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THE IMPACT OF THE COMMON EXTERNAL TARIFF (CET)
ON JAMAICA'S BEEF SECTOR

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Eric B Bailey

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M.S

degree in

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**THE IMPACT OF THE COMMON EXTERNAL TARIFF ON JAMAICA'S BEEF
SECTOR**

By

Eric Burham Bailey

A THESIS

**Submitted to
Michigan State University
In partial fulfillment of the requirements
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ABSTRACT

THE IMPACT OF THE COMMON EXTERNAL TARIFF ON JAMAICA'S BEEF SECTOR

By

Eric B. Bailey

In the context of liberalization of international trade, the governments of CARICOM countries implemented a policy of a phased reduction of the Common External Tariff (CET) in 1991. This policy has been blamed for causing a contraction in the domestic beef sector in Jamaica. This thesis investigates the trade dynamics of the Jamaican beef sector with respect to the world market. The prime focus was to determine what impact, if any, the phased reduction of the CET had on meat import demand and the output of the Jamaican beef sector. It also sought to identify the most effective policy alternatives to increase the competitiveness of the local beef industry.

Using time series data from 1979 to 2005, demand and supply equations were estimated using Seemingly Unrelated Regression to test for structural changes through the use of dummy variables. The analysis revealed that there is substitutability between imported meats and domestic beef, and a statistical significance of the policy change for imported meat. Furthermore, the short term supply response of domestic beef with respect to its own price was inelastic and became more inelastic after the policy change. A welfare analysis conducted on an alternative tariff regime (assuming a 30% increase in tariff), showed a net loss in social welfare.

Dedication

This thesis is dedicated to my late father Charles Clinton. The path he has charted before provides a clear guide to finding life's true value.

And to my dear mother Georgiana, who embodies the warrior spirit of Nanny of the Maroons simultaneously with the prayerfulness of Hanna.

Acknowledgment

"No duty is more urgent than giving thanks"

James Allen

Completing this thesis represents the culmination of two years of intense work. Throughout this time, I have been the recipient of much goodwill and support, for which I now pause to acknowledge.

I express heartfelt thanks to my committee members for their advice and guidance throughout this research process. Special thanks to my guidance committee chairman, Dr. Dave Weatherspoon, for his wise counsel and support over the years. I also thank the faculty members in the department, and my peers for the collegial atmosphere which were shared. Throughout my graduate program, I received a graduate assistantship from the Land Policy Institute (LPI). Special thanks are extended to Dr. Adesoji Adelaja for his mentorship and support during my masters program, and to the entire staff at LPI for the open friendly and supportive environment I was privileged to have been a part of.

In accessing data for this thesis, it was necessary to interface with several public and private institutions in the Caribbean. I am grateful to staff members from the Bank of Jamaica CARICOM Secretariat, Ministry of Agriculture's Data Bank, Ministry of Foreign Affairs and Foreign Trade, Statistical Institute of Jamaica (STATIN), Planning Institute of Jamaica (PIOJ), and the Jamaica Livestock Association (JLA). It would have been impossible to have conducted this analysis without their collective support.

I must also extend gratitude to my family for their constant love and prayerful support throughout the period. The sacrifices which you have made have not gone unnoticed. Words alone are inadequate to express my appreciation to you all.

Pursuing an academic degree ought not to be an end to itself, but a means through which one fulfill a larger purpose in life. I want to put on record my thanks to God Almighty, for allowing me to travel along this path, and for permitting me success. I humbly lay this achievement upon God's alter and ask for his divine guidance in remaining true to his purpose.

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Abbreviations

Bank of Jamaica	BOJ
Caribbean Community	CARICOM
Caribbean Free Trade Association	Carifta
Caribbean Single Market and Economy	CSME
Caribbean Single Market	CSM
Common External Tariff	CET
Consumer Price Index	CPI
European Union	EU
General Consumption Tax	GCT
General Agreement on Tariffs and Trade	GATT
Gross Domestic Product	GDP
Imperfect Substitute Model	ISM
International Monetary Fund	IMF
Jamaica Agricultural Society	JAS
Jamaica Commodity Trading Company	JCTC
Jamaica Livestock Association	JLA
Micro and Small Enterprises	MSEs
National Training Agency	NTA
Net International Reserves	NIR

Ordinary Least Squares	OLS
Perfect Substitute Model	PSM
Planning Institute of Jamaica	PIOJ
Private Sector Development Program	PSDP
Rural Agricultural Development Authority	RADA
Scientific Research Council	SRC
Seemingly Unrelated Regression	SUR
Statistical Institute of Jamaica	STATIN
United Nations	UN
World Trade Organization	WTO

Chapter 1

1.0 Introduction

The headline in Jamaica's leading daily newspaper, on the 17th of November 1998, read: "Clarke backs call to boycott imported beef." The article reported on a speech by Jamaica's Minister of Agriculture to the beef farmers, in which he announced an increase in tariff rates on imported beef. This speech was made in the context of dissatisfaction among beef farmers, with the trade policy of increased market liberalization which has been pursued by the government of Jamaica since 1991. More recently, the president of the Jamaica Agricultural Society, while speaking at the Barbados Agricultural Show, called for a ban on meat imports to the Caribbean region (Gleaner, 2007). The sentiments presented above, is reflective of a general belief among leaders of the livestock sector that the prevailing trade policy has impacted negatively on the Jamaica livestock sector.

The beef industry was established in Jamaica during the early years of the 20th Century, and has a tradition of contributing to wealth and employment creation in rural communities throughout the Island. Today, the most powerful beef organization, Jamaica Livestock Association (JLA), has vocalized its concern for the long-term viability of the sector, due to a perceived loss in price competitiveness over the last 10 to 15 years. This lack of competitiveness has been attributed to the policy of a phased reduction of the common external tariff

(CET) on meat products entering the CARICOM¹ region, which was implemented over the period from 1991 to 1998.

The value of investment in the beef sector in 2004 was US\$117 million (JA\$7.5 billion), and its direct contribution as a single sub-sector of the livestock industry was US\$53 million (JA\$3.4 billion) (Duffus and Jennings, 2005). The industry currently provides direct employment to 12,680 individuals, representing approximately 6.6 percent of the employment opportunities in the agricultural sector (Duffus and Jennings, 2005). Since the early 1990s, contraction in the domestic beef sector has resulted in a loss of over 13,870 jobs (Duffus and Jennings, 2005). In the context of a pre-existing high unemployment rate, this erosion of income compounds the economic and social problems of Jamaica, while retarding the prospects for the economic prosperity of rural communities.

Parallel to this contraction occurring in the domestic beef sector, the JLA recognizes potential growth opportunities. The creation of the Caribbean Single Market and Economy (CSME) is expected to expand regional market access for local producers. In addition, the projected growth of the local and regional tourism sectors is expected to generate increased demand for beef (current hotel demand is currently being met through imports). Global demand for beef is also expected to increase from 209 million tons in 1997 to 327 million tons by 2020

¹ A regional intergovernmental body formed in 1973 to promote and facilitate greater regional economic, cultural and political integration among member countries. The members include Antigua and Barbuda, Barbados, Belize, Dominica, Guyana, Haiti, Jamaica, Montserrat, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, and Trinidad and Tobago

(Haan et al., 2001). Most of this demand is expected to be supplied from developing countries.

A 2005 report commissioned by the JLA revealed that domestic demand and price was high, while the ability of the sector to respond to demand was weak. This was attributable to the reduction in the size of the industry over the last 12 to 15 years. Since the local sector lacks the capacity to adequately meet local demand, it is highly unlikely that the industry will be able to respond to anticipated regional and global demands without significant policy initiatives that focus on rebuilding the base of the beef sector.

For the last two years (since 2005), the domestic beef sectors have been consulting with its members and stakeholders, with a view to repositioning the sector to benefit from emerging and projected market opportunities. However, in order to design and implement effective policy, it is essential that the factors which led to the contraction of the sector over the last fifteen years be fully understood. It is in that context that this study investigates the impact of the phased lowering of the CET on the beef industry in Jamaica.

1.1 Knowledge Gap and Uniqueness of Study

No systematic study has been conducted that assesses the real impact of the new tariff regime on the beef sector. The 2005 JLA report provides a comprehensive overview of the demographic status of the sector, the levels of output produced, and the efficiency of resource use. Its conclusion on the impact of the new tariff regime on local demand was based more on observation and feedback from stakeholders, rather than any rigorous statistical analysis. The

report did not consider other factors which could have implications for efficiency and competitiveness of the beef sector was not fully addressed.

It is important to determine what impact, if any, the lowered CET might have had, as well as the magnitude of that impact. It is equally important to determine the impact of any other policy or existing economic condition which could have impacted on the demand and supply relationship of beef in the domestic market. This research will establish how trade liberalization since 1991, as well as how other macro economic variables, may have affected the competitiveness of Jamaican beef producers. This study will help inform national and regional trade policies, and form the basis for further research. This study is therefore uniquely placed to contribute to the ongoing dialogue on the strategic direction of the beef industry in Jamaica.

1.2 Research Objectives

The objectives of this research are to:

1. Determine how the 1991 CET regime implemented by CARICOM has affected the demand for imported meats and the demand and supply of domestic beef.
2. Conduct scenario analysis of two alternative tariff regimes on domestic beef demand and supply, and
3. Conduct a welfare analysis of a potential tariff increase.

1.3 Outline of Thesis

This thesis is organized in the following manner. Section two provides the literature review which includes an overview of the macro economic and trade environment in Jamaica, an overview of the Jamaican beef sector, and a review of econometric methods used in estimating import demand, domestic demand and supply functions. Section three outlines the conceptual framework guiding the analysis as well as modeling and data transformation procedures which have been adapted to the research question. In section four the results of the econometric analysis are presented and interpreted. In addition, scenario analysis and welfare analysis are conducted. Section five presents a discussion on the policy implications of the results and the future prognosis of the beef sector under varying policy regimes.

Chapter 2

2.0 Literature Review

In this chapter, the policy environment prevailing in Jamaica (the macro economic environment and the international trade policy environment), the Jamaican beef sector, and previous studies conducted on the beef sector are discussed. It also presents a review of econometric modeling procedures which were used to estimate import demand as well as domestic demand and supply equations.

2.1 Policy Environment

2.11 Macro Economic Environment

The macro economic policies of Jamaica were set within “The Medium Term Socio-Economic Framework” designed to govern the direction of the country from 2004 to 2008 (PIOJ, 2007). The outlook of the policy was to create an enabling environment, to foster private sector led economic growth. This was intended to be achieved by maintaining macro-economic stability, developing physical infrastructure, and implementing of sector specific initiatives to improve global competitiveness.

Between 1999 and 2006 Jamaica’s economy experienced a relatively steady, but slow growth of 1.32 percent per year (PIOJ, 2007). During the same period, the Bank of Jamaica (BOJ), through use of monetary policies was able to reduce

inflation² to an average of 10.25 percent per year. Containment of the inflation rate and stabilizing of the exchange rate were seen by the government as necessary conditions for inspiring confidence in the local economy. The government's short term macro economic objectives for 2005 were as follows (PIOJ, 2007)

1. Achieve real GDP growth of 3 to 4 percent per year;
2. Maintain the inflation rate at single digit levels;
3. Reduce the fiscal deficit to 2.5 percent of GDP;
4. Accumulate Net International Reserves (NIR) of US \$2,118.6 million; and
5. Achieve a debt/GDP ratio of 118.5 percent, down from 131.5 percent in 2005.

