, 86 countries including United States and 3,220 pairs of commodities by pesticides. Overall, the veterinary drugs MRLs database contains 276,920 records. However the

veterinary drugs MRLs database is incomplete at product level. Unlike the pesticides MRLs database which has a balanced aggregation – countries have relatively the same products and pesticides, the veterinary drug MRLs database is not balanced – different products for different countries. For this reason, we modified the structure of veterinary drug MRLs database in order to harmonize it efficiently with pesticides MRLs database, based on products by pesticides. As in pesticides MRLs database, the non-established MRLs values of the veterinary drugs MRLs database are manually substituted by default MRLs values determined by countries. In this work, we do not consider the countries, which their default veterinary drug MRLs values are also missing.

**Table 5.** Data of MRLs databases

<b>Data</b>	<b>Pesticides MRLs database</b>	<b>Veterinary drug MRLs database</b>
<b>Products / Commodities</b>	698	310
<b>Pesticides / active ingredient</b>	359	89
<b>Countries</b>	85	86
<b>Pairs of products by pesticides</b>	44,739	3,220
<b>Total records</b>	3,802,815	276,920

### 3.4. Data and Methodology

We apply the aggregation index of Non-tariff measures established by Beghin and Li (2014) to quantify the protectionism relative to Codex Alimentarius international standards. More precisely, we apply the protectionism index to Maximum Residue Levels (MRLs) measures, as quantitative standards. Following Li and Beghin (2014), we use the Codex Alimentarius international standards a benchmark referring to the non-protectionist level. MRLs that exceed Codex levels are considered to be protectionist. Protectionism scores of aggregate-country level over the products, give information on the differences among countries according to their relative MRL protectionism issue. According to Beghin 2014, an importers' MRL is considered as protectionist when its stringency exceed the analogous international MRL (integrated by Codex). If an importer's MRL is higher than analogous international MRL, than we consider the MRL as non-protectionist. The protectionism of MRLs for a given product and country (importer), aggregating over substances (chemicals) is shown as follows:

$$S_{ij} = \frac{1}{K_{(j)}} \left( \sum_{K_{(j)}=1}^{K_{(j)}} \exp \left( \frac{M_{intl,jk_{(j)}} - M_{ijk_{(j)}}}{M_{intl,jk_{(j)}}} \right) \right)$$

where,  $K_{(j)}$  expresses the pesticides (chemicals) applied in product (j);  $M_{ijk_{(j)}}$  is the maximum residue level of importer (i) for product (j) and pesticide  $K_{(j)}$ , while  $M_{intl,jk_{(j)}}$  is the international maximum residue levels for product (j) and pesticide  $K_{(j)}$

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Following Xiong and Beghin 2012, the scores index of the above equation measure the stringency of a country's MRL toward a given product. The higher the score is, the more stringent the country's MRLs are towards the products.

MRLs have different scales, which could vary from 0.01 ppm (parts per million) to 10 ppm or more. The lower MRL value is, the stricter the standard is, and it is exhauster for exporters to comply with. The scores equal to 1, signify a "non-protectionist" policy, the scores greater than 1 specify a "protectionist" policy because MRLs are consider more stringent than Codex, and scores less than 1 indicate an "anti-protectionist" policy because MRLs can be "softer" than Codex.



## **Results and Discussions**

Our empirical analysis focuses on the MRLs implemented in 85 countries involved in this research work and their impact on trade performance.

EU countries have the same EU standards and similar trade structure, so instead of individual EU countries we report for the aggregate EU 15.

Table 6 presents the average protectionism index by country. The first and the second column express the countries and the respective observations considered for this research work. The third column of the table shows the un-weighted scores with the non-established MRLs substituted with the default values.

As we can see from the table, Taiwan and Australia rank among protectionist countries with the highest protectionism scores, respectively 1.97 for Taiwan and 1.71 for Australia, which means that those countries have established more stringent standards compared to international standards (Codex). Conversely countries of Kuwait, Saudi Arabia and Bahrain have the lowest protectionist scores, respectively 0.77 for Kuwait, 0.71 for Saudi Arabia and 0.71 for Bahrain. This means that the low-standard countries, with high values of MRLs are based on Codex internationally accepted standards or even lower. In wider terms, we notice that Europe with the protectionism score of 1.2, have more stringent standards compared to the rest of the world and US with protectionism score of 1.0.

