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BEEF EXPORT PRICE RESPONSE TO SANITARY STATUS AND TRACEABILITY SYSTEMS: IMPLICATIONS FOR PARAGUAY

A Thesis presented to the

Faculty of the Agribusiness Department

California Polytechnic State University, San Luis Obispo

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Masters of Science in Agribusiness

by

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ABSTRACT

Beef Export Price Response to Sanitary Status and Traceability Systems: Implications for Paraguay

Silvana Careaga

Global beef markets are highly influenced by sanitary issues, mainly related to animal health and food safety, which have been determining levels and trends in global beef trade. Food safety issues affecting human health such as bovine spongiform encephalopathy (BSE) associated with Creutzfeldt-Jacob Disease (vCJD) in humans, and other diseases affecting production such as foot and mouth disease (FMD) has encouraged putting these issues to beef trade attention. A way to address these concerns and comply with international standards is the use of traceability systems in order to quickly identify hazard sources and assure beef quality and safety. The goal of this research was to assess the effect of exporting countries sanitary status of BSE and FMD, and traceability systems in beef export prices and to examine Paraguayan beef exports relative to other exporting countries. Data of the top beef exporters was collected from the United Nations Commodity Trade Database (UN Comtrade), including export operations volume and receipt with each of their trading partners, from 2000 to 2012. Four commodities were studied: Frozen and Fresh/Chilled bone-in and boneless beef cuts. The data was analyzed using ordinary least squares regression methods (a hedonic price equation). Five models were run, one for each commodity and lastly one with all four together. Results revealed that both FMD and BSE affect negatively to beef exports prices, as well as shipments from India, that has no official FMD status and any traceability system in place. Apart from sanitary status, epidemiological events also have

a negative impact on beef prices. On the other hand, the implementation of traceability systems improves prices. In this scenario, Paraguay lags behind in the adoption of emerging markets standards for traceability systems, therefore does not access most competitive markets, which pay higher prices. As such, Paraguay faces challenges to maintain and expand beef exports, especially in regards to keeping the country's FMD free status.

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A mi familia y seres queridos: Gracias por el constante cariño y apoyo que siempre me demostraron.

Gracias Dios. *"Be strong and courageous. Do not be afraid or terrified, for the LORD your God goes with you; he will never leave you nor forsake you"* Joshua 1:9.

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ACRONYMS

CJD - Creutzfeld-Jacob Disease.

FMD - Foot and Mouth Disease

BSE - Bovine Spongiform Encephalopathy

OECD - Organization for Economic Co-operation and Development

HS - Harmonized System code

WTO - World Trade Organization

OIE - World Organization for Animal Health

Codex - Codex Alimentarius Commission

GATT - General Agreement on Tariffs and Trade

SPS - Sanitary and Phitosanitary Standards

HACCP - Hazard Analysis and Critical Control Points

MBM - Meat and Bone Meal

FMDV - Foot and Mouth Disease Virus

MRLs - Maximum Residue Limits

ADI - Acceptable Daily Intake

SRMs - Specified Risk Materials

UTM - Under Thirteen months

CHAPTER I

INTRODUCTION

The world food economy is being increasingly driven by the shift of diets and food consumption patterns towards livestock products (FAO, 2003). World meat consumption increased from 47 million tons in 1950 to 260 million tons forecast for 2014 (McAlpine, *et al.*, 2009); more than doubling the consumption per person from 17 to 40 kg year, from which bovine meat is 10kg (FAO, 2003). Beef, historically linked to western culture (Rifkin, 1992), is becoming increasingly popular and/or affordable in new consumer societies such as China, Korea, Malaysia, Philippines, Indonesia, and Brazil due to growth of personal income in those societies (Myers and Kent, 2004) . Bovine meat consumption has become a status symbol of the growing affluence of the new consumer societies (Bruinsma, 2003).

Global beef markets are highly influenced by sanitary issues, mainly related to animal health and safety concerns, which have been determining levels and trends in global beef trade. More recently, food safety issues affecting human health have been of increasing concern (Delgado, *et al.*, 1999). The appearance of livestock disease, bovine spongiform encephalopathy (BSE) associated with Creutzfeldt-Jacob Disease (vCJD) in

humans, has encouraged putting animal disease issues to consumers attention (Kerr, 2004). Other diseases that affect mainly production, such as foot and mouth disease (FMD) and bluetongue, as well as diseases related to pathogen contamination; such as *E. coli*, *Salmonella*, and *Listeria*, and the use of growth hormones and veterinary medicines have major impacts on market access and, thus, trade flows (Wilson, *et al.*, 2003).

All of these issues created the need to set standards and regulation to deal with them. Beef exports are regulated by international animal health, sanitary, and food safety standards, which are set by the World Trade Organization (WTO) (Surak, 2009). The WTO is also responsible for making sure member countries are taking the necessary measures to adhere to regulations to protect their animal and human populations (GATT, 1947). The WTO agreement on the application of sanitary and phitosanitary (SPS) measures establishes a framework to create these regulations, and recognizes two international organizations that develop and review accepted beef trade standards and guidelines: the World Organization for Animal Health (OIE) and Codex Alimentarius (Codex) (GATT, 1994).

Another way to address these concerns and comply with international standards is the use of traceability systems. Countries have implemented traceability systems in order to quickly identify hazard sources. Many exporting countries are developing mandatory or voluntary programs using traceability to assure animal and beef safety, as well as many importing countries are demanding only traceable beef imports. The use or not of this technology may affect considerably the access of markets that pay higher prices for beef products (Schroeder, *et al.*, 2007). Because beef products are heterogeneous commodities, there are distinct preferences and prices for particular cuts in various

markets. Higher demand for boneless products is associated with lower transportation costs and lower risk of disease transmission, such as BSE and FMD. This is because it is known that infected animals, as well as some of their infected products, can introduce FMD virus (FMDV) and give rise to outbreaks. In the UK, some outbreaks of FMD were attributed to imports of frozen bone-in meat from FMD infected countries in South America; some studies suggest that the risk of this occurrence could be greatly reduced by restricting imports to boneless beef (Paton, Sinclair, & Rodriguez, 2009). As for frozen products, lower conservation and logistics costs contribute to this preference.

From 2003 to 2013, global beef exports increased 29 percent, with Brazil and India accounting for most of that growth, both driven by expanding herd size (USDA/FAS, 2013). Paraguay is responsible for nearly 4 percent of global beef exports, positioning itself 8th among major beef exporters in the world (USDA/GAIN, 2013). Almost 90 percent of exports from Paraguay are frozen boneless beef destined to price conscious markets, where prices and trade regulations are lower, such as Russia and Egypt (DESA/UNSD, 2013).

The traditional profile of the Paraguayan beef industry has gradually and systematically changed over the past ten years (2003-2013). During that time, Paraguayan meat has gained prominence, not only at home, but worldwide (USDA/FAS, 2013). Paraguay's beef sector is very dependent on exports, which account for roughly half of the production. From 2000 to 2006, Paraguayan exports multiplied by six fold; from U$S72 million exported in 2000 to more than U$S420 million in 2006. Nevertheless, 2003 exports volume fell due to the outbreak of FMD in 2002. The last fall in exports happened in 2011/2012 as a result of a severe drought that hit the country in

late 2011 and early 2012, as well as the negative impact of an outbreak of FMD detected in the same period (ECLAC, 2013). Despite the latest FMD outbreak, the reopening of key export markets is expected to further boost the country's beef industry. In recent years, the Paraguayan livestock sector has received strong investment, attracting many producers from neighboring countries as land prices are significantly lower than in their respective countries and production conditions are very good (USDA/ GAIN, 2013).

Within this context, this study developed a quantitative model to analyze the effect of exporting countries sanitary status, the use of traceability systems and diseases outbreaks in export beef prices over time. Using export annual data from 2000 to 2012 of fresh or chilled and frozen bone in and boneless beef cuts. Additionally, the implications of the relationships between export beef prices and sanitary issues and traceability systems for the Paraguayan beef industry; as well as where the country stands in relation to other exporters.

Problem Statement

How do sanitary standards and regulations for international beef trade, as well as the implementation of beef traceability and FMD and BSE status affect beef exports prices? Furthermore, what are the implications for the Paraguayan beef industry and how it is positioned relative to its competitors for frozen and fresh or chilled beef exports to the better markets?

Hypotheses

Beef international trade is conditioned by animal health, sanitary, and food safety standards. Exporting countries that have better conditions in these matters, such as good

sanitary status and traceability programs, are able to access markets that pay higher prices per ton. Whereas exporting countries that lack ideal production conditions may only have access to lower-paying markets with less demanding standards.

Traceability is becoming an important instrument to assure food quality, particularly safety in the beef industry worldwide. Many countries are developing mandatory or voluntary programs using traceability to assure animal and beef safety. Motivations for their introduction arise from a variety of scientific, social, and most importantly economic factors. Countries that assure traceable beef products can access the most demanding markets that pay more.

Paraguay lags behind major beef exporter countries in terms of adoption, implementation and development of beef traceability, as well as complying with sanitary and food safety standards. This affects market access and makes it harder for Paraguay to compete with other players in the global beef trade.

Objectives

1. To develop a conceptual framework and quantitative model in which to formally consider the effect of exporting countries sanitary status of BSE and FMD, and traceability systems in beef price.

2. To use the results to empirically verify and assess the impacts of sanitary status and traceability systems on beef trade.

3. To examine Paraguayan beef exports relative to other exporting countries, in terms of capability of accessing premium markets, according to its BSE and FMD status, and compliance to food safety standards, and volume traded on price of beef exports.

Justification

Global production for 2014 is forecast to increase marginally to 58.6 million tons, as most major producers are expected to benefit from cheaper feed supplies and rising import demand (mostly from China and Hong Kong). Global consumption is forecast maintain practically same level as 2013, from 56.8 to 57.0 million tons in 2014, while international trade is expected to continue reaching new records. Global exports are forecast at 9.2 million tons, expanding 24 percent in just 5 years, with Brazil and India accounting for most of that growth (USDA/FAS, 2013). Major players in the beef trade, such as the United States, Brazil, Australia, and India, account for almost 70 percent of the global exports.

While Russia, the United States, and Japan are responsible for nearly 40% of all imports demand, followed by Hong Kong and China (DESA/UNSD, 2013). Although cattle slaughter in India is an historic taboo subject because of the cow's traditional status as a sacred animal in Hinduism, laws governing cattle slaughter vary greatly from state to state in India, and some of them do not prohibit cattle slaughter (Gulati, Mehta, & Narayanan, 1999). Cows are routinely shipped to states with lower or no requirement for slaughter even though most States make it illegal to transport the animals for slaughter across state borders (Budhwar, 2001).

Animal health, sanitary and food safety issues have had significant effects on beef trade. The compliance of beef trade standards and regulations imposed by international organizations, such as the WTO, OIE and Codex, and importing countries determines the type of beef products to be exported (GATT, 1947). Beef has become a heterogeneous

product sold in many forms: fresh, chilled or frozen, as carcasses and cuts, and with or without bones. It can be in the form of muscle cuts, edible offal (heart, liver, tongue and brain), or fully processed (sausages). Because of differences in the market characteristics and trade restrictions among these products, it is important to disaggregate products in this sector to the fullest extent possible, in order to comply with the specific regulations related to each commodity (USITC, 2008).

Paraguay's production for 2014 is forecast to be 8 percent higher than 2013 at 540,000 tons, supported by herd expansion. Improvements in herd management, such as reproductive efficiency are still yet to be undertaken, although large investments are being made in the sector. Exports are predicted to increase by 8 percent to a record 325,000 tons, largely due to Russian demand. Although the FMD outbreak in the past years had limited Paraguay's access to many beef trade markets and recovery has been slow, access has been restore to Chile, a major Paraguayan fresh or chilled beef importer country (USDA/FAS, 2013).

In 2014, globalized consumers are becoming more demanding and selective, seeking for food safety in beef products. Animal diseases such as BSE and FMD usually create great economic damage in the beef industry and affects trade. Sanitary policies in importing countries are intended to avoid the introduction of these diseases; as a result exporting countries are face with numerous non tariffs barriers and constraints to enter these markets. In order to gain access to demanding markets that pay higher prices, beef exporting countries should adapt their production systems accordingly to the standards and regulations of demanding countries.

CHAPTER II

REVIEW OF THE LITERATURE

The economic prosperity of the beef industry of the countries mentioned in this research depends on access to foreign markets. Gaining presence in global markets enables exporting countries to raise producer prices and revenues. However, global market access has changed dramatically when exporting countries are affected by animal diseases, beef products food safety issues affecting human health or lack of technology to assure product quality and security like traceability systems. These factors affect global beef trade flows because they can limit trade flows between countries. Therefore are of great importance to understand their impact in the industry. This section provides an overview of the global beef market during 2000 to 2012. Information on how it is positioned relative to other meats, production, consumption, and the industry's latest trends and major players; as well as background information of the factors mentioned. The greatest challenge in the Paraguayan beef industry are associated to the extreme changes in export prices as a result of the closure of international markets in response to diseases outbreaks, especially FMD. Nowadays, the beef industry is facing globalized consumers, who are becoming more demanding and selective, seeking for quick and accurate information and quality of the products. In this sense, Paraguay needs to be more competitive investing in policies and technologies that would enable the entry to top

importing markets. Lastly, a description of Paraguay's current beef industry scenario is included, to further understand how it's positioned relative to other exporting countries.

Global Meat

Global meat exports have grown over 40 percent in the last ten years (2003-2013), with 2014 forecast at another record on rising incomes and stronger demand (Fig.1) (USDA/FAS, 2013); despite to the supply and demand imbalances in the feed sector of the past years, which has incited swings in feed prices (FAO, 2013). Rocourt, *et al.* (2003) stated that meat prices should remain at high levels due to the combined effect of a tight supply situation from low livestock numbers and high feed costs, especially in developed countries; as well as the introduction over the years of more stringent food safety, environmental, and animal welfare regulations and traceability by major meat producing countries.

The global economic crisis that started in late 2008 has led to a sharp curtailment of international trade, including a short-term decline in the value of global agricultural trade of around 20 percent. While not uniform across commodities and regions, the trade impact was stronger on crops than on livestock. The decline in producer prices from their peak 2007-08 levels led to a decline on production. In general, production of most of the food crops, feed crops, and livestock products slowed or declined from 2008-10 and then begins to strengthen by 2011 as the economy recovered. The effect of lower prices on meat production did not become evident until 2010; reflecting in part the time it takes for increases in feed costs to affect production decisions. Growth in beef production continued contracted in 2011; reflecting the length of time it took to make adjustments in herd size in response to lower prices (Peters, *et al.*, 2011).

Growth in foreign production of meat, such as beef and veal, slows through 2011 as well, but at 1.4 percent, also grows faster than food grains production. The relative strength of growth in production of feed grains and meat reflects the continued shifting of diets to meat in emerging and developing countries even as global consumption growth slows.

Although export have grown considerably, despite the financial crisis, meat production has risen at a slow pace for the past ten years, averaging just 1.8 percent (USDA/FAS, 2013), for the reasons already mentioned, however, an increase is expected predominantly in developing countries, which will be responsible for about 78 percent of the growth (FAO, 2013).

Global Beef Industry

Variation in beef production and consumption facilitates a better understanding of export and imports trends over time. Large shift on these factors have had substantial effects on beef trade, especially on prices, and therefore demand.

Global beef production increased by about 15 percent during 2003 to 2013, from 50 million metric tons (mmt) carcass weight equivalent (cwe) to 58.5 mmt cwe (Fig. 2). The United States is the leading producer, accounting for 20 percent of the global beef production in 2013, followed by Brazil (16 percent), the European Union (13 percent) and China (10 percent). The major players responsible for the growth during this period were Brazil, China and India; countries that had remarkably increased beef production in the past five years (USDA/FAS, 2013).

Although the United States is still the world's largest beef producer, its production has been declining (after a rebounding from 2005 through 2007) since 2008,

from 12.1 to 11.7 million tons in 2013, and is forecast to plunge 6 percent to 11.0 million tons by 2014 (USDA/NASS, 2013). Declining cattle inventories, spurred by lower calf crops in recent years, and fewer live cattle imports have resulted in tight supplies available for slaughter. Although the discovery of BSE in the U.S. in December of 2003 does not appear to have directly affected production, as it did to exports, the decline during that period was primarily because of lower slaughter rates and partially due to the ban on all Canadian cattle and beef in response to the discovery of BSE in Canada in May 2003 (Sparling and Caswell, 2006).

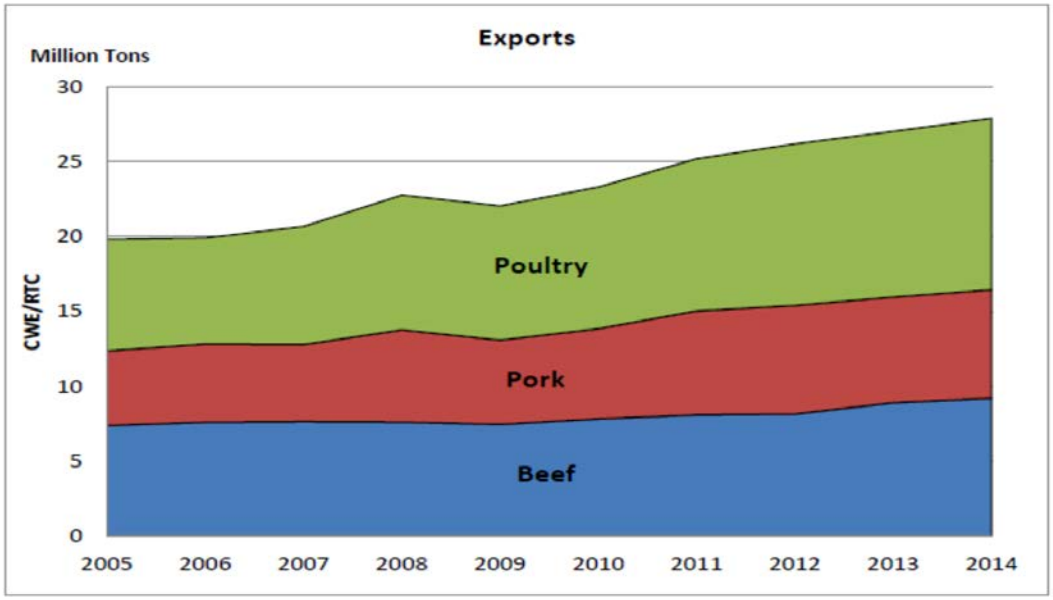


Figure 1. – Global meats exports from 2005 to 2014. 1,000 Metric Tons (Carcass Weight Equivalent), Metric Tons (Ready to Cook Equivalent).
Source: FAS/USDA. Livestock and Poultry: World Markets and Trade 2014. Office of Global Analysis. November 2013.

The EU's beef production also declined 7 percent in the past ten years; from 8.2 to 7.6 million tons; however, it is expected to rise slightly to 7.8 million tons as relatively low feed prices and high beef and milk prices support herd expansion and increased supplies of slaughter cattle (USDA/FAS, 2013). In 2002, the EU was virtually self-sufficient in beef production, but in the following years production declined. This

resulted from the drop of cattle supply, especially drop in the size of dairy herd that accounted for 25 percent of all cattle; this was because fewer cows were needed to fill the domestic milk production quotas, as milk yields per cow improved (USDA/FAS, 2005). Higher feed prices that reduced profitability for beef cattle production, despite higher beef prices, also contributed to the production declined (USDA/FAS, 2008). On the other hand, EU producers benefited from significant government support during the beginnings of 2000s, although this support has generally declined over time (USTRa, 2008). OECD (2013) data estimates from average fund prices for livestock products received by EU farmers were 4% higher than those on the world market in 2010-12; while prices received for beef and poultry were about 30% higher.

While Brazil's production is forecast up to 3 percent at a record 9.9 million tons, driving by expanding herd, which is aided by government programs subsidizing interest rates to encourage pasture improvements and the use of high quality genetics (Ramos, *et al.*, 2009), as well as increase in feedlots and moderating feed prices. China has also increased slaughter and cattle weights due to stronger demand. High profit margins are attracting large investment from beef companies, while backyard producers continue to exit the industry because of lower efficiency and limited investment (USDA/FAS, 2013).