Gross Domestic Product grew by 2.5 percent in 2005 (PIOJ, 2006). The sectors responsible for this growth were agriculture, mining and quarrying, and the service sector (mainly the restaurant and hotel sectors). During 2005, the inflation rate was contained to 5.8% (the lowest in over ten years). The lowering of the benchmark (30-day and 180 day instruments) interest rate also enabled a lowering of commercial lending rate from 23.45 percent to 22 percent. There was also a 0.9% reduction in the unemployment rate and the exchange rate remained relatively stable with other major currencies. Table 1 shows the exchange rate in relation to the US dollar for the period 1979 to 2005. There was however a deterioration in the fiscal deficit from US\$137 million (JA \$8.5 billion)

² In 1995-1997 the country experienced a instability in a number of commercial banks and insurance companies. This resulted in a hyper inflationary condition during that time. The government through the BOJ provided significant capital injection and strengthened banking regulations in an effort to respite stability to the banking sector.

in financial year 2004 to US\$601.5 million (JA \$37.9 billion) in financial year 2005. The current account deficit widened during 2006, from US\$3,207.9 million in 2005 to US\$3,666.9 million in 2006. This worsening trade balance was attributable mainly to the current inflationary trend of fuel price on the global market.

Table 1. Exchange Rate with the US Dollar

Year	Jamaican dollar equivalent to the US dollar	Year	Jamaican dollar equivalent to the US dollar
1979	2	1993	25
1980	2	1994	33
1981	2	1995	35
1982	2	1996	37
1983	2	1997	36
1984	4	1998	37
1985	6	1999	39
1986	6	2000	43
1987	6	2001	46
1988	6	2002	49
1989	6	2003	58
1990	7	2004	62
1991	13	2005	63
1992	23	2006	66

A new ruling by the World Trade Organization (WTO), in relation to banana and sugar trade with the European Union (EU), adversely affected the competitive position of these sectors vis a vis competing products from Central and South America. In January 2006, the Caribbean Single Market (CSM) was formally launched with 12 member countries of CARICOM. The total value of exports grew by approximately US\$452.0 million in 2005.

Currently the macro economic environment is stable. The government has been successful in containing inflation, lowering interest rates, attaining

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stability in the exchange rate and restoring some confidence in the local economy. However, while the rate of economic growth has been consistent in recent years, it has not been robust enough to raise the standard of living for the average citizen. The challenge therefore exists to develop policies and programs which will jump start the economy on a more progressive path.

2.12 International Trade Policies Affecting Beef

Jamaica's international trade policy has been influenced by two main factors;

1. The economic policies during the decade immediately following political independence in 1962.
2. A move towards market liberalization over the last 15 years, through the General Agreement on Tariffs and Trade/World Trade Organization (GATT/WTO) and other multilateral institutions.

The foundation for Jamaica's trade policy was framed in the economic thought of the import substitution industrialization which was promulgated by the Prebisch - Singer³ hypothesis of the 1950s. Jamaica employed a mix of protectionist and liberal policies in a bid to contain its trade deficit and protect sensitive sectors, while meeting shifting political and economic commitments. The major considerations then were the need to increase income and employment and the preservation of rural economies (Lightbourne, 1969). The policies implemented during that period were geared towards the following objectives:

³ The Prebisch-Singer hypothesis (1950) argued that there was a persistent declining term of trade for commodities from developing countries, and predicted that this trend would continue into the future. They suggested that developing countries should implement protective tariff barriers in order to facilitate the development of new domestic manufacturing industries.

1. Protect traditional markets for primary products by stabilizing their prices through commodity agreements at a bilateral or multilateral level;
2. Reduce dependence on imports by applying trade restrictions, and simultaneously developing an indigenous manufacturing sector;
3. Increase the manufacturing base by promoting exports of manufactured goods;
4. Diversify the agricultural sector for both local and export markets;
5. Rapidly expanding the tourism sector in order to generate employment; and
6. Maximize returns from the mining industry by processing bauxite to alumina, rather than only exporting bauxite ore.

This general policy direction is credited with reducing the rate of import growth of consumer goods from 47.4 percent in 1965 to 41.5 percent in 1968. Quantitative restrictions on imports (final goods) were predominantly used as a means of fostering growth in import substitution while industrial inputs were allowed to be imported without duty (Hudson, 2003).

Jamaica's first steps towards more liberalized trade began in 1968, when membership was gained in the Caribbean Free Trade Association⁴ (CARIFTA). Within this framework, all quotas and licensing requirements⁵ were lifted. This policy remained in place for a limited time period due mainly to member states not conforming to the rules. The institutional arrangement in CARIFTA was

⁴ CARIFTA can be considered the fore runner of CARICOM. The members include Antigua, Barbados, Belize, Dominica, Grenada, Montserrat, St. Kitts-Nevis-Anguilla, St Lucia, St. Vincent, and Trinidad and Tobago.

⁵ A reserve list of products were exempted from this policy, but allowed for a gradual removal of protection.

strengthened and resulted in the formation of CARICOM and the implementation of a common external tariff⁶ in 1973. The prevailing macro economic environment in the mid 1970s resulted in a sharp devaluation of the Jamaican currency. This prompted the government to introduce stringent import controls in order to coordinate foreign exchange inflows with import payments (Hudson, 2003). A special agency, the Jamaica Commodity Trading Company (JCTC), was established to implement the import policies towards the end of the 1970s and early 1980s.

Jamaica's trade policy orientation gradually transitioned to a liberalized mode in the 1980s in the context of the World Bank and International Monetary fund (IMF) led structural adjustment programs. This shift, like many others in the developing world was not done voluntarily, but attached to IMF and World Bank conditionalities (United Nations 1999). This involved a commitment from the government, to not introduce new tariff restrictions and to reduce existing restrictions over a five year period (1982-1987), while simultaneously converting some quotas to tariffs. Jamaica's momentum towards greater trade liberalization continued in 1990, through the commitments made by CARICOM countries to reduce the CET as well as through the country's increasing integration into the world trading system as a member of the World Trade Organization (WTO).

The revised CET provided for a phased reduction from an average of 80 percent in 1992 to its highest binding rate of 20 percent in 1998 (Hudson 2003). Imported goods were classified as competing and non-competing as well as

⁶ Trade in goods within CARICOM countries attracted no tariff. Goods from third countries attracted a uniform tariff structure and or quantitative restriction.

input, intermediate and final goods. This classification formed a continuum where non competing inputs had the lowest tariffs and competing final goods had the highest tariffs (United Nations 1999). A commodity is classified as “competing” if its production in any CARICOM territory accounts for less than 75 percent of regional consumption. Within CET rules, a country may be allowed to protect this competing industry by applying a higher tariff rate than the established CET.

The 1990s, therefore, represented the period of greatest trade liberalization, **as** the country attained compliance with its tariff obligations under the CET (see **a**ppendix I for tariff schedule). In spite of increased liberalization in recent years, **s**ome levels of protection have been retained. These take the form of an **a**dditional stamp duty, special consumption tax, an import cess, and an **e**nvironmental levy (which raises the level of import taxes on some goods to as **h**igh as 90 percent). In addition, there were upward movements in tariff on **s**pecific imports (e.g. chicken parts, beef and some fruits and vegetables), in an **e**ffort to protect domestic industries from global competition as well as diseases (**e.g.** bovine spongiform encephalopathy).

Jamaica has fulfilled all major commitments for tariff reductions at the **m**ultilateral and bilateral levels. However, the process of market liberalization is **o**ngoing. There are real prospects for further market liberalization through the **e**stablishment of the Caribbean Single Market and Economy (CSME), the **i**mplementation of the Free Trade Area of the Americas (FTAA), and the

establishment of the European Union Economic Partnership Agreement (EUEPA).

Specifically related to the meat industry, tariff rates have been traditionally high. Prior to 1990 the average effective tax rate applied to meats was 186 percent (STATIN, 2007). The policy toward greater market liberalization saw a phased reduction of this level of tariff from 140 percent in 1991, to 100 percent in 1994 and to 38 percent in 1997 (STATIN, 2007). While the average tariff rate has remained constant since then, there were tariff changes for some categories of meat products. For example in October 1999, an additional stamp duty was applied to mince, boneless beef trimmings and fresh briskets.

2.13 Review of the Beef Sector

Beef production in Jamaica has had a prestigious tradition. The modern era of cattle production began in the 1940s with pioneering research and development work by cattle breeders at the Boodles Agricultural Research Station (and later at private farms). This led to the development of indigenous breeds⁷ of cattle, with desirable traits, which were adapted to the tropical conditions.

Another important factor leading to the development of the local beef sector was the establishment of the Jamaica Livestock Association in 1942. Its main purpose then was to provide formal representation of the livestock industry to the colonial government and to provide technical support to independent farmers in order to develop the industry. Within this framework, breeder societies

⁷ From R&D work the Jamaica Hope (dairy breed), Jamaica Red, Jamaica Black and Jamaica Brahmin breeds of cattle were established.

for all major beef breeds were established. Those societies worked closely with the JLA and the Ministry of Agriculture to maintain a registry of all cattle and to conduct annual appraisals of all registered beef herds in the country. This led overtime to the continuous improvement of the breeds to conform consistently to specific phenotype and performance traits. Overtime Jamaica has developed a reputation for providing genetic material to other countries.

Another significant event influencing the modern growth of the sector was the advent of the bauxite and alumina sector in the early 1950s. As part of the mining regulations, bauxite mines are required to be restored either for agricultural or residential purposes. As a consequence, significant tracts of restored lands have been devoted to cattle production. In fact, the alumina firms,⁸ in order to demonstrate their commitment to restoring the land to productive use, established several large dairy and beef farms on previously mined lands. These large farms often serve as “mother herds”⁹ to the network of small farmers who may own few heads of cattle. These combined factors have resulted in Jamaica having a rich history in the cattle industry with the accompanying experience, technical expertise and land infrastructure to support an industry capable of meeting local demands, as well as the emerging CARICOM markets.

Table 2 shows the summary of findings of a 2005 cattle industry report which was commissioned by the JLA. This report indicated that the beef sector in

⁸ Most livestock farms owned by alumina companies have been divested to private operators.

⁹ A large cattle farm from which small farms source breeding stock, sire services, and other forms of support. In some instances mother farms may have milk or beef purchase agreement contract with small farms.

Table 2. Summary of the Cattle Sector in 2005

	Beef	Dairy
Number of farmers	3,964	245
Distribution by size	Small (0.85) Medium (0.13) Large (0.02)	Small (0.73) Medium (0.15) Large (0.12)
Total pasture land (ha)	26, 800	7,225
Percentage in improved grasses	49	89
Number of employees	3,002	539
Estimated job losses (1990-2005)	12,680	1,190
Cattle population	66,500	17,300
Percent pure bred cattle	14.4	85.5
Total breeding herd	34,615	10,690
Stocking rate (au/ha)	1.29	1.48
Installed processing capacity	76,900 heads	80 M liters
Throughput 2004	52,379 heads	15.4 M liters
Value of output at current prices	\$728M	\$498M
Gross returns on asset employed (%)	9.7	21.7
Contribution to GDP	\$3.4 billion	\$1.6 billion
Main technical limitation	Pasture Management	Pasture Management
Main strategy for increasing market share	Upstream integration through central abattoir	Upstream integration through JDFF
Perceived role of government	(a) Reduced interest rate on farm loans (b) Increased tariff on imports (c) Concession on import duties, and GCT, on imports for cattle sector	(a) Reduced interest rate on farm loans (b) Research and Development

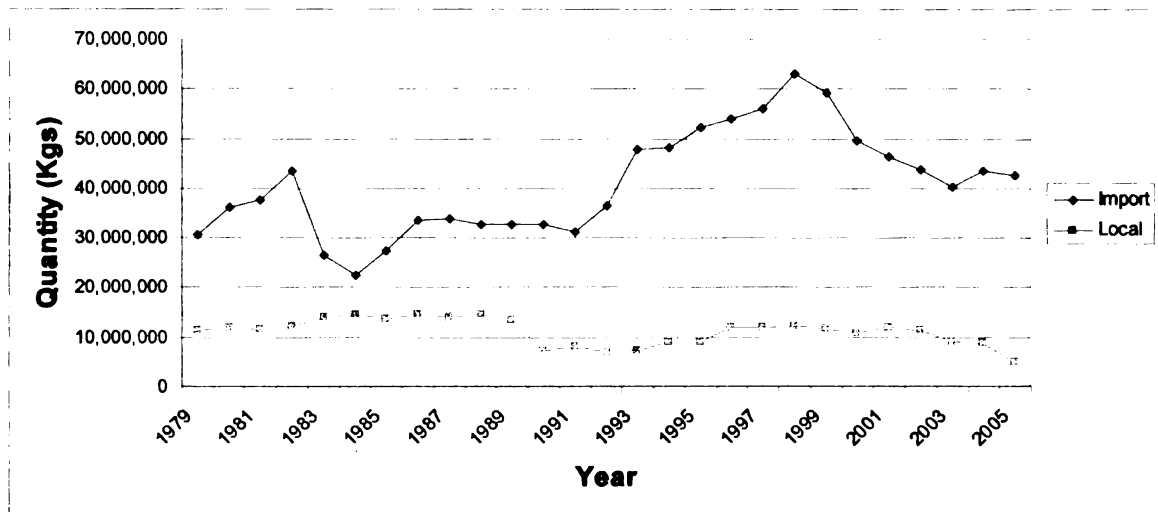
(Source) Adopted from The Current State of the Jamaican Cattle Sector Report.

