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Caribbean Food Import Demand: An Application of the CBS Differential Demand System

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Abstract

This study uses a Central Bureau Statistics (CBS) demand system to estimate food import demand parameters for the Caribbean region. The analysis is based on food import data for 1961–2009 from the FAO-STAT database. The study determined that for the defined period the Caribbean food import demand was price inelastic, and that tourism arrivals and real income growth were not statistically significant in determining food import demand. However, per capita agricultural production was found to be statistically significant in determining Caribbean food import demand over the study period.

Keywords: Caribbean; Central Bureau Statistics demand system; food import demand; price elasticity; scale elasticity

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Introduction

The Caribbean region comprises a diverse set of countries, including the small island nations of the Organization of the Eastern Caribbean States (OECS) and Barbados, the larger island nations of Haiti, Trinidad and Tobago, Dominican Republic, Cuba and Jamaica, the continental countries of Guyana, Belize and Suriname, and several dependent territories and special municipalities. As small, open economies[1], they are easily affected by global events, and tend to rely on the United States, the European Union, China and Taiwan for trade, economic assistance and financial investment. The region also has a history of high levels of international migration. Several countries in the region hold membership in the Caribbean Community (CARICOM) and the Organization of the Eastern Caribbean States (OECS); these organizations were established in 1973 and 1981, respectively, in order to enhance the economic leverage and effectiveness of member states in their integration efforts with the global economy. Among other objectives, they promote socio-economic development and functional cooperation among members, and coordinate policy formulation within the region. Table 1 lists the member and associate states of both organizations, along with the other countries and territories of the Caribbean region.

With the exception of Belize, Guyana, and Suriname, most Caribbean countries are net food importers that have grown increasingly dependent on food imports over time. Increased incomes and population, urbanization, lifestyle changes, expansion of the tourism sector, the decline in agriculture and low domestic capacity for food production in general have been identified as contributing factors (Caribbean Community 2010; Gonzalez 2011). Imported foods account for much of the caloric intake in the region, and particularly for subgroups such as CARICOM. For some food categories—staples[2] in particular—the gap between domestic consumption and production is quite significant, with consumption two to nearly four times greater than production (Mendoza and Machado 2009). The vulnerability posed by this gap was apparent during the global food price escalations in 2007/2008: across the Caribbean, food price increases directly impacted domestic inflation rates[3] but had no discernible impacts on food import levels, signaling an inelastic demand for food imports to the region (Mendoza and Machado 2009). Food import bills across the region increased sharply in 2008, with CARICOM spending close to US $4 billion on food imports in that year alone (IICA 2010). It is worth noting that as a subgroup of Caribbean countries, issues faced by CARICOM members are consistent with those that affect the region in general.

Given geographical proximity, the United States is a major supplier of food products to the Caribbean with an estimated market share of 58%, and the region is the 7th largest export market for US consumer-oriented foods (Gonzalez and Nishiura 2013). In 2009, approximately 87% of the wheat imported into the CARICOM was sourced from the United States, in addition to 98% of maize imports and 79% of poultry imports (Agritrade 2011). Overall, the strong appeal of US

[1] Open economies are those that readily engage in international trade and global financial transactions. Proxies most widely used in economic literature to reference small size include a country's population size and its share of world trade. Despite a high degree of openness, small states usually represent very small shares of world trade (WTO, 2002), and are price takers in international markets.

[2] In the context of the Caribbean diet, staples comprise such food items as corn, potatoes, rice, wheat, cereals and pulses, and are the dominant portion of the diet. Wheat is not grown in the region and must be imported.

[3] The effect of price increases on the Caribbean consumer price index is expected given the importance of food imports in the consumption basket on which the index is based.

products among the Caribbean population and the expansion of the tourism sector are additional factors that fuel the demand for US products (Gonzalez 2014).

Table 1. The CARICOM, the OECS, and other Caribbean countries and territories

(a) Member and Associate States of the CARICOM and the OECS[4]	**(b) Other**
Antigua and Barbuda*	Cuba
Anguilla*	Dominican Republic
The Bahamas	Aruba, Curacao, Sint Maarten, Bonaire,
Barbados	Saint Eustatius, and Saba[5]
Belize	Guadeloupe, Martinique, St. Barthélemy,
Bermuda	and St. Martin[6]
British Virgin Islands*	Puerto Rico
Cayman Islands[a]	United States Virgin Islands
Dominica*	
Grenada*	
Guyana	
Haiti	
Jamaica	
Montserrat*	
St. Lucia*	
St. Kitts and Nevis*	
St. Vincent and the Grenadines*	
Suriname	
Trinidad and Tobago	
Turks and Caicos	

Given the preceding context, the objectives of this study are to characterize the trends in food imports to the Caribbean and to estimate agricultural food import demand parameters. Our analysis is based on data for 1961-2009 from the FAO-STAT database. The Central Bureau Statistics (CBS) demand system by Keller and Van Driel (1985) is used to estimate the food import demand parameters, and is specified as a set of partial-differential equations. Aside from one study that looked at Caribbean import demand for starchy staple foods (Dameus et al. 2001), we are unaware of other studies that analyze Caribbean food import demand across several food product categories. Research that addresses this deficit could allow for better understanding of food import demand in the region, particularly in light of its importance as an export market for US consumer oriented foods.