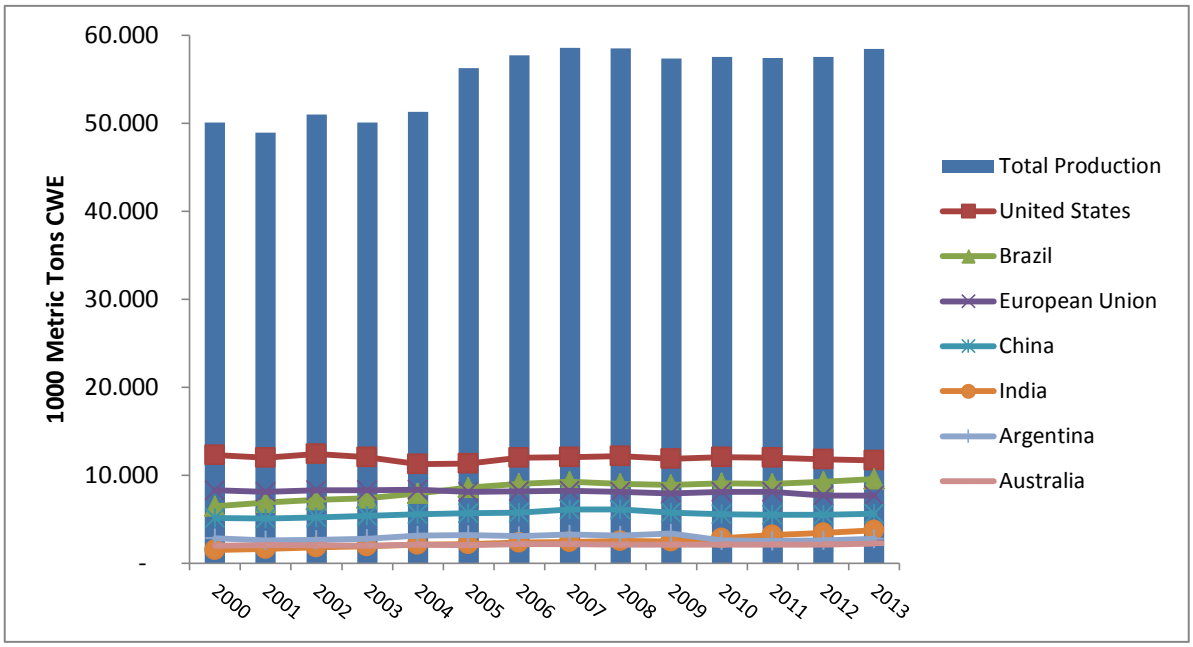


Figure 2 – Global beef production from 2000 to 2013, in 1,000 Metric Tons (Carcass Weight Equivalent). Source: USDA/FAS (2013).

Before this, mass-market beef was largely produced from grass-fed, draft-quality indigenous "yellow cattle" breeds and cull dairy cows, and were supplied by these backyard producers (Gong, *et al.*, 2006). To the present day, China's quality beef production is reportedly constrained by a lack of breeding animals, underdeveloped knowledge of and technology in animal husbandry, and limited available land (Ming-li, 2013).

Global beef consumption increased by approximately 14 percent during 2003 to 2013, driving the trend in production (Fig. 3). Major consuming markets in 2013, in absolute terms, include the United States with 20 percent of the quantity of global beef consumption, followed by Brazil (14 percent), the EU (14 percent) and China (11 percent). Consumption was flat or declined in the more affluent markets, like the U.S., EU and Japanese (that accounts for 2 percent of global consumption), while lower

income markets such as Brazil, Argentina, India and Pakistan grew substantially, as well as China (DESA/UNSD, 2013).

Average global meat consumption reaches 41.9 kilograms per person/year. In developed countries the annual consumption reaches 78.4 kg per person, as for developing countries 32 kilograms per person. Poultry is the most consumed meat, followed by pork and beef. The country which has the greatest beef consumption is Uruguay, reaching about 62 kilograms in 2012, followed by Argentina (55.7 kilograms), the U.S. (39 kilograms), Brazil (38 kilograms), Paraguay and Australia with 35 kilograms both (OECD and FAO, 2012).

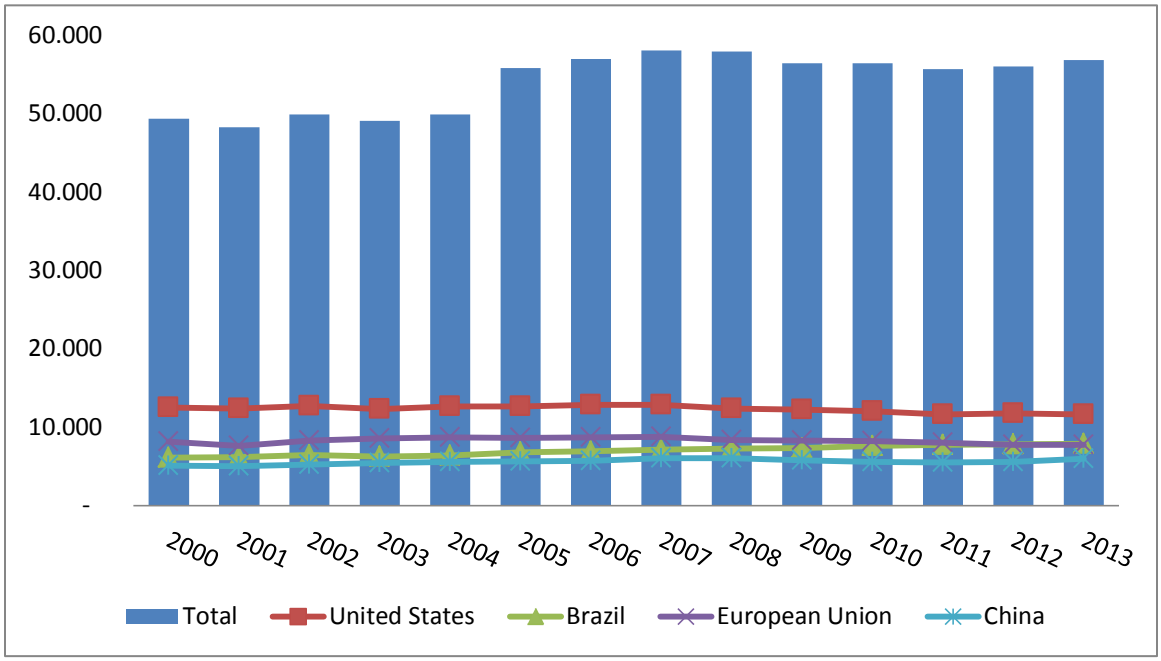


Figure 3 – Global Beef Consumption and Top Consuming Countries from 2000 to 2013, in 1,000 Metric Tons (Carcass Weight Equivalent).
Source: USDA/FAS (2013).

High prices and increasing awareness of the impact of meat production on the environment are expected to exert some adverse effect on beef demand, particularly in developed countries. Nevertheless, higher meat consumption brought about by income

growth and urbanization will strengthen the intake of animal proteins at the expense of foods of vegetal origin in emerging economies. Expected demand growth will mostly stem from large economies in Asia, Latin America, and oil exporting countries (FAO, 2013). USDA agricultural projections to 2022 (USDA, 2014), population gains in developing countries, along with expansion of the middle class, are particularly important for the projected growth in beef demand. Populations in developing countries, tend to be both younger and undergoing more rapid urbanization, factors which lead to expansion and diversification of meat consumption.

Global beef exports increased approximately 29 percent in the past ten years, from 6.3 mmt to 9 mmt in 2013 (Fig. 4) (USDA/FAS, 2013). This increase resulted from a combination of generally rising beef prices and increase exports of higher-value beef cuts from South America exporters, such as Brazil, Argentina, Uruguay, and Paraguay, which account for 30 percent of global beef exports in 2013. While developed country (including the U.S., Canada, and the EU) increase exports at an almost flat rate; because of comparative production costs, domestic demand trends that affect production levels, and exchange rate movements (USITC, 2008).

An expansion of world poultry and beef will lead world meat exports to increase 16% by 2020 relative to the beginnings of 2000s (FAO, 2013). Beef exports during this period may expand at 1.8% p.a. compared to 2.9% p.a. in the past decade.

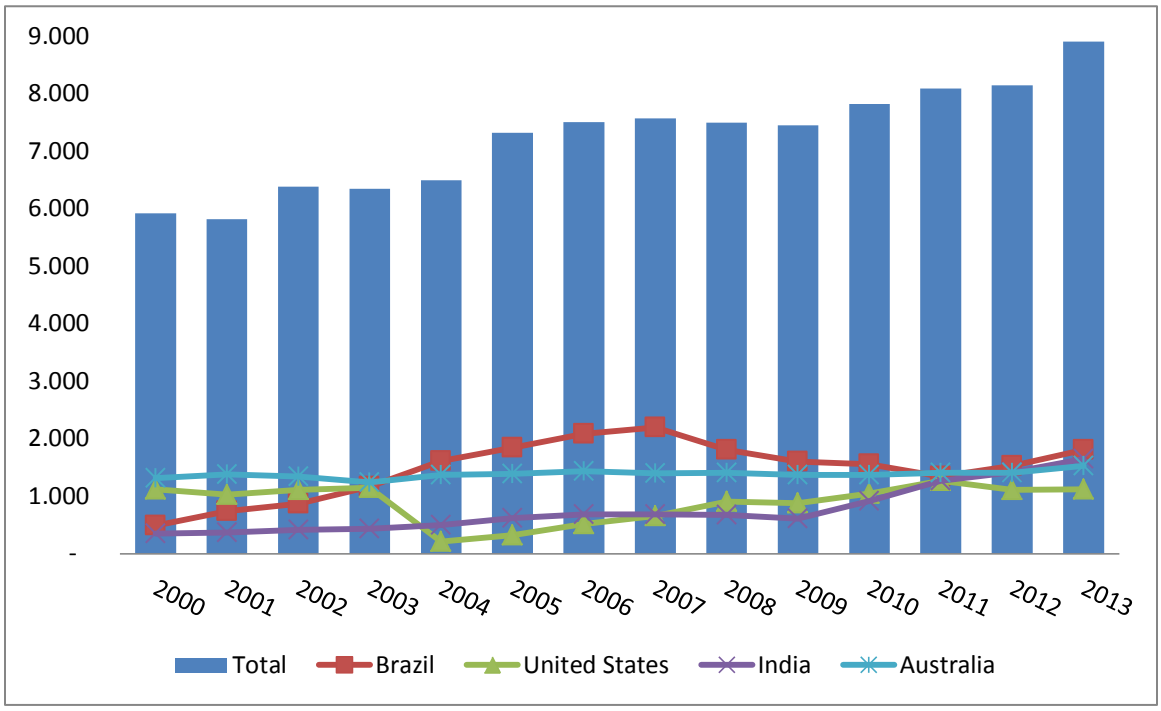


Figure 4 – Global beef exports and top 4 exporting countries from 2000 to 2013, in 1,000 Metric Tons (Carcass Weight Equivalent).
Source: USDA/FAS (2013).

Beef Trade

Beef is a highly heterogeneous agricultural commodity[1], and it can be traded in three categories: raw (88%), salted, in brine dried or smoked (0.8%), and prepared or preserved (12%) (Ramos, *et al.*, 2009). Raw beef goes through a cleaning, aging and cold preservation process, without any other type of processing involved; while other categories go through a drying or cooking process with food additives (Scott and Stevenson, 2006).

Raw beef can be traded as fresh, chilled or frozen; carcasses and cuts; and with or without bones, and it can be in the form of muscle and edible offal (heart, liver, tongue, and brains), while fully processed beef preparations include muscle, offal, sausages and

[1] According to the Terrestrial Animal Health Code (2007), a commodity means animals, products of animal origin intended for human consumption, for animal feeding, for pharmaceutical or surgical use or for agricultural or industrial use, semen, embryos/ova, biological products and pathological material.

corn beef. Because of differences in the characteristics of the market and trade restrictions among these products, it is important to disaggregate beef products to the fullest extent possible to facilitate trade (USITC, 2008).

All traded products use an international nomenclature for their classification. The "harmonized system" (HS) developed by the World Customs Organization (WCO, 2012) provides a classification for traded goods on a common basis for customs purposes (Surak, 2010). Under the HS, beef products are then consistent across all countries at the six-digit subheading level. There are 12 major product categories that account for trade in beef at this level of disaggregation (Table 1) (USITC, 2008).

Table 1. Beef Product Categories, HS Subheading Codes and Examples products traded.

Product	HS	Example of products
Raw		
Fresh/Chilled		
Carcass and half carcass	20110	Full and half carcasses
Bone-in cuts	20120	Rib, chuck, loin, clod, finger meat, flat
Boneless cuts	20130	Iron, short plate, knuckle, brisket
Frozen		
Carcass and half carcass	20210	Full and half carcasses
Bone-in cuts	20220	Rib, chuck, loin, clod, finger meat, flat
Boneless cuts	20230	Iron, short plate, knuckle, brisket
Offal (beef variety meats)		
Fresh/Chilled	20610	
Frozen		
Tongue	20621	Tongue
Liver	20622	Liver
Other	20629	Hearts, kidneys, brains, tail, feet, tendons, cheek meat, libs
Salted, in brine dried or smoked	21020	Meat and offal
Prepared or preserve	160250	Preparation of meats, offal, blood, such as corned beef

Source: Adapted from USITC. September 2008

Among all beef products, raw beef has the higher share in global trade (Fig.5) (Ramos, *et al.*, 2009), and within this category, frozen boneless beef is dominant (Fig.6).

According to Hartnett, *et al.* (2007) the preference for boneless beef can be related to the advantage of not dealing with bones, as they can carry diseases organisms virus like FMD or BSE, as well as lower transportation costs.

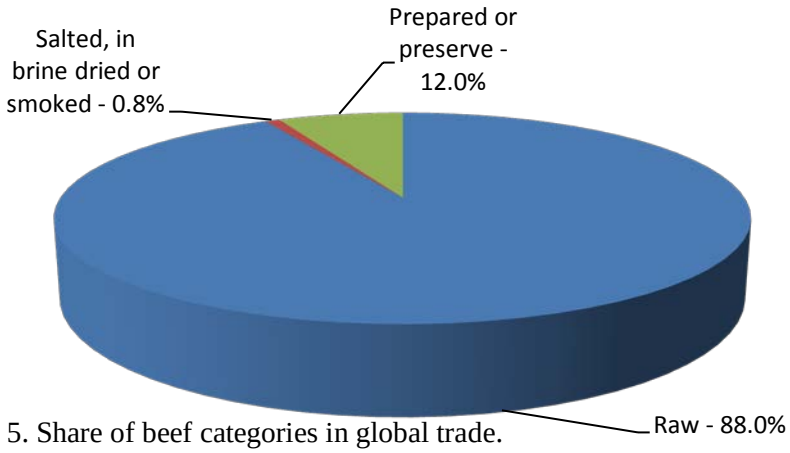


Figure 5. Share of beef categories in global trade.
Source: Ramos, *et al.*, 2009.

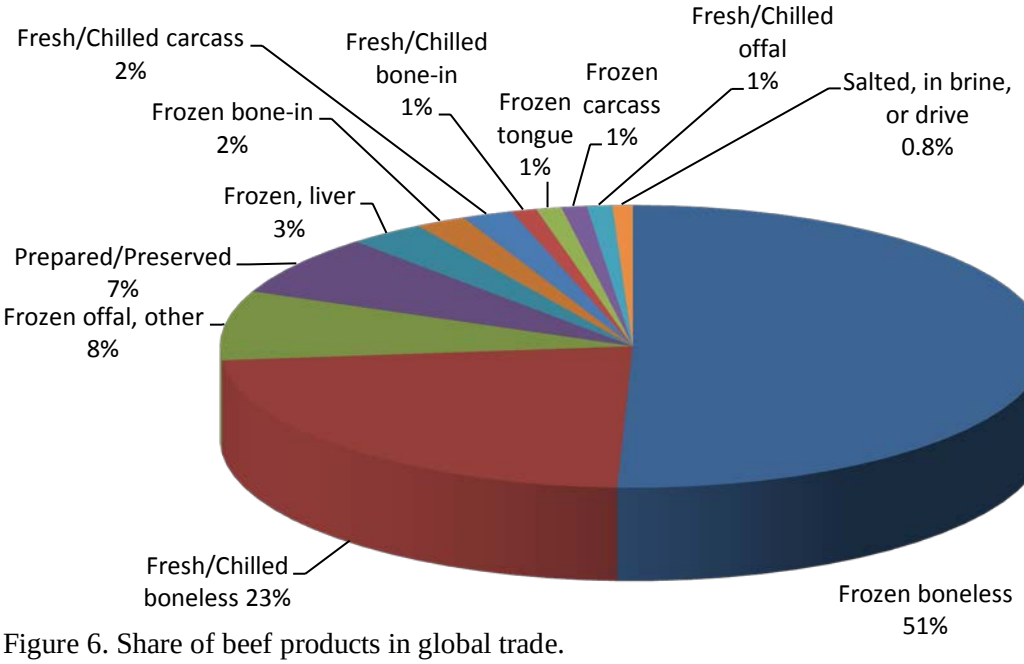


Figure 6. Share of beef products in global trade.
Source: USITC. September 2008.

Fresh or chilled beef like many commodities derived from livestock, presents two additional complications: (i) high potential for perishability and (ii) the risks associated

with such trade are not confined to the private domain. Risks to the public within the importing country are of two major types that overlap to some extent, threats to human health where the imported commodity is destined for inclusion in human foodstuffs and, secondly, threats to animal populations in cases where the commodity, beef in this case, could potentially disseminate animal diseases that may have serious consequences for rural communities and the environment. These threats are real and of increasing concern to both individual importers and the guardians of the public good in importing countries (Thompson, *et al*., 2008).

Standards and Regulations in Beef Trade

Because of all the implications that come with beef trade, especially the ones associated with fresh or chilled products, the beef industry had to ensure the delivery of safe products. This is the main reason why standards and regulations in beef trade were key to the continue beef trade.

Food safety regulations are motivated by the protection of public health. When regulations are set to protect public health, they are also driven by the perception of risk in food consumption. In beef trade over the 90's up to the present, the outbreak of FMD and BSE has heightened public awareness of food safety risks. The use of veterinary drugs in livestock, such as growth hormones and veterinary medicines in beef has also been the subject of international debate and concern over the past decade (Wilson, *et al.*, 2003). For importers of beef, especially those located in developed countries, an overriding pre-occupation when it comes to the acceptability of imported animal products is human food safety. Therefore, exporters of beef and by-products need to be able to

provide convincing evidence that the commodities destined for export are safe for human consumption.

Regulations between exporting and importing countries may not be equivalent, which creates a need to harmonize standards and regulations at the international level. At the international level, a number of organizations have focused technical efforts on harmonizing both regulatory and customer requirements (Surak, 2010). These organizations include the World Trade Organization (WTO), the Codex Alimentarius Commission (Codex), and the World Organization for Animal Health (OIE). These organizations set the baselines for all kind of standards and regulations used in the beef industry.

World Trade Organization

The WTO (2013) is the only global international organization dealing with the rules of trade between nations. Prior to the formation of the WTO, the General Agreement on Tariffs and Trade (GATT) managed the rules that governed world trade; however, that changed in the Uruguay Round Agreement (GATT, 1994).

The agreement on the application of sanitary and phytosanitary measures (SPS) was one of the major products of the GATT's Uruguay round of multilateral trade negotiations, signed in Marrakesh in April 1994 (WTO, 1998). The SPS agreement's main intent is to provide guidelines and provisions to member countries to facilitate trade, while taking measures to protect human, animal and plant life or health. The agreement dictates that all sanitary measures must be scientifically based and not more restrictive than required to avoid the risk identified (Surak, 2010). These measures must be applied to domestic

food or local animal and plant diseases, as well as products coming from another country. However, country members can set standards other than the international standards, guidelines, or recommendations only when there is scientific justification for doing so, or if scientific evaluation of the international standards, guidelines, or recommendations reveals. The standards do not afford the level of safety the member determines to be appropriate. In other words, if a country chooses to apply more restrictive measures than those in the international standards, it has to justify its position through a risk analysis, thus avoiding the use of sanitary and phytosanitary measures as unjustified barriers to trade (Zepeda, *et al.*, 2005).

Specifically, the SPS agreement has placed an increased emphasis the importance of sanitary and phytosanitary measures, requiring improved surveillance and monitoring systems, adequate laboratory diagnosis, risk analysis capabilities and quality assurance (Vallat and Wilson, 2003). A review of the operation and implementation of the agreement recognized that although it has improved international trading relationships and has led to increased transparency on the application of SPS measures, several developing countries still have implementation problems (WTO, 1998).

The WTO Agreement on SPS encourages member countries to harmonize national standards with international standards, and recommendations developed by other WTO member governments in international organizations for food safety. The SPS agreement explicitly recognizes three relevant international organizations that develop and review accepted standards, guidelines, and recommendations. These are the OIE, the Codex Commission, and the International Plant Protection Commission (Surak, 2010). The first two are important to beef trade. Although membership of all international

organizations is not mandatory, the SPS agreement has led to an increase in the number of countries belonging to and actively participating in these organizations (Zepeda, *et al.,* 2005).