Jamaica is comprised of 3,964 farmers, 2 percent of which are large commercial size farms (greater than 99 heads), 13 percent are medium size farms (between 29-99 heads), and 85 percent are small farms.

Of the 26,800 hectares devoted to beef production, 49 percent have improved pastures¹⁰. The population of beef herds is 66,500 (34,615 breeding cows), of which 14.4 percent are pure bred cattle of the indigenous breeds mentioned earlier. The status of pastures and prevailing climatic conditions allow for an average stocking density of 1.29 animal units per hectare.

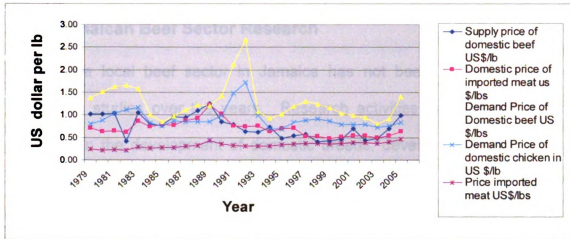
In spite of this illustrious history, Jamaica has never been fully self sufficient in beef production. Figures 1 and 2 provides graphs of production and price trends for domestic beef and imported meats 1979-2005.

Figure 1. Level of Meat Imports and Domestic Beef Production



¹⁰ Improved pastures include lands which have been developed primarily for cattle grazing. These lands are generally fenced, planted with high quality pasture grass, frequently fertilized and irrigated.

Figure 2. Price Trends for Imported Meats, Domestic Beef and Domestic Chicken



Output from the sector reached its highest level of 29.6 million lbs in 1990. At that time, domestic production accounted for 82.9 percent of consumption. This fell to 56.6 percent by 2000. Over the last decade, per capita consumption of beef increased by approximately 25 percent. This increase in consumption was primarily driven by import demand rather than domestic consumption. On the contrary, the number of animals slaughtered fell from 85,248 in 1993 to 52,379 in 2004.

Currently the beef sector has little vertical integration¹¹ and is comprised mainly of small farmers (Duffus and Jennings, 2005). During the last decade, there has been a steady attrition rate of farmers and a systematic reduction of herd size. The result is a situation where the demand for local beef is high, but the capacity to meet that demand is low. This provides a window of opportunity to formulate appropriate policies which could guide the revival of the industry in

¹¹ There is one large feed lot operator, with contract growers and a heavily mechanized processing operation.

order to benefit from this favorable condition, as well as position Jamaica's beef industry to compete in the global market.

2.14 Jamaican Beef Sector Research

The local beef sector in Jamaica has not been the subject of many economic studies over the years. Research activities have been traditionally devoted to the development of domestic breeds, developing improved pasture management systems and other technical issues related to animal husbandry.

In the context of deteriorating market conditions affecting the domestic beef and dairy industry, the Jamaica Livestock Association (JLA) commissioned a study of the local cattle sector in May of 2005. The main purpose of this study was to obtain qualitative and quantitative information on the demographics of the industry and identify the key constraints facing the industry. This study was completed in September of 2005 and the findings were presented to a broad stakeholder group. The recommendations emanating from this study are being incorporated into a strategic development plan which will guide policy formulation and the long term direction of the sector.

The following were the important recommendations from this report.

1. Create a fiscal environment to provide a cushion against imports.
2. Ensure the sustained generation of cost-effective and appropriate technology, for primary production as well as value added, by enabling the R&D arm of the Ministry of Agriculture and the Scientific Research Council (SRC).

3. Raise the competencies of farmers through the Rural Agricultural Development Authority (RADA), Heart NTA¹², and other educational institutions.
4. Facilitate the availability of low cost capital with extended payment periods.
5. Facilitate greater levels of cooperation among members of the beef sector through the promotion of network collaboration.
6. Establish a centrally located abattoir and meat processing facility while allowing beef farmers the option of investing in its capitalization.

The JLA commissioned study provided a good indication of the state of the industry, and pointed towards important imperatives which need to be addressed in the short and medium term in order to rebuild the beef sector.

2.2 Review of Modeling Methods

2.21 Single Equation Import Demand

Seminal work by Goldstein and Khan (1985) provides a comprehensive summary of methods used in estimating trade equations, and forms the reference point for much of the quantitative work which was subsequently carried out in international trade. This article identified the two models used in estimating trade functions as being (1) The Imperfect Substitute Model (ISM) and (2) the Perfect Substitute Model (PSM).

¹² The Heart NTA is the national training agency through which vocational training is provided.

The ISM assumes that imported goods are imperfect substitutes for domestic goods. This can be readily seen by the disparity in prices for the “same” product in different countries, as well as differences between domestic and export prices of a given product within a country. The import demand model in this framework for a given country (i) in relation to the rest of the world is specified as follows;

$$ID_i = f(Y_i, P_i, P_i)$$

where,

ID_i = quantity of imports by country i

Y_i = the income of the importing country

P_i = is the price of the imported commodity, and

P_i = is the price of the domestically produced substitutes.

The PSM is primarily used when the good in question is homogenous or highly standardized across countries and is traded in an institutional framework where price differentials between domestic and foreign goods do not exist. The demand and supply relationship in this framework is specified as follows;

$$D_i = (P_i, Y_i)$$

$$S_i = n(P_i, F_i)$$

$$I = D_i - S_i$$

$$X_i = S_i - D_i$$

$$P_i = P_i = P X_i = e. P_w$$

where,

D_i = is the total quantity of traded goods demanded in country i,

P_i = is the price of the traded good,

Y_i = is the money income in county I,

S_i = is the supply of locally produced goods in country i,

I_i = is the quantity of imports of traded goods, and

X_i = is the quantity of export of the traded good.

In contrast to the ISM, there is no separate function for import demand and export supply. There is only a function for total traded product. Demand for import, or excess demand is represented by the difference between total demand and supply. There is also one traded price with local price being equal to world price.

The ISM is the more widely used method of the two, although the PSM can provide important insights when appropriately used. Of prime interest in this research is the impact of a trade policy change on the quantity of meat imports. In this framework, the impact of the price of domestic beef and chicken on imported meat demand will necessarily be taken into consideration. It could be argued that imported meats serve a similar nutritional function as domestic beef and chicken, and as such could be substitutes. However, given the different characteristics of these products, and price differentials across markets, they satisfy the conditions of imperfect substitutes. The remaining portion of this literature review will therefore focus on the ISM, as the subject of this research appears to be more compatible to this approach.

The effect of income, price and exchange rate on the quantity of imports was investigated by (Deyak, Sawyer, and Sprinkle, 1993) by using the model specified below;

$$QM = f(+YD, - PF, + PD, + ER, + Q2, +Q3, +Q4)$$

where QM is the volume of imports, YD is real domestic activity measured by GDP, PF is foreign currency price of imports, PD is the domestic price of measured by Canadian wholesale price index, ER is the exchange rate, and Q2, Q3, and Q4 are dummy variables for different quarters (1 if period is 2nd, 3rd, or 4th quarter or 0 otherwise). In order to account for delays in responding to changes in the independent variables, this model was modified to a polynomial distributed lag function and expressed as follows;

$$\ln M_t = B_0 + \sum B_i \ln YD_{t-i} + \sum B_j \ln PF_{t-j} + \sum B_k \ln ER_{t-k} + B_m \ln PD_{t-m} + B1Q2 + B2Q3 + B3Q4 + \varepsilon_t$$

All explanatory variables used were found to be statistically significant at the 5 percent and or 10 percent levels.

A 2004 study by the Central Bank of Turkey (Aydin, Ciplak, and Yucel 2004) employed both single equation and Vector Auto Regression (VAR) to estimate import demand and export supply. The single equation model specified below used quarterly data from 1987 to 2003.

$$LMQ = C + LY + LRER + D1 + D2 + D3 + \varepsilon$$

where LM is the natural logarithm of imports, LY is the natural logarithm of real GDP, and LRER is the natural logarithm of the CPI based index. The variables D1, D2 and D3 are dummy variables to capture quarterly variations in trade.

From this study it was shown that imports were largely determined by exchange rates and national income, with an increase in real income and an appreciation of the currency leading to more imports. The VAR provided similar results, but with the additional insight that real exchange rate was more important to import but not significant in determining exports.

An estimate of the import demand for Croatia by Merver (1993) used the traditional (ISM) demand function specified as follows;

$$I_m = g(Y_d, P_d, P_m)$$

where I_m represents the quantity of imports, Y_d represents real income of the importing country, P_d represents the price of domestic substitutes in the importing country, and P_m represents the price of imported commodities. In order to overcome data limitations in a country which was at an initial stage of transition, the author used domestic industrial production as a proxy for real income, and an index of real effective exchange rate as a proxy for relative prices. Additional variables used were the exchange rate between Croatia and Germany and dummy¹³ variables for February and May of 1992, and January and February 1993. Using OLS regression on monthly data for the period January 1990 to December 1993, the model showed that there was a significant negative relationship between imports and the index of real exchange rate.

A slightly modified approach was used to conduct an analysis of Fiji's import demand (Narayan and Narayan, 2005). While drawing on the framework of ISM, an attempt was made at disaggregating income into various components

¹³ The dummy variables were integrated to evaluate the significance of structural shifts in the economic transformation process.

of private and government consumption and expenditure on investment. The function was specified as follows;

$$\ln M_t = \sigma + B_1 \ln CG_t + B_2 \ln I_t + B_3 \ln X_t + \alpha \ln R_{pt} + \varepsilon_t$$

where $\ln M_t$ is the natural log of imports, $\ln CG_t$ is the natural log of the sum of government and private consumption, $\ln I_t$ is the natural log expenditure on investment, $\ln X_t$ is the natural log of expenditure on exports and $\ln R_{pt}$ is the natural logarithm of the ratio of the imports price index to domestic price index.

The analysis revealed that all the regressors used were statistically significant but with an inelastic effect on the quantity of imports. The model also allowed the impact of various kinds of expenditure on import demand to be observed. A one percent increase in expenditure on exports and consumption increased imports by .69 percent, while a one percent increase in investment expenditure increased imports by .17 percent. Additionally, a one percent increase in relative price results in a .4 percent reduction in imports.

Where as the previous models were used to estimate aggregate import demand, a similar approach was used to estimate import demand functions for dairy products for the Mexican economy for the period 1975 to 1995 (Tanyeri-Abur and Rosson, 1998). The model was designed to account for structural shifts associated with the new trade policies through the North American Free Trade Agreement (NAFTA) and currency devaluations.

The function which was based on the ISM was specified as follows;

$$\ln M_t = \beta_0 + \beta_1 \ln(P_m/P_d) + \beta_2 \ln Y_t + \beta_3 \ln M_{t-1} + \beta_4 D_t + \varepsilon_t$$

where,

$\ln M_t$ = the natural log of volume of imports in period t

$\ln M_{t-1}$ = the natural log of volume of imports of period t-1

$\ln(P_m/P_d)$ = the natural log of relative price.

$\ln Y_t$ = the natural log of real GDP at time t

$D_t = 0$ before January 1994 and 1 after.

The analysis revealed that there was a significant positive relationship between income and the imports of both fluid milk and cheese.

