Caribbean Food Import Demand:
Influence of the Changing Dynamics of the Caribbean Economy

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ABSTRACT

Using FAO data for 1961-2009, this study characterizes the trends in Caribbean food imports and uses the Central Bureau Statistics demand system to estimate import demand parameters. The findings and policy implications of the study are evaluated in the context of Caribbean food security concerns.

Introduction

The Caribbean region comprises a heterogeneous set of countries, with distinct country groupings including the continental countries of Guyana, Belize and Suriname, countries with sizeable populations (Haiti, Trinidad and Tobago, Dominican Republic, Cuba and Jamaica), and the smaller countries of the Organization of the Eastern Caribbean States (OECS) and Barbados. By definition, the countries are small, open economies that are easily affected by the ongoing events in the global economy due to their reliance on developed nations[1] for trade, economic assistance and financial investment (USITC, 2008). According to the USDA-Foreign Agricultural Service, Caribbean demand for U.S. foods increased 5 percent in 2010 with the Caribbean Basin becoming the 7th largest export market for U.S. consumer-oriented foods.

Historically, economic activity in many Caribbean countries has been driven by few sectors, usually agriculture and/or tourism, or light manufacturing. Agricultural production in the region has traditionally been oriented towards export markets and less so for domestic consumption. For decades, the sugar and banana industries have been the primary agricultural earners for many Caribbean countries. These industries enjoyed higher preferential marketing prices under the Lomé Convention[2]. However, the challenges of globalization and the emergence of a single European (EU) market led to reforms in trade away from quotas to a tariff-only system in 2006. This opened up the Caribbean sugar and banana industries to greater competition from Latin America and Africa.

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[1] The United States, the European Union, China and Taiwan provide ongoing support and assistance to Caribbean countries via different arrangements.

[2] 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.

With the loss of preferential access to international markets, regional governments have opted to pursue economic diversification strategies that are more focused on service oriented industries such as financial services and tourism. Consequently, agriculture's contribution to GDP has steadily declined over time. Coupled with constraints on productivity due to small scale operations, limited public and private investment and natural disasters, the agricultural sector has performed relatively weakly in many countries (Bourne, 2008). Domestic food production has consistently been inadequate to satisfy domestic demand and, as such, Caribbean countries have grown increasingly dependent on food imports over time. Most countries are net food importers and in some food categories – staples in particular – the gap between domestic consumption and domestic production is quite significant, with consumption two to nearly four times greater than production (Mendoza and Machado, 2009).

Given this level of dependency on food imports, regional food security is clearly vulnerable to changes in global economic conditions. This was quite apparent during the world food price escalations of 2007/2008 which saw marked increases in the prices of staple foods worldwide. Given the importance of imported food in the consumption basket used to assess the consumer price index for Caribbean countries, the most direct effect of these price increases has been on domestic inflation rates (Mendoza and Machado, 2009). Interestingly, although food import bills in the Caribbean increased sharply[3], there was no noticeable impact on the level of Caribbean food imports, signaling possible inelasticity of demand for these items (Mendoza and Machado, 2009).

Concerns of an imminent food crisis prompted policymakers in the region to swiftly adopt various measures to ensure short term food security and availability of food supplies at

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[3] The Caribbean Community (CARICOM) group of countries reported food import bills approximating $4 billion during this period (IICA, 2010).

more affordable domestic prices[4]. Several countries suspended or reduced their import restrictions, whereas others curtailed exports to decrease the likelihood of food shortages and price spikes (Le Vallée, 2011). Other measures, including subsidized food sales, price controls and social programs, were targeted directly toward the most vulnerable groups and poor households. The impact of high food prices on this demographic is particularly concerning since they comprise roughly 20% of the region's population, and have food expenditure levels that comprise between 20% and 40% of total household expenditure (Bourne, 2008).

Given the aforementioned context, the objective of this study is to characterize the trends in food imports to the Caribbean and to estimate agricultural import demand parameters. Considering that the Caribbean and global economies have undergone significant change over the past few decades, and that there is a paucity of studies on food demand in the region, there is ample justification for this particular type of work.

The Central Bureau Statistics (CBS) demand system derived by Keller and Van Driel (1985) is used to estimate Caribbean agricultural food import demand parameters. The analysis is based on data from the FAO-STAT database for 1961-2009. The CBS model 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; Barton, 1969). The CBS demand system is specified as a set of partial-differential equations.

Following this introduction, sections two and three discuss the data and methodology, and the results of the analysis, respectively. Concluding remarks that are given in the final section serve to evaluate our findings and present the policy implications of the study in the context of Caribbean food security concerns.

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[4] Measures included fiscal operations to reduce or limit increases in consumer prices, and switching to less expensive foreign suppliers (Bourne, 2008).

Data & Methodology

The data consist of Caribbean food import data from 5 broad food categories—dairy products, animal products, fruits and vegetables, oils, staples and all other food. 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 variables 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) were obtained the USDA-Economic Research Service International Macroeconomic Data Set. Tourism arrivals data was obtained from the World Tourism and the Caribbean Tourism Organizations.