The above results might be interpreted that importers are not implying the stringent standards to protect their domestic markets; instead, the stringency might aim to protect the consumers by providing higher quality standards on food.

**Table 6.** Average protectionism index by country

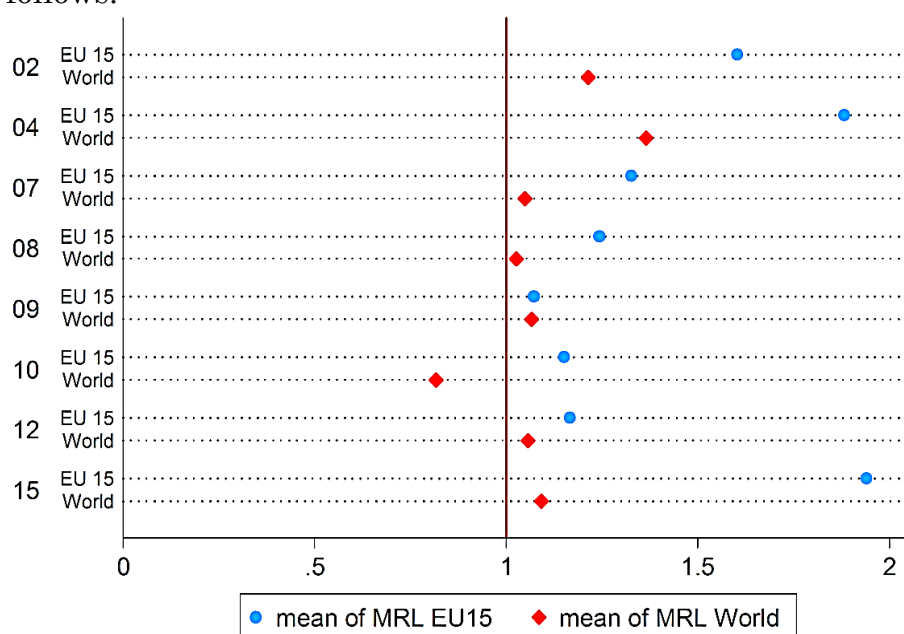
<b>Countries</b>	<b>Observations</b>	<b>Mean</b>	<b>Standard. Deviation.</b>
Taiwan	6922	1.973593	0.9452084
Australia	6922	1.712509	1.0089980
Haiti	29	1.383499	0.5914433
Switzerland	6922	1.329768	0.8443108
European Union	6922	1.283254	0.8295127
Norway	6539	1.251460	0.7683089
Canada	6922	1.240583	0.9317671
Turkey	6922	1.238340	0.7584327
Iceland	6289	1.193151	0.7244479
French West Indies	6155	1.158051	0.7580825
Israel	6537	1.116774	0.5385092
Japan	6922	1.090251	0.7851793
Brasil	6922	1.079975	0.3986229
Korea	6922	1.077727	0.6036937
Sri Lanka	1412	1.051270	0.6581161
Russia	6922	1.046065	0.3053079
Argentina	6922	1.040544	0.4502883
Chile	6922	1.033469	0.2861286
Malaysia	6922	1.023115	0.2810799
Vietnam	6819	1.016000	0.2317240
Jamaica	6537	1.011074	0.3065078
Netherlands Antilles	6537	1.011074	0.3065078
Dominican republic	6787	1.010667	0.3008161

<b>Guatemala</b>	6787	1.010667	0.3008161
<b>Venezuela</b>	6787	1.010667	0.3008161
<b>United States</b>	6922	1.009857	0.7994749
<b>Indonesia</b>	1992	1.009326	0.2342989
<b>India</b>	6922	1.008904	0.4042879
<b>Oman</b>	1716	1.007557	0.6870519
<b>Jordan</b>	5974	1.006078	0.2555618
<b>Thailand</b>	6922	1.003647	0.1745710
<b>Trinidad and Tobago</b>	6659	1.002944	0.0652396
<b>Lebanon</b>	5154	1.002158	0.0521898
<b>Pakistan</b>	5154	1.002158	0.0521898
<b>Nicaragua</b>	5645	0.998871	0.0290706
<b>China</b>	6922	0.998580	0.1544129
<b>United Arab Emirates</b>	6922	0.993785	0.1091113
<b>Morocco</b>	6672	0.987208	0.3962820
<b>Qatar</b>	1716	0.979538	0.6660671
<b>Singapore</b>	6922	0.972632	0.3194739
<b>Mexico</b>	6672	0.962466	0.6338938
<b>New Zealand</b>	6922	0.951806	0.2020442
<b>Council Gulf Cooperation</b>	1851	0.941920	0.2755699
<b>South Africa</b>	6922	0.937495	0.4739987
<b>Kuwait</b>	676	0.795348	0.5781752
<b>Saudi Arabia</b>	350	0.716075	0.6905979
<b>Bahrain</b>	333	0.710555	0.6326749

The last column shows the standard deviation of the country by product level protectionism score. In most cases the

standard deviations values are small relative to respective scores, by suggesting that the data's values are supportive.