Dutta and Nasiruddin (2006) utilized the ISM within a small country framework to estimate an aggregate import demand for India. Their objective was to estimate the impact of income and relative prices on import demand in the context of trade liberalization. The long run demand function was specified as follows;

$$\ln RIMPORT = \beta_0 + \beta_1 \ln IMPRICE1 + \beta_2 \ln RGDP + \beta_3 \ln Dt + \varepsilon_t$$

Where,

RIMPORT = real quantity of merchandise import

RIPRICE = relative price of imports

RGDP = real GDP (1990)

D = Dummy variable (D= 0 between 1971-1991 and 1 between 1992-1995)

In the model estimated, real import prices and real income was lagged for two years. The dummy variable was introduced to capture the effect of the policy shift from protectionism to trade liberalization. The aggregate import demand was found to be price inelastic. However, the income elasticity was greater than unitary. This suggests that demand for import grows faster than a given increase

in income. The dummy variables were found to be statistically insignificant at the 10 percent level. This suggests that liberalization policies have had little effect on import demand.

2.22 Demand and Supply Models

Approaches to single equation supply models are first presented, followed by approaches which seek to estimate demand and supply in a system.

An OLS estimation of Hungarian pork supply (Nyars and Vizvari, 2005) in the context of a transitioning economy is presented as a starting point to showcase econometric procedures used to estimate the supply function in the meat industry. The model was specified as follows;

$$Q_s = \beta_0 - \beta_2 M_{t-2} + \beta_2 P_{t-2} - \beta_3 I_{t-2} + \beta_4 C_t + \epsilon_t$$

where, Q_s represents the quantity of pork supplied in time t , M_t represents the price of maize in time t , P_t represents the price of pork in time t , I_t represents the price of piglet in time t and C_t represents the price of chicken. The coefficients on the regression followed the economic convention, i.e. increasing in its own price, decreasing in the price of input (maize), decreasing in the competing use price (piglets), and increasing in price of substitute (chicken).

In investigating the supply behavior for beef producers, Reutlinger (1966) found that there was a negative price elasticity of supply. This finding was confirmed in subsequent research (Nelson and Spreen, 1978; Ospina and Shumway, 1981; Bessler, 1982). The reason advanced for this seemingly contradiction of generally accepted economic theory is the dual use of cattle as

both a final product to be consumed as meat, as well as animal stock which can be held for future production and sale.

Recognizing the interdependence between demand and supply in any market, a more rigorous approach to trade modeling was developed by Brooks, Baudin, and Schwarzbauer (1995) and used by the Food and Agriculture Organization (FAO), to conduct a multi country assessment of trade in forestry products. Their model was represented by the following;

Consumption = $f(\text{Domestic price, Import Price, and Demand Shifters})$

Production = $f(\text{Domestic price, Export Price, and Supply Shifters})$

They further postulated that consumption is comprised of goods from local consumption as well as imports. Similarly total production comprised of production for the local markets as well as for exports. In order to account for that dynamic, the equations above were expanded in the following manner;

$D_d = f(P_d, P_m, \text{Demand Shifters Domestic Market})$

$D_m = f(P_d, P_m, \text{Demand Shifter Import market})$

$S_d = f(P_d, P_x, \text{Supply Shifters for Domestic markets})$

$S_x = f(P_d, P_x, \text{Supply Shifters for Export Markets})$

where D_d is domestic demand, D_m is import demand, S_d is domestic supply, S_x is export supply, P_d is domestic price, P_m is import price and P_x is export price. While there were wide variations in the estimated elasticities across countries the signs of the cross price elasticities were consistent with economic theory. This is indicative of substitution between imported and domestic wood products as well as substitution between the domestic market and export market.

The system represented by the expanded equations utilized variables which were previously used in single equation models, but allowed for the analysis of the dynamic relationships between the domestic market and the international market. It allowed for isolating those factors important for the local market from those important to the export market, as well as examining the relationship between them.

A simultaneous equation model (SEM) was utilized to evaluate the impact of declining US retail beef demand on farm level prices and production (Marsh, 2000). Marsh utilized a four equation demand and supply system to capture the dynamics of both the beef market as well as the feeder cattle market. The system was specified as follows;

$$P^d_s = f(Q^d_s, D_r, P_b, M, \mu_1) \quad \text{Beef Inverse Demand}$$

$$Q^s_s = f(P^s_s, P_c, P_f, I, T_f, \mu_1) \quad \text{Slaughter Supply}$$

$$Q^d_s = Q^s_s = Q_s ; \quad P^d_s = P^s_s = P_s \quad \text{Market Clearing}$$

$$P^d_f = f(Q^d_f, P_s, P_c, I, T_f, \mu_3) \quad \text{Feeder Inverse Demand}$$

$$Q^s_s = f(P^s_f, P_w, P_h, T_c, \mu_4) \quad \text{Feeder Supply}$$

$$Q^d_f = Q^s_f = Q_s ; \quad P^d_f = P^s_f = P_s \quad \text{Market Clearing}$$

where Q^d_s and Q^s_s are quantity demanded and quantity supplied of cattle in million of heads and P^d_s and P^s_s are the respective demand and supply prices of slaughtered cattle. Similarly, Q^d_f and Q^s_f are the quantity demanded and quantity supplied of feeder cattle in million of heads and P^d_f and P^s_f are the respective demand and supply prices of feeder cattle. P_w is the price of slaughter cows, D_r is the estimated retail demand index, P_c and P_h are the prices

for yellow corn and hay respectively, P_b is the price of beef bi-products, M is an index of food marketing costs, I is the US prime interest rate, T_f is the technology in cattle finishing and T_c is the technology in feeder cattle production.

In order to account for delays in response to changes in price of output (slaughter animals/ feeder animals) and cost of input, as well as delays in building up the herd due to biological constraints, the system was modeled as an auto regressive distributed lag in the supply function and estimated by the iterative three stage least square (I3SLS) method.

The results of the estimation are shown in the following four equations, with most variables being statistically significant at the 5% level.

Slaughter Demand and Supply

$$\ln P_s^d = 7.566 - 0.668 \ln Q_s^d + 0.604 \ln D_r + 0.382 \ln P_b - 0.805 \ln M$$

$$\ln Q_s^s = 2.244 + .0264 \ln P_s^s - .437 \ln P_f - .013 \ln P_{c-1} - .09 \ln I_{t-1} - .12 \ln T_f \\ + 0.55 \ln Q_{s-1}^s$$

Feeder Demand and Supply

$$\ln P_f^d = 3.749 + 1.199 \ln P_s - 0.158 \ln P_c - 1.347 \ln Q_f^d + .024 \ln I - 0.220 T_f$$

$$\ln Q_f^s = 0.939 + 0.220 \ln P_{f-2}^s - 0.020 \ln P_{h-2} - 0.120 \ln P_{w-1} - 0.154 \ln T_c \\ + .0922 \ln Q_{f-1}^s$$

The above results conform generally to economic expectation. For example it can be seen that price and quantity demanded are inversely related, while marketing costs are negatively related to price. The statistically significant price elasticity of supply for slaughter animals shows that there is a co-

dependency between the price of slaughtered cattle and the quantity supplied. Feeder cattle, being an input cost is negatively related with quantity supplied.

A Simultaneous Equation Model (SEM) was employed by Noel Roy (1994) to analyze market conditions in the Canadian Atlantic Cod market. The equations were specified as follows;

$$Y_d = \alpha_d + \gamma_1 \ln Y_{(d-1)} + \gamma_2 \ln P_t' + \gamma_3 \ln P_t'' + \gamma_4 \ln P_t''' + \gamma_5 \ln I_{(t-1)} + D_{mt} + v_t$$

$$\ln Y_s = \alpha_s + \beta_1 \ln Q_t + \beta_2 \ln P_t' + \beta_3 \ln W_t + D_{mt} + u_t$$

Where,

Y_d = demand for products across time

P_t' = Price of cod across time

P_t'' = Price of substitutes across time

P_t''' = Consumer Price Index across time

I_{t-1} = Disposable income lagged by one time period.

Y_s = supply of products across time

Q_t = cod landings across time

W_t = factor prices

D_{mt} = Monthly dummy variables

Dummy variables were introduced in order to access seasonal variation in Atlantic cod demand and supply. This model was estimated using monthly time series data for the period 1972 to 1987 using three stage least square. The results of this estimation showed that demand for Atlantic cod was income elastic

and showed significant seasonal variations in demand comparative with the seasonal variation in supply.

2.3 Summary of Literature Review

Since the mid 1990s, the government of Jamaica has succeeded in maintaining stability in inflation and exchange rates, as well as achieving a small positive GDP growth rate. The country's trade policies have continued on the trend of increased liberalization, primarily through the phased reduction of the Common External Tariff. In this context of lower protection from international trade, the beef sector has experienced a contraction (number of farmers, as well as animal population) from 1990 to 2005.

Import demand has been predominantly estimated using the Imperfect Substitute Model, where quantity of imports is modeled as a function of price of imported good, price of domestic substitutes and real income. Other relevant explanatory variables and qualitative structural dummies have also been integrated. The traditional supply equation has been modeled as a function of product price, input prices and other relevant shifter. Simultaneous equation models have also been successfully used to evaluate market conditions. In this context qualitative variables have been used to account for seasonal variation.

This inquiry is primarily concerned with market demand and supply (import meat demand, domestic beef demand and domestic beef supply) response to exogenous variables. The prevailing conditions in this study include a structural shift (trade policy change), and possible interactions between import meat demand, and domestic beef supply and demand. Studies by Tanyeri-Abur and

Roson (1998), and Dutta and Nasiruddin (2006), have demonstrated the usefulness of dummy variables to test trade policy changes in import demand models. Brooks, Baudin and Schwarzbauer (1995) successfully used a system of four equations to estimate import demand, domestic demand, export supply and domestic supply, in order to account for substitutability between categories of markets. A two equation system, with dummy variables (to test for seasonal changes) was also employed by Roy (1994) to estimate the demand and supply of Canadian Atlantic cod. These studies show the econometric procedures which have been successfully used to study situations with features similar to the subject of this inquiry.

Chapter 3

3.0 Modeling and Data

In this section, the theoretical framework underlying the specification of the econometric model is provided. This forms the basis for specifying an import demand model, and a three equation system of import meat demand, domestic beef demand and domestic beef supply model. A description of the sources of data, and data transformation procedures followed is also presented.

3.1 Analytical Framework for Demand models

The underlying principles for the demand function specified was the Imperfect Substitute Model (Goldstein and Khan, 1985) but also informed by consumer utility maximization (Robert and Daniel, 2005). Although domestically produced beef is a different product from imported meats, (a composite group of products) it may display some level of substitutability in use. Meat consumers in the Jamaican meat market will seek to maximize utility, subject to their income constraint as shown below:

$$\text{Maximize } U(I_m, D_b, X_i) \text{ subject to } P_{im}I_m + P_{db}D_b + X_i \leq Y \quad (1)$$

Where,

I_m = Imported meats

D_b = Domestic beef

X_i = all other goods

Y = Income

P_x = 1

The LaGrange function therefore is;

$$L = U(I_m, D_b, X_i) + \lambda(Y - P_{im}I_m - P_{db}D_b - X_i) \quad (2)$$

The first order condition are represented as;

$$L_{IM} = \frac{\partial U}{\partial I_m} - \lambda P_{im} = 0$$

$$L_{DB} = \frac{\partial U}{\partial D_b} - \lambda P_{db} = 0$$

$$L_X = \frac{\partial U}{\partial X} - \lambda = 0$$

$$L_\lambda = Y - P_{im}I_m - P_{db}D_b - X = 0$$

$$I_m^* = f(P_{im}, P_{db}, Y) \quad (3)$$

$$D_b^* = f(P_{im}, P_{db}, Y) \quad (4)$$

Quantity of imported meats (I_M^*) is determined by the price of imported meats, the price of locally produced beef (substitutes), and real income (among other shifters), which is represented in equation 5.

$$\text{Import meat demand} = f(\text{Import Price, Local Price, Income}) \quad (5)$$

Demand for locally produced beef (D_b^*) is also dependent on the price of imported meats, the price of local beef, and income, as shown in equation 6.

$$\text{Local beef demand} = f(\text{Import Price, Local Price, Income}) \quad (6)$$

The solutions represented by equations 5 and 6 are consistent with the estimation approaches employed by Goldstein and Khan (1985), and the

extensions to various research contexts (Deyak, Sawyer, and Sprinkler, 1993), (Merver, 1993), Narayan and Narayan, 2005) and (Tanyeri-Abur and Rosson, 1998).