The Codex Alimentarius Commission

The Codex Commission is the recognized international authority for measures dealing with food safety standards and codes of practice. It deals both with hygiene (i.e., microbiological criteria and their controls) and residue limits for materials such as metals, pesticides, veterinary compounds, food additives, and preservatives (CODEX, 2013).
The Codex was adopted by the SPS as a reference to set food safety standards. One of its goals is to harmonize national regulations to reduce barriers to trade and increase the free movement of food products among countries. As a result, developing and emerging economies can use the Codex standards to develop regulations and deal with issues of trade facilitation (Surak, 2010). When establishing or maintaining sanitary or phytosanitary measures to achieve the appropriate level of protection, members shall ensure that such measures are not more trade-restrictive than required, taking into account technical and economic feasibility.

Indeed, this necessitates monitoring systems, laboratories and testing equipment to support attainment of set standards. It also means that the beef needs to be derived from cattle slaughtered in export approved abattoirs with acceptable levels of hygiene, ideally adopting the principles of 'hazard analysis and critical control points' (HACCP) stipulated by the Codex Alimentarius and most private standard-setters in relation to food safety. It is important to note that during the production of fresh meat, control steps that

ultimately guarantee the absence of identified microbiological hazards are not possible. For this reason 'pure HACCP' can only be delivered in the production of processed meats. For fresh, chilled meat the 'principles of HACCP' are utilized to control identified hazards to 'an acceptable level' (this level equates with the OIE's 'acceptable risk' and 'appropriate risk'). Such a systematic, disciplined approach would map-out the entire process, identify where the hazards can arise, and identify appropriate and effective control measures as well as specifying valid targets and critical limits, monitoring procedures, and corrective action. Documentation and records would be properly controlled. This would bring the further benefit that the system would be audited, which would support certification to satisfy the concerns of the importers and their regulators.

World Organization for Animal Health

The World Organization for Animal Health was founded in 1924 as the Office International des Epizooties (OIEa, 2014). In 2003, the OIE was renamed; however, it retains the historical acronym. OIE collects, analyzes, and disseminates veterinary science information on animal disease control, in addition, it provides assistance to developing, and less developed nations on animal disease control and eradication operations (Surak, 2010). The official agreement between the WTO and the OIE further confirmed the OIE's mandate to recognize disease and pest-free areas for trade purposes, in the context of the WTO Agreement on the Application of SPS.

OIE classifies countries according to their sanitary condition and risk occurrence of diseases, determining whether a country is free of a disease. One of OIE's missions is to ensure transparency in and enhance knowledge of the worldwide animal health situation,

including zoonoses[2]. Among the formal obligations of OIE member countries is the submission of information on the relevant animal disease situation, including on zoonoses present in their territory , in the most timely and transparent way (OIE, 2014b).

A country may either lose or enhance its commercial attractiveness in the eyes of potential or existing importing partners, depending on official recognition of its OIE disease status. By acquiring and maintaining its official status, a country also demonstrates transparency and helps to promote animal health and public health worldwide, thereby gaining the trust of its partners and of the international community (OIE, 2014c). Studies, such as Pritchett, *et al.* (2005) evaluated animal disease economic impacts, and concluded that Bovine Spongiform Encephalopathy (BSE) and Foot and Mouth Disease (FMD) are diseases that increasingly affect the most international trade, food safety, and human health.

Bovine Spongiform Encephalopathy

BSE is a fatal neurological disease afflicting adult cattle that was first recognized in the United Kingdom in 1986. Researchers believe that BSE is caused by a prion, a protein that is not destroyed by cooking or other commonly used measures to control pathogens such, as bacteria. BSE is likely spread by consumption of meat and bone meal (MBM) containing the infective agent prions incorporated into cattle feed (OIE, 2013d). Since the emergence of the disease in the United Kingdom, and the subsequent discovery of a possible link between the BSE prions and fatal new variant Creutzfeld-Jacob Disease

[2] Zoonoses are diseases and infections that are naturally transmitted between vertebrate animals and humans. A zoonotic agent may be a bacterium, a virus, a fungus or other communicable disease agent. At least 61% of all human pathogens are zoonotic, and have represented 75% of all emerging pathogens during the past decade (Acha and Szyfres, 1987).

(vCJD) in humans; various beef importing countries have implemented measures to prevent BSE from entering their territory, prevent its spread, and safeguard human health. These measures included: 1) restrictions on imports of live animals, meat products, and feedstuffs; 2) restrictions on feeding certain ruminant derived tissues back to ruminant animals; 3) a disease surveillance program; 4) and restrictions on blood donations from individuals who previously resided in BSE affected countries (Coffey, *et al.*, 2011). All trade in livestock commodities implies some risk of disease transmission and therefore the concept of 'zero' risk is no longer internationally acceptable (a principle accepted by the WTO). The acknowledged principle is that trade should occur only where the risk of the identified hazard occurring is below an acceptable level, referred to by the WTO as the 'appropriate level of protection' (Article 5 of the SPS Agreement). (Thompson, *et al*., 2008).

The OIE has developed standards and guidelines regarding appropriate government responses to a BSE discovery. The Terrestrial Animal Health Code contains standards, guidelines and recommendations to be used by national veterinary authorities. The aim is to prevent the introduction of infectious agents pathogenic for animals and humans by way of imported animals and animal products, while avoiding unjustified trade barriers. The OIE Terrestrial Animal Health Code classified countries into one of five BSE risk categories (BSE free, BSE provisionally free, country of minimal risk, country of moderate risk, and country of high risk). The OIE did not and does not assign countries to particular risk categories. While OIE standards are recognized as reference international sanitary rules by the World Trade Organization, its Terrestrial Animal Health Code is non-binding.

Since the Terrestrial Animal Health Code is not binding, governments in importing countries are free to make their own judgment on the BSE status of an exporting region. The large trade disruptions from reporting and confirming a case of BSE did not come from a region losing its BSE free status. Instead, national governments completely prohibited beef and cattle trade imports without consulting the recommendations in the Code or conducting a risk analysis in accordance with their OIE and WTO obligations. Trade was prohibited even for the slightest BSE risk (Le Roy, *et al.*, 2006).

Rather than a total import prohibition, the Code prescribed increasingly restrictive recommendations commensurate with the level of BSE risk in each country. The OIE became concerned about large international trade disruptions that were a product of governments misinterpreting its Terrestrial Animal Health Code. As a result, the OIE set new guidelines in 2005 with respect to beef exports and risk. Since then, countries are placed in one of three categories—negligible risk, controlled risk, or undetermined risk based on an assessment of the risk to animal and human health in the importing country (USITC, 2008). The risk status is based on four criteria spelled out in the Terrestrial Animal Health Code: (1) an assessment of the incidence of BSE in the member country (through a surveillance program); (2) an established program for the detection of possible BSE cases; (3) the compulsory notification and testing of possible BSE cases; and (4) the existence of approved laboratory and testing procedures for tissues collected in the surveillance program (OIE, 2013d).

In the OIE Terrestrial Animal Health Code (2013) countries are classified by the OIE as negligible BSE risk, controlled BSE risk, and undetermined BSE risk.

Classifications are based on the outcome of a risk assessment, surveillance; identification of affected cattle, their progeny, and other animals raised with them; as well as the incidence of BSE, if applicable. The OIE does not assess the risk status of a member country that has not requested classification of risk.

OIE guidelines recommend that all beef from negligible BSE risk countries be authorized for import, provided that it can be demonstrated that the cattle have not been exposed to BSE and were born after the date of an effective feed ban to control the spread of the infective agent. However, for controlled BSE risk countries, OIE guidelines recommend that all fresh meat and meat products, except for mechanically separated meat from the skull and vertebral column of over 30 month (OTM) aged cattle, be authorized for import if control procedures are in place. Recommended control procedures include antemortem and postmortem inspections of all cattle for human consumption, a ban on certain unapproved stunning or slaughtering processes (use of a device injecting compressed air or gas into the cranial cavity, or to a pithing process is not allowed), and verification that the meat or meat products have been produced and handled in a manner such that they have not been contaminated with Specified Risk Materials (SRMs)[3] or mechanically separated meat from the skull and vertebral column from OTM cattle (Terrestrial Animal Health Code, 2013).

[3] Specified risk material (SRM) is the general term designated for tissues of ruminant animals that cannot be inspected and passed for human food because scientists have determined that BSE-causing prions concentrate there. SRMs listed by the OIE for cattle originating in a controlled risk country are the tonsils and distal ileum of cattle of any age, plus the brains, eyes, spinal chord, skull, and vertebral column from cattle OTM. OIE Terrestrial Animal Health Code (2005), art. 2.3.13.14.

Foot and Mouth Disease

Foot and mouth disease (FMD) is the most contagious disease of mammals and has a great potential for causing severe economic loss in susceptible cloven-hoofed animals. There are seven serotypes of FMD virus (FMDV). FMD is characterized by fever and blister-like sores on the tongue and lips in the mouth, on the teats, and between the hooves (Terrestrial Animal Health Code, 2013). Although rarely fatal in adult animals, FMD causes significant production losses in the affected animals because ruptured sores can result in extreme lameness and reluctance to eat. Even after the animals recover from the disease, FMD often still leaves them weakened, with their productivity impaired (USITC, 2008).

Transmission between animals is generally effected by direct contact between infected and susceptible animals or more rarely, by indirect exposure of susceptible animals to the excretions and secretions of acutely infected animals, or uncooked meat products (Juleff, *et al*., 2008).

The control of FMD is usually a national responsibility and, in many countries, the vaccine may be used only under the control of the competent authority (Terrestrial Animal Health Code, 2013). Routine vaccination against FMD is used in many countries or zones recognized as free from foot and mouth disease with vaccination and in countries where the disease is endemic. In contrast, a number of disease-free countries have never vaccinated their livestock, but have preferred the use of strict movement controls and culling of infected and contact animals when outbreaks have occurred. Nevertheless, many disease-free countries maintain the option to vaccinate and have their

own strategic reserves of highly concentrated inactivated virus preparations (Doel, *et al.*, 1994).

FMD is the first animal disease for which OIE established an official list of FMD-free countries and zones, beginning in 1996. There are two categories within the FMD-free classification: (1) FMD free without using vaccination (country or zone) and (2) FMD free with the use of vaccination (country or zone). There are currently 66 countries that are recognized as FMD-free by the OIE without vaccination (OIE, 2013e).

Much of the global FMD burden of production losses falls on the world's poorest communities, and those which are most economically dependent upon the health of their livestock. In countries with ongoing control programs, FMD control and management creates significant costs. These control programs are often difficult to end due to risks of FMD incursion from neighboring countries. The greater movement of people, livestock and commodities implies that risks of international transmission of FMD are increasing. This risk further compromises these countries in their ability to export livestock and livestock products as the presence, or even threat, of FMD prevents access to lucrative international markets (Pendell, *et al.*, 2007).

According to Perry and Randolph (2003) found some direct and severe impacts of FMD more production lost, including reduced milk production, reduced livestock growth, mortality in young stock, and abortion. Extensive systems of production do not have such pronounced losses. FMD can be an important economic burden, via vaccination cost. Costs associated with outbreak control, sometimes culling and compensation represent a great deal of government expenditure, especially in developing and less-developed

countries. Some national FMD vaccination programs vaccinate all bovines three times a year; this limits resources available to combat other diseases (Clavijo, *et al.*, 2004).

Even if a country is FMD free there are ongoing costs due to efforts to reduce the chance of disease re-introduction, including border and import controls and inspections, as well as costs maintain the capability for early detection and control of FMD, including surveillance, ensuring sufficient organizational capacity in the veterinary services and permanent restrictions on the livestock sector (such as post-movement standstills) (Thompson, *et al.*, 2002).

Beef Trade and Use of Veterinary Drugs

Hormones are used to promote weight gain in beef cattle and allow a higher feed conversion ratio along with a higher ratio of muscle mass to fat. These veterinary drugs are commonly used by beef producers, especially in the United States, but also in other top beef exporting countries such as Brazil and Australia.

International standards applied to the use of veterinary drugs are developed, in part, to mitigate against problems associated with discordances between importing and exporting countries with differing food safety standards, as well as attitudes toward foodborne risks (Wilson, *et al.*, 2003). Even though outbreak of diseases have been suspected to be the consequence of antibiotic use in animal feed, lack of scientific evidence cannot always prove that the use of antibiotic is the actual cause for the disease or illness.

In the case of drugs residues, the Codex maximum residue limits (MRLs) are supposed to be consistent with the safe levels of Acceptable Daily Intake (ADI), when veterinary drugs are used in accordance with good veterinary practice (WTO, 1998).

Moreover, Codex and the WTO have limited ability to encourage adoption of the MRLs (Wessel, 1992) and the differences in food safety standards across countries have often resulted in trade disputes (IATRC, 2001). These include the widely long running and publicized dispute at the WTO between the U.S. and EU over hormone treated beef. Currently no veterinary medicines are approved for use as growth-promoting agents in the EU (USITC, 2008).

The safety of the growth-promoting hormones used in the production of beef cattle is supported by the findings of the FAO/WHO JECFA and the MRLs that have been established and published by the Codex (2013). The original U.S.-EU hormone dispute involved six hormones that are generally administered through implants in cattle[4]. Three are naturally occurring hormones that the JECFA has determined "are unlikely to pose a hazard to human health" when used in accordance with good animal husbandry practices. Two are veterinary drugs for which the Codex has established maximum levels (Tylor, *et al*., 2003).

Antibiotics and antimicrobial drug residues are present in animal bodies even after they are slaughtered; this is particularly true when sufficient time is not allowed for the residues to leave the animal's system prior to slaughter. In addition, cattle fed with antibiotics can lead to the development of antibiotic resistant pathogens (Wilson, *et al.,* 2003). Although resistant pathogens may not directly cause human disease, they can transfer this resistance to pathogenic bacteria in the human body (Prescott, 1997). In rare cases, the dietary intake of antibiotics and other veterinary drugs are also believed to

[4] The six hormones are estradiol, progesterone, testosterone, melegestrol acetate, trenbolone acetate, and zeranol.

cause a direct adverse health effect on humans (Botsoglou and Fletouris, 2001). Besides a few isolated cases[5], it is very hard to link human illness with consumption of veterinary drugs used in animal feed or used for animal health protection. Even though outbreak of diseases have been suspected to be the consequence of antibiotic use in animal feed; and yet direct scientific evidence of risks associated with veterinary drugs is very limited (Wilson, *et al.*, 2003).

Tightening food safety regulations on the use of veterinary drugs could induce significant additional costs to livestock producers because such drugs are widely used to prevent infectious diseases caused by bacteria, to reduce the amount of feed needed for each animal, and to increase the rate of weight gain (stimulate growth) (Taylor *et al*., 2003).

Beef Traceability

Animal diseases, such as FMD and BSE, the use of veterinary drugs, like growth hormones and antibiotics, and foodborne illness, were the top motivations for the design of traceability systems. Demand for greater food safety, referring mainly to animal health and sanitary issues is still an emerging topic. However, this concern goes even further, involving issues such as environmental protection, animal welfare and production practices (Farina and Rezende, 2001).

[5]Antibiotics known as chloramphenicol and a beta-2 agonist called clenbuterol are capable of having direct toxic effect. Chloramphenicol has been the cause of fatal aplastic anemia that results in death in approximately 70 percent of the cases and people recovering have high chances of experiencing acute leukemia. A veterinary drug known as clenbuterol has caused food poisoning in Spain affecting 135 people. Consumption of veal liver meals with clenbuterol residue caused food poisoning in France as well. In Italy 62 people had clenuterol intoxication after consuming beef. (Botsoglou and Fletouris, 2001).

Efforts to establish traceability have their roots in 1994 in the BSE outbreak in England, which resulted in the sacrifice of 137,000 heads of cattle (Ceolin, *et al.,* 2010). Two additional EU food crises occurred almost simultaneously with BSE. One of these outbreaks involved *Salmonella* contamination in Danish pork and the other *E. coli.* traced to Scotland (USITC, 2008). These food scares coupled with a lack of confidence by EU consumers regarding government regulation of food safety has led to the establishment of traceback systems in Europe. Food safety and quality assurance characteristics are used in marketing efforts in the EU to differentiate food products as being safe, environmentally friendly, animal friendly, *etc*. Consequently, traceable systems have been developed in Europe to address the demand consumers have for expanded information about the food they consume (Schroeder and Tonsor, 2011).

According to Malafaia and Barcellos (2007), report disease outbreaks in the global beef sector led consumers to reduce meat consumption, and in addition increase their requirements in relation to quality and food security, which meant adding information about the product that is being offered; as well as, increasing food safety consumer concerns. These concerns increased the need of improving beef quality through traceability systems, country of origin, sanitary status, documentation of product processes, beef brands, among other mechanisms, began to be important in a global context (Ceolin, *et al.,* 2010). On the other hand, there are still important components that have not been considered important for final consumers, although these have a direct influence on the final product's quality; such as age, feeding, gender and breed of the animal (Mantese, *et al.*, 2005).

In this sense, product history or supply chain information as a quality indicator and is an essential component of competitive advantage¸ even more when exporting countries reward quality warranties with higher prices (Quadros, 2001). Braga (2010) considered that the more information available the less friction and greater social cohesion and would exist between industry and consumers.

The Paraguayan Beef Industry

Paraguay is a landlocked developing country in central South America of about 6.0 million people, with over 20 percent of the population engaged in subsistence agriculture. The livestock industry employs 17,5 percent of the total active working population (ARP, 2012). For the past decades the Paraguayan beef industry has become one of the most important components of the country's economy, which contributes about 5 percent of the Gross Domestic Product (GDP) (BCP, 2013).

There are about 133,000 cattle ranches in Paraguay, with 13.1 million head spread over 30 million hectares devoted to cattle production, 90 percent of the ranches have less than 100 head each, and the other 10 percent account for 12 million head of cattle. Only 16 percent of this area has planted pastures, while the rest is natural pastures and woodland. Most of the cattle are grass-fed (ARP, 2012). The Paraguay River divides the country in two main regions that define livestock production system; the eastern region, where roughly 62 percent of the herd is located, and the western region with 38 percent, which is drier and less developed, in terms of urbanization (USDA/FAS, 2006).

Cattle can be commercialized in three distinct markets: to direct export meat packers, domestic demand retail, and to rural countryside use and on-farm consumption.

The first two are closely followed and tracked, with good information and data available. However, the last sector is difficult to track as there is very little information reported (USDA/FAS, 1999). There are 12 large slaughter plants in the country, with 10 eligible to exports. The export plants cumulatively slaughter between 1.3-1.5 million head per year, and have a total capacity of slaughtering 1.8 million animals per year. There are also about 50 small slaughter plants close to Asuncion, the capital city, sourced from close-by auction markets, selling about 200,000-300,000 heads per year (USDA/FAS, 2013).

Paraguay has in place two cattle traceability programs, one for the Chilean market, which currently has over one hundred approved operations (prior to the last FMD outbreak there were more than 1500 registered ranches with 3 million cattle), and one for exports to the EU (currently suspended) with approximately 40 ranches with 300,000 head of cattle. The number of ranches eligible to export to Chile is expected to grow significantly by 2014 (USDA/GAIN, 2013).

From 2000 to 2003 beef production had been stable and 74 percent of the beef was consumed by the domestic market. However, since 2004 beef production increased at a fast pace; from 2003 to 2004 beef production and exports increased by 30 percent and 126 percent respectively (Patiño, 2013). After that period, exports began to increase considerably, mainly because international prices were higher than domestic prices and Paraguay was gaining access to markets demanding beef (Ferreira and Vasconsellos, 2006). This growth was a consequence of the use of good animal genetics, which brought a significant improvement in meat quality, as well as the heavy investments by the local meat packing industry to increase capacity for export. About US$ 40 million was invested in expanding cold chambers, de-boning rooms, and slaughter capacity

(USDA/FAS, 2006). Another key element for this expansion was entering the European market; in 2001, the EU gave a quota (Hilton Quota) of 1,000 tons annually, but in 2010 and early 2011 the country also exported a similar volume beyond the quota (USDA/FAS, 2013). Even though this amount did not represent much of beef exports, it helped to reach other markets (Patiño, 2013). After this period, Paraguay's cattle/beef sector became very dependent on exports which normally account for more than half of the production.