[4] The countries listed in part (a) comprise the Caribbean Community (CARICOM). Anguilla, Bermuda, the British Virgin Islands, the Cayman Islands, and the Turks and Caicos Islands are associate member states of CARICOM. Although not it is considered part of the Caribbean geographically, Bermuda acquired membership in July 2003, and is therefore listed. The Organization of the Eastern Caribbean States (OECS) subgroup is denoted by an asterisk. Anguilla and the British Virgin Islands are associate member states of the OECS. Anguilla, Bermuda, the British Virgin Islands, the Cayman Islands, Montserrat and the Turks & Caicos Islands are also British Overseas Territories.
[5] This group comprises the Dutch Caribbean. The first three islands are constituent countries of the Kingdom of the Netherlands. The last three islands are characterized as special municipalities of the Netherlands.
[6] This group comprises the French Overseas Territories.

Changing Dynamics in the Caribbean Economy

The past fifty years have been a period of remarkable socio-economic change in the region. Within this time frame, most countries achieved independence and became more deeply integrated with the global economy, albeit via a system of protected integration that ensured Caribbean agricultural exports preferential access to European markets (Lewis 2002). For decades, the sugar and banana industries were the primary foreign exchange earners for some countries and received higher preferential marketing prices under the Lomé Convention[7]. Despite the benefits afforded by preferential access, it tended to disincentivize production of more highly valued, non-traditional agricultural commodities for export markets (ECLAC 2010). It also reinforced and encouraged production and export of a narrow range of primary commodities by most of the countries in the region. Caribbean agricultural trade therefore remained relatively undiversified, with agricultural production more export oriented and poorly aligned with domestic food and manufacturing production (Hornbeck 2008).

In 2006, the challenges of globalization and the emergence of a single European (EU) market led to trade reforms away from quotas to a tariff-only system, thereby exposing Caribbean economies to greater global competition. With the loss of preferential market access, an inability to effectively compete in global markets became apparent: production constraints imposed by small size significantly limited the possibilities for exploiting economies of scale, resulting in higher costs for exported goods and reduced competitiveness of the sugar and banana industries. Significant economic and employment losses were recorded in several countries, particularly those that relied on earnings from sugar and banana exports.

In the years following these events, some regional governments have opted to pursue economic diversification strategies oriented more toward service sectors such as financial services and tourism. The tourism sector expanded significantly over the past thirty years and, except in the immediate aftermath of the September 2001 terrorist attacks and the 2008 global recession, recorded solid growth during the 2000s due to foreign direct investment inflows and steady growth in key advanced economies. Tourism has assumed greater economic importance in many Caribbean countries, as reflected in its contribution to GDP, employment and foreign exchange earnings, in particular, at the regional level and in individual countries. At the regional level, tourism revenues comprised about 16.6% of GDP between 1980 and 2008. At national levels, the tourism sector's importance is even more pronounced: in 2008, for example, its share in GDP ranged from 4.4% in Suriname to 73.5% in Antigua and Barbuda. Similar trends were evident for its share in total employment: from 4% in Suriname to 80.6% in Antigua and Barbuda (WTTC 2009; ECLAC 2010). The World Travel and Tourism Council (WTTC) estimated that travel and tourism contributed about US $26.2 billion dollars of visitor export earnings to Caribbean economies in 2011 (WTTC 2011). Economic trends such as these could be expected to positively affect levels of food imports to the Caribbean (Gonzalez 2011).

In contrast, the contribution of the agricultural sector to GDP has declined over time for the region as a whole (Agritrade 2011; Bourne 2008). On the supply side, productivity constraints

[7] The Lomé Convention provided a framework of cooperation between the European Community (EC) and the developing African, Caribbean and Pacific (ACP) Countries. It provided for duty free entry of agricultural exports into the EC. It also offered preferential access based on a quota system.

due to small scale operations, limited public and private investment, labor shortfalls and natural disasters are key factors that have contributed to low food production capacity. In addition, the divergence between the commodity composition of domestic food demand and that of domestic food supply, and a lack of price competitiveness in export and domestic markets are other issues that further exacerbate weak performance of the sector in many Caribbean countries (Bourne 2008). With respect to lack of price competitiveness in domestic markets, imported food products are often significantly cheaper than domestic production in some countries (Agritrade 2011).