The maximization problem expressed as an implicit function facilitates conducting a comparative static analysis of the impact of domestic price, import price and a tariff on both import and domestic demand.

$$\text{Maximize } U(I_m, D_b, Y - P_{im}(t)I_m - P_{db}D_b) \quad (7)$$

$$\text{Where } X = Y - P_{im}(t)I_m - P_{db}D_b$$

The comparative static is facilitated by taking the total derivative of the unconstrained utility function, and individually investigating the impact of the exogenous variables (prices, and tariff rates) on the endogenous variables. In Appendix III, the complete mathematical derivation for this comparative static is presented. The results of this comparative static show that;

$$\frac{\partial I_m}{\partial P_{im}} < 0, \quad \frac{\partial I_m}{\partial P_{db}} > 0, \quad \frac{\partial I_m}{\partial t} < 0, \quad \text{and} \quad \frac{\partial D_b}{\partial P_{im}} > 0, \quad \frac{\partial D_b}{\partial P_{db}} < 0, \quad \frac{\partial D_b}{\partial t} > 0$$

These results imply that as the price of imported meat increases the quantity demanded will decrease; as the price of domestic beef increases the quantity of imported meats will increase; and as the tariff rate increases the quantity of imported meats will decrease. Additionally, as the price of imported meats increases the quantity demanded from domestic beef sector will increase; as the price of domestic beef increases the demand for domestic beef will decrease; and as tariff increases, demand for domestic beef will increase.

3.11 Estimated Demand Models

The utility maximization shown in the previous section (equations 1 to 6) provided the foundation for developing the estimated economic model.

$$\text{Import Meat Demand} = f(\text{Meat import Price, local beef price, Income}). \quad (8)$$

Exchange rate was shown by Aydin, Ciplak, and Yucel, (2004) to be significant in determining the quantity of imports to Turkey. Macro economic theory suggests that when a currency devalues it becomes relatively more expensive to purchase imported goods (Shafaeddin, 1995). In Jamaica's case the Jamaica Dollar has lost value against most major currencies consistently over the last three decades (see Table 1). Exchange rate was therefore included in order to evaluate its impact on meat imports. Per capita consumption of chicken in 2006 was approximately 80 kg per capita per year (Levey, 2007). This level of consumption is close to the per capita consumption in the United States, and above the average consumption in industrialized countries (Jamaica Broilers, 2007). This data suggest that chicken is an important meat source in Jamaica and could be a substitute for imported meats as well as domestic beef. It was therefore initially included as an explanatory variable in the import demand equation. However, preliminary examination of the data revealed that domestic price of chicken was highly correlated with the price of domestic beef. As a result it was dropped from the model. In order to evaluate the impact of the trade policy shift on the quantity of meat import demand, an intercept dummy variable was introduced; where D equals 0 between 1979 to 1993, and 1 between 1994 to

2005. The model with anticipated signs of the coefficients is specified as follows;

$$\text{Import Meat Demand} = f (-\text{Import Price}, +\text{Local Beef Price}, +\text{Income}, + \text{Exchange rate}, + D) \quad (9)$$

The domestic beef demand was specified using a similar mix of variables to the import meat demand in equation 9. The model with the anticipated signs of the coefficients is specified as follows;

$$\text{Local beef demand} = f (+ \text{Import Price}, - \text{Local Beef Price}, + \text{Income}) \quad (10)$$

3.2 Analytical Framework for the Supply Model

Conventional economic theory suggests that firms will seek to maximize their profits by increasing or decreasing their output in relation to output prices and input costs. The supply of beef from the local sectors will be driven by the desire of farmers to maximize profits, given a particular production function, where profit (π) is the difference between revenue and costs.

$$\Pi = P.f(l, k) - wl - rk \quad (11)$$

Where

P = price of domestic beef

l= labor

k = capital

w= wages (labor cost)

r = interest rate (capital cost)

The LaGrange representing this is;

$$\mathcal{L} = P.Y - rk - wl + \lambda[f(l, k) - Y] \quad (12)$$

The first order condition with respect to labor, capital cost, and the LaGrange multiplier (λ) is;

$$\frac{\partial L}{\partial l} = -w + \lambda fl(l, k) = 0$$

$$\frac{\partial L}{\partial k} = -r + \lambda fk(l, k) = 0$$

$$\frac{\partial L}{\partial \lambda} = f(l, k) - Y = 0$$

$$\frac{\partial L}{\partial Y} = P - \lambda = 0$$

The solution from this first order condition yields the optimal demand for labor and capital represented by;

$$l^* = g(p, w, r,) \quad (13)$$

$$k^* = g(p, w, r,) \quad (14)$$

The profit function above is converted into a value function by inserting these optimal inputs to yield;

$$\Pi^* = P \cdot f(l^*, k^*) - w l^* - r k^* \quad (15)$$

$$\Pi^* = P \cdot f[(g(p, w, r,), g(p, w, r,)) - w[g(p, w, r,)] - r[g(p, w, r,)] \quad (16)$$

By Hotelling's Lemma, the partial derivative of the optimal profit function with respect to output price yields the supply function;

$$\frac{\partial \Pi}{\partial P} = f[g(p, w, r,), g(p, w, r,)] \quad (17)$$

The traditional supply function shown above, derived from the optimal profit function with respect to output price, shows that quantity supplied is a function of price of product and cost of input. In this framework, quantity supplied

is expected to be increasing with price and non increasing in input costs. Output from the sector will therefore be largely determined by the price of local beef, and the cost of factor inputs.

3.21 Estimated Supply Model

Building from the supply equation derived in the previous section and the precedents observed in the literature, the domestic supply for beef was specified as follows;

$$\text{Local Beef Supply} = f(+\text{Local Supply Price}_{t-1}, -\text{Wage rate}_{t-1}, -\text{Bank Lending Rate}_{t-1}, -D, -D^* \text{ Local Supply Price}) \quad (18)$$

The practice of applying a one year lag to supply variables has been a convention of past estimations of beef supply functions (Reutlinger, 1966). It is conceivable that the price received in a previous time period will serve as an indicator of future prices for the product. The production processes involved in beef production are inherently long-term. It is therefore conceivable that costs associated with beef production in earlier periods could impact on production decisions, thereby impacting supply in future periods. As a result one year time lags were also applied to the cost variables (wage rate and bank lending rate). As in the import demand model previously shown, dummy variables were applied to assess the impact of the trade policy change in quantity of domestic beef supplied. In addition in order to evaluate the responsiveness of the domestic beef sector to price signals before and after the policy changes a slope dummy variable (associated with domestic beef supply price) was applied.

3.3 Approaches to Estimation

Micro economic theory suggests that substitute products (in this case imported meats and domestic beef) cause a shift in demand. This is indicative that there will be an interactive relationship between quantity of imported meats and the quantity of beef produced from domestic sources. Likewise local supply and demand will seek to find equilibrium quantity and price. From these relationships it is implicit that import demand for meats, and domestic supply and demand for beef (locally produced) are interrelated and could be estimated by a simultaneous model.

A review of existing literature revealed that a single equation import demand model adequately captures the effect of structural changes. It was also shown in the literature review that systems estimation such as Brooks, Baudin and Schwarzbauer (1995), were effective in estimating products substitutability in a given market.

Two approaches were adopted in this study. Firstly, a single equation import demand model (as specified in equation 9) was estimated using Ordinary Least Squares (OLS). Robust standard errors were calculated, and corrections for autocorrelation were done using Cochrane-Orcutt transformations. Secondly, as a basis for comparison, the import demand was integrated into a three equation system (equations 9, 10 and 18) and estimated using Seemingly Unrelated Regression (SUR). The SUR approach was used as the research question required that the impact of exogenous variables on demand and supply response be explicitly modeled. An additional advantage of this method of

estimation, over estimating each model individually, was an improvement in the efficiency of the estimates which were derived. The results of both models are presented in Section 4.

3.4 Data Considerations

Table 3 provides a summary of the data used in this study and the sources from which they were drawn.

Table 3. Data Sources for the Study

Variables	Import Meat Demand	Domestic Beef Demand	Domestic Supply Beef	Data Source
Quantity of meat imports	√			UN Comtrade
Domestic beef output		√	√	Ministry of Agriculture
Price of imported meats	√	√		UN Comtrade
Demand price of domestic beef	√			Statistical Institute of Jamaica
Price of domestic chicken	√	√		Statistical Institute of Jamaica
Per capita income	√	√		World Bank
Exchange rate	√			Bank of Jamaica
Supply price of domestic beef			√	Jamaica Livestock Association
Domestic interest rate			√	Bank of Jamaica
Minimum wage rate (used as a proxy for farm wage)			√	Planning Institute of Jamaica
Dummy	√		√	
Dummy*supply price domestic beef			√	

Yearly time series data for the period 1979 to 2005 were used in this analysis, i.e. 27 observations for the single equation model, and 26 observations for the SUR model. The low number of observations represents a weakness of this research as the normality assumptions of the error term may not be met. This weakness is partly offset by estimating the model in a SUR, thereby improving the efficiency of the estimates.

Various forms of data transformations were conducted prior to estimating the model. A brief description is provided below.

1. Quantity of meat imports: UN Comtrade provided the data for quantity of imported meats in kilograms. This was converted to pounds.
2. Price of meat imports: UN Comtrade provided the volume of meat imports as well as the total value. The unit price was therefore calculated from the given volume and value.
3. Domestic beef output: The Ministry of Agriculture's Data Bank provided the total weight of animals in pounds for before 1989, and kilograms (kgs) from 1990 to 2005. The quantities in kgs were converted to pounds.
4. Domestic demand beef price: The Statistical Institute of Jamaica provided monthly prices in Jamaican currency (cents). This was first aggregated to an average annual price in Jamaican dollars converted to real prices (2005 dollars) and then converted to US dollars.
5. Domestic supply price for beef was sourced from the minutes of beef committee meetings of the Jamaica Livestock Association. This price

was also converted to real prices (2005 dollars) and expressed in US dollars.

3.5 Chapter Summary

Consumer utility maximization and profit maximization provided the conceptual foundations for developing the econometric models. Drawing on the precedents set in previous estimations of similar research questions, three models were specified. Import demand was estimated using OLS, and a three equation system (which included import meat demand, domestic beef demand and domestic beef supply) was estimated using SUR. Data used in the analysis were sourced from several public bodies in Jamaica, the Jamaica Livestock Association, the United Nations and the World Bank.

Chapter 4

4. 0 Presentation of findings

In this section, the results of the models are shown. A brief discussion of these findings is also presented. Lastly, various scenario analyses are conducted to evaluate possible market outcomes with two tariff policy approaches.

4.1 Import Demand Model

Table 4 shows the coefficients and associated t statistics for the single equation import demand model. The explanatory power of the model is demonstrated through the R^2 value which indicates that the model explains 47% of import demand. The coefficients shown in Table 4 in general have the expected signs and should be interpreted as elasticities.

Table 4. Results for Import Demand Model

Variables	Cons	Import Meat Price	Dom Beef Price	GDP Per Capita	Exchange Rate	D2
Coefficients	19.3	-0.21	0.16	-0.21	-0.007	0.57
t value	2.04	-0.71	0.87	-0.19	-0.08	2.22
N=26			$R^2 = .47$			

In this model the only significant variable was the dummy variable. The result provides evidence that the trade policy change¹⁴ brought about by the phased reduction of the CET, resulted in a 57% increase in the quantity of

¹⁴ The policy change in question involved a phased reduction in the tariffs on imported meet from 187% in 1991 to 38% in 1998.

imported meats. This is consistent with international trade theory which posits that a tariff reduction will result in an increase in the volume of imports. The high t statistic associated with this variable provides strong evidence of a trade creating impact of the policy change.