Paraguay had two FMD outbreaks in the past, the most recent in late 2002 and 2011, which led to the suspension of Paraguay's "FMD-free with vaccination" status (Roberts and Hammond, 2011). This had a negative impact on exports, because most of international markets closed their borders to Paraguayan beef in 2011 and 2012. One of the most catastrophic consequences of the outbreaks was the loss of the Chilean market sales, which accounted for approximately 40 percent of Paraguay's total beef export volume and almost 50 percent of export value. During that period, of closed markets, Paraguay almost double its exports of chilled beef to Brazil, while at the same time; Brazil tripled its shipments to Chile, becoming the leading supplier there, a position previously held by Paraguay (USDA/FAS, 2007). Moreover, the country sought markets with no restrictions on FMD, which led to a considerable loss in export value, since 90 percent of exports were frozen boneless beef, mainly to the Russian Federation, while fresh, chilled boneless beef accounted for the balance (DESA/UNSD, 2013).

In spite of the animal health emergency from the FMD outbreak in 2011, beef exports were up 6% in 2012, with a redirection of exports to new international markets over the course of that year (ECLAC, 2013). In July 2013, Chile announced that it was

fully opening its market to Paraguayan beef, provided they comply with the sanitary and quality standards. In July 2013, Chile announced that it was fully opening its market to Paraguayan beef, provided they comply with chilean sanitary and quality standards (USDA/FAS, 2013).

In 2013 over 1.4 million head were slaughtered by export meat plants, of which 65 percent were steers and 35 percent cows and heifers. About 600,000 head were slaughtered to supply the entire Paraguayan market. Cattle markets near Asuncion, which supply supermarkets and shops, typically sell 60 percent cows and 35 percent steers. An improved sanitary status and thus a larger presence in world markets made local cattle prices increase significantly, which coupled with low costs of production and the assistance of low cost credits promoted the expansion and the improvement of the sector. It is forecast that Paraguay's cattle herd at 17 million head by 2016 (USDA/FAS, 2013).

Paraguay has a vast extension and much of it is in the process of being put into production. Therefore, there is still room for agricultural and livestock production to grow. In the past decade there has been a significant shift from pastures into cropland, especially in the eastern and central parts of the country where the best soils are. This process is expected to continue in the future; which might lead to a shift in cattle production systems, from extensive to more intensive systems.

Regression Models in Beef Studies

Beef trade has been studied before, through regression models leading to important information about beef demand, consumer preferences, and trends of consumption for a type of product, product origin and quality, as well as consciousness

regarding nutritional and sanitary values (Schroeder, *et al.*, 2007; Jarvis, *et al.*, 2005; Patino, 2013).

Schroeder, *et al*. (2007) used a regression equations to study beef consumption responses to food safety risk perceptions. In particular, they tested whether consumers from four different countries have altered their beef consumption habits because of risk aversion and risk perception stemming from beef food safety concerns. To determine whether differences in risk attitudes and perceptions were related to stated changes in beef consumption by consumers in each of the four countries, and to allow for nonlinear interactions, they incorporated risk attitudes and perceptions by interacting each index with country dummy variables as well as with each other. Their model proved that risk attitude and risk perception significantly affect consumption decisions.

Although there are not a lot of studies evaluating the impact of cattle diseases outbreaks and beef traceability systems in export beef prices, in the agricultural economics literature, there has been considerable focus on analyzing structural change in meat demand. While the regression methods and explanations may vary, nearly all of the studies of meat demand find support for some form of structural change (Bryant and Davis, 2008; Goodwin, Harper, and Schnepf, 2003), that can be attributed to animal diseases outbreaks, foodborne illnesses or health concerns.

Jarvis, *et al.* (2005) used a regression model to analyze the effect of FMD on beef trade and prices. They assumed that beef export price is a linear function of country characteristics such as beef quality, the exporter's and importer's per capita GDP, trade agreements, time trend, regional dummy and FMD status.

CHAPTER III

METHODOLOGY

Procedures for Data Collection

Data was collected from the United Nations Commodity Trade Database (UN Comtrade), which is undertaken by the Trade Statistics Branch of the United Nations Statistics Division - Department of Economic and Social Affairs (UNSD/DESA). The database covers more than 3.1 billion annual and monthly trade data from 1962 to the most recent year, including detailed import and export statistics reported by statistical authorities of nearly 200 countries or areas. The database is continuously updated; whenever trade data are received from the national authorities; they are standardized by the UN Statistics Division and then added to UN Comtrade database.

All commodities in the database are classified consistent with the Harmonized Commodity Description and Coding System (Harmonized System, or HS), and the valuation method adopted for all trade operations is the WTO Agreement on Valuation. Under the Agreement, the majority of the reporting data are in American dollars (US$), “Free on Board” (FOB)-type for exports and “Cost, Insurance and Freight” (CIF)-type values for imports. FOB values include the transaction value of the goods and the value of services performed to deliver goods to the border of the exporting country. CIF values include the transaction value of the goods, the value of services performed to deliver goods from the border of the exporting country to the border of the importing country.

Imports values reported by one country do not coincide with exports reported by its trading partner. These differences are due to various factors including valuation (imports CIF versus exports FOB), differences in inclusions/exclusions of particular commodities and timing.

Data was obtained for the top eleven major beef exporters, for their export operations volume (metric tons) and export receipt (American dollars per metric ton) with each of their trading partners, from 2000 to 2012. The list of major beef exporting countries are reported in the Livestock and Poultry: World Markets and Trade Annual report, elaborated by the Foreign Agricultural Service's United States Department of Agriculture (USDA/FAS, 2013); where information about production, consumption, imports and exports of major traders in the beef, poultry and pork industry is included. The exporters included in this research are ten countries and one economic block shown in Table 2.

Given the importance of food safety standards in beef trade, importing countries set regulations and bans product based on Sanitary and Phytosanitary Standards (SPS), specially related to BSE and FMD; exporting countries hold an official sanitary status in regards to these diseases. They are called the Official Diseases Status and set by the OIE (2013). All exporters considered, along with their BSE and FMD official status during the period of analysis are shown in Table 3. The World Animal Health Information Database (WAHID, 2013) Interface provides access to all data held within OIE's animal diseases information. Immediate notifications and follow-up reports submitted by country members notifying exceptional epidemiological events current in their territory are included in the database; information about BSE and FMD events in exporting countries

was also incorporated in the study (Table 4). Collectively, these countries accounted for 93 percent of world beef trade in 2013 (UNSD/DESA).

According to the OIE's Terrestrial Animal Health Code (2005), member countries shall make available to other members, through the OIE, whatever information is necessary to minimize the spread of important animal diseases. This means that any epidemiological event should be notify in accordance to the OIE disease reporting format within 24 hours. Some of these events may lead to the loss of a country's official status; this is determined by the OIE authorities, depending on each particular event. For the purpose of this research, all events reported by exporting countries, whether it led to the loss or not of their official status, are considered.

Beef is a heterogeneous product, with its unit value varying according to type of animal, production technology, specific cut, whether is sold bone in or boneless, and whether is fresh/chilled or frozen. Although most beef trade 40 years ago was in carcass form, nearly all trade today occurs in the form of specific cuts (Javis, *et al.*, 2005). All beef exports were disaggregated according to four commodities classified by the HS codes: fresh/chilled bone-in cuts (HS020120), fresh/chilled boneless cuts (HS020130), frozen bone-in cuts (HS020220), and frozen boneless cuts (HS020230).

Table 2. Major Exporting Countries in Global Beef Trade, Total Traded Volume in 1000 Metric Tons (carcass weight equivalent) and percentage of Market Share, from 2000 to 2013.

Country	Total	% Share
United States	12,412	12%
Brazil	20,610	20%
India	10,547	10%
Australia	19,349	19%
New Zealand	7,320	7%
Uruguay	4,648	5%
Canada	6,963	7%
Paraguay	2,451	2%
European Union	4,940	5%
Argentina	5,527	5%
Mexico	925	1%
Total	101,231	100%

Source: Foreign Agricultural Service/USDA (2013)

Due to the increasing concern about these diseases and their impact in food safety, traceability systems were introduced into the beef supply. The adoption of traceability system enables beef traders to quickly identify the source of potential animal or human health hazards, limiting the chances of outbreaks. Animal identification is the base for traceability systems in the beef industry (Souza-Monteiro and Caswell, 2004).

Traceability systems, or lack thereof, as well as exporting counties' sanitary status could have an important impact on beef export prices, volume, and even market access; mainly because some importing countries impose certain conditions for beef trade, and only products that comply would have access.

Adoption of traceability systems are different in each country, in terms of depth and extent of information they contain. Some may just involve individual animal identification, traceability to ranch of origin, animal movement tracking, animal age and product processing verification systems (Schroeder and Tonsor, 2011).

Table 3. Beef Exporting Countries with their respective BSE and FMD Official Status.

Country	BSE Status	FMD Status
United States	Negligible Risk	free where vaccination is not practiced
Brazil	Negligible Risk	free where vaccination is practiced
India	Negligible Risk	No recognized status
Australia	Negligible Risk	free where vaccination is not practiced
New Zealand	Negligible Risk	free where vaccination is not practiced
Uruguay	Negligible Risk	free where vaccination is practiced
Canada	Controlled Risk	free where vaccination is not practiced
Paraguay	Negligible Risk	free where vaccination is practiced
European Union*	Controlled Risk	free where vaccination is not practiced
Argentina	Negligible Risk	free where vaccination is practiced
Mexico	Controlled Risk	free where vaccination is not practiced

Notes: All sanitary status are determined by the World Health Organization (OIE, 2013), based on risk assessment, surveillance; identification of affected cattle, their progeny, and other animals raised with them; as well as the incidence of BSE and FMD, if applicable.
*70% of EU members have a BSE Controlled Risk status and 30% Negligible risk, all members are free of FMD without vaccination and have mandatory traceability system.
Sources: USDA, FSIS, Export Requirements for Meat and Poultry Products (2013).
USDA, FAS, Global Agricultural Trade System (2013).

For the purpose of this research, countries that have an individual animal identification system will be considered as countries with traceability system in place. This system consists in the identification of animals using individual ear or tail tags, or rumen bolus; which is a device with a radio frequency transmitter placed in the animal's stomach (Souza-Monteiro and Caswell, 2004). All traceability data (generally birth date, sex, transfer history, feed intake-grass or grain- and notification of slaughter) is recorded in computerized databases being kept and verified by designed national authorities (Schroeder and Tonsor, 2011). Exporters' traceability systems are included in Table 3.4, and are divided in two categories, depending on the depth of use:

1 – Mandatory Traceability System for all animals: countries that have adopted mandatory national cattle identification system.
2 – Mandatory Traceability System only for export animals: countries that have adopted cattle identification systems only for animals destined to importing countries that demand it as a condition for trade.

Table 4. Epidemiological Events in Beef Exporting Countries from 2000 to 2012.

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Argentina	X	FMD	FMD	X	X	X	FMD	X	X	X	X	X	X
Australia	X	X	X	X	X	X	X	X	X	X	X	X	X
Brazil	FMD	FMD	X	X	FMD	FMD	X	X	X	X	X	X	BSE
Canada	X	X	X	BSE	BSE	BSE	X	X	X	X	X	X	X
European Union*	FMD/BSE	FMD/BSE	BSE	BSE	BSE	BSE	X	FMD	X	BSE	BSE	BSE	X
India	X	X	X	X	X	X	X	X	X	X	X	X	X
Mexico	X	X	X	X	X	X	X	X	X	X	X	X	X
New Zealand	X	X	X	X	X	X	X	X	X	X	X	X	X
Paraguay	X	X	FMD	FMD	X	X	X	X	X	X	X	FMD	FMD
United States	X	X	X	BSE	BSE	BSE	X	X	X	X	X	X	BSE
Uruguay	FMD	FMD	X	X	X	X	X	X	X	X	X	X	X

Source: World Animal Health Information Database (2013)

* The occurrence of an epidemiological event in the EU-27 was considered if at least one country member had a case of FMD or BSE in the corresponding year

Full description of epidemiological events of the EU-27 in Appedixes

Table 5. Traceability systems in Beef Exporting Countries from 2000 to 2012

Country	Traceability System
United States	Mandatory for export
Brazil	Mandatory for export
India	Any system in place
Australia	Mandatory for all animals
New Zealand	Mandatory for all animals
Uruguay	Mandatory for all animals
Canada	Mandatory for all animals
Paraguay	Mandatory for export
European Union*	Mandatory for all animals
Argentina	Mandatory for export
Mexico	Mandatory for export

Source: USDA, FSIS, Export Requirements for Meat and Poultry Products (2013).

Although India is one of the top beef exporting countries, its beef industry is very particular and different from the rest. India is officially recognized as a country with negligible BSE risk by the OIE; however, the country has no official status recognition of FMD. The disease is still prevalent in an endemic form in some states of India. The

Government of India has established 3 zones with 56 districts to control FMD, and hopefully, in another 2 or 3 years, the OIE recognized FMD free zones with vaccination would be established in the country (Umali-Deininger and Sur, 2005). There are no traceability systems in place in the country up to the present date. For these reasons, a dummy variable for India was included. Another aspect of India is that most of their beef exports are buffalo meat; this is another reason why the exporting country is treated as a separated dummy variable. The USDA-FAS Report (2013) includes buffalo meat in beef trade.

Cluster Analysis

Originally, the research intended to group trade partners according to the price exporting countries got from trade partners, volume traded, sanitary status and traceability systems of exporters; through a statistical technique called the *TwoStep* Cluster Analysis in *SPSS Statistical Software*. This statistical technique, commonly used for determining market profiles, group variables by similarity; this means that markets clusters are integrated by countries that exhibits "natural" groupings with relatively homogeneous characteristics, but with heterogeneous characteristics relative to other exporters outside the cluster they belong. A previous study by Ramos et al., 2009, utilized the same technique to analyze global chilled boneless beef markets, however, sanitary status and traceability systems were not considered to cluster beef markets.

The outcome of the cluster analysis showed no consistency. Two clusters were formed and they did not follow any pattern, results reveled that they were segmented according to their FMD status, which was not the intention of the study. In this scenario,

it is impossible to identify markets by export prices and preferences in terms of sanitary status, safety and traceability systems. This is why cluster analysis was discarded from the research. Results are displayed in the Appendix section.

Procedures for Data Analysis

Following Ramos, *et al.* (2009) methodology, all export operations that involved volumes less than 18 metric tons, which is the maximum capacity of a reefer container (Conway, 2012), were removed from the sample. Fresh/chilled bone in beef cuts sample size reduced from 2699 export operations to 1095, fresh/chilled boneless cuts from 5234 to 3471, frozen bone-in and boneless cuts from 4269 to 2200, and from 9045 to 7144 respectively. Beef export price for each exporter's beef products were calculated using the respective value of exports, divided by the total quantity of exports, as reported by each data source. All export prices were deflated using the U.S Wholesales Price Index (WPI) and 2013 as the base year for all commodities (BLS, 2013). On average, fresh/chilled boneless cuts are more valuable, followed by fresh/chilled bone-in cuts, with frozen boneless and bone-in cuts the least valuable and nearly same in price. A wide range of prices for each of the four beef categories was encounter; the very high and very low prices included outliers that were a result of unusual transactions, usually very high prices received for small shipments. Jarvis, *et al.* (2005) encounter same outliers in their research, using same database. As these cases were rare and there was no clear pattern among them, they were removed. As for exported volume, frozen boneless cuts accounted for 63 percent of the product volume for the research timeframe, followed by

fresh/chilled boneless cuts with 30 percent, and fresh/chilled and frozen bone-in with 3 and 4 respectively.

Procedures included descriptive data analysis, identification of collinearity, and data process through the statistical package *JMP® Pro Software*. In order to assess export beef price differences and measure the impact of sanitary status and traceability systems of exporting countries across global beef markets, Ordinary Least Square (OLS) models were performed. An hedonic price equation is utilized to estimate beef export prices for each commodity, as a function of period of trade operations, volume traded (in metric tons), BSE and FMD sanitary status of exporting countries, and epidemiological events regarding these diseases during the period from 2000 to 2012.

Hedonic price functions, in general, are based on the premise that products are heterogeneous. Thus, the underlying framework for beef characteristics demand model presumes that it should be analyzed as a heterogeneous product. Hedonic analysis begins with some insights into the products attribute likely to be important for the demand; in this study sanitary and traceability attributes are considered. The model used to show the relationship between export beef prices paid by importing countries for beef cuts and the quality contained in regards to sanitary status and traceability system of exporting countries.

The equation is specified as follows:

$$P_b = f\ (\underset{(\beta\neq 0)}{YEAR},\ \underset{(\beta<0)}{VT},\ \underset{(\beta<0)}{BSE},\ \underset{(\beta<0)}{FMD},\ \underset{(\beta>0)}{TS},\ \underset{(\beta<0)}{EP_{EVENT,}}\ \underset{(\beta<0)}{D_{INDIA}})$$

Where:

P_b = Average beef cut export real price per ton (American dollars per metric ton).

YEAR = Time period from 2000 to 2012, numbered 1-13.

VT = Total volume traded in metric tons per period.

BSE = Dummy for exporting country official sanitary status (0=Negligible BSE risk, 1=Different from Negligible risk; which means that it is a BSE Controlled risk status).

FMD = Dummy for exporting country official FMD status (0= FMD free where vaccination is not practiced status, 1= Different from free where vaccination is not practiced status; which means that it does not hold any FMD status or it is FMD free where vaccination is practiced).

TS = Traceability System beef exporting countries have in place. (0= No mandatory traceability system, 1= Mandatory traceability system).

EP_{EVENT} = Annual Epidemiological event in exporting countries, from 2000 to 2012. (0= No event, 1= FMD, BSE or both diseases).

The traditional normal test statistics, F^2 and R^2 for equation evaluation and test significance were used in analyzing all beef price models.

Assumptions and Limitations

In this research beef exporting countries' BSE and FMD official status are constant through the period of study (2000-2012), although there are years that exporting countries have changed their status because of diseases outbreaks. However, the epidemiological event variable considered these outbreaks.

This study focuses on the impact of traceability systems and sanitary status in global beef trade, however, it only considers the four major commodities involved in beef trade, and there are a wide range of other beef products such as industrialized beef products and offal that were not considered.

SPS is considered an important factor influencing beef trade; originally, beef importing countries' SPS were intended to be included as a variable, however, 236 importing countries are included in this study, and since this type of information is country-specific and cannot be applied within a broad scope that includes all infected countries, zones and compartments globally, it was complicated to adjust them into specific categories.

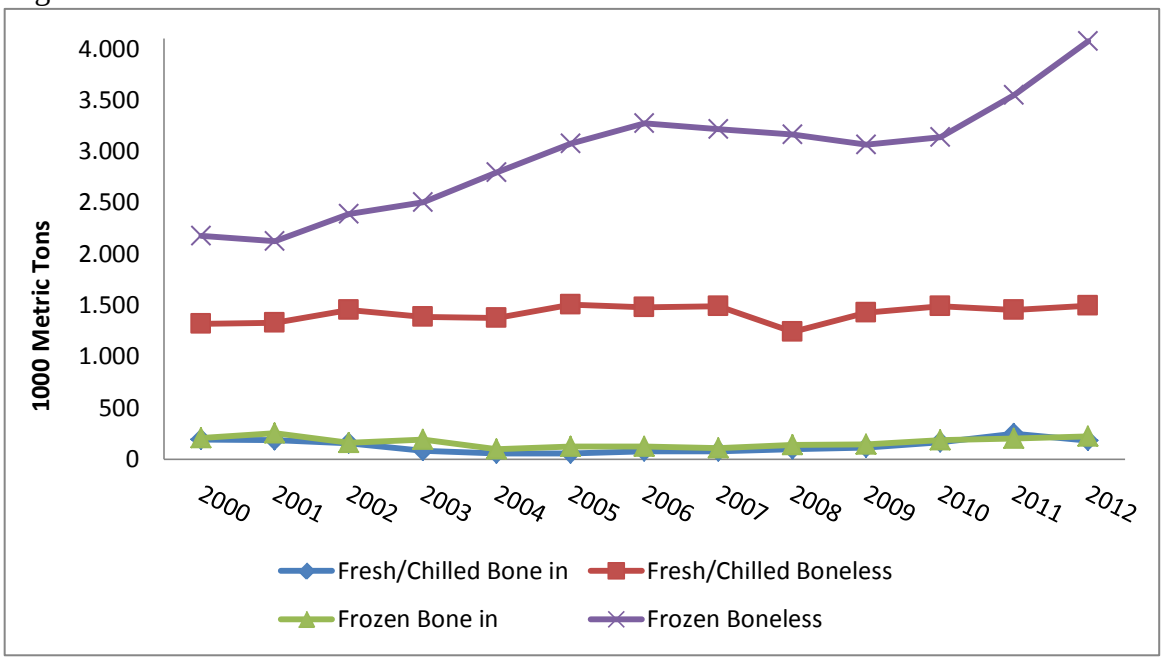
CHAPTER IV

RESULTS

Description of Major Findings on Beef Commodities

The growth of international beef exports from 2000 to 2013 was of approximately 30 percent. During this period most of exported beef cuts had experienced interruptions in the mid-2000s due to diseases outbreaks, except for frozen boneless cuts, that were not considerably affected by such events (Fig. 7 and Fig. 8).