In tandem, the aforementioned conditions appear to have contributed to the region's dependency on food imports over time. Import data from the Food and Agriculture Organization (FAO) for 1961-2009 show the trends in Caribbean food imports across several product categories (Figures 1 and 2). These include dairy, animal products, fruits and vegetables, oils, staples and a miscellaneous foods category, which includes beverages and spices. Imports increased across all food categories over time, with the largest increases recorded for the staples and miscellaneous foods categories. The staples and miscellaneous foods categories show the largest increases in import quantities over time (Figure 1). Consequently, import values also increase over time, and particularly for the miscellaneous foods category that comprises more high-value consumer food products (Figure 2).

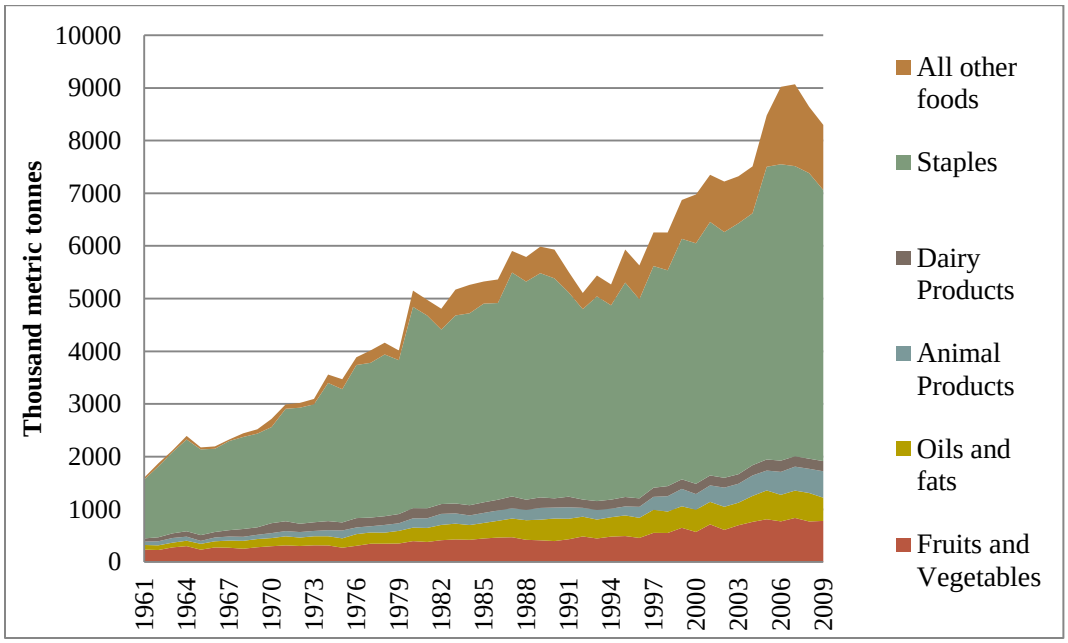

Figure 1. Quantity of food imported to the Caribbean region by category, 1961–2009.

Source: Food and Agriculture Organization of the United Nations (FAO). 2011. TradeSTAT

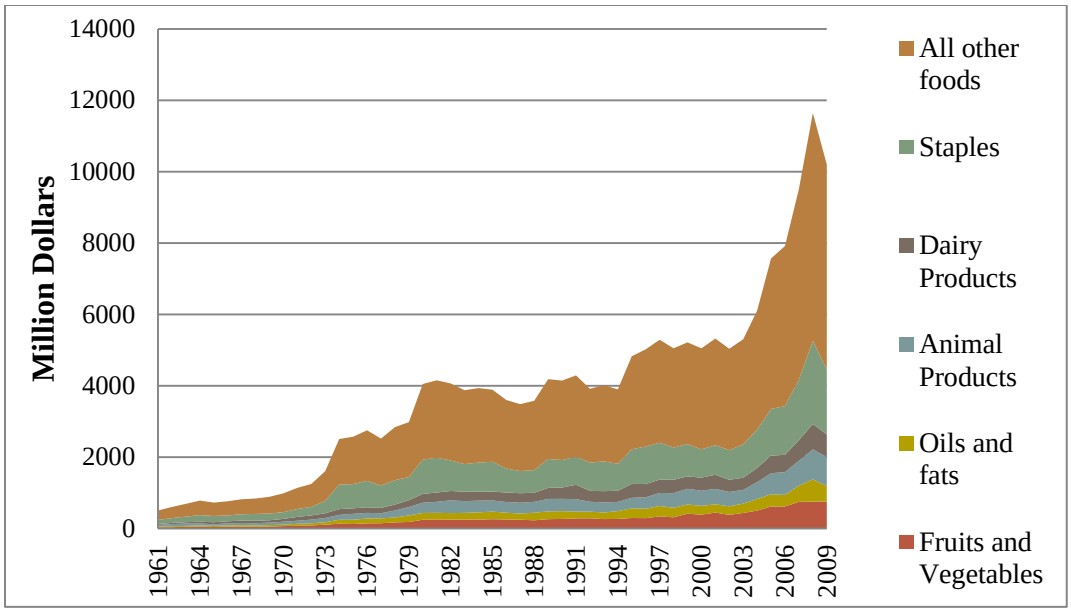

Figure 2. Value of Caribbean food imports by category, current dollars, 1961–2009.