Moreover, the average MRL scores by sectors of EU15 are computed, versus the other countries of the world, shown as follows:



**Figure 3.** Average MRLs scores by sector of EU15 versus world

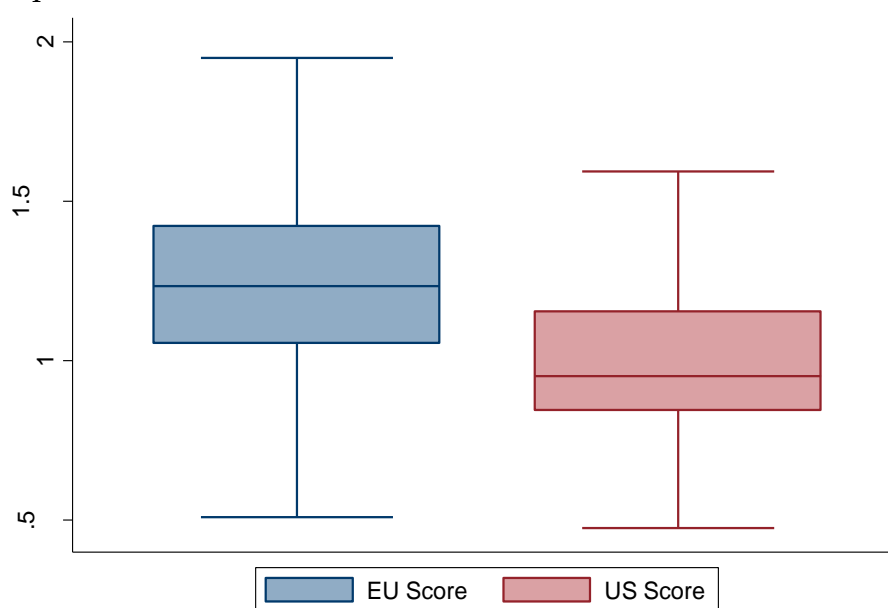
First, the figure 3, shows that both average MRLs scores by sectors of EU 15 and average MRL score of the world exceed the international standards referred as Codex equal to one, considered as benchmark. This means that in general both EU standards and the other countries' standards including US standards, are more stringent than Codex international standards (MRL score >1 ), in all the sectors expressed in two-digit level according to the harmonized classification system, respectively: meat (02), dairy products (04), vegetables (07), fruits and nuts (08), coffee and spices (09), oils seeds (12) and animal and vegetables fats and oils (15).

We notice that the sector of cereal (10) for the rest of the other countries has less stringent standards compared to Codex international (MRL scores <1).

In addition, from the figure we notice that the MRL scores of EU15 is even more stringent compared to MRL scores of other countries in all the sectors, in particular for the sector of meat (01), dairy products (02) and animal and vegetables fat oils (15). In the same time we can see that of the sector of coffee (09) has almost the same level of MRL scores, for both EU15 and the world.

To better make clear the country level protectionism scores, we have a look at the score distribution boxplot to investigate their MRL protectionism. The figure 4 shows the MRLs scores EU15 versus US.

As we can see, the EU15 scores generally show a higher level of protectionism versus US scores.



**Figure 4.** MRLs scores EU15 versus USA

Foremost, we calculated the average MRL scores by sector of EU15 versus US. Figure 5, shows that both MRL scores of EU15 and MRL scores of US have a higher score level than Codex international (MRL >1). This means that in general EU 15 and US have more stringent standards than Codex and they are considered as more protectionist countries (MRS score > 1), besides of the sector of coffee and nuts (08) where US have less stringent standards than Codex (MRL score <1).