4.2 Seemingly Unrelated Regression Demand and Supply Model

Results from the seemingly unrelated regression estimates are provided in Table 5. Included in this model were equations for meat import demand, domestic beef demand and domestic beef supply, and the results demonstrated explanatory power with R^2 values of .73, .61 and .39 respectively.

Table 5 Results for Seemingly Unrelated Regression Estimates

Import Demand						
Variables	Cons	Import Meat Price	Dom Beef demand Price	GDP Per Capita	Exchange Rate	D
Coefficients	19.4	0.08	0.37	-0.23	-0.09	0.92
z value	2.65	0.24	2.86	-0.26	-1.39	4.95
N=27			R ² = .73			
Domestic Demand						
Variable	Cons	Domestic beef demand price	Import Meat Price	GDP Per Capita		
Coefficients	33.99	-0.25	0.48	-1.91		
z value	10.04	-3.52	2.30	-5.00		
N = 26			R ² = .61			
Domestic Supply						
Variables	Cons	Domestic Beef supply Price	Wage Rate	Bank Lending Rate	D	D* Beef supply price
Coefficients	17.84	0.28	0.004	-0.24	-0.12	-0.57
z value	50.9	1.94	0.06	-2.79	-0.97	-2.67
N = 26			R ² = .39			

The estimates of the seemingly unrelated regression model resulted in more variables being statistically significant, while generally conforming with the expected signs. In the import demand equation, significant variables at the 5% level were domestic beef demand price and the dummy variable. The result suggests that a one percent increase in the price of domestic beef will increase the quantity of imported meats by .37%. This level of elasticity suggests that there is some substitutability between domestic beef and imported meats. This is lower than the elasticity of .6 for chicken with respect to beef price in Turkey (Halil, 2002), as well as the elasticity of 1.54, for low quality imported beef with respect to the price of poultry and pork, in the US (Van, Everett, and Wayne, 2000).

In relation to the dummy variable, the result implies that consequent to the change in trade policy, the quantity of imported meat increased by 92%. This result provides strong evidence of the trade creating impact of tariff removal on imported meats.

On the domestic demand side, the significant variables at the 5% level were the domestic beef demand price, price of imported meats and per capita income. The results suggest that a one percent increase in domestic beef demand price will reduce its demand by .25%. In addition a percentage point increase in the price of imported meats will increase the demand for domestic beef by .48%. This is further evidence of the substitutability between domestic beef and imported meats. The results also show that a one percentage increase in income will reduce the demand for domestic beef by 1.91%. The negative

income elasticity implies that domestic beef has the characteristics of an inferior good in the domestic market. This result was counter to expectations, as Jamaican beef is considered to be of fairly high quality and is perceived as a better product than many of the cheaper imported substitutes. This is a very significant finding, and warrants further discussion under a separate heading (see section 4.3).

On the domestic supply side of the model, domestic beef supply price was significant at 10%, and commercial bank lending rate and the slope dummy variable (interaction term associated beef domestic supply price), was significant at the 5% level. The results suggest that a percentage point increase in the supply price of domestic beef will result in a .28% increase in the quantity of domestic beef supplied. Given the long term nature of cattle production this inelastic short term price response is understandable. In addition the coefficient on the interaction term suggests that after the policy change the price elasticity of supply was reduced by .57%. This means that after the policy change the short term supply response became more inelastic. Studies earlier cited in the literature review such as (Reutlinger, 1966) even showed a negative short term price elasticity of supply. It has been accepted that beef farmers in response to high price show a tendency to cut back on the sale of animals in the short term in order to maximize future earnings at a higher price. On the flip side, in a flat market with reducing prices, it could be anticipated that farmers may slaughter more animals in order to reduce future losses. While the elasticity in this analysis was positive, the small price response may be reflecting the dynamic profit

maximizing (loss minimizing) decision making of farmers. The JLA report (previously cited in the literature review), indicated that beef farmers in Jamaica reduced the size of their herds in the face of lower priced imported meat products. It is therefore possible that in more favorable price environments (which occurred towards the end of the study period in 2004 and 2005), farmers did not have the capacity to respond. An alternative reason for this response may be that farmers not only viewed their animals as commodities per say, but as capital stock which guarantees future earnings. These factors may help to explain the inelastic supply response suggested by the result.

The commercial bank rate results imply that a percentage point increase in bank lending rate will reduce beef supply by .24%. This makes a strong link between the cost associated with capitalizing a farm and the decision to expanding output.

4.3 Why is Domestic Beef an Inferior Good?

In the domestic demand results presented in the previous section, the negative coefficient on income suggested that Jamaican domestic beef is an inferior good, or may be viewed as such by Jamaican consumers. This is a very significant finding and runs counter to expectations. From a purely technical, product content point of view, Jamaican beef may be comparable or even superior to beef from other countries in the world. In defending the quality of Jamaican beef, industry representatives often refer to local cattle as being completely grass fed, uses more environmentally friendly production practices, free from diseases such as BSE, and does not use antibiotics at the same level

as farmers in some other countries. This section, (while acknowledging the need for further research) attempts to provide some contextual arguments why this phenomenon may be true.

There are three main reasons which could explain the perception of Jamaican beef to be a negative good. These arguments are health related, product innovation, and restaurant market development. The last two factors are somewhat related.

First, over the last decade and a half, medical research has reported extensively that red meat (which includes beef) contributes to the incidence of heart diseases. There has been reports which established a link between cardiovascular disease and increased consumption of red meat (Pramparo Palmira et al., 2006). Findings such as these influence public education efforts geared towards preventing diet related diseases. It is therefore plausible that over time consumers changed their preference away from beef to more healthy options. There is some indication that Jamaican consumers view beef as a less healthy meat option, compared to chicken, pork and a vegetarian diet. Since the real income in Jamaica has been increasing with time, the analysis may therefore show a reduction of beef demand with income as consumers shifted their preference to more healthy options.

Second, over the last ten years, local meat companies have been developing indigenous brands of local convenience foods. Most of these innovations have been in the chicken, and the vegetable industries. For example, one local company has developed an entire family of products

including, pre-cut chicken, pre-seasoned chicken and pre-cooked chicken among others. The beef industry, has lagged behind in this respect, and persists in selling basic cuts through the traditional channels in the local markets and supermarkets. The development of convenience foods may be in response to the demands of a new and emerging market. As the society evolves and more women become involved in the work place, the opportunity cost of meal preparation time increases. It has been found in previous studies that shoppers with limited meal preparation time and higher incomes will pay a higher price for convenience (Capps, Tedford, and Havlicck, 1985). To the extent that the beef industry lags behind in this kind of product innovation, consumers may purchase less beef as their income increase.

Third, over the last 15 to 20 years, there has been a significant increase in the number of fast food restaurants across the island. These include international chains (such as KFC), but also local chains (such as Island Grill, and Juicy Patties), which provide menus which are biased towards chicken, fish and pork dishes. As a consequence, with increasing incomes, and a greater capacity to eat prepared meals away from home, the structure of the market provides few opportunities for beef consumption compared with other forms of meat.

These three factors to varying degrees could help to explain the findings of domestic beef being an inferior good which was presented earlier. These ideas could provide the basis for further economic analysis. However, it may be worthwhile to consider this result in designing a strategic redevelopment plan for

the industry. Recommendations based on these findings will be provided in the conclusion.

4.4 Scenario Analysis of Alternative Trade Regimes

As indicated in the introduction of this thesis, major players in the domestic beef industry have actively lobbied the government to provide tariff protection for the local beef sectors. The government of Jamaica through the protocols governing the CET in CARICOM has the autonomy to increase tariff rates against products which are considered competing goods. A policy decision in this direction would however be counter to the general trend of increased market liberalization, and may attract countervailing tariffs from existing trade partners. While acknowledging that this may be an improbably course of action, it is useful to evaluate the market response which may result under two different tariff regimes. The analysis is conducted by utilizing results for calculating demand and supply shifters presented in Nicholson (2005). The resulting formula from this derivation is applied as follows;

$$\text{Elasticity}_{\text{beef price, tariff}} = \frac{\text{Elasticity}_{\text{beef quantity demanded, tariff}}}{\text{Elasticity}_{\text{beef supply, supply price}} - \text{Elasticity}_{\text{beef demand, demand price}}}$$

An increase in the tariff rate would raise the price of imported meats at the same rate as the tariff increase (Jamaica being a small country). Therefore the elasticity of beef demand with respect to import price, is representing the elasticity of beef demand with respect to tariff. Using the estimates¹⁵ from the

¹⁵ The supply estimates in this study yielded inelastic short run own price supply elasticities. In the long run it is anticipated that the response will become more elastic. For the purpose of this analysis the price supply elasticity previously estimated by Brester (1996), was used.

econometric analysis and the formula outlined the price elasticity with respect to tariff is calculated.

The elasticity of quantity demanded with respect to tariff = 0.48

The elasticity of supply with respect to price = 0.28

The elasticity of supply with respect to price (Brester 1996 estimate) = 0.86

The elasticity of demand with respect to price = -0.25

Therefore Elasticity_{price, α} = .48/ (.86-(-.0.25)) = 0.78

This elasticity means that a one percent increase in tariff would increase the domestic price of beef by 0.78%.

4.41 Scenario One: Increasing Import Tariff from 38% to 68%

Under this scenario, if the government of Jamaica increases its tariffs on meat from 38% to 68%, then the price of beef would increase by 23.4%. By multiplying this percentage change in price by the elasticity of supply we obtain an estimate of the percentage change in quantity of output which could be expected from the producers. Therefore, as shown in table 6, a 20.1% increase in output would result from the increasing tariff by 30%.

Table 6. Supply Response with a 30% Tariff Increase

Beef supply 2005 (kgs)	Tariff increase	Change in supply price	Change in supply	Quantity of supply after tariff (kgs)
18,550,457.00	30 %	23.4%	20.1%	22,279,098.86

4.42 Scenario Two: Increasing Import Tariff from 38% to 98%

Under this scenario, if the government of Jamaica increases its tariffs on meat from 38% to 98%, then the price of domestic beef would increase by

46.8%. As shown in table 7 this will result in the supply of beef increasing by 40.2%.

Table 7. Supply Response with a 60% Tariff Increase

Beef supply 2005 (kgs)	Tariff increase	Change in supply price	Change in supply	Quantity of supply after tariff (kgs)
18,550,457.00	60 %	46.8%	40.2%	27,232,070.88

4.43 Summary of Scenarios One and Two

It can therefore be concluded that the application of a tariff on imported meats will result in an increase in the domestic supply over the medium to long term. Table 8 shows a summary of the changes calculated in scenarios one and two.

Table 8. Anticipated Changes in Beef Supply for Scenarios One and Two

	Beef supply 2005 (kgs)	Anticipated beef supply after tariff increase (kgs)	Change in beef supply (kgs)
Scenario 1	18,550,457.00	22,279,098.86	3,728,641
Scenario 2	18,550,457.00	27,232,070.88	8,681,613

The supply response which was observed in this analysis is a non-trivial outcome, especially for members of the farming community. For example, the anticipated change in supply under scenario 2, represents potential earning of US\$8.2 million or J\$5.1 billion (using 2005 nominal price). Beef farmers therefore have strong incentives to lobby government to provide protection from international trade, through the imposition of higher taxes.