Source: Food and Agriculture Organization of the United Nations (FAO). 2011. TradeSTAT

Import Demand Analysis via System-Wide Approach

Studies that have analyzed import demand at a disaggregated level in a system-wide approach are fairly common in recent literature. A number of these studies have considered the import demand for one commodity but either by product types or product form (DeVoretz 1982; Muhammad, Jones and Hahn 2007; Schmitz and Seale 2002; Goodwin, Harper and Schnepf 2003). Other studies have considered demand for a product based on source country, product type, and/ or product form for the same commodity (Jones, Hahn and Davis 2003; Muhammad and Jones 2009; Muhammad and Jones 2011; Jones, Muhammad and Mathews 2013).

A number of demand studies have also analyzed consumption patterns within a particular industry. Demand studies within the meat industry abound. It is typical to include broad categories such as beef, pork, and poultry. These aggregate demand studies assume that meat types from all sources are homogeneous with single prices (for example: Eales and Unnevehr 1988; Lusk et al. 2001; Taljaard and Schalkwyk 2004; Henneberry and Hwang 2007; Holt and Balagtas 2009). Other studies have looked at source of origin in order to isolate quality or other attributes that origin may offer (Mutondo and Henneberry 2007; Jones, Hahn and Davis 2003; Muhammad and Jones 2011). However, in the case of import demand studies, if consumers (or importers) are indifferent to the exporting country, this allows for aggregation across exporting sources in the analysis indicating that no additional information is obtained by further disaggregation (Asche, Bremnes and Wessells 1999).

Demand studies covering the food and agriculture sector are also common. Huang (1988) applied the inverse demand system to thirteen aggregate food categories and non-food sectors from 1947 to 1983. His study was aimed at exploring the interdependent nature of food price variations in

response to quantity changes. Janda, McCluskey and Rausser (2000) estimated the Czech Republic food import demand during the transition period of the 1990s and looked at eight crop and livestock food commodities. Blanciforti and Green (1993) incorporated habit formation in an Almost Ideal Demand System (AIDS) model to make the model dynamic. For the Caribbean specifically and differentiating by import source (US and the rest of the world), Dameus et al. (2001) estimated import demand elasticities for several starchy staple foods (wheat, corn, rice and fresh potatoes) using a Restricted Source Differentiated Almost Ideal Demand System (RSAIDS).

All of the aforementioned models were designed to capture the demand for food and aggregate commodity groups. It is not uncommon to extend the basic demand systems model to capture demographic and other demand shifters (Alston, Chalfant and Piggott 2001). Common extensions include seasonal dummy variables and time trend variables (Arnade and Pick 1998). In most studies, the importance of these variables are evaluated based on the statistical significance of the parameter estimates. Other studies have extended their model to look at the impact of advertising (Brester and Schroeder 1995; Coulibaly and Brorsen 1999); advertising and health, (Kinnucan et al. 1997); and disease risk in demand (Burton and Young 1996; Burton, Young and Cromb 1999).

Methodology

Demand-Model Structure

The Central Bureau of Statistics (CBS) differential demand system derived by Keller and Van Driel (1985) is chosen to estimate Caribbean agricultural import demand parameters. Differential demand systems with price effects (CBS and Rotterdam) better explain consumers' purchase allocation decisions compared with models containing variable price effects (Almost Ideal Demand System (AIDS) and National Bureau of Research (NBR) (Fousekis and Revell 2000). In addition, the CBS model combines attractive features from both the AIDS and the Rotterdam models, in that it combines the non-linear expenditure effects of the Almost Ideal Demand System (AIDS) (Deaton and Muellbauer 1980b) and the price effect of the Rotterdam model (Theil 1966; Barten 1969).

The Rotterdam model meets negativity conditions on the Slutsky matrix required for a downward sloping demand curve if its price coefficients are negative, semi-definite.