Figure 7. Beef Cuts Traded in the World from 2000 to 2012.



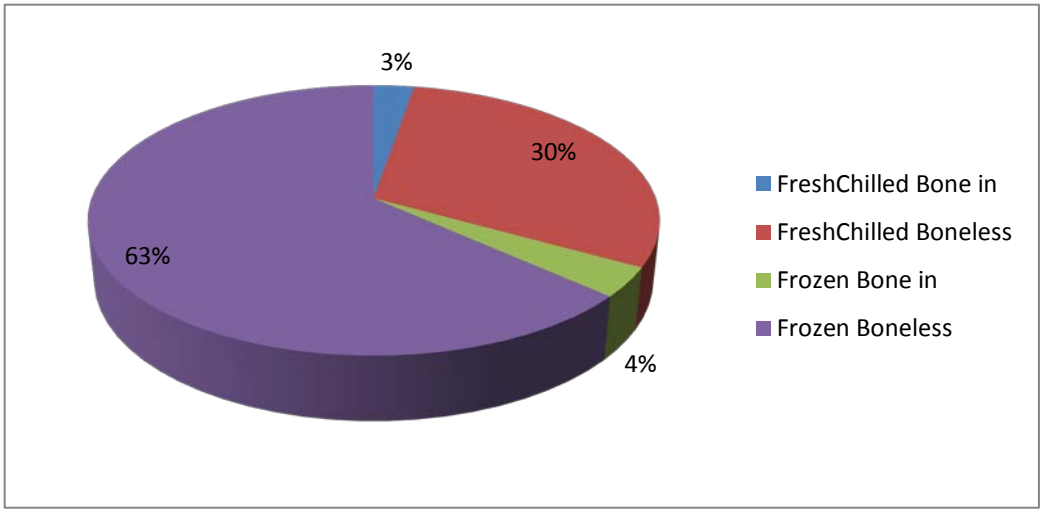
Source: DESA/UNSD (2013).

Most members of the EU had been impacted by a BSE outbreak in 2000; 10 out 15 EU countries have been affected by the disease that year. Although the numbers of incidences were relatively few, the discovery of the disease across the continent dramatically changed in beef consumption (USDA/FAS, 2001). Consumers' perception about beef where negatively affected. Apart from being extremely upset by the thought that one could die from eating beef, because of its link with CJD's virus and prions, consumers were shocked by an industry producing beef and MBM from ruminants (Vos, 2000). In addition, the United Kingdom had a FMD outbreak in 2001 that resulted in an EU worldwide ban imposed on all British exports of livestock, meat and animal products (Scott, *et al.*, 2004).

International meat markets in late 2000 were thrown into turmoil as BSE outbreaks in previously disease-free European countries led to countries around the global restricting access to EU livestock and bovine meat product exports. Market uncertainties were compounded by consumer responses to BSE concerns; beef consumption in Europe initially dropped 40 percent in late 2000, forcing prices downward and heightening awareness among EU policy makers regarding market, budget and policy implications (Morgan, 2001).

Other diseases outbreaks during 2000 happened in countries from South America, which collectively reported 279 FMD outbreaks. Uruguay suffered severe consequences, an attempt to eliminate FMD that led to the loss of 20,000 animals (bovine, pigs and sheep) at a cost of $3.5 million, while Argentina got banned from most of its export markets (Correa Melo, *et al.*, 2002).

Figure 8. Share of Beef Cuts Traded from 2000 to 2012.



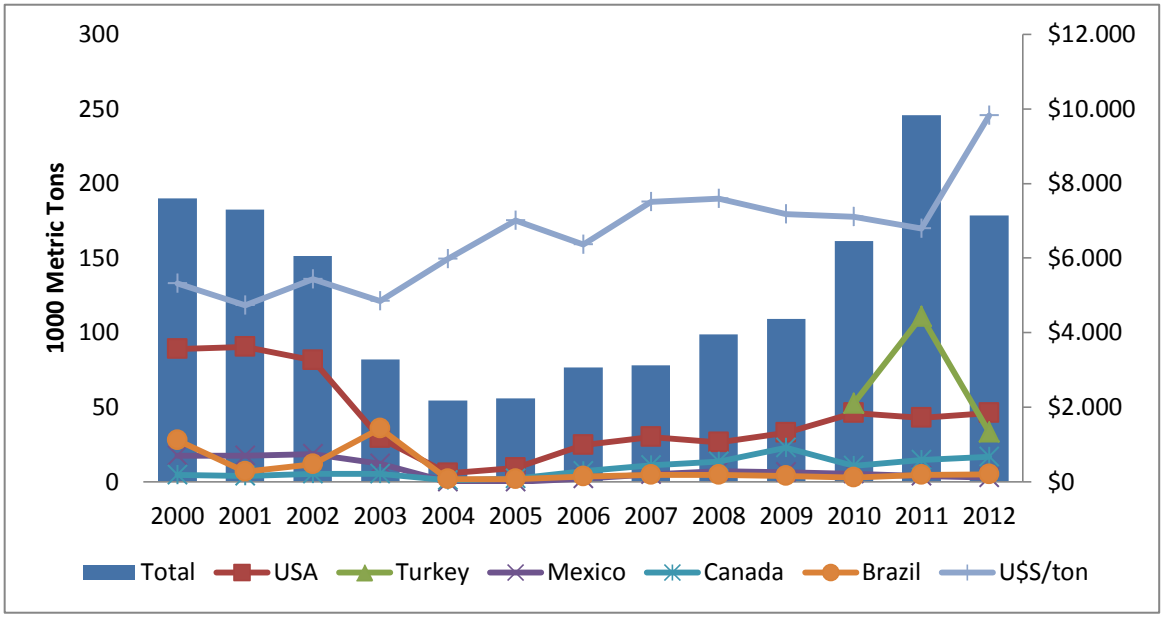
Source: DESA/UNSD (2013).

The consequences of BSE and FMD outbreaks started to diminish by late 2001 and 2002. Consumer confidence in regards to beef started to recover again during this period, and so exports picked up their pace again. However, in Japan, a case of positive BSE in late September 2001 caused an immediate drop in consumption. As a result, consumer confidence in Japanese governmental programs and industry actions taken to address the problem resulted in reduced demand for both domestically produced and imported beef (USDA/FAS, 2001). Japan is the only country among those where BSE has been confirmed that has implemented a screening test of all slaughtered cattle destined for human consumption. The manageable scale of slaughtering facilities in Japan, maximum capacity of 300 to 400 head per day, has allowed equipment to be cleaned after each animal, eliminating the possibility of contamination (Peterson and Chen, 2005).

Beef exports, in general, were again significantly disrupted in 2003 and 2004 after BSE was discovered in Canada and the United States; especially bone-in beef cuts

exports (Fig. 9 and Fig. 10). The majority of beef importing countries placed import bans on all U.S. and Canadian beef, which represented a drop in global beef exports of 9 percent in 2004; while the U.S and Canada's beef exports dropped 83 percent (USITC, 2008). The U.S suffered a major trade disruption upon the outbreak, which resulted in the closing of more than 70 foreign markets to beef imports from the U.S, including Japan and South Korea (Schroeder, *et al.*, 2007). The USITC (2008) estimated that the losses of U.S beef exports to Canada, historically top destination of U.S beef, due to BSE-related restrictions were $348 million during 2004-05, primarily in fresh or chilled boneless beef. Mexico, an important destination for U.S beef exports, also placed BSE-related restrictions on beef exports resulting in losses of $342 million during 2004-05. However, the market was quickly reopened to imports of boneless beef from cattle aged under thirty months (UTM). To date, Mexico continues to prohibit the import of U.S beef cattle and beef products from cattle aged over thirty months (OTM).

Figure 9. Total traded volume in 1000 metric tons of Fresh or Chilled Bone in and major importers from 2000 to 2012.

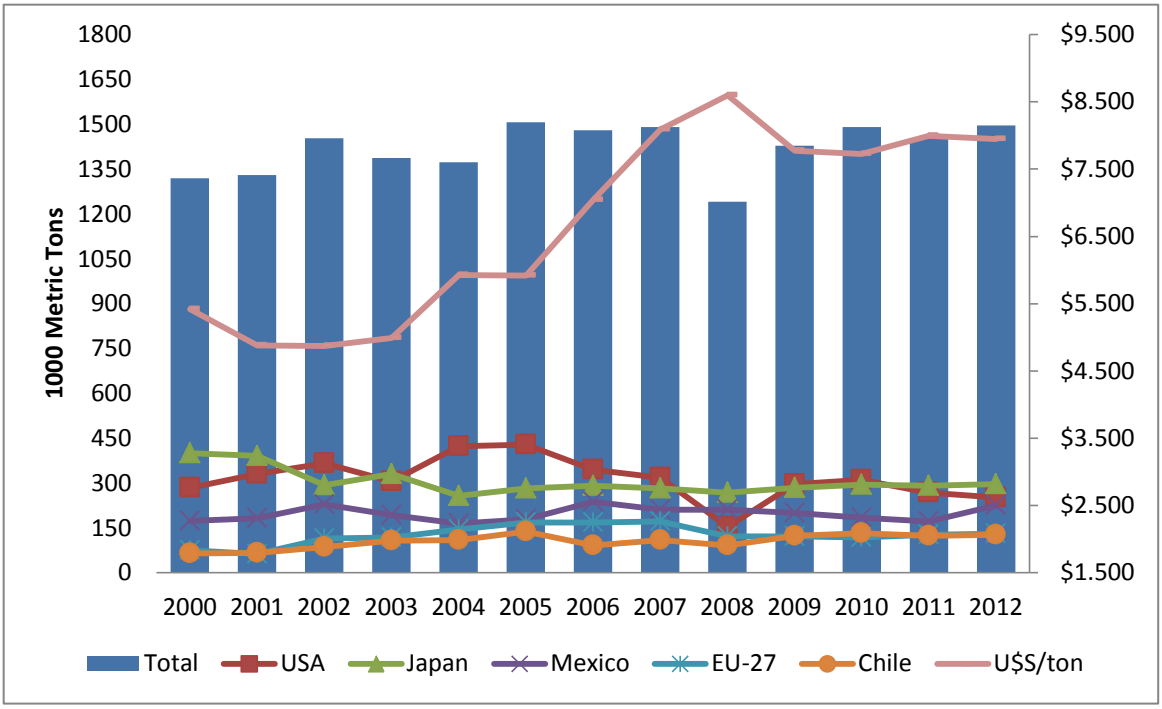


Source: DESA/UNSD (2013).

Among all beef cuts in this study, fresh or chilled bone in beef (Fig. 9) has been impacted the most during the mid-2000s. Public awareness, as well as bans from importing countries clearly affected beef exports, and created a ripple effect for policy change throughout the world. The main reason why only certain beef products were more affected than others is that different commodities derived from animals intrinsically present different levels of risk as far as disease transmission; and therefore regulations for each one varied accordingly (Thompson, *et al.*, 2009). BSE is most highly concentrated in the brain and spinal tissue of infected cattle; because of this boneless cuts (see Fig. 10 and Fig. 12) were not significantly affected by BSE outbreaks. Since the infective BSE prion has been shown to be resistant to conventional forms of sterilization, cattle that were fed with infected MBM contract the disease; and therefore raw and processed bone-in beef were avoided in global trade.

Boneless beef exports completely replaced what were formerly bone-in exports. In Britain the de-boning of imported beef has a proven track-record of decisively reducing the risk of importing FMD from endemically infected countries. Although risks associated with international trade in cattle are considerably higher for most important infections of cattle than the risks associated with trade in fresh or frozen beef.

Figure 10. Total traded volume in 1000 metric tons of Fresh or Chilled Boneless and major importers from 2000 to 2012.



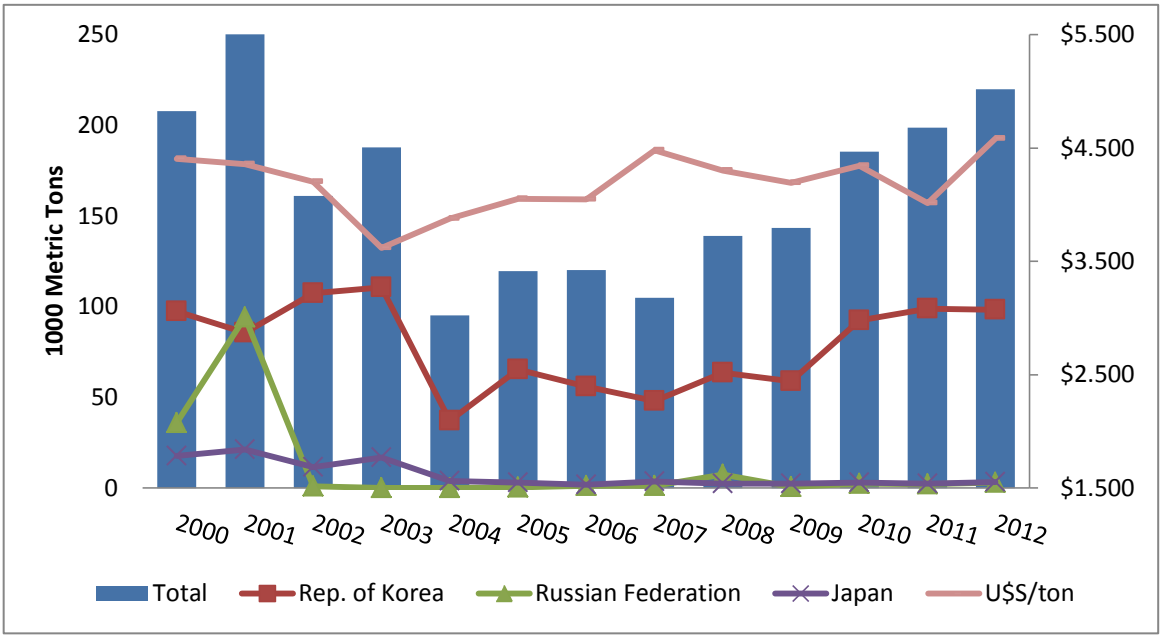
Source: DESA/UNSD (2013)

Fresh or chilled boneless cuts exports (Fig. 10) have virtually unchanged from 2000 to 2012, during this period growth reached 12 percent; and total traded volume was of over 18.6 million tons with a total receipt of $72.6 billion. Although boneless cuts exports were not greatly disrupted volume-wise, exports prices had increase significantly during the period from 2004 to 2008. After the BSE outbreak, imports fell, and importing countries such as Japan, Korea, and Russia that placed bans on the U.S and Canada constrained imports and pushed import beef prices high; while the EU producers had never fully recovered from the BSE discoveries.

Developing countries, especially from South America (Brazil, Argentina, Uruguay, and Paraguay) boosted their beef exports and expanded markets, filling part of the beef deficit left by import restrictions on the U.S and Canada. Higher beef prices

during that period made it more difficult for developed countries to compete with South American suppliers (ECLAC, 2013). Australia and New Zealand also increased their export in Asian markets like Japan and Korea, which were left with a great gap in beef supply. Reduced U.S. cattle slaughter and the continued ban on imports of Canadian cattle into the United States were factors underlying Australia's exports of beef to the United States for manufacturing and processing (USDA/FAS, 2003).

Figure 11. Total Traded Volume in 1000 Metric Tons of Frozen Bone-in and Major Importers from 2000 to 2012.



Source: DESA/UNSD (2013)

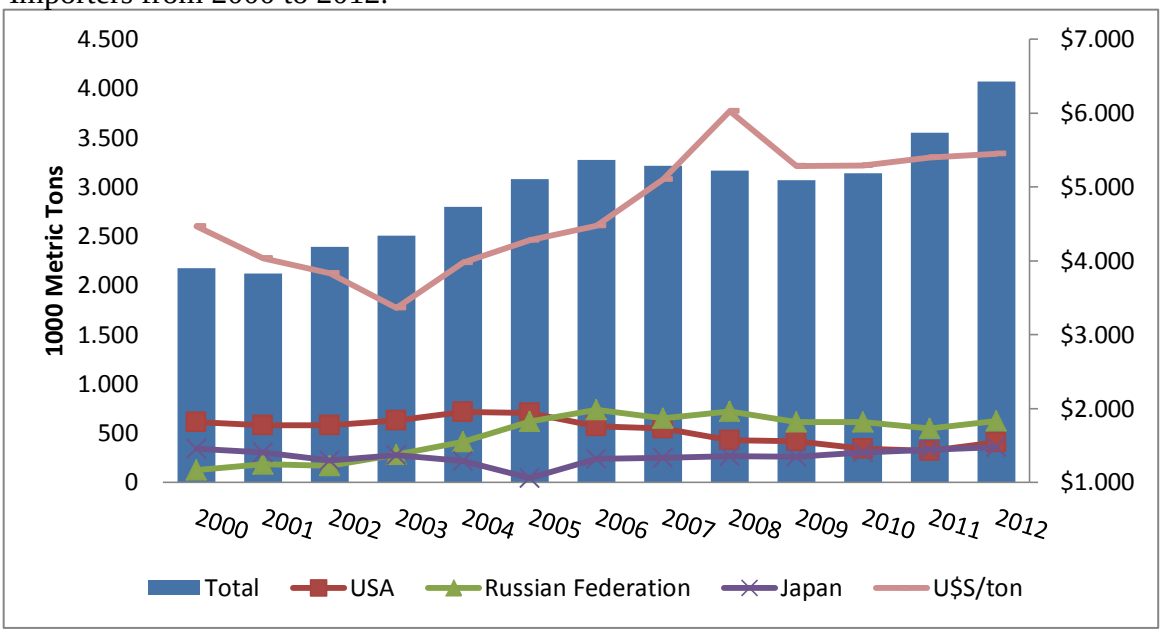
Frozen bone-in and boneless cuts exports are displayed in Figure 11 and 12 frozen beef are destined for processing, primarily as ground beef, also called industrialized beef. This is low-quality beef, as well as low-valued.

Frozen bone-in cuts were affected by BSE and FMD outbreaks, as stated before in fresh or chilled cuts. After the BSE outbreaks in the U.S and Canada during 2003, the

global beef market turned more competitive as South American countries, such as Argentina, Brazil, Uruguay and Paraguay, started to increase considerably to export fresh/chilled cuts (USDA/FAS, 2003), that were more profitable than frozen cuts. Although fresh/chilled cuts get higher prices in the global beef trade, frozen boneless cuts account for more than half of beef trade.

Frozen cuts had experience an important growth throughout 2000 to 2012; boneless cuts were responsible for most of the growth, increased by 47 percent, while bone-in cuts barely by 5.5 percent. An important factor that boosted boneless cuts was the recovery of the financial crisis in Russia from 1998 to 2000 (Ramos, *et al.*, 2009). In 2001 Russian imports increased significantly, associated with the increase in oil exports, by 2006 Russia became the top frozen boneless cuts importer. Nevertheless, the increase of economic welfare was not the major motivation for beef imports, during this period the country was going through herd reductions after the dissolution of the Soviet Union, which led to the extinction of high subsidies for agriculture activities during the Cold War (Segrillo, 2000).

Figure 12. Total Traded Volume in 1000 Metric Tons of Frozen Boneless and Major Importers from 2000 to 2012.



Source: DESA/UNSD (2013)

Descriptive Statistics

Descriptive statistics (see Table 6) were run to display the behavior of the data set used in the study. The results show the statistics of the dependent variable Nominal price per ton (Nom$/Ton), Real price per ton (Real$/Ton) and explanatory variable Export volume traded (VT) of four beef commodities from 2000 to 2012, the other explanatory variables were not included because they are qualitative. During this period, in average, Fresh/Chilled boneless beef was the commodity with higher prices, followed by fresh/Chilled bine-in, frozen boneless and lastly frozen bone-in. It is clear that boneless beef were and still are the most valuated cuts in global trade.

All commodities have a high coefficient of variation; this is mainly due to the wide range of transactions throughout the period of study between exporting and importing countries. Each transaction has its unique characteristics, for example, India is

one of the top beef exporting countries in the world and exports fresh/chilled boneless cuts; however, most of the exported beef is of low quality, and therefore prices per ton are lower compared to the price per ton that other top exporting countries get from same commodity. India's average price per ton for fresh/chilled boneless beef is $2,479, while Australia's is $9,721, the U.S' $8,019, and Paraguay's $5,567. This just shows the high variation within the same commodity, depending on the exporting county. Australia and the U.S access markets that pay higher prices, such as Japan and Korea, who are more demanding quality-wise, on the other hand India's fresh/chilled beef is destined to west Asia and north Africa, and mostly buffalo meat.