IF we compare EU 15 and US, we see that EU 15 has more stringent standards in the sector of meat (02), dairy products (04), vegetables (07), fruits and nuts (08), and cereal (10), while in the sector of olis seeds (12) and animal and vegetables fats oils (15), both EU 15 and US have the same level of protectionism. The only sector, US have more protectionist standards than EU 15 is coffee and spices (09).

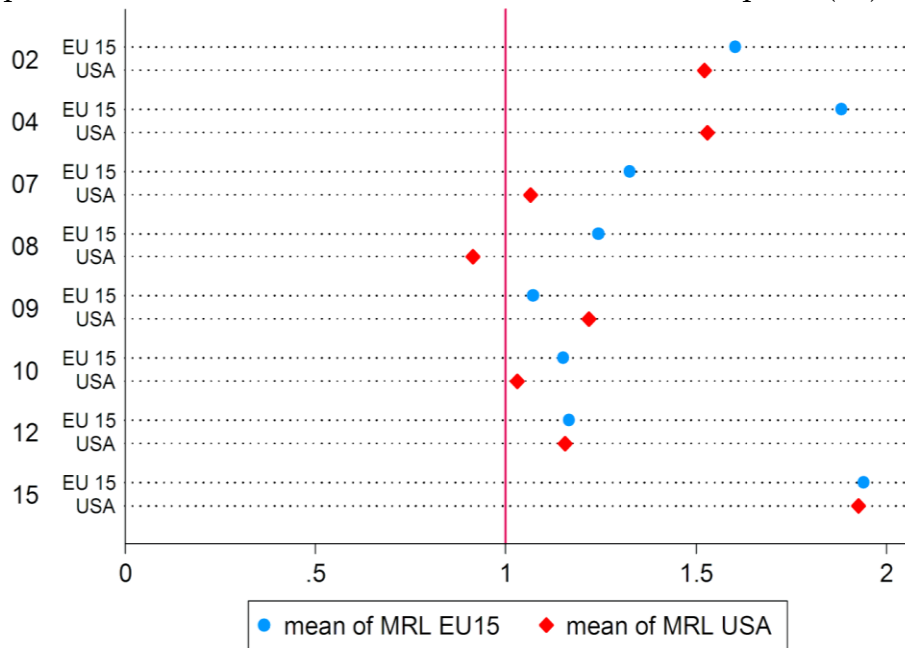


Figure 5. Average MRL scores by sector EU15 versus US

Moreover, two different models are used to analyze the importers' and exporters' results:

1. Imports to EU
2. Exports from EU to other countries

$$E(X_{ijk}) = \exp\left(\alpha_0 + \alpha_1 score_{jk} + \alpha_2 score_{ik} + \sum_n \varphi_n E_n + \sum_m \varphi_m E_m + \sum_l \gamma_l S_l\right)$$

where,  $X_{ijk}$  imports of county ( $j$ ) from country ( $i$ ) for product ( $k$ );  $score_{jk}$  is score of importing country for product ( $k$ );  $score_{ij}$  is the score of exporting country for product ( $k$ );  $I_n$  dummy variable equal to one if ( $n$ ) is importing country;  $E_m$  dummy variable equal to one if ( $m$ ) is exporting country;  $S_l$  dummy variable equal to one if product ( $k$ ) belongs to sector ( $l$ )

Two methods are used to calculate the importers' and exporters' results:

1. Ordinary Least Squared (OLS) which do not consider the zero-trade issue.
2. Poisson Pseudo Maximum Likelihood regression (PPML) within the context of gravity equation, takes into consideration the zero-trade issue.

We noticed from the table 7, that there is a negative relationship between MRL scores and imports to EU. It means that the variables are significantly related in a negative way (-0.475\*\*\*). It means that if MRL score is high, the imports to EU are low. In other words, the stringent standards (protectionist policies) impede imports to EU, because of the difficulties of compliance with the standards' required by EU.

From the other hand, there is positive relationship for the MRL and exports to EU. If MRL is high (protectionist), the exports to EU are also high.