The CBS demand system starts with a set of partial-differential equations:

$$(1)\quad w_i \cdot \left[\partial \ln(q_i) - \sum_j w_j \partial \ln(q_j) \right] = \sum_j c_{i,j} \partial \ln(p_j) + b_i \left[\partial \ln(x) - \sum_j w_j \partial \ln(p_j) \right]$$

where ln(.) is the natural-logarithm; q_i and p_i are the quantity and price of the i^{th} good, x is the total group expenditure, and w_i is the budget share for the i^{th} good, defined as $w_i = \frac{p_i q_i}{x}$. The terms $c_{i,j}$ and b_i are coefficients. In order for the system of equations to be consistent with theory, the following restrictions on the coefficients must hold:

(2) $$\sum_i c_{i,j} = \sum_j c_{i,j} = \sum_i b_i = 0,$$

(3) $$c_{ij} = c_{ji}, \forall i, j$$

Homogeneity of degree 0, consistent with the budget constraint, and Slutsky symmetry conditions are satisfied by Equations 2 and 3. Demand elasticities are derived from model coefficients and the budget shares:

(4) $$\varepsilon_{i,j} = \frac{c_{i,j} - b_i w_j - w_i w_j}{w_i}$$ (price elasticities)

(5) $$\varepsilon_{i,x} = 1 + \frac{b_i}{w_i}$$ (expenditure elasticities)

Although the CBS demand system is based on consumer demand theory, we use unit values which we characterize as wholesale demand value to capture Caribbean agricultural import demand. Given the analytic parallel between consumer demand and derived demand, use of the CBS model in a derived demand context is simply a matter of interpretation. The CBS model, like other differential demand systems, starts with a set of differential-in-logarithms equations. The budget constraint in log-differential form is expressed as:

(6) $$\partial \ln(x) = \sum_i w_i \partial \ln(p_i) + \sum_i w_i \partial \ln(q_i)$$

From equation (6) we define the Divisia price (P) and quantity (Q) indices respectively as:

(7) $$\partial P = \sum_i w_i \partial \ln(p_i)$$

(8) $$\partial Q = \sum_i w_i \partial \ln(q_i)$$

Rearranging equation (6), and substituting in equation (7) and (8) yields:

(9) $$\partial \ln(x) - \sum_i w_i \partial \ln(p_i) = \sum_i w_i \partial \ln(q_i) = \partial \ln(x) - \partial P = \partial Q$$

Equation (1) can then be re-specified as:

(10) $$w_i \cdot \left[\partial \ln(q_i) - \partial Q\right] = \sum_j c_{i,j} \partial \ln(p_j) + b_i \partial Q$$

In a production context, the Divisia can be thought of as a measure of total Caribbean food import expenditures. Equation (10) implies that the change in demand for each Caribbean imported food category is driven by the changes in all Caribbean imported foods and the overall size of the Caribbean agricultural industry. In a derived demand context, b_i is referred to as a scale coefficient rather than an expenditure coefficient. By construction, the endogenous variables of the CBS demand system sum to 0 in every time period, which makes the error terms

sum to 0 as well. As such, to avoid singularity, an equation is dropped in the estimation process and retrieved at the end of the process since the estimates will be invariant to the dropped equation. In our case, we dropped the rest of the food products (ROFP) equation.

The standard CBS model is extended to include differenced variables that capture tourism arrivals, real per capita income, and value of Caribbean agricultural production. Differential demand systems offer the advantage of incorporating taste shifts into differential models much more easily than other common specifications (Alston et al. 2000). Also, transforming the data into period-to-period differences also help to address issues of stationarity. The aim is to capture the extent to which these shift variables influence overall Caribbean food import demand. One of the attractive features of the CBS demand system is that it is linear in its parameters. There is often a concern for violating Closure Under Unit Scaling (or CUUS) when incorporating shift variables such as demographics into singular expenditure systems (Lewbel 1985; Pollak and Wales 1981). However, CUUS is maintained when the incorporated parameters do not depend on the data's scaling, especially the scaling of the data related to the shift variables themselves (Alston, Chalfant and Piggott 2001; Piggott and Marsh 2004). In this case, the tourism, GDP and value of production variables are invariant to data scaling. Hypothesis tests based on the likelihood ratio test are used to capture the impact of these variables. The likelihood ratio (LR) test was used to determine if the model, with the new variable, was significantly different from the restricted model and was given as:

$$(11) \quad LR = -2[L(\tilde{\beta}, \tilde{\sigma}^2) - L(\hat{\beta}, \hat{\sigma}^2)] \sim X^2_m$$

where $L(\tilde{\beta}, \tilde{\sigma}^2)$ is the maximum of the log likelihood function when the restriction is imposed, $L(\hat{\beta}, \hat{\sigma}^2)$ is the maximum of the log likelihood function when the restrictions are not imposed and *m* is the number of restrictions.

Data

The data consist of Caribbean food import data from five broad food categories—dairy products, animal products, fruits and vegetables, oils, staples and a miscellaneous rest-of-food products (ROFP). The latter category classifies imported food items that do not fit into the previous categories, and includes beverages and spices. Dairy products comprise all dried, condensed and evaporated milk, cheese from whole milk, butter from cow's milk and eggs from poultry. Animal products comprise all meats, fresh or frozen and sausages from cattle, hogs, poultry, sheep and goats. The fruits and vegetables category consists of all of the major fruits and vegetable that are imported in fresh, frozen, peeled, dried or concentrate forms. The oils comprise olive oils, and other boiled and hydrogenated oils from vegetables. Finally, staples comprise corn, potatoes, rice, wheat, cereals and pulses.