Most of the minimum prices in all commodities correspond to India, while the maximum prices to Australia. These extreme implicit prices and volumes are the result of unusual transactions, such as very low shipments and very high prices or vice versa. This is perhaps because all the data used by the Comtrade UNSD database comes from each country's national authorities, which can be inconsistent. This means that some countries that do not export significant amounts of beef may declare all the shipments of a single year as one observation; while other countries declare every single shipment throughout the period, which ends up with various observations in a single year.

Table 6. Descriptive Statistics All Beef Commodities Data Set 2000-2012, for Left Hand Side Dependent and Parametric Explanatory Variables*.

Variable	N	Mean	SE Mean	StDev	CV	Minimum	Q1	Median	Q3	Maximum
Nom$/Ton (Nominal Beef Export Prices in American Dollars per Metric Ton)										
HS20120	1,127	4,799.20	96.93	3,254.32	67.81	72.35	2,499.74	4,026.56	6,286.61	21,255.60
HS20130	3,471	5,144.99	72.44	4,267.94	82.95	82.28	1,921.09	4,293.75	7,216.00	55,823.00
HS20220	2,168	3,116.17	51.65	2,405.18	77.18	72.00	1,360.39	2,409.50	4,048.51	15,514.30
HS20230	7,144	3,610.67	29.15	2,664.60	73.80	16.68	1,887.60	3,027.45	4,591.80	26,762.30
Real$/Ton (Real Beef Export Prices in American Dollars per Metric Ton)										
HS20120	1,127	6,350.24	118,70	3,985.15	62.76	95.00	3,505.00	5,346.00	8,388.00	23,553.00
HS20130	3,471	6,778.47	89,59	5,278.54	77.87	114.00	2,812.00	5,894.00	9,515.00	79,407.00
HS20220	2,168	4,189.62	68,87	3,206.79	76.54	87.00	1,940.25	3,236.00	5,346.00	22,291.00
HS20230	7,144	4,752.09	36,20	3,059.90	64.39	29.79	2,735.12	4,116.34	5,829.05	45,054.30
VT (Total Volume of Beef Exported by country in Metric tons)										
HS20120	1,127	1,474	194	6.497	441	18	35	88	557	111
HS20130	3,471	5,316	388	22.875	430	18	59	236	1,628	334,187
HS20220	2,168	977	105	4.886	500	18	39	96	398	93,959
HS20230	7,144	5,395	282	23.858	442	18	67	259	1,520	447,271

Note: *All other explanatory variables are qualitative.

Beef Export Price-Health Hedonic Model Results

The hedonic price equations attempted to explain the effect of beef exporters' sanitary status and traceability systems, as well as diseases outbreaks on export beef prices. The predicted price was determined by using all estimated parameters (independent variables) in the first model; in the second model volume traded was excluded from the model; in the third, the period (YEAR) variable was removed; and in the last model YEAR and D_{INDIA} were removed. The various models and removing variables of the model helped to see the interaction between the key diseases and sanitary issues and traceability systems on export beef prices from different perspectives. The same models were used in all four commodities. Lastly, a model with all commodities, except frozen bone-in cuts, was included, frozen bone-in cuts were removed since it's the commodity with the lowest value.

The hypothesis indicates that sanitary issues such as FMD, BSE, traceability and epidemiological events should negatively affect export beef prices. Exporting countries with an FMD free by vaccination should get lower prices compared to exporting countries with FMD free without vaccination; as well as countries with BSE negligible risk status should obtain higher prices than exporting countries with BSE controlled risk status. On the other hand, the hypothesis also affirms that the implementation of traceability systems should have a positive impact on beef prices. Since India differs from the rest of beef exporting countries, in terms of not possessing a FMD official status, and not having a traceability or cattle identification system, should also be expected to have a

negative impact on beef price. Export volume traded (VT) is expected to have a negative impact on beef price, as Law of Demand states an inverse relationship between the price of a product and the amount of that product the demand side is willing-to-pay. It can be anticipated that as export beef volume increases, prices would decrease, and vice versa.

Fresh/Chilled Bone-in Beef Cuts Models

Table 7. Estimated Hedonic Models of Beef Export Price-Health for Fresh/Chilled Bone-in Cuts, for 2000 to 2012 by Country (HS code 20120) – n = 1127.

	Models			
Variable	ALL	w/o VT	w/o YEAR	w/o YEAR - Dindia
Constant	11304,9	11383,5	12067,4	11782,2
	(18,64)*	(18,80)*	(20,08)*	(22,93)*
YEAR	167,52	168,32		
	(5,83)*	(5,85)*		
VT	-0,0314		-0,03165	-0,03204
	(-1,79)*		(-1,86)*	(-1,88)*
BSE	-1281,5	-1371,1	-1060,8	-1094,5
	(-4,44)*	(-4,81)*	(-3,65)*	(-3,80)*
FMD	-2639,7	-2647,6	-2809,5	-2553,1
	(-6,71)*	(-6,72)*	(-7,06)*	(-9,02)*
TS	-601,7	-607,5	-404,6	-363,5
	(-2,37)	(-2,39)	(-1,58)	(-1,44)
Dindia	940,4	980,0	827,4	
	(1,060)	(1,10)	(0,920)	
Epevent	-1356,4	-1336,3	-1615,5	-1597,4
	(-4,74)*	(-4,67)*	(-5,63)*	(-5,59)*
S	3590,430	3593,98	3642,84	3642,58
R-sq (adj)	18,8%	18,7%	16,4%	16,5%
F	38,31*	44,08*	37,93*	45,35*
df	1119	1121	1120	1123,00

Notes: t statistics are in parenthesis, *Significance
t one-tail, $\alpha = 0.05$; all df values = 1,64; $F_{7-\infty} = 2.01$

Table 7 shows the estimated parameters for the commodity Fresh/Chilled bone-in beef (HS code 020120). In the first model ALL, were fresh/chilled bone in beef prices are

determined by using all independent variables, not all the estimated coefficients got the expected sign, although all of them, except for D_{INDIA} and TS, are statistically significant. According to the model, YEAR has a positive effect on beef price; this means that there is a positive trend of price throughout time, which is shown graphically in Figure 9. Contrary to what Jarvis, *et al*. (2005) assumed in their research about the effect of FMD on beef price. They said that there is a longer-term tendency for the price of beef to decline when they attempted to explain the price of beef received by different exporters in different import markets.

VT had the expected negative impact on price, as well as BSE, FMD and EP_{EVENT}; however, D_{INDIA} and TS had no price impart (not significant) per ton of fresh/chilled beef cuts. India became a strong beef exporter in 2012, accounting for nearly half of the world's growth in that year on increased supplies and price-competitive shipments to emerging countries. In addition, strong global demand for price-competitive bovine meat, especially buffalo, generated incentives for slaughter facilities in India to export. However, India has a limited market access compared to other leading suppliers; exports go mostly to North African countries and Middle East. Although the country maintains its BSE negligible risk status, its FMD status poses issues with gaining additional market access; despite the disease is controlled though vaccination programs, India does not maintain an FMD status classification with the OIE (USDA/FAS, 2012).

Comparing the main fresh/chilled bone-in model to others, where variable such as VT, YEAR and D_{INDIA} were removed, there were no substantial changes on the estimated coefficients, overall, BSE, FMD, TS, and EP_{EVENT} maintained their signs and the range of values. Beef export prices for countries with an FMD free with vaccination status

received significantly less than exporting countries with a BSE controlled risk, almost decreasing by two fold the amount per ton, in average. Jarvis, *et al*. (2005) found " FMD sanction" affected beef prices for exporting countries (not free of FMD), suggesting that FMD reduced trade between countries and accordingly reduced the price received from 9 to 12 percent, nonetheless, the "FMD sanction" was smaller than what they hypothesized. In this study, there is a reduction of 50 to 53 percent in relation to the average price of fresh/chilled bone-in beef cuts during 2000 to 2012.

Marsh, *et al.* (2008) analyzed the impact of BSE outbreak in U.S cattle prices, one of their findings was that U.S fed and feeder cattle prices, as well as export prices experienced significant price reductions. As U.S export share declined, as foreign markets placed restrictions on U.S beef, and thus prices decreased by 15 percent, which represented a decreased in revenues of $114 per head, after the BSE outbreak in 2003 and 2004. In these models the lost on beef prices for exporting countries that held a BSE controlled risk status are ranged between 20 to 26 percent in fresh/chilled bone-in cuts. Keeping in mind that countries that have a BSE controlled risk have appropriated measures to manage risks of BSE, however these measures have not been taken for more than 7 years, or they had cases of BSE outbreaks (OIE, 2005). While losses due to epidemiological events (BSE or FMD outbreaks) were also significantly negative.

Fresh/Chilled Boneless Beef Cuts Models

Table 8. Estimated Hedonic Models of Beef Export Price-Health for Fresh/Chilled Boneless Cuts, for 2000 to 2012 by Country (HS code 20130).

	Models			
Variable	ALL	w/o VT	w/o YEAR	w/o YEAR - Dindia
Constant	-70,2	-161,7	1367,2	5710,3
	(-0,13)	(-0,29)	(2,49)*	(11,78)*
YEAR	282,58	284,83		
	(12,35)*	(12,41)*		
VT	-0,0166		-0,01768	-0,017409
	(-4,50)*		(-4,67)*	(-4,45)*
BSE	2419,1	2350,3	2629,4	1530,3
	(8,30)	(8,05)	(8,84)	(5,13)
FMD	1058,8	1133,8	951,7	-341,4
	(5,08)	(5,44)	(4,47)	(-1,69)*
TS	893,4	858,8	1145,6	-44,7
	(4,22)*	(4,04)*	(5,32)*	(-0,22)
Dindia	-7071,6	-7055,0	-7797,6	
	(-14,09)*	(-14,02)*	(-15,32)*	
Epevent	-341,6	-300,5	-835,4	28,2
	(-1,49)	(-1,30)	(-3,61)*	(0,12)
S	4959,350	4973,12	5066,60	5234,57
R-sq (adj)	11,7%	11,2%	7,9%	1,7%
F	66,87*	74,22*	50,40*	12,71*
df	3463	3465	3164	3497

Notes: t statistics are in parenthesis, *Significance
t one-tail, $\alpha = 0.05$; all df values = 1,64; $F_{7-\infty} = 2.01$

Table 8 shows the estimated parameters for the commodity Fresh/Chilled boneless beef cuts (HS code 020130). The estimated coefficients for the base model ALL which included all the variables are partially consistent with expectations. YEAR, VT, TS, and D_{INDIA} have all expected signs and significant values. The positive sign of BSE and FMD on beef price does not match with the study hypotheses. It can be said that the risk of contracting these diseases are removed by deboning beef cuts. The rest of the models show little variation in some of the variables, like YEAR, which is positive and

significant as expected, as well as VT and D_{INDIA} that affect negatively in beef prices. EP_{EVENT} only show significant value in the model where YEAR is removed, and compare to fresh/chilled bone-in cuts the losses for boneless cuts are considerably less.

Traceability systems had a positive impact on fresh/chilled boneless beef prices. The premium priced commodity, is in average, between $858 to $1,145 per metric ton of exported beef, however, when VT is excluded the price dropped $40 per metric ton. In a study where the effect of food traceability system for price premium and buying behavior in Korea was analyzed, Choe, *et al.* (2008), found consumers were willing to buy more food and pay more for it when they used a traceability system. The use of these systems mitigate uncertainty and turn out to play a key role in price premium and purchase intention and had a larger impact on purchase intention than price premium, implying that consumers were inclined to buy more food rather than pay more. This is supported by Souza-Monteiro and Caswell (2004), who found that, after analyzing the economic implications of traceability systems, most beef exporting countries were adopting some kind of traceability system in response to mandatory systems introduced by important importing countries (Japan and the EU) for high quality beef cuts, as Japan and the European Union. The exporters' main motivation is to maintain or increase their positions in international markets for beef.

Nearly all fresh/chilled boneless models estimated positive coefficients for BSE and FMD variables, although not significant. This may be due to the relation of these diseases to bone-in cuts and therefore, boneless cuts are not that negatively affected by them; although the values are relatively high, suggesting that exporting countries that have a BSE controlled risk and FMD free with vaccination status get premium prices,

even more than exporting countries that have mandatory traceability systems. Top importers for this commodity are the U.S, Japan, Mexico, the EU and Chile; which are considered stringent sources in terms of sanitary status and traceability system requirements; which are not consistent with the models coefficients.

Frozen Bone-in Beef Cuts Models

Table 9. Estimated Hedonic Models of Beef Export Price-Health for Frozen Bone-in Cuts, for 2000 to 2012 by Country (HS code 20220).

	Models			
Variable	ALL	w/o VT	w/o YEAR	w/o YEAR - Dindia
Constant	5947,5	5848,5	5740,4	5586,1
	(14,11)*	(13,88)*	(13,91)*	(17,73)*
YEAR	-37,81	-36,56		
	(-2,35)	(-2,26)		
VT	-0,04078		-0,04009	-0,03993
	(-3,27)*		(-3,21)*	(-3,20)*
BSE	-230,0	-215,3	-254,9	-220,0
	(-1,15)	(-1,07)	(-1,27)	(-1,15)
FMD	-3491,4	-3453,1	-3470,0	-3403,5
	(-19,32)*	(-19,11)*	(-19,21)*	(-24,39)*
TS	2219,0	2209,3	2189,0	2222,0
	(14,41)*	(14,31)*	(14,25)*	(15,57)*
Dindia	138,7	113,7	237,0	
	(-0,34)	(-0,28)	(0,58)	
Epevent	242,7	241,9	291,8	266,9
	(-1,40)	(-1,4)	(1,7)	(1,60)
S	2826,43	2832,77	2829,38	2828,94
R-sq (adj)	22,3%	22%	22,2%	22,2%
F	89,93*	102,67*	103,78*	124,51*
df	2160	2162	2161	2164

Notes: t statistics are in parenthesis, *Significance
t one-tail, $\alpha = 0.05$; all df values = 1,64; $F_{7-\infty} = 2.01$

Table 9 shows the estimated parameters for the commodity frozen bone-in beef cuts (HS code 020220). Frozen Bone-in cuts get the lowest price per ton in the global

beef markets; these cuts are associated with low quality meat destined to industrialized purposes, like sausages and hamburgers. The amount of frozen bone-in traded from 2000 to 2012 is considerable lower than fresh/chilled cuts, they only account for 4 percent of global trade. The base model ALL got significant and expected values on VT, FMD and TS. The impact of FMD on export beef prices is higher than in previous fresh/chilled commodities; this is possibly linked to the bones and the lower quality of cuts associated to the commodity. Interestingly, exporting countries where TS is mandatory have a significantly higher plus on export prices (over $2,000); this reflects that traceability systems are more important in commodities that are perceived as more hazardous than others, such as boneless cuts. The other reduced specifications models showed stable coefficient values, indicating that there is no a major difference by removing variables of the model.

Frozen Boneless Beef Cuts Models

Table 10. Estimated Hedonic Models of Beef Export Price-Health for Frozen Boneless Cuts, for 2000 to 2012 by Country (HS code 20230).

	Models			
Variable	ALL	w/o VT	w/o YEAR	w/o YEAR - Dindia
Constant	6523,5	6418,1	7215,1	8336,9
	(28,18)*	(28,68)*	(32,16)*	(45,77)*
YEAR	153,115	152,145		
	(17,19)*	(17,03)*		
VT	-0,0097		-0,0093	-0,009725
	(-7,06)*		(-6,66)*	(-6,86)*
BSE	-738,4	-700,6	-588,9	-855,5
	(-6,43)*	(-6,09)*	(-5,04)*	(-7,91)*
FMD	-1635,13	-1637,59	-1629,77	-1929,77
	(-19,72)*	(-19,69)*	(-19,26)*	(-24,99)*
TS	567,33	581,18	685,67	379,48
	(6,43)*	(6,76)*	(7,87)*	(4,73)*
Dindia	-1214,5	-1250,0	-1503,3	
	(-6,96)*	(-7,14)*	(-8,48)*	
Epevent	-189,20	-185,87	-452,29	-253,99
	(-2,13)*	(-2,08)*	(-5,06)*	(-2,93)*
S	2782,96	2792,47	2839,81	2853,88
R-sq (adj)	17,3%	16,7%	13,9%	13%
F	214,20*	239,95*	192,69*	214,72*
df	7136	7138	7137	7140

Notes: t statistics are in parenthesis, *Significance

t one-tail, $\alpha = 0.05$; all df values = 1,64; $F_{7-\infty} = 2.01$

Table 10 shows the estimated parameters for the commodity frozen boneless beef cuts (HS code 020230). All the coefficients in all models for this commodity showed expected signs and significance, in accordance with the study's hypotheses. FMD free without vaccination is consistently the factor that pushes beef export prices down the most, followed by Indian shipments, BSE and EP_{EVENT}. Traceability systems adds a

premium in frozen boneless prices, supported by the study conducted by Schroeder and Tonsor (2011), which emphasized that competing beef exporting nations were using their national traceability systems as platforms to launch enhanced producer-level marketing and product differentiation efforts. They felt that countries with well-developed mandatory animal identification and traceability programs would enjoy comparative advantages in red meat exports relative to countries without such systems. As well as, most widely recognized international animal health, food safety, and trade organizations have endorsed animal traceability programs as essential components of food animal production and meat product trade.

Morgan (2001) attempted to analyze the repercussions of BSE on international meat trade, and mentioned that to compound the uncertainty generated by escalating cases of BSE, and surfacing and spreading of FMD in Europe (during early 2000s) and beef exporting countries in South America, have led to importing countries scrambling to procure FMD-free product, pushing meat prices higher. And it is shown in these results, where export beef prices are considerably negatively affected by FMD.

Table 11. Estimated coefficients of Beef Trade export price-health Hedonic Models for all commodities beef cuts.

	Models			
Variable	ALL	w/o VT	w/o YEAR	w/o YEAR - Dindia
Constant	3899,4	3861,9	4615,8	6334,1
	(18,67)*	(18,45)*	(22,21)*	(35,27)*
YEAR	154,197	153,923		
	(18,61)*	(18,53)*		
VT	-0,012445		-0,012336	-0,012774
	(-8,38)*		(-8,21)*	(-8,42)*
BSE	-79,2	-73,5	58,5	-369,5
	(-0,78)	(-0,72)	(0,570)	(-3,69)*
FMD	-1160,42	-1147,12	-1192,16	-1782,96
	(-14,66)*	(-14,46)*	(-14,88)*	(-24,84)*
TS	831,94	833,50	962,18	478,01
	(10,63)*	(10,62)*	(12,19)*	(6,50)*
Dindia	-2491,7	-2518,8	-2814,8	
	(-14,66)*	(-14,40)*	(-16,01)*	
Epevent	-236,08	-224,27	-490,10	-172,38
	(-2,82)*	(-2,68)*	(-5,87)*	(-2,11)*
20130	2693,7	2637,5	2696,7	2851,2
	(26,82)*	(26,25)*	(26,52)*	(27,91)*
20120	1959,1	1952,8	1967,1	1995,5
	(14,64)*	(14,56)*	(14,52)*	(14,60)*
20230	833,72	775,76	872,06	1010,39
	(9,19)*	(8,55)*	(9,50)*	(10,95)*
S	3628,63	3637,66	3673,42	3707
R-sq (adj)	15,8%	15,3%	13,7%	12,1%
F	261,05*	280,85*	245,48*	239,72*
df	13902	13904	13903	13906

Notes: t statistics are in parenthesis, *Significance

t one-tail, $\alpha = 0.05$; all df values = 1,64; $F_{7-\infty} = 2.01$

Table 11 shows the estimated parameters for the best paid commodities in the global market. There is a significant different between the prices paid for each commodity. Firstly, fresh/chilled boneless cuts (HS code 020130), which in average during the period of 2000 to 2012 got a price of U$S 6,778.48 per metric ton, followed by

fresh/chilled bone-in (HS code 020120) with U$S 6,407.02, frozen boneless cuts (HS code 020230) with U$S 4,752.09 and lastly frozen bone-in cuts (HS code 20120) with U$S 4,192.79. Although fresh/chilled cuts are significantly more valuable than frozen cuts, their share in global beef trade is still smaller; frozen boneless cuts are more commonly trade. This is mainly due to the logistics implications when it comes to trade fresh products; like shelf life, pH and temperature. Although these are also important aspect to consider when trading frozen products, there are more easily managed; in addition frozen products have more shelf life, and therefore storage and transportation are easily achieved.