**Table 7.** Importers' results

Dep. Variable	(1)	(2)	(3)	(4)	(5)	(6)
	OLS (ln) import	OLS (ln) import	OLS (ln) import	PPML import	PPML import	PPML import
MRL EU15	0.193 (0.121)		0.0485 (0.132)	-0.231** (0.101)		-0.475*** (0.148)
MRL Exporters		0.550*** (0.174)	0.522*** (0.190)		0.489* (0.292)	0.847** (0.359)
Product FE	YES	YES	YES	YES	YES	YES
Importer FE	YES	YES	YES	YES	YES	YES
N	5113	5113	5113	16708	16708	16708
R-sq	0.296	0.297	0.297	0.055	0.057	0.059

\*\* 95% significant; \*\*\* 99% significant

We notice that the coefficient (0.193) switched from a positive to a negative value (-0.231), which means that PPML regression is more reliable method for zero trade flow in the gravity model

**Table 8.** Exporters' results

Dep. Variable	(1)	(2)	(3)	(4)	(5)	(6)
	OLS (ln) export	OLS (ln) export	OLS (ln) export	PPML export	PPML export	PPML export
MRL EU15	0.405*** (0.113)		0.350*** (0.114)	0.248** (0.126)		0.160 (0.129)
MRL Importers		0.176*** (0.0428)	0.160*** (0.0431)		0.278*** (0.107)	0.231** (0.0918)
Product FE	YES	YES	YES	YES	YES	YES
Importer FE	YES	YES	YES	YES	YES	YES
N	6899	6897	6897	16694	16692	16692
R-sq	0.413	0.413	0.414	0.149	0.151	0.153

\*\* 95% significant; \*\*\* 99% significant



Regarding to the exporters' results shown in the table 8, there is a positive relationship between MRL and exports from EU to other countries. When MRL is high, the imports from EU are high as well. There is positive relationship for the MRL of importers. When MRL is high, the exports from EU to other countries are high.

## **Conclusions**

The trade effect of standards is an important issue especially in agri-food sector in two main directions: agri-food standards specify and guarantee essential requirements of products, such as quality and safety and in the same time, the quality required by importing and exporting partners can facilitate trade exchange. However, the researchers and the economists are quite convinced that the economic impact of “food standards” and “food regulations” is not as different (Swann 2010). Trade may increase or decrease by imposing food standards, thus there is not yet a clear trend about the effects of stringent food standards, whether they promote or hinder trade. In this context, the food standards are also used as a protectionist policy instrument on trade. Protectionism in agriculture trade takes the form of non-tariff measures (NTMs), including Maximum Residues Levels (MRLs), an index which represent the maximum concentration of a pesticide residues allowed in food and animal feed. As a such, MRLs are considered as quantitative standards. For this reason, the aim of this reaseach work is to quantify the protectionism of MRLs standards relative to the stringency of international standards of Codex Alimentarius; to evaluate the protectionist nature of MRLs and to provide insights into the potential protectionist effects of the stringency for the European MRL standards on trade versus US and other countries.

We implemented the agregation index of NTM established by Li and Beghin (2014), to quantify the protectionsim of MRL standards for a given product and country compared to the stringency of interntional standards. We calculated the trade scores of MRL and the non-established data substituted with the default value. We used data from USDA MRL pesticides

and veterinary drug databases and addition complementary trade data from Eurostat.

MRLs have different scales, which could vary from 0.01 ppm (parts per million) to 10 ppm or even more. Based on Li and Beghin (2014) an importer's Maximum Residue Limits (MRL) is defined as protectionist when the stringency of MRL standards (less than value 1), exceeds the levels of Codex's MRL. Importer's MRL lower than international MRL means that the importer's MRL is protectionist. This means that the more stringent is a standard (measured by the lowest value of MRL), the more protectionists it is considered. If an importer's MRL is higher than the international MRL, the MRL is considered as non-protectionist. Importer's MRL higher than international MRL means that the importer's MRL is non-protectionist

In our research work, the country-level results show that Europe is ranked as most protectionist, while US is less protectionist compared to EU. Average MRL scores of EU 15 versus World by sector is more than one, which means stricter for most of food sectors, and less than one, which means less stricter only for cereal sector. Average MRL scores of EU 15 versus US is generally more protectionist. Average MRL scores of EU 15 versus US by sector, is more protectionist for most of the sectors and less protectionist for fruits and nuts sector. Regarding to imports to EU, there is a negative relationship between MRL and imports to EU. When MRL score is high, the imports to EU are low, and there is positive relationship for the MRL and exports to EU. When the MRL score is high, the exports to EU are high. Regarding to the exports from EU to other countries, there is a positive relationship between MRL and exports from EU to other countries. When the MRL score is high, the imports from EU are also high. There is positive relationship for the

MRL of importers. When the MRL score is high , the exports from EU to other countries are also high.

The above results are consistent to the work of Li and Beghin (2014)

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