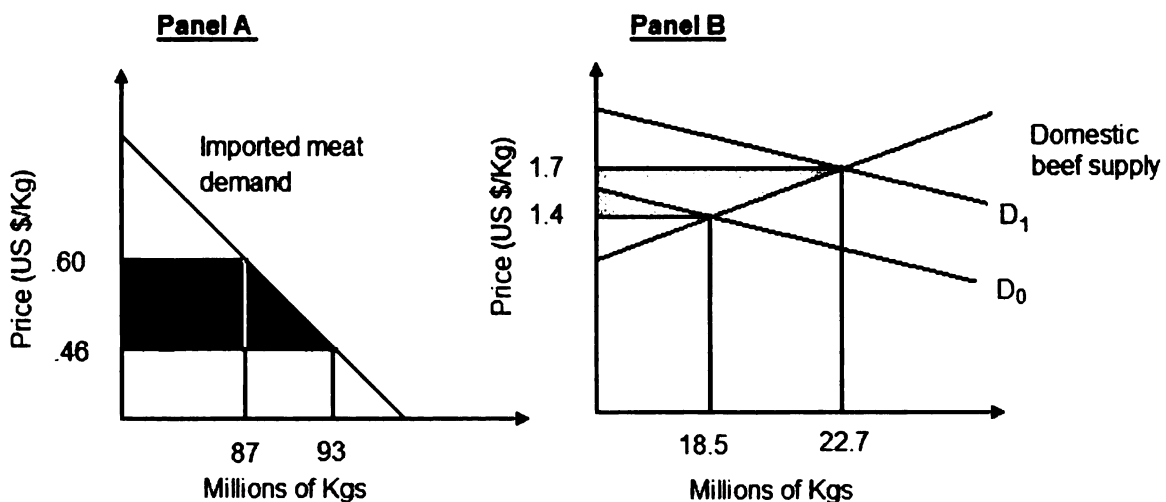
The analysis would not be complete without looking more generally at the welfare impacts of any new trade policy. In Section 4.5, a welfare analysis using scenario one is presented.

4.5 Welfare Analysis

It is generally accepted that in any policy change there may be winners and losers associated with the transfer and distribution of consumer surplus and or producer surplus. This analysis will examine the impact of a 30% tariff increase on consumption and production decisions in order to identify who the losers and winners may be, and estimate the welfare impact to society in general.

Social welfare is the sum of producer and consumer surplus. The graphs in Figure 1 illustrate the distribution of consumer and producer surplus given this hypothetical tariff increase.

Figure 3. Welfare distribution of 30% Tariff Increase



Panel A represents the reduction in the quantity of imported meats demanded with a 30% increase in tariff. Since imported meats and domestic beef are substitutes, a reduction in quantity demand of imported meats due to price increase results in an increase in demand for domestic beef. This increase in demand is represented in panel B, by an outward shift in the demand curve from D_0 to D_1 . This increase in demand and the price signal it brings is the main cause for the increase in supply of domestic beef. The change in consumer and producer surplus presented in sections 4.51 and 4.52, were calculated using shaded areas under the curves in figure 1. The area shaded black in panel A, represents the reduction in consumer surplus that would occur given a 30% increase in tariff on imported meats. The area shaded grey in panel B represents the increase in producer surplus farmers would be expected to gain given a 30% tariff increase.

4.51 Change in Consumer Surplus

As noted earlier, an increase in tariff will increase the price of imported meats by the amount of the tax. Therefore a tariff increase by 30% would raise the price to the consumer from US \$0.46 per pound in 2005 to US \$0.6. This means consumers would have to cut back in consumption and or switch to more affordable meat substitutes. The results from the import demand model suggest, that a 30% increase in the price of imported meats would decrease imported meat demand by 6.3%. This means that demand of imported meats would fall from 93.3 million kilograms to 87.4 kilograms. Using these prices and quantities, and calculating the shaded area in panel A of figure 1, a 30% increase in tariff on

imported meats results in a loss of US\$ 12.6 million (JA\$763 million) to consumers, or JA \$282.59 per capita. Imported meats are generally cheaper sources of protein upon which the lower income groups depend. This policy could therefore impose economic harm on the poor and vulnerable groups in the society. In addition, the domestic price of beef would be expected to increase by 23.4%. This means that the quantity of domestic beef consumption could fall by 5.85%. This is another source of loss in consumer surplus. However, this component of change in consumer surplus was not quantified.

4.52 Change in Producer Surplus

The analysis presented in the previous section showed that a 30% increase in tariff would increase production by 20%. This represents a n increase from 18,550,457 kgs in 2005 to 22,260,548.40 (or a change of 3,710,091.4 kgs) in the short to medium run. Using output and the prices change of 23.4% suggested by scenario analysis 1 (see section 4.41), this projected increase in output would represents an improvement in the welfare position of producers to the tune of US\$ 6.15 million (JA\$385.4 million)

4.53 Total Welfare Change

The total welfare change of a 30% tariff increase is the sum of the changes in producer and consumer surpluses generated by the tariff. From quantifiable results, the total welfare change would be minus US \$6.65 million (minus JA \$418.9 million). Figure 1 illustrates that the area representing gains to producers (shaded area in panel B), is smaller than the area representing loss to

consumers (shaded area in panel A). This suggests that by applying a tariff of 30%, while the producers may benefit greatly the society in general will face a net loss. This finding is consistent with traditional trade theory which posits that tariffs do not satisfy the conditions of Pareto efficiency due to the generation of dead weight loss.

4.6 Chapter Summary

In chapter four the conceptual and analytical frameworks were presented. A single equation import demand model was estimated using ordinary least squares. Demand and supply equations were also estimated using seemingly unrelated regression. The results and discussions of the results showed that the tariff regime did have an impact on meat import demand. It was also shown that there was substitutability between imported meats and domestic beef. The supply response of domestic beef with respect to its own price was inelastic in the short term, and became even more inelastic after the policy change. Further analysis of the results showed that a policy of increasing tariff would reduce consumer surplus resulting in a net loss to the society.

Chapter 5

5.0 Policy Implications

This study found that the potential welfare effects of increasing tariffs, make protectionism an unattractive and improbably policy option at this time. A brief discussion on possible courses for the strategic direction of the Jamaican beef sector is presented. Given the sector's response, and the policy initiatives of the government, Jamaica's beef sector could rebound in response to emerging market opportunities. Recommendations on possible future research are also made.

5.1 Possible Course of Action for Domestic Beef Sector

The analyses which were presented in the previous chapter showed clear relationships between the trade policies of the last two decades and the economic wellbeing of the consumers of imported meats and domestic beef, as well as farmers who are involved in beef production. Farmers are not without good cause in lobbying for change in order to protect their interests. What ever actions are taken can now be partly informed by this research.

It is important to note that the options of retuning to a high tariff regime may not be the most appropriate response for the beef sector. First, as the welfare analysis showed, an increase in tariff would erode consumer surplus, especially among the poor in the society. This would not be a politically appealing decision for the government. Second, Jamaica is a signatory not only

to the CET of CARICOM, but to several other bilateral and multilateral trade treaties (including the WTO). A protectionist policy would run counter to Jamaica's interest in gaining access to global markets. Third, the provision of tariff protection may not provide the right kinds of incentives which will stimulate the industry to adopt and respond appropriately to the changing market environments.

The following three recommendations are proposed as alternatives strategies to the provision of tariff protection.

5.11 Strategy One

The first recommendation involves organizing farmers as a coordinated production system with greater levels of vertical integration. Currently, there is little vertical integration in the system. Farmers are involved in all stages of production, and compete against each other within the same small market. It may be possible to gain scale efficiencies in some operations, by specializing in a specific subset of the production process (e.g. growing weaners, or fatteners). By organizing the sector in this way, the industry can work strategically to regain price competitiveness, as well as to attain consistency in standards.

The Jamaica Livestock Association, with its long standing traditions may be ideally suited to provide leadership in this kind of organization. This concept of vertical integration could be extended to include slaughtering, meat distribution and marketing functions in which member farmers have a share in ownership.

5.12 Strategy Two

The second recommendation is for the beef sector to aggressively launch a public relations campaign which focuses on the quality of Jamaican beef. Results from beef demand estimates presented in chapter four, which suggested that Jamaican beef is an inferior good, make this recommendation especially important. In addition, the sector should invest resources in developing new and attractive ways of serving beef in local restaurants. They should also invest resources in developing and promoting processed beef products to tap into the increasingly expanding convenience foods market. Adopting this approach could attract attention to domestic beef and its potential positive attributes as an alternative source of animal protein.

5.13 Strategy Three

The third strategy is for the domestic sector to target critical niche markets which exist in Jamaica and throughout the Caribbean. For example, the local hospitality sector sources most of their beef products from the United States. By working through the vertically integrated approach, mentioned in strategy one, premium specialized cuts of beef required by the hospitality sector can be supplied. This market is valued at US \$8 million (JA \$560 million) (USDA, 2002)

5.14 Role of Government

Although tariff protection is not being recommended at this time, the government of Jamaica can play an important role in helping to revitalize the sector. They could provide fiscal incentives through the provision of tax credits,

and or low interest loans for infrastructure and herd improvement. This is particularly important given the negative relationship shown between commercial lending rates and domestic beef supply. Bearing in mind the negative relationship between domestic lending rates and domestic beef supply, the government in partnership with lending institutions, could create a line of credit at lower interest rates. This could provide the financial support required to recapitalize the sector and to attain the levels of production efficiencies required.

The government through its research and extension institutions must continue to provide the technical support required by farmers. This will help farmers to improve their cattle husbandry practices and attain greater productivity. A key role for the government is to access technical support and new farming techniques through institutions such as Caribbean Agriculture Research and Development Institute (CARDI), and the Inter American Institute for Cooperation on Agriculture (IICA) among others. The government through the Ministry of Science and Technology's Food Technology Institute can also provide technical support in helping the industry develop marketable products as a part of a product diversification and rebranding drive. Support could also involve the importation of mature heifers to provide breeding stock (as well as sire services and or artificial insemination services) in order to quickly restore the size of herds. This way the government could help restore the capacity of the sector to respond to the positive price signals which are now present in the market.

5.2 Prognosis for the Future

In spite of the challenges which the domestic sector faced over the last 10 to 15 years, the Jamaican beef sector can create a better future. The level of success will be contingent on how well the industry, in partnership with government, responds to changing market environments.

Two forces operating at the global level have slowly been increasing the price of imported meats. First, the aggressive bio-fuels policy which has been pursued in the United States (from which most if Jamaica's meat imports originate) has caused an increase in the price of corn and subsequently the price of meats. Second, the increasing price trend of fuels will increase transportation costs and may also impact on the price competitiveness of imported products. These two changes could provide the price incentive for Jamaican farmers to reorganize the industry.

Jamaican beef farmers therefore have reasons to be optimistic about the future. This can be realized if the sector is re-organized in such a way as to capture production efficiencies, implement programs which re-brand beef as a healthy, nutritious, convenient and delicious meat alternative and aggressively position itself to cater to niche markets (such as the hospitality industry), in Jamaica and the Caribbean region.

5.3 Conclusion

Through the use of traditional trade equations (Ordinary Least Squares and Seemingly Unrelated Regression), the results showed that the phased

reduction of the Common External Tariff did harm the domestic beef sector. These points to the need for governments to implement programs which will empower domestic industries to adapt to international competition when trade policies change. The results also showed that domestic beef is viewed as an inferior good. A Welfare analysis computed using the estimated elasticities showed that an increase in tariff, while creating benefits to farmers, will not be welfare improving to society in general. Given the prevailing international trading environment, the use of tariff protection goes against the trend of increased liberalization and could spawn a "tariff war" with trading partners.

A more viable option to restoring the domestic beef industry is to find new efficiencies through industrial reorganization and vertical integration, repositioning the sectors for emerging market opportunities through the CSME, develop and market value added products, and aggressively promote the consumption of domestic beef as a healthy meat alternative. The government will need to play an important role in providing: fiscal incentives; access to capital; extension service, marketing and product development and other forms of support. Recent inflationary market forces could provide the price incentives for farmers to re-organize and expand the domestic beef industry. Efforts at re-organization should be focused on making beef farmers more efficient, promote the use of appropriate modern techniques, promote product development geared towards value added products and being responsive to niche markets which exist in Jamaica and the Caribbean (such as the hospitality industry). This approach

would position the domestic industry to compete more effectively in both the domestic and global market.