Annual import quantities and expenditures used for developing the base model for each category, as well as the value of agricultural production and Caribbean population, were obtained from the Food and Agricultural Organization (FAO) of the United Nations Trade Statistics Division. All expenditures are in U.S dollars and all quantities are expressed in tons. Per-unit values ($/ton) for each food category was calculated. Caribbean agricultural production, tourism growth and per capita income growth were used as demand shifters in the extended model to evaluate their

impact on Caribbean food import demand. The value of agricultural production and Caribbean population were also obtained from the FAO. Per capita income (in 2005 dollars) was obtained the USDA-Economic Research Service International Macroeconomic Data Set. Tourism arrivals data was obtained from the World Tourism Organization (2011) and the Caribbean Tourism Organization (2011).

Ideally, data on quantities consumed and prices of domestically produced goods for each of the above categories are preferable. However, data on consumption of the good produced domestically are often not available, and in our case was unavailable for the Caribbean. Moreover, Emran and Alam (1999) developed a theoretically consistent test for weak separability and applied it to the case of consumer goods imports of Bangladesh and found that the null hypotheses for weak separability of non-tradeables from consumer goods imports was accepted, thus giving some credence to exclusion of domestically produced consumption from import demand study. In addition, a number of studies have assumed weak separability of consumer goods imports from non-tradeables and estimated import demand separately (Henneberry and Hwang 2007); Schmitz and Seale 2002; Muhammad and Jones 2011; Jones, Muhammad and Mathews 2013).

Results

Descriptive statistics for model variables are presented in Table 2. Both expenditure and quantity of Caribbean imports of all the food categories have steadily increased since 1961. For the period 1961 to 2009, the Caribbean spent an average of 2 billion nominal dollars per year on imported food. Expenditure on staples varied widely with a high of over $2 billion in 2008 to as little as $100 million in 1961 and averaging 740 million dollars per annum. Average Caribbean import expenditure on oils ($186 million) has been the least, though it has expanded rapidly from as low as $23 million dollars to over $600 million in 2008. In 2009, overall Caribbean food import expenditure saw a 10 percent year over year reduction from that of 2008.

Staples accounted for the largest expenditure share of food imports by the Caribbean (38.6%), whereas oils accounted for the smallest expenditure share (9.1%) of food imports. Animal products, dairy products, fruits and vegetables and the rest of the food products categories all ranged between 10% and 20% of the food expenditure share. While the share of expenditure on most food groups have remained fairly stable, the share of staples declined steadily from a high of more than 50% to just above 30% in 2009. At the same time, the share of rest of food products (ROFP) steadily increased from as low as 4% to as high as 23.5% in 2009. This suggests that Caribbean consumers are expanding the range of food products they consume to capture a more diverse set of food groups. Moreover, while the staple food category commanded the largest share of expenditure, it accounted for the lowest unit value ($197.6 per ton) of food imported by the Caribbean. Animal products were by far the most expensive product imported into the Caribbean with an average unit value of $1,322.4 per ton.

Estimated conditional price and share demand coefficients are reported in Table 3. As expected, all compensated own price coefficients were negative and, for the most part, compensated cross price effects were positive. Based on the estimated price and share demand coefficients along with the average budget shares for the sample period, own and cross price elasticities and scale or expenditure elasticities were calculated. These estimates are presented in Table 4. The standard errors are asymptotic estimates generated in SAS using the estimate procedure.

Table 2. Descriptive statistics for Caribbean food imports, 1961-2009.

Commodity Group	Mean	Standard Deviation	Minimum	Maximum
	Annual Budget Share (%)			
Dairy Products	13.2	2.0	10.1	18.3
Animal Products	14.4	1.8	10.7	19.0
Fruits and Vegetables	12.9	1.3	9.7	15.2
Oils	9.1	1.0	6.4	11.8
Staples	38.6	6.4	27.8	53.6
Rest of Food Products (ROFP)	12.0	5.9	3.6	23.5
	Annual Unit Price ($/ton)			
Dairy Products	531.8	208.4	112.5	934.7
Animal Products	1,322.4	343.3	712.3	1,826.9
Fruits and Vegetables	522.8	213.6	153.6	984.9
Oils	558.0	195.7	249.9	1,152.0
Staples	197.6	71.4	100.4	429.5
Rest of Food Products (ROFP)	583.7	151.4	272.4	1,044.6
	Annual Quantity (1,000 tons)			
Dairy Products	450.0	173.7	227.4	836.1
Animal Products	203.1	117.6	56.1	502.2
Fruits and Vegetables	450.0	173.7	227.4	836.1
Oils	301.3	136.2	88.1	547.3
Staples	3,439.1	1,259.1	1,116.6	5,625.7
Rest of Food Products (ROFP)	464.7	396.5	29.3	1,554.1
	Annual Expenditure ($ Million)			
Dairy Products	260.42	161.79	26.46	713.72
Animal Products	289.08	195.31	43.09	838.89
Fruits and Vegetables	265.70	192.51	36.13	757.51
Oils	186.03	124.21	23.04	623.05
Staples	740.21	454.72	114.08	2328.16
Rest of Food Products (ROFP)	314.08	328.68	15.71	1290.66