Demand-Model Structure

The CBS demand system derived by Keller and Van Driel (1985) is used to estimate Caribbean agricultural import demand parameters. The CBS model 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; Barton, 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 ith good, x is the total group expenditure, and w_i is the budget share for the ith 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 optimization theory, the following restrictions on the coefficients must hold:

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

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

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) $\quad \varepsilon_{i,j} = \dfrac{ci, j - b_i w_j - w_i w_j}{w_i}$ (price elasticities)

(5) $\quad \varepsilon_{i,x} = 1 + \dfrac{b_i}{w_i}$ (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:

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

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

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

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

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

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

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

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

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

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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 product (ROFP).

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). The aim is to capture the extent to which these variables influence overall Caribbean food import demand. Hypothesis tests based on the likelihood ratio test are used to capture the impact of these variables.

Results

Descriptive statistics for model variables are presented in Table 1. 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.

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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 other food products 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 2. 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 3. The standard errors are asymptotic estimates generated in SAS using the estimate procedure.

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,

revealing that the the Caribbean region's demand for imported food is price unresponsive. This is particularly the case with the staples, oils and rest of food products (ROFP) categories. Such response implies that exporters of these products to the Caribbean can increase revenue by lowering the quantity supplied. It also implies that an increase in exporters' prices for these products would result in a less than proportionate decrease in the quantity demanded by Caribbean countries. Indeed, these implications were reflected in the 2007/2008 food price spikes that resulted in large expenditure increases on imported food but with minor downturn in demand, as indicated by Mendoza and Machado (2009).

The imported fruits and vegetables, animal products and dairy categories were less inelastic than the staples, ROFP and oils categories. The fruit and vegetables category was the most responsive (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%. Although still inelastic, the magnitude of response in these categories – relative to the staples, ROFP and oils categories – would suggest that Caribbean consumers may be more inclined forego healthier imported foods than the more inelastic staples and the other food products.

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

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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 3. The scale elasticities for all commodities were positive and significant. The estimated scale elasticities for animal products and rest of food products (ROFP) were greater than one. ROFP 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 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 arrival, real per capita income and per capita value of Caribbean agricultural production. The aim was to capture the extent to which these variables influenced overall Caribbean food import demand. Table 4 shows the hypothesis tests based on the likelihood ratio test. Tourism arrivals, which have grown from 3 million people per year in 1961 to more that 20 million people in 2009, was not statistically significant in determining Caribbean food import demand. Real per capita income, which has increased approximately $35 per year since 1961, was also not statistically significant in determining Caribbean food import demand. However, the per capita value of agricultural production, which has 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

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Caribbean food import demand. Based on the impact of the individual variables it can be said that the combined effect of the three variables was largely driven by the decline in the per capita value of domestic agricultural production.

Policy Implications

The Caribbean is a heterogeneous set of islands and is characterized by varied inequality in incomes between countries and within countries. However, a study on food import demand for the Caribbean as a whole can be quite instructive. A number of the findings have policy implications and can help to inform policy within the respective countries. In this section, four key findings of the paper will be discussed: (a) the non-responsiveness of the Caribbean population to food import demand; (b) the insignificance of tourism arrivals to food import demand; (c) the insignificance of real income to import demand; and (d) the statistical significance of the decline in per capita agricultural production value to import demand.

The fact that the Caribbean is highly non-responsive to the changes in the import price of all its food import commodity groupings is important. From the standpoint of the countries exporting food products to the Caribbean, this means that they can easily increase prices to expand their revenue stream, assuming lack of competition. From the standpoint of the Caribbean region however, increases in import food prices would significantly increase food expenditures. Indeed, this 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. Clearly, 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.

With food price increases, food insecurity becomes a concern. As prices continue to increase, the likelihood of food insecurity increases, particularly for the lower income consumers in the Caribbean region. Although the Caribbean is highly insensitive to imported food prices, it is not a perfect correlation. As such, imported food price increases may also tend reduce the import demand due to lower demand, resulting in a food-deficit situation.

Nutrition also becomes a concern in situations of rapid price increases. In looking at the price sensitivities of all the food import commodity groupings, though all commodities were insensitive to price changes, some were more insensitive to price changes than others. For instance, animal products category which comprise 14% of Caribbean food imports was the least insensitive to price changes. This implies that price increases could result in Caribbean consumers foregoing animal products much quicker than the other import food commodities, resulting in a deficiency of the primary source of protein.

Tourism has grown as a major economic activity in the Caribbean, and this is reflected in data which shows increases in tourist arrivals from 3 million people annually in 1961 to 22 million people in 2009. However, our model shows that tourism arrivals were not significant in determining overall Caribbean food import demand over the study period. A number of reasons may reflect why this is so. While tourism arrivals appear to have shown significant increases, most tourists spend less than one week in the Caribbean. This implies that a tourist spending one week may be consuming only 1/52 of a resident on the island each year, which may not necessarily register a noticeable impact on overall consumption. However, it is expected that tourist arrivals increase overall economic activity on the island and may be reflected in income of the residents in the region.

Despite tourism activity reflecting in the incomes of the Caribbean residents, real per capita income did not significantly influence overall food import demand. Caribbean real per capita income has grown an average of $34 per year since 1961 but, besides food, demand for other goods and services has also grown.

The per capita value of agricultural production was determined as the indicator that significantly influenced the Caribbean overall food import demand over the study period. The per capita value of agricultural production has declined from a high of $300 dollars in the late 1960s to less than $200 in 2009. Much of this