Fresh/chilled beef is associated with high quality cuts, and therefore are better paid. Most of the exported cuts of these commodities are vacuum-packaged and ready to sell in retail stores or restaurants. However, quality does not rely entirely on whether the cuts are frozen or chilled. Early studies (Jennings, Berry and Joseph, 1978) proved that attributes such as marbling and aging are the key factors that contribute the most with beef quality. Aging can improve eating quality and is a process that occurs as the muscle fibers in meat are slowly broken down by naturally-occurring enzymes. This leads to the muscle fibers being weakened and, as a result, aged beef tends to be more tender. The appearance of beef does not change with aging, as the breaking down of the muscle fibers happens on a microscopic level. This can significantly influence shelf life, which is also greatly affected by pH, color, and microbiological quality, as well as adequate vacuum packing and temperature control through the supply chain.

Conceptual Framework of Beef Exports

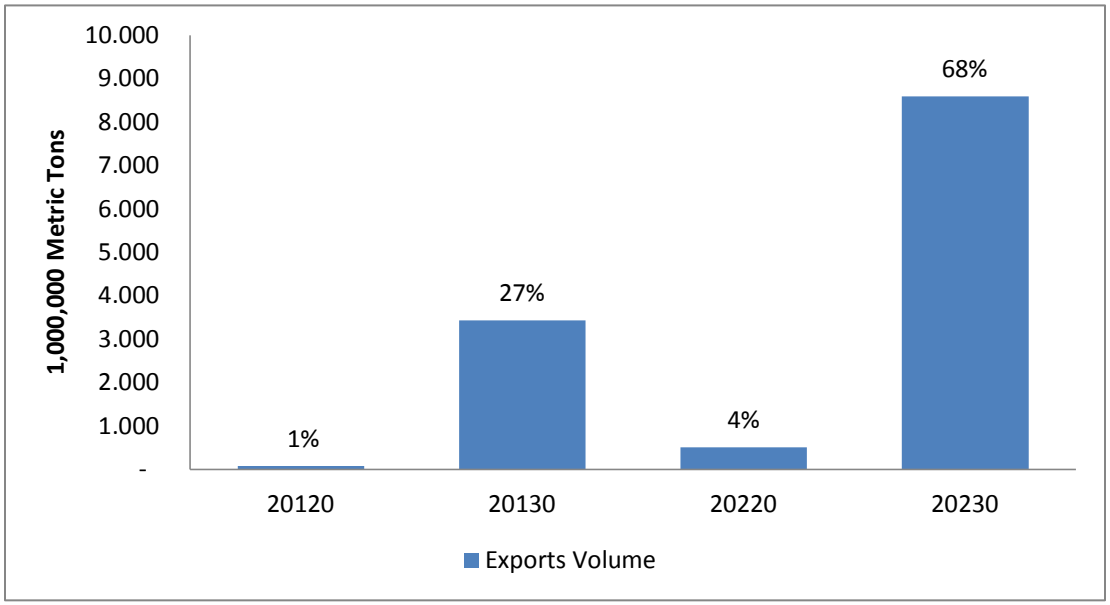
In order to verify and assess the impacts of sanitary status and traceability systems on beef trade the top exporters, in terms of export performances in beef trade (the U.S and Australia), were compared to India which is considered as an exporter that lags behind in terms of beef production systems, sanitary status and traceability systems.

It is important to highlight that although the OIE provides guidelines and standards regarding the safety of beef trade, it has no power to require that countries conform to its standards (Metcalf, Blackwell and Acree, 1996). Besides the internationally SPS set by the OIE, importing countries can apply more restrictions based on scientific research. This is the reason why importing countries have different SPS, therefore making beef trade requirements inconsistent across markets. For example, maximum age requirements are common but vary, country-specific export verification programs are often required, different requirements and definitions exist across countries relative to specified risk material (SRM), some programs require tracing to farm of origin, and EU requires non-hormone treated cattle (NHTC) verification (USITC, 2008). Countries that comply and are able to adapt through this inconsistencies in global beef trade are going to stand out.

Australia is considered one of top world's leading suppliers of high quality live and products from cattle and sheep countries around the world, in particular throughout the Middle East and South-East Asia (FAO, 2003). Among beef products, 68 percent of exports are frozen boneless beef, followed by fresh/chilled boneless cuts and frozen cuts (Fig. 13). Japan is Australia’s largest beef export market, followed by the U.S, South

Korea (for frozen grass-fed beef in particular) and other Asian countries; these importers are characterized by their high income levels and demand of safe products through good sanitary conditions, traceability systems and certification processes (Ramos, *et al.,* 2009). A typical example is the U.S, which only import beef from countries that carry out auditing systems and are recognized by the USDA-Animal and Plant Health Inspection Service (APHIS). While Japan and South Korea only import beef from FMD free countries (not endemic), and their beef trade relationships are preferably with countries that have internationally recognized sanitary controls and production systems.

Figure 13. Australia's Fresh/Chilled and Frozen Beef Cuts Exports and Shares from 2000 to 2012.



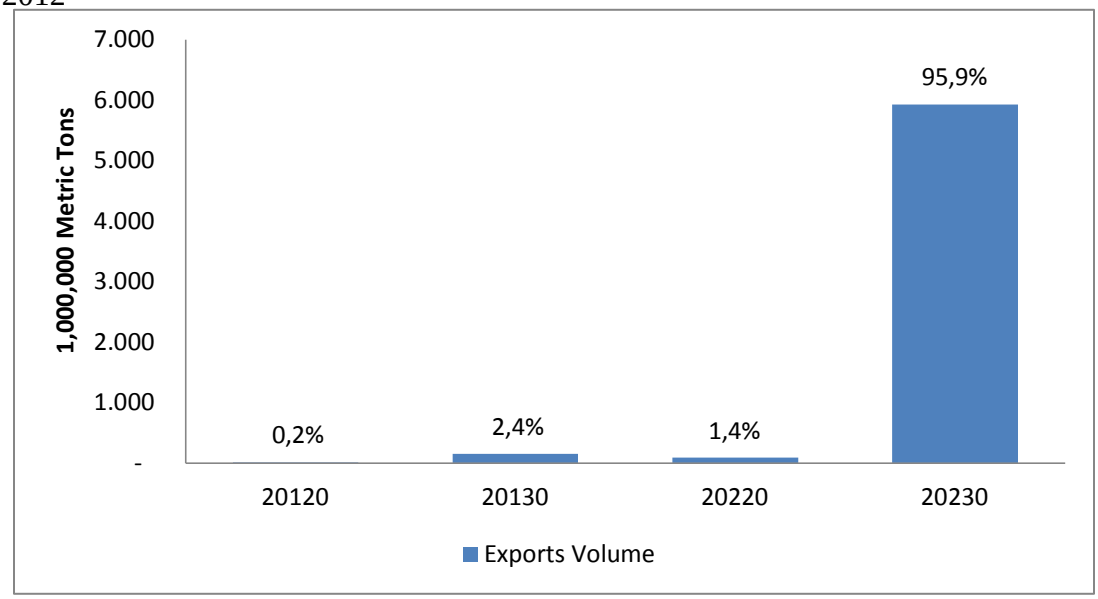
Frozen grass-fed beef makes up the majority of Australian beef sent to the US. However, fresh/chilled grass-fed beef exports have been on the rise for the past decade, and manufacturing beef made up 70% of total Australian beef exports to the US in 2013. Australia was the largest source of imported beef in the US in 2013 (USDA/FAS, 2014).

The Australian meat industry has implemented several measures along the supply chain to ensure the safety, quality and integrity of Australian beef; these measures are essential to ensure market access and demand for beef. The Australian Government implements an integrated trade policy program with the goal of creating new and more open markets for exports; one of them is the National Livestock Identification System (NLIS). From 1999 the NLIS enabled the industry to cattle diseases and food incidents, and it is endorsed by producers, feedlots and processor bodies. This type of system gives Australia the opportunity to access stringent markets such as Japan, who also pay higher prices. Japan requires that exporting countries adopt practices such traceability systems (from origin to product packaging), a carcass classification and unique product identification system, as well as BSE testing in cattle older than 21 months (Schroeder and Tonsor, 2011). Australia complies with all these requirements. Other countries that export to Japan are the U.S, Mexico and Canada.

On the other hand, India is considered a beef exporting country that lags behind in terms of productions systems and product quality. There are several reasons why India, although is responsible of a large share of beef exports growth, still can compete with supplier such as Australia and the U.S. The main reason is religion. Cows in India are often either illegally transported long distances to where slaughter is legal, such as southern Kerala state and neighbouring country of Bangladesh, or killed in illegal slaughterhouses. There are an estimated 30,000 illegal, unlicensed slaughterhouses in India. This are constraints that the Indian beef industry needs to overcome in order to get an official OIE FMD disease status and the implementation of a traceability system.

Most of the beef exported from India is low quality frozen boneless cuts (see Figure 14), exports account for 44% of beef production in the country. Top beef importers of Indian beef are Malaysia, Vietnam, Philippines and Middle East countries (Egypt, Jordan and Saudi Arabia), which are considered price-sensitive markets. These markets also required the removal of the vertebral column from animals 30 months of age and older. Establishments must also be approved for Halal export by Malaysia. Halal approval is granted for specific Islamic Centers to carry out and certify slaughter at individual plants (Gulati, Mehta and Nerayanan, 1999). Although most of the beef exported by India is buffalo meat, economically, it competes in the same markets as beef from cattle. To its credit, deboned frozen buffalo meat, also called "carabeef", from India is lean and has positive blending characteristics important to processors.

Figure 14. India's Fresh/Chilled and Frozen Beef Cuts Exports and Shares from 2000 to 2012



The U.S is a country traditionally recognized as an important beef producer and exporter. Most of the country's beef exports are fresh/chilled boneless cuts, followed by

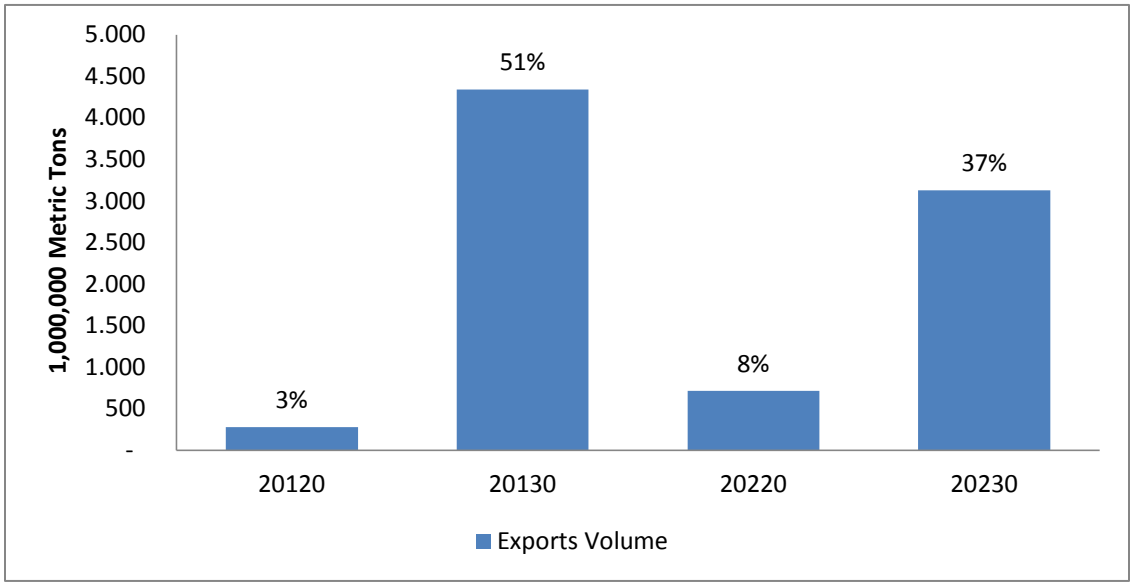
frozen boneless and lastly bone-in cuts (Fig. 15). Top importers of U.S beef are Mexico, Japan, Canada, South Korea and Hong Kong. Mexico and Canada are responsible for 62 percent of fresh/chilled cuts exports, followed by Japan with 23 percent; while South Korea and Japan are responsible for 66 percent of frozen cuts exports. Generally, fresh/chilled cuts are high-quality products destined to hotels, restaurants and institutions; while frozen cuts are more likely to be used for lower-value products, such as manufacturing beef.

Global market access for U.S beef changed dramatically in 2003. Restrictions imposed by Korea and Japan on imports of U.S beef after the BSE outbreak in 2003, have resulted in significant losses in exports sales to the industry. During 2004-07, these two countries accounted for 86 percent of the lost exports sales caused by BSE-related restrictions (Kerr, 2004). There are other types of barriers that these countries impose to beef imports such as cumbersome document inspections, higher inspection rates than international standards and strong domestic beef industry in Japan. In response, the USDA and industry members took several steps to ensure the safety of the U.S beef and provide assurances to customers in foreign markets. The USDA's Food and Safety Inspection Service (FSIS) enforced federal meat inspection requirements to designate certain materials as SRM, which were declare from then on as inedible and prohibited for human food. And in 2004 the USDA began an enhanced a surveillance program for BSE and a feed ban (Morgan, 2011).

The U.S. animal identification system is limited. Therefore, export market access restrictions based on ID and traceability requirements will place the U.S. beef industry at a competitive disadvantage. Additionally, if the United States suffers an animal disease

outbreak, the lack of traceability could again contribute to a long-term disruption in U.S. beef exports, at tremendous costs to the United States industry. Although there are several beef traceability systems, however, they have been mainly private and market driven systems widespread in the industry. In 2003, the USDA launched the voluntary Beef Export verification (BEV) program that assures Asian buyers that product shipped overseas come from slaughtered in the U.S. Under this program the USDA also audits products eligible to export to Japan too.

Figure 15. United States' Fresh/Chilled and Frozen Beef Cuts Exports and Shares from 2000 to 2012



Implications for Paraguay

Paraguay's beef exports started to increase dramatically from the year 2000, as new slaughter plants opened and others increased their capacity. Records indicate that slaughter of cattle destined to international markets was from 100 thousand heads to 800 thousand heads from 2000 to 2005, which implies a growth of 167 percent. This

happened as exported Paraguayan beef had significantly higher prices in foreign markets compare to the domestic market (Ferreira and Vasconsellos, 2006). From 2000 to 2012, frozen boneless cuts accounted for 61 percent of beef exports, followed by fresh/chilled boneless and then frozen cuts. Top importers of Paraguayan beef are Chile, Brazil and Lebanon for fresh/chilled beef and Russia, Israel and Angola for frozen cuts. However, during the FMD outbreaks frozen boneless cuts reached 90 percent of exports (USDA/FAS, 2013).

Paraguay had three FMD outbreaks during the period of this study (in 2002, 2011 and 2012) and one right before in 1999. At the end of 2002 Paraguay suffered a FMD outbreak, Brazil and Chile that accounted for 90 percent of Paraguayan beef exports banned beef imports. The industry had to seek for other markets in order to avoid irreparable losses in the industry, such as Israel and Taiwan. During that time most of bone-in and fresh/chilled cuts were suspended. Fresh/Chilled beef cuts traded value in 2002 was of $56 million and traded volume 43,752 metric tons, which dropped to $21 million and 14,735 metric tons in 2003; a total loss of 34 and 38 percent in volume and traded value. The Chilean market was less flexible towards the outbreak, while Brazil opened the market to Paraguayan beef more rapidly.

The FMD incidents in September of 2011 and January of 2012 resulted in even more devastating losses, volume and economic wise. Before the last FMD outbreak Paraguay was reaching record exports volume and receipts, reaching 93,349 metric tons and $500 million in 2010 (a growth of more than 100 percent from 2003). In 2012 beef exports volume and value fell 23 percent and 20 percent respectively; but the greatest losses were the closure of important markets that were gained in previous years,

especially the EU. The FMD incident provides an example of the imbalance between imposing and relaxing trade restrictions. Once the existence of FMD was confirmed in Paraguay, countries banned Paraguayan beef within days. More than two years after these restrictions were imposed, few of them continue (like the EU), generally in a modified form, preventing less than full market access.

Figure 16. Paraguay' Fresh/Chilled and Frozen Beef Cuts Exports and Shares from 2000 to 2012

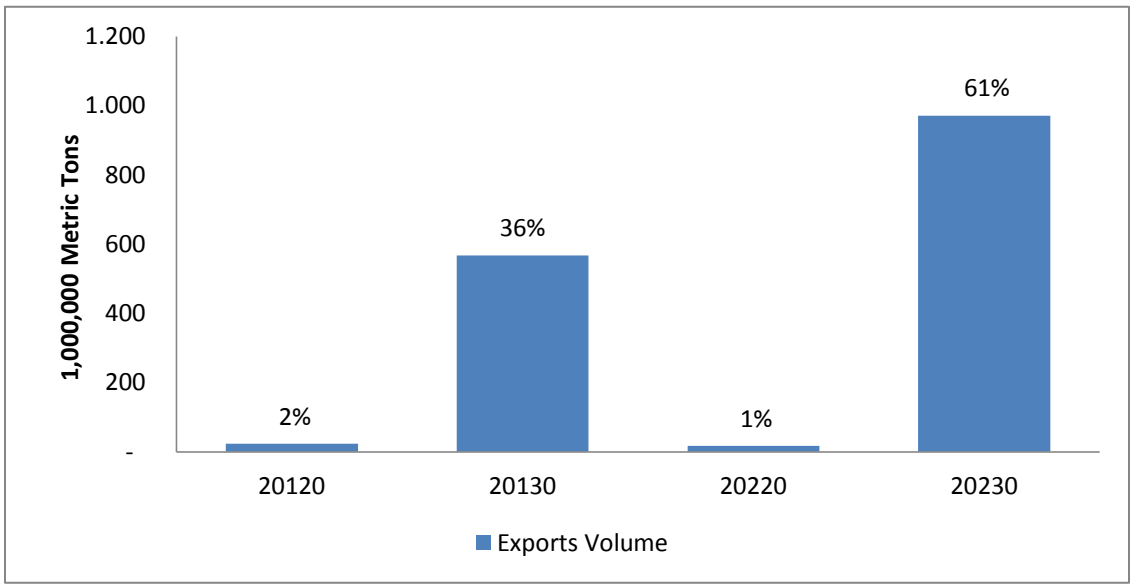
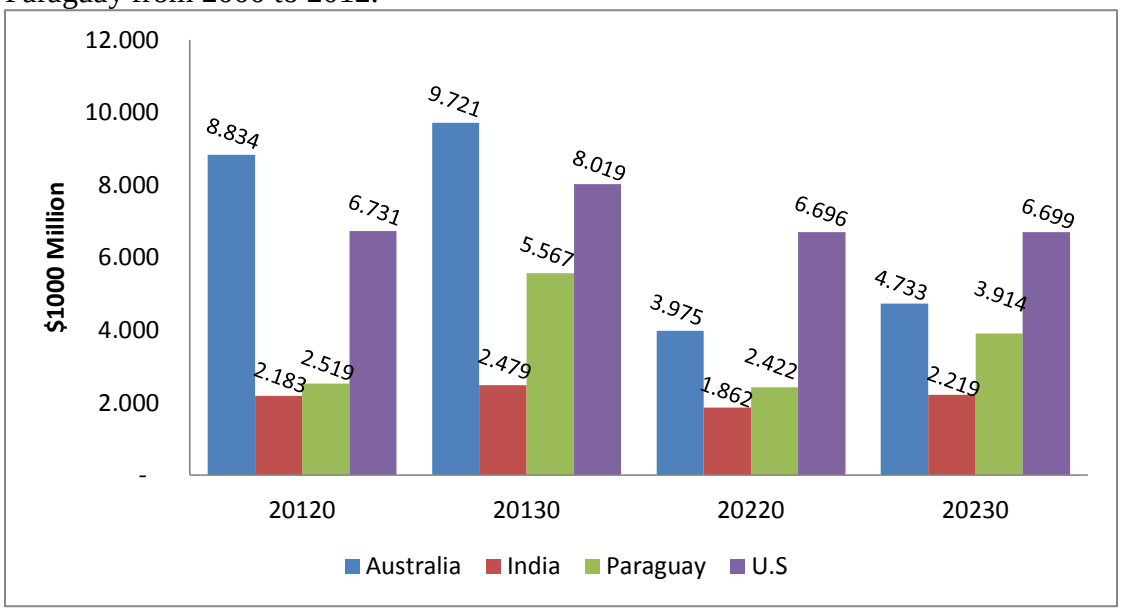


Figure 17 illustrates how Paraguay is positioned in relation to the U.S and Australia, which are considered top quality beef exporters and India, which is considered the exporter with least beef quality. All prices that are shown in Fig. 17 are in FOB-type format (includes the transaction value of the beef product and the value of the services performed to deliver the products to the border of the exporting country). Indisputably Australia and the U.S get higher prices because of the markets they export to, Japan and Korea. These market are the most valuables and stringent at the same time. Another advantage that these two countries have compare to India and Paraguay are their sanitary status, both of them have negligible risk of BSE and are free of FMD without

vaccination. The quantitative model carried out in this study revealed substantial reduction on export beef prices associated with a FMD free with vaccination status, which is the status held by all the FMD endemic countries. India at the same time gets significantly lower prices, mainly due to the lack of an official FMD status recognition by the OIE.