5.4 Possible Future Research

This research showed that domestic beef is an inferior good. While the results were conclusive using the existing data, this phenomenon needs to be investigated in more detail. My recommendation is to use a mixed method approach utilizing both qualitative and quantitative techniques. The qualitative approaches could investigate domestic demand for beef, while including other meat sources as substitutes in the model. An additional quantitative approach may also be to investigate the relationship of fast food restaurants to beef consumption and other meats. Alternatively, a qualitative inquiry could be conducted utilizing in-depth interviews or focus groups with shoppers/home makers to elicit their perceptions of beef vis a vis other meats, and the manner in which they arrive at their shopping and consumption decisions. These procedures would bring more clarity to the issue and provide useful information to guide the strategic direction of the beef industry.

Appendices

Appendix I Trends in Tariff Levels

Table 9. Average Tariff Rates Applied to Selected Imports

	1993	1995	1999
Aerated water	30.0	25.0	20.0
Infant formula	20.1	17.5	10.0
Fish (snapper, mackerel, etc)	26.1	25.5	28.4
Chicken and parts thereof	20.0	24.0	28.7
Medicaments	9.8	9.71	15.0
Printed books and periodicals	0.0	0.0	0.0
Napkins/sanitary towels/diapers/toilet tissues	26.7	23.3	20.0
Paper/paperboard	5.0	0.0	0.0
Jewellery	30.0	30.0	30.0
Watches and calculators	30.0	30.0	30.0
Tennis shoes/slippers/footwear	21.3	22.8	15.8
Articles of plastic	13.9	11.2	7.4
Motor cars	19.8	19.8	25.0
Corn seed	0.0	0.0	0.0
Refined sugar	40.0	0.0	0.0
Wheat	0.0	0.0	0.0
White rice	30.0	25.0	25.0
Sodium hydroxide (caustic soda)	5.0	0.0	0.0
Paper products (paper boxes)	19.0	13.9	10.6
Bottles and Jars	15.0	10.0	4.6
Bunker (c grade oil)	15.0	15.0	10.0
Motor spirit (gasoline)	3.8	3.8	3.8
Parts for aircraft engines	5.0	5.0	10.0
Tyres	10.3	7.0	6.7
Parts for motor vehicles	8.2	8.6	13.9
Coaches and buses	7.9	5.4	5.7
Construction materials	16.5	10.9	8.4
Telephonic and telegraphic applications	5.0	5.0	5.0
Data processing equipment	5.0	5.0	5.0

(Source: Statistical Institute of Jamaica)

Appendix II Optimization Problems

Import and domestic demand

Maximize $U(I_m, D_b, X_i)$ subject to $P_{im} I_m + P_{db} D_b + X_i \leq Y$

Where

I_m = Imported meats

D_b = Domestic beef

X_i = all other goods

Y = Income

$P_x = 1$

The LaGrange function therefore is;

$$L = U(I_m, D_b, X_i) + \lambda(Y - P_{im} I_m - P_{db} D_b - X_i)$$

First order condition

$$L_{IM} = \frac{\partial U}{\partial I_m} - \lambda P_{im} = 0$$

$$L_{DB} = \frac{\partial U}{\partial D_b} - \lambda P_{db} = 0$$

$$L_X = \frac{\partial U}{\partial X} - \lambda = 0$$

$$L = Y - P_{im} I_m - P_{db} D_b - X = 0$$

$$I_m^* = f(P_{im}, P_{db}, Y)$$

$$D_b^* = f(P_{im}, P_{db}, Y)$$

Comparative Static

A comparative static was conducted in order to establish a sound theoretical basis for the expected signs of the coefficients which were to be estimated. The approach taken was to convert the utility function previously outlined into the implicit function.

$$\text{Maximize } U(I_m, D_b, Y - P_{im}(t)I_m - P_{db}D_b)$$

$$\text{Where } X = Y - P_{im}(t)I_m - P_{db}D_b$$

The total derivative of this implicit function is then taken.

$$DU = \frac{\partial U}{\partial I_m} .dI_m + \frac{\partial U}{\partial D_b} .dD_b + dY - \left[\frac{\partial U}{\partial P_{im}(t)} \cdot \frac{\partial P_{im}(t)}{\partial t} .dt .I_m + \frac{\partial U}{\partial I_m} .dI_m .P_{im} \right]$$

$$- \left[\frac{\partial U}{\partial P_{db}} .dP_{db} .D_b + \frac{\partial U}{\partial D_b} .dD_b .P_{db} - \right] = 0$$

$$DU = \frac{\partial U}{\partial I_m} .dI_m + \frac{\partial U}{\partial D_b} .dD_b + \frac{\partial Y}{\partial Y} dY - \frac{\partial U}{\partial P_{im}(t)} \cdot \frac{\partial P_{im}(t)}{\partial t} .dt .I_m - \frac{\partial U}{\partial I_m} dI_m .P_{im}(t)$$

$$- \frac{\partial U}{\partial P_{db}} .dP_{db} .D_b - \frac{\partial U}{\partial D_b} .dD_b .P_{db} - \left] = 0$$

This forms the basis for conducting a comparative static. The research is concerned primarily with how a change in tariff impacts the quantity (demand) of imported meat, as well as the quantity (demand) of domestic beef. However, this comparative statistic also looked at how the demand changed with respect to the price of substitutes, and income.

To determine the impact of P_{im} on the demand for I_m divide by dP_{im} and assume no change in domestic price, income and tariff. Set $dP_{db} = dY = D_t = 0$

$$\frac{\partial U}{\partial I_m} \frac{dI_m}{dP_{im}} + \frac{\partial U}{\partial D_b} \frac{dD_b}{dP_{im}} - \frac{\partial U}{\partial I_m} \frac{dI_m}{dP_{im}} P_{im}(t) - \frac{\partial U}{\partial D_b} \frac{dD_b}{dP_{im}} P_{db} = 0$$

$$\frac{dI_m}{dP_{im}} = \frac{\frac{\partial U}{\partial D_b} \cdot \frac{dD_b}{dP_{im}} \cdot P_{db} - \frac{\partial U}{\partial D_b} \cdot \frac{dD_b}{dP_{im}}}{\frac{\partial U}{\partial I_m} - \frac{\partial U}{\partial I_m} \cdot P_{im}(t)} < 0$$

To determine the impact of P_{db} on the demand for I_m , divide by dP_{db} and assume no change in domestic price, income and tariff. Set $dP_{im} = dY = D_t = 0$

$$\frac{\partial U}{\partial I_m} \frac{dI_m}{dP_{db}} + \frac{\partial U}{\partial I_m} \frac{dI_m}{dP_{db}} - \frac{\partial U}{\partial I_m} \frac{dI_m}{dP_{db}} P_{im}(t) - \frac{\partial U}{\partial P_{db}} \cdot D_b - \frac{\partial U}{\partial D_b} \frac{dD_b}{dP_{db}} P_{db} = 0$$

$$\frac{dI_m}{dP_{db}} = \frac{\frac{\partial U}{\partial D_b} \cdot \frac{dD_b}{dP_{db}} \cdot P_{db} - \frac{\partial U}{\partial D_b} \cdot \frac{dD_b}{dP_{db}}}{\frac{\partial U}{\partial I_m} - \frac{\partial U}{\partial I_m} \cdot P_{im}(t)} > 0$$

To determine the impact of tariff (t) on the demand for I_m , divide by dt and assume no change in import price, domestic price, and income. Set $dP_{im} = dY = dP_d = 0$

$$\frac{\partial U}{\partial I_m} \frac{dI_m}{dt} + \frac{\partial U}{\partial D_b} \frac{dD_b}{dt} - \frac{\partial U}{\partial I_m} \frac{dI_m}{dt} P_{im}(t) - \frac{\partial U}{\partial D_b} \frac{dD_b}{dt} P_{db} = 0$$

$$\frac{dI_m}{dt} = \frac{\frac{\partial U}{\partial D_b} \cdot \frac{dD_b}{dt} \cdot P_{db} - \frac{\partial U}{\partial D_b} \cdot \frac{dD_b}{dt}}{\frac{\partial U}{\partial I_m} - \frac{\partial U}{\partial I_m} \cdot P_{im}(t)} < 0$$

Jamaica being a small country, an increase in tariff will also increase the price, therefore demand for imported meats will decrease.

To determine the impact of P_{im} on the demand for D_b , divide by dP_{im} and assume no change in domestic price, income and tariff. Set $dP_{db} = dY = D_t = 0$

$$\frac{\partial U}{\partial I_m} \frac{dI_m}{dP_{im}} + \frac{\partial U}{\partial D_b} \frac{dD_b}{dP_{im}} - \frac{\partial U}{\partial I_m} \frac{dI_m}{dP_{im}} P_{im}(t) - \frac{\partial U}{\partial D_b} \frac{dD_b}{dP_{im}} P_{db} = 0$$

$$\frac{dI_m}{dP_{im}} = \frac{\frac{\partial U}{\partial I_b} \cdot \frac{dI_m}{dP_{im}} \cdot P_{im}(t) - \frac{\partial U}{\partial I_m} \cdot \frac{dI_m}{dP_{im}}}{\frac{\partial U}{\partial D_b} - \frac{\partial U}{\partial D_b} \cdot P_{db}} > 0$$

To determine the impact of P_{DB} on the demand for D_B , divide by dP_{db} and assume no change in import price, income and tariff. Set $dP_{im} = dY = D_t = 0$

$$\frac{\partial U}{\partial I_m} \frac{dI_m}{dP_{db}} + \frac{\partial U}{\partial D_b} \frac{dD_b}{dP_{db}} - \frac{\partial U}{\partial I_m} \frac{dI_m}{dP_{db}} P_{im}(t) - \frac{\partial U}{\partial P_{db}} \cdot D_b - \frac{\partial U}{\partial D_b} \frac{dD_b}{dP_{db}} P_{db} = 0$$

$$\frac{dD_b}{dP_{db}} = \frac{\frac{\partial U}{\partial I_m} \cdot \frac{dI_m}{dP_{db}} \cdot P_{im}(t) - \frac{\partial U}{\partial I_m} \cdot \frac{dI_m}{dP_{db}}}{\frac{\partial U}{\partial D_b} - \frac{\partial U}{\partial D_b} \cdot P_{db}} < 0$$

To determine the impact of tariff (t) on the demand for D_B , divide by dt and assume no change in import price, domestic price, and income.

Set $dP_{IM} = dY = dP_d = 0$

$$\frac{\partial U}{\partial I_m} \frac{dI_m}{dt} + \frac{\partial U}{\partial D_b} \frac{dD_b}{dt} - \frac{\partial U}{\partial P_{im}(t)} \frac{dI_m}{dt} P_{im}(t) - \frac{\partial U}{\partial D_b} \frac{dD_b}{dt} P_{db} = 0$$

$$\frac{dD_b}{dt} = \frac{\frac{\partial U}{\partial P_{im}(t)} \cdot \frac{dI_m}{dt} \cdot P_{im}(t) - \frac{\partial U}{\partial I_m} \cdot \frac{dI_m}{dt}}{\frac{\partial U}{\partial D_b} - \frac{\partial U}{\partial D_b} \cdot P_{db}} > 0$$

Supply Function

Supply derived from maximized profit function, where profit (π) is represented by;

$$\Pi = P \cdot f(l, k) - wl - vk$$

Firms will seek to maximize profits subject to a technology constraint. The LaGrange function is;

$$L = P \cdot Y - rk - wl + \lambda[f(lk) - Y]$$

FOC

$$\frac{\partial L}{\partial l} = -w + \lambda f_l(l, k) = 0$$

$$\frac{\partial L}{\partial k} = -r + \lambda f_k(l, k) = 0$$

$$\frac{\partial L}{\partial \lambda} = -f(l, k) = 0$$

The solutions provide optimal input demand for labor and capital

$$L^* = g(w, r, y)$$

$$K^* = g(w, r, y)$$

Inserting these optimal inputs into the profit functions yield a value function

$$\Pi = P \cdot f(l^*, k^*) - w l^* - r k^*$$

$$\Pi = P \cdot f[g(w, r, y), g(w, r, y)] - w[g(w, r, y)] - r[g(w, r, y)]$$

The partial derivative of the profit function with respect to output price yields the supply function.

$$\frac{\partial \Pi}{\partial P} = f[g(w, r, y), g(w, r, y)]$$

Supply will therefore be a function of product price, price of labor, and price of capital.

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