The conditional own price elasticities represent both the substitution and the income effects of price changes and are conditional on total Caribbean expenditure on agricultural imports. The own-price elasticities for all imported products had the expected negative sign and were all statistically significant. The own-price elasticities range between -0.251 and -0.902; this indicates that the Caribbean region's demand for imported food is price inelastic. This is particularly the case with the staples, oils, and rest of food products (ROFP) categories. This finding appears consistent with Mendoza and Machado (2009), who suggested demand inelasticity for wheat and other major food imports given an observed unresponsiveness to rising international prices between 2006 and 2008. In their study of starchy foods (specifically, wheat, corn, rice and fresh potatoes) imported by the Caribbean, Dameus et al. (2001) reported own-price inelastic responses for rice sourced from the United States, and for wheat and rice sourced from the rest of the world. The region's demand for US wheat imports was found to be own-price unitary elastic.

Table 3. Estimated conditional CBS price and scale coefficients for Caribbean food imports.

	Dairy	Animal Products	Fruits and Vegetables	Oils	Staples	ROFP	Scale Coefficient
Dairy	**-0.051*** **	0.023	0.005	0.004	0.004	0.002	-0.013
	(0.018)	(0.014)	(0.015)	(0.009)	(0.012)	(0.007)	(0.026)
Animal		**-0.072*** **	0.039**	0.019*	-0.006	0.012	-0.017
Products		**(0.022)**	(0.015)	(0.010)	(0.015)	(0.009)	(0.034)
Fruits and			**-0.100*** **	-0.009	0.028**	0.016**	-0.008
Vegetables			**(0.026)**	(0.012)	(0.012)	(0.007)	(0.028)
Oils				**-0.015**	0.007	0.001	-0.053***
				(0.010)	(0.008)	(0.005)	(0.016)
Staples					**-0.003**	0.009	-0.019
					(0.020)	(0.012)	(0.045)
ROFP						**-1.077**	-0.013
						(2.307)	(0.026)

Note. Asymptotic standard errors are in parentheses. ***Significance level < 0.01; **Significance level < 0.05; *Significance level < 0.10

Table 4. Uncompensated price and scale elasticities for a CBS model of Caribbean food imports.

	Dairy	Animal Products	Fruits and vegetables	Oils	Staples	ROFP	Scale Elasticities
Dairy	**-0.519*** **	0.033	-0.091	-0.061	-0.355***	-0.103*	0.900***
	(0.135)	(0.107)	(0.117)	(0.070)	(0.089)	(0.057)	(0.201)
Animal	0.030	**-0.644*** **	0.141	0.040	-0.428***	-0.039	0.884***
Products	(0.098)	**(0.153)**	(0.106)	(0.067)	(0.103)	(0.061)	(0.234)
Fruits and	-0.093	0.157	**-0.902*** **	-0.164*	-0.170*	0.004	0.940***
Vegtables	(0.119)	(0.119)	**(0.202)**	(0.090)	(0.094)	(0.057)	(0.215)
Oils	-0.089	0.064	-0.233*	**-0.251** **	-0.306***	-0.108**	0.413**
	(0.101)	(0.107)	(0.127)	**(0.106)**	(0.085)	(0.053)	(0.180)
Staples	-0.121***	-0.159***	-0.057*	-0.072***	**-0.393*** **	-0.097***	0.950***
	(0.031)	(0.038)	(0.031)	(0.020)	**(0.051)**	(0.032)	(0.117)
ROFP	0.112	-0.037	0.300**	-0.058	-0.287	**-0.340** **	1.916***
	(0.155)	(0.188)	(0.146)	(0.100)	(0.256)	**(0.145)**	(0.433)

Note. Asymptotic standard errors are in parentheses.; ***Significance level < 0.01; **Significance level < 0.05 *Significance level < 0.10

The imported fruits and vegetables, animal products and dairy categories were less inelastic than the staples, rest of food products (ROFP) and oils categories. The fruit and vegetables category

was the least inelastic to price changes, with an own-price elasticity of -0.902, implying that a 10% increase in imported price of fruits and vegetables would decrease the quantity of imported fruits and vegetables demanded by 9%. The magnitudes of response in these categories appear to suggest that Caribbean consumers would likely replace these imported foods with locally sourced substitutes when faced with higher food import prices. This appears less likely to be the case with some staple foods, oils and items from the ROFP category, particularly if these products are not produced in the region and must be imported.