Figure 17. Beef Commodities Average Price Comparison of Australia, India, the U.S and Paraguay from 2000 to 2012.



Most direct competitors to Paraguayan beef exports are countries from the Southern Cone, Argentina, Brazil and Uruguay. These countries share similar production systems and sanitary status as Paraguay; all of them are endemic FMD countries with an official status of FMD free with vaccination. During the second half of the 20th century, all of these countries were unable to export beef to countries that were FMD free. As a result of the frequently severe restrictions on beef FMD endemic countries, international beef markets were largely divided into two segments: FMD free and FMD endemic. Prices during these times were as much as 50 percent higher in the latter. However, this has not changed during the 21th century, where exporting countries with FMD free with

vaccination still get significantly lower prices, according to the quantitative models performed in this study.

Figure 18 shows the share of beef commodities exported by Argentina, Brazil and Uruguay. In terms of volume, Brazil exports considerably larger amounts of beef compared to other South American countries, currently positioned as the second largest beef producer in the world, following the U.S, and leading in global beef exports. Most of the beef exports from Brazil are frozen boneless cuts, followed in small portion by fresh/chilled boneless cuts. Brazil's top importing markets are Russia, Egypt, Venezuela and China for frozen cuts, and Chile, the EU and Lebanon for fresh/chilled cuts.

Argentina is positioned as the 10th largest beef exporter, most of the country's exports are frozen bone-in cuts, which are associated with low-quality cuts and is the commodity that get lowest prices in global market (Fig. 18). In 2006, the country's government took a drastic measure banning all beef exports for a period of 180 days, in order to stop price rises in the domestic market. Exports has soared after the economic collapse of 2001 forced the government to let the national currency (pesos) float and depreciate. As a result, international prices of beef rose considerably and part of the beef production was diverted from the local market to importers abroad. Increasing demand, both local and foreign, also contributed to this scenario. In 2005 Argentina exported 40% more beef with respect to the previous year. In late 2005 and 2006, months of unsuccessful negotiations went on between the national government and the beef producers and traders, which included considerable political and media pressure by the former. All of these factors contributed to the decline of the Argentinean beef industry, although the country is recovering in the present time.

Uruguay was recently authorized to participate as a supplier of EU´s 620 Quota (formerly 481 Quota) which is exclusively for high-quality beef from steers or heifers which are less than 30 months of age, are hormone free, and have been fed high energy feed for a minimum of 100 days. The quota for 2012-13 is 45,000 tons and only the USA, Canada, Australia, New Zealand, and Uruguay have access to it. This helped Uruguay to position the country's beef industry in a unique place in relation to other Southern Cone's countries. Of the country's total slaughter, the vast majority is done in officially inspected plants, which have government control boxes, unlike any other South American country. The government has a few programs under the *Programa Ganadero* to support small cattle producers to improve production efficiency and their income. In general, the government's policy for the sector is to maintain stable policies, promote investment, and provide transparent information and to continue to have a very strict sanitary system to allow the opening of new markets. Uruguay has approximately 120 markets open, of which it supplies to roughly 100. The country is free of foot and mouth disease with vaccination and presents a negligible risk for BSE. Uruguay´s sanitary status is well recognized as well as its traceability program and its "natural" production system.

The Southern Cone beef exports growth was stimulated by the EU BSE and FMD outbreaks during the beginning of the 2000's. Those events contributed to the sacrifice of a great number of animals to make sure the total eradication of the diseases; at the same time traditional EU beef importers needed to fill the gap in beef supply. Importing countries such as Russia, Egypt, Lebanon and Iran started importing beef from Brazil, Argentina, Uruguay and Paraguay. India was also benefitted by these events. Compare to competitors in the Southern Cone, Paraguay lags behind in production efficiency. Brazil,

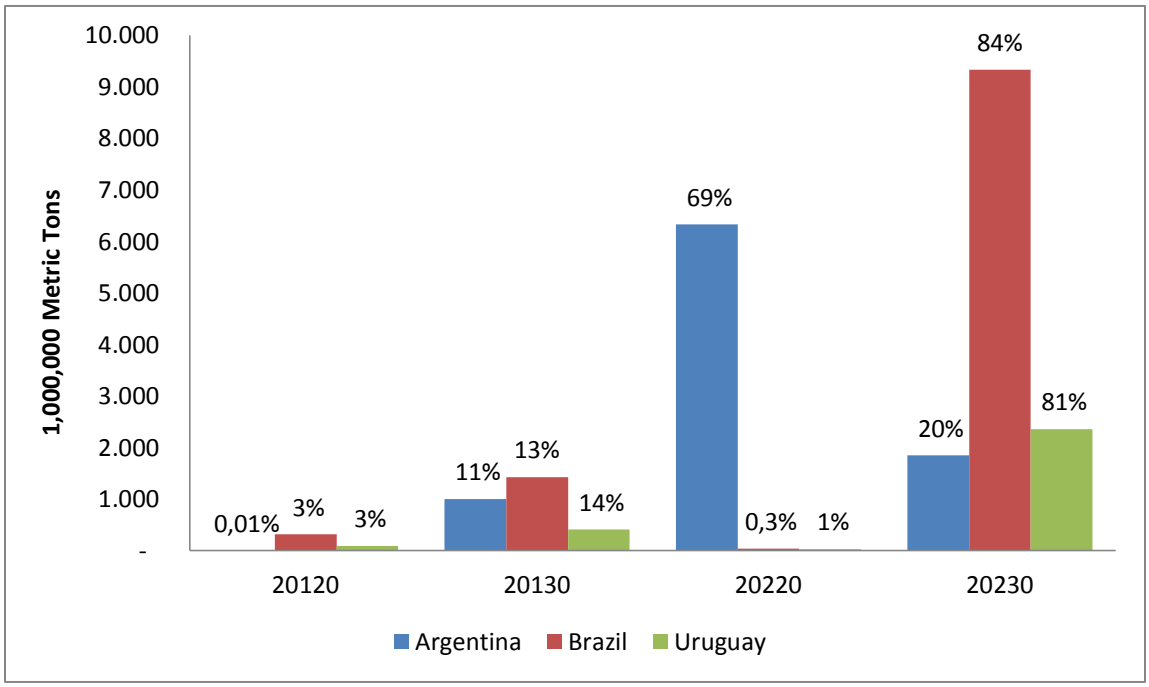
Argentina and Uruguay produce beef more efficiently. Paraguay's extraction rate is significantly lower compared to countries in the Southern Cone. The available land in Paraguay is also another limiting factor, since crops such as soy are capturing most of the usable land.

Another aspect to consider when analyzing Paraguay's beef industry is the existence of local slaughterhouses that do not comply with international standards. Slaughterhouses operate at lower cost to supply local demand; they do not have the adequate infrastructure, or any type of sanitary processing inspections. These are potential disseminator agents of diseases. While these slaughterhouses keep on working in the country without any type of official supervision, there is no possibility for Paraguay to enter more stringent markets.

Paraguay's beef exports to markets in the region (Chile and Brazil) are performed by land, while other markets such as the EU, Africa and Asia by sea transportation. This entails an additional cost compared to other countries with coastlines, since Paraguay is landlocked and has to go through ports in neighbouring countries; in addition it requires extra logistics transportation and documentation. In order to access markets such as Japan and Korea Paraguay must gain the recognition of country free of FMD free without vaccination. Another constraint the industry faces is the limited amount of cattle for slaughter, and seasonality. Paraguay's production system is mostly extensive in grassland; therefore the majority of cattle are available during the last weeks of summer and beginning of the autumn; where producers lighten the cattle loads of their grassland, in order to go through the winter.

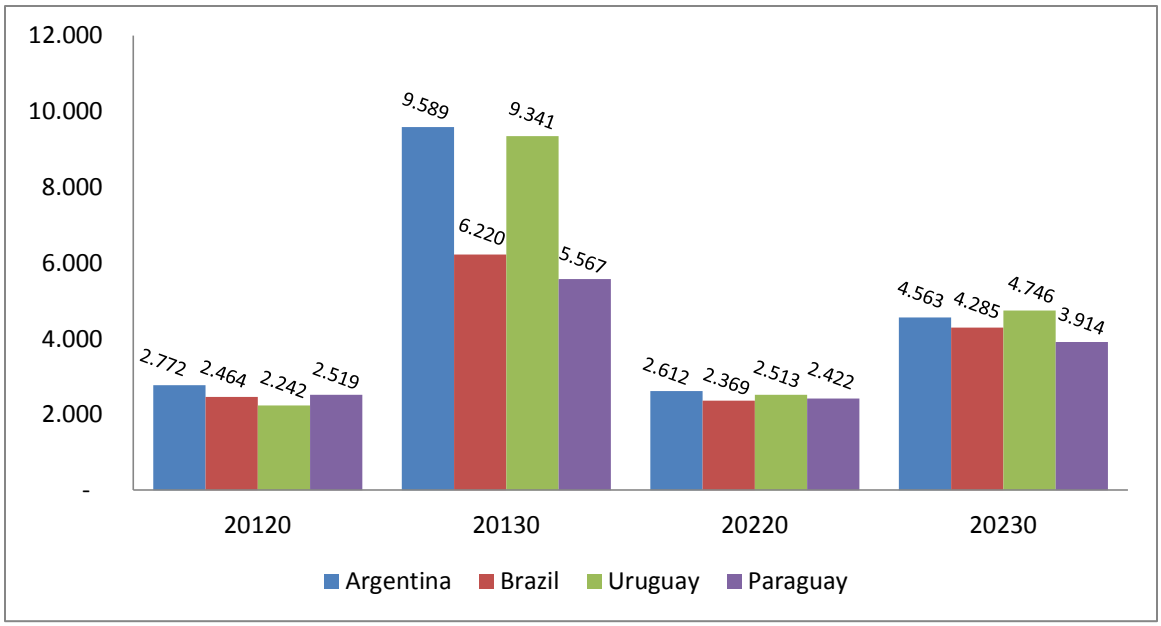
Certain beef products from exporting countries like Australia and the U.S receive higher price premiums when sold abroad compared to the domestic market. For example, exports of rounds, chucks, and offal to Mexico; livers hearts, and kidneys to Russia; short ribs, chuck roll, and intestines to South Korea; and tongue to Japan all receive prices higher than if sold domestically.

Figure 18. South American Countries' Fresh/Chilled and Frozen Beef Cuts Exports and Shares from 2000 to 2012.



However, countries such as Argentina and Uruguay, after eradicating FMD in the late 1990s and accessed majors FMD free markets in the Pacific Rim (U.S, Canada, Mexico, Japan and South Korea); contrary to expectation, got export prices 10-15 percent higher. The magnitude of these increase suggested that the price differential or premium between FMD free and FMD endemic markets are lower than expected.

Figure 19. Beef Commodities Average Price Comparison of Paraguay, Argentina, Brazil and Uruguay from 2000 to 2012.



CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The imposition of restrictions on imported beef in response to food safety concerns, especially animal diseases outbreaks can occur quickly; lifting these restrictions takes time. Typically, governments immediately close their borders when faced with concerns over the safety of beef products imports. However, once the market is closed, reopening can take months or even years, translating into devastating economic losses in exporting countries.

International meat markets have been increasingly affected by animal disease outbreaks which have caused trade diversion and shifting market shares between exporters of the same and different types of beef products. Epidemiological events such as FMD and BSE outbreaks show negative impacts on beef trade. Most of the impacts are on the demand side, as consumers shift to other meats because of concerns about the beef safety. Exporting countries FMD and BSE sanitary status also affect beef export prices. Countries with status that represent minimal risk of the disease presence access most stringent and competitive markets, which pay higher prices.

Global beef trade has recognized significant value in traceability systems. Concerns for animal and human health, as well as food safety assurances, have motivated efforts to adopt animal these systems; and most importantly, exporting countries loss of

important beef markets due to the lack of standards adoption in regards to traceability systems. In response, exporters who developed mandatory traceability systems get higher beef export prices and access most competitive markets.

All quantitative models assessed these impacts in beef trade, supported by the conceptual framework described in the study. The risk of animal disease outbreaks will continue to create added uncertainty in the beef market; as export prices are affected by these matters. At the same time, an increasing demand of traceability systems creates an added value to beef products.

Conclusions

From all hedonic models developed in this study, the model that included all the variables and most valuable commodities revealed more consistent and significant results compare to others. Animal diseases status such as free FMD with vaccination and controlled BSE risk have a negative impact on beef export prices, compared to countries that possess free FMD without vaccination and BSE negligible risk. Epidemiological events (FMD and BSE outbreaks in exporting countries) also showed a negative effect on prices. While beef shipments from India got significantly lower prices, related to beef exports of lower quality. On the other hand, the use of mandatory traceability systems adds a premium value to beef export prices. In regards to the different beef commodities, bone-in cuts export prices from countries with FMD free with vaccination and BSE controlled risk were more negatively impacted compared to boneless cuts prices, which are not that affected by exporting countries sanitary status.

Exporting countries such as Australia, Uruguay and New Zealand, that have better sanitary status, efficient FMD and BSE surveillance programs, mandatory traceability and very strict SPS audit system (mostly promoted by cooperation of the industry and government) access more stringent and high-valued markets, like Japan and South Korea. This means that exporting countries falling behind demanding beef markets standards, such as traceability systems, face the risk of losing market share to major competitors over time. Furthermore, market access to certain importers might be constrained in the absence of efficient SPS compliance.

Although the latest FMD outbreaks in Paraguay led to the awakening of the beef industry due to due to the economic losses, and encourage the governmental sanitary service to a more efficient cooperation with the industry to recover the country's free status as soon as possible; there are still other aspects that need to be attained in order to be more competitive globally. Paraguay lags behind its competitors in developing and employing traceability systems; the country does not maintain the same mandatory traceability standards for cattle and beef products compared to major beef exporters, this positions Paraguayan beef exports in less stringent and valued markets.

Recommendations

These findings emphasize that exporters' FMD and BSE sanitary status, epidemiological events and the use of traceability systems have a direct impact of beef export prices. It is important to highlight that the results should be viewed as an estimation of the effect of sanitary status, diseases outbreaks and implementation of traceability systems on beef export prices in top beef export markets; there are other

important economic factors (such as country's GDP and income) that were not included in this study and are relevant when analyzing commodities prices.

In this scenario, if the Paraguayan beef industry wants to target beef exports to more competitive markets, that are more demanding in terms of SPS and traceability systems, an efficient vertical integration should be implemented in the industry; encouraging producers, governmental sanitary service and beef plants to work jointly. The industry should focus on encouraging producers to comply with international standards that would add value to Paraguayan beef; such incentives like beef certification programs with premium prices, campaigns and promotion of the use of traceability systems.

A successful FMD eradication strategy in Paraguay should rely on high level of vaccination, effectiveness of outbreak responses, and control of animal movement. This strategy must have a regional, not only national, focus and must be based on risk analysis methodology. The multilateral administration of vaccination campaigns and field activities to ensure wide and simultaneous vaccine application, along with primarily prevention and joint border activities are key to eradicating FMD and maintaining areas free of the disease.

Finally, it can be said that the Paraguayan beef industry has the intention of getting access to more valuated beef markets; however it is necessary to comply those markets demands, prioritizing sanitary issues and the implementation of mandatory traceability systems.

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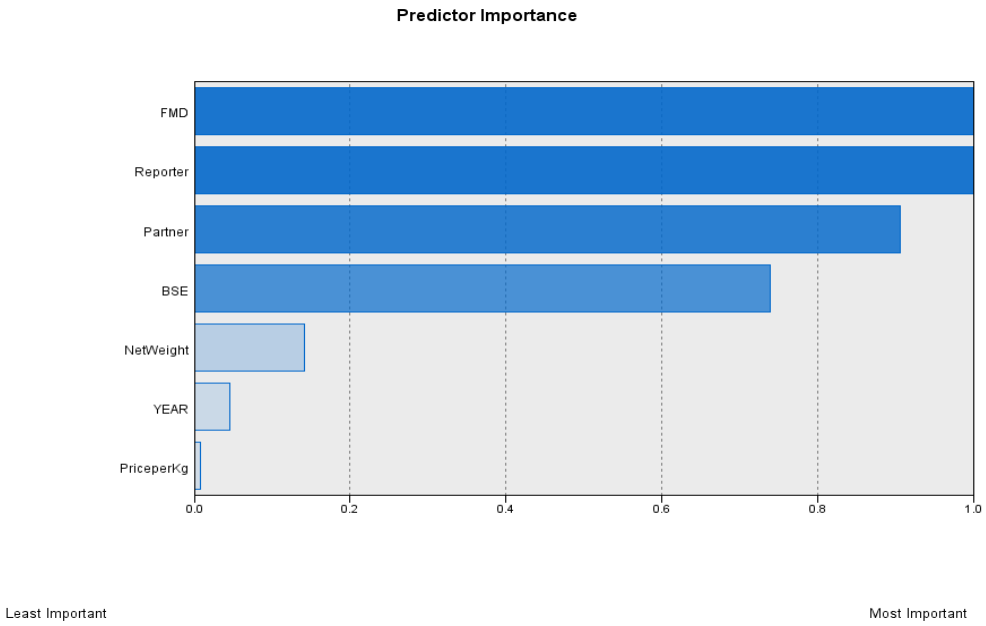
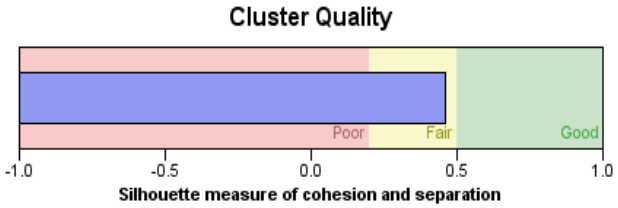
APPENDICES

Appendix A. Cluster Analysis preliminary results: Predictor of Variables Importance, Cluster Shares in the population, Model Summary and Countries participating in each Cluster.



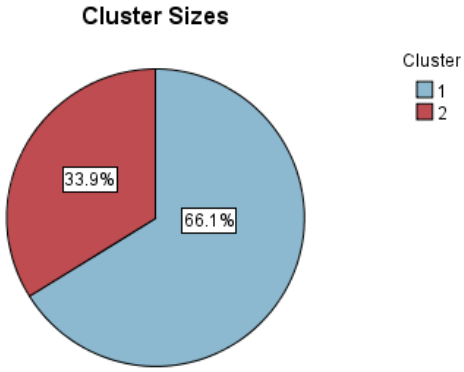
Model Summary

Algorithm	TwoStep
Inputs	7
Clusters	2



Participation in clusters

CL 1	%	CL 2	%
Australia	18.50%	Argentina	25.71%
USA	18.44%	India	20.21%
EU	15.95%	USA	19.57%
New Zealand	14.12%	Australia	10.92%
Brazil	12.84%	EU	8.23%
Canada	8.29%	New Zealand	7.66%
Uruguay	6.05%	Uruguay	6.03%
Paraguay	4.82%	Canada	0.80%
Mexico	0.97%	Brazil	0.76%
Argentina	0.00%	Mexico	0.08%
India	0.00%	Paraguay	0.04%



Appendix B. Correlation Matrix of ALL variables and all beef commodities.

	Real$/tn	Period	tns	BSE	FMD	TS	Dindia
Period	0.168						
	0.000						
tns	-0.059	0.007					
	0.000	0.402					
BSE	0.013	-0.002	-0.017				
	0.112	0.798	0.044				
FMD	-0.230	-0.044	0.005	-0.284			
	0.000	0.000	0.560	0.000			
TS	-0.131	-0.006	0.003	-0.352	0.729		
	0.000	0.510	0.732	0.000	0.000		
Dindia	-0.245	-0.064	0.009	-0.135	0.719	0.679	
	0.000	0.000	0.269	0.000	0.000	0.000	
EPevent	-0.003	-0.128	-0.024	0.370	-0.108	-0.057	-0.168
	0.700	0.000	0.005	0.000	0.000	0.000	0.000

Appendix C. U.S and EU Wholesales Price Index (WPI) Regression.

```
Regression Analysis: wpiUS versus wpiEU

The regression equation is
wpiUS = - 11.4 + 1.09 wpiEU


Predictor     Coef  SE Coef      T      P
Constant   -11.380    5.846  -1.95  0.066
wpiEU      1.08945  0.07957  13.69  0.000
```