As noted earlier, the cross price elasticities are conditional on total expenditure of agricultural products imported by the Caribbean and account for both substitution effects and expenditure effects of price changes. The cross-price effect varied for most of the commodities. Positive cross price elasticities suggest some degree of substitution between imports of the different commodities, while negative cross price elasticities suggest that the expenditure effect of price changes outweigh the pure substitution effects. Cross elasticities were negative and small and statistically significant for several of the categories, particularly staples.

The scale/expenditure elasticity measures the degree by which the amount of the different groups of imported agricultural products demanded change when the overall demand for food products by the Caribbean changes. This scale elasticity is also the elasticity of the total imported agricultural products expenditure. The scale elasticities are presented in Table 4. The scale elasticities for all commodities were positive and significant. The rest of food products (ROFP) category had the largest scale elasticity of demand of 1.916, which implies that given a 10% increase in the overall food import demand by the Caribbean, the import demand for the rest of food products (ROFP) would increase by 19%. Oils showed the smallest increase in demand, 4.1%, given a 10 percent increase in the overall Caribbean food import demand.

Extensions to the standard CBS model included the addition of differenced variables of tourism arrivals, real per capita income and per capita value of Caribbean agricultural production. Treated as import demand shifters, they are included to capture the extent to which these variables influenced overall Caribbean food import demand. Table 5 shows the hypothesis tests based on the likelihood ratio test. Of these, only the per capita value of agricultural production, which declined from a high of $300 dollars in the late 1960s to less than $200 in 2009, was seen to be highly significant in determining the overall Caribbean food import demand. All three variables combined (tourism arrival, real per capita income and per capita value of Caribbean agricultural production) were found to be statistically significant in determining Caribbean food import demand. Based on the impact of the individual variables, one can conclude that the combined effect of the three variables was largely driven by the decline in the per capita value of domestic agricultural production.

Table 5. Likelihood ratio tests of the significance of tourism, income and agriculture for Caribbean food imports

		Log-Likelihood Value	LR-Statistics	P[X2< LR]=0.95	P-value
	Unrestricted	*Restricted*			
Tourism	863.699	859.620	8.157	11.070(5)	0.148
Real Per Capita Income	860.577	859.620	1.912	11.070(5)	0.861
Per Capita Ag. Production Value	866.500	859.620	13.759	11.070(5)	0.017
All Combined	871.952	859.620	24.664	24.996(15)	0.055

Summary and Conclusions

The goals of this study were to characterize the trends in food imports to the Caribbean and to estimate agricultural food import demand parameters. The analysis is based on data for 1961-2009 from the FAO-STAT database, and a Central Bureau Statistics (CBS) demand system was used to estimate the demand parameters.

We found increased levels of imports over time across six defined categories (dairy, animal products, fruits and vegetables, oils, staples and miscellaneous foods), with the largest increases recorded for staples and miscellaneous foods. The Caribbean region's demand for food imports is price inelastic, and overall food import demand over the study period was significantly influenced by the per capita value of agricultural production. The fact that Caribbean's demand for food imports is price inelastic is important. Assuming a lack of competition, increased prices for imported food may benefit food exporters in source countries although, clearly, for the Caribbean region, this would also imply significantly increased expenditures. Indeed, the latter was the case during the global food price escalations of 2007/2008, following which many countries reported significantly higher expenditures on food imports. Foods in the staples category – one of the most price-insensitive imported food groups – showed large price increases during the past decade. For Caribbean countries with an average per capita real income of less than one-tenth of that of the United States, these price increases raise concern given the region's significant dependence on imported food overall.

The per capita value of agricultural production was determined as the indicator that significantly influenced the Caribbean's overall food import demand over the study period. The per capita value of agricultural production declined from a high of $300 dollars in the late 1960s, to less than $200 in 2009. Over the same period, Caribbean agriculture as a share of GDP declined from an average high of 8% to below 3% in 2009. Much of this can be attributed to the shifting role of the agricultural sector in many Caribbean countries: economies that were once based on export-oriented crops such as sugar, bananas and cotton have significantly reduced or ceased production in recent years, while service oriented sectors have assumed more economic importance. Amidst these changes, regional population continued to grow, and increased at an average of about 4% annually between 1961 and 2009. In light of these developments, there continues to be a heavy dependence on imported food products. Therefore, evaluations of Caribbean food import demand in various contexts—differentiating by source, for specific product categories, countries or subgroups—remain areas for much needed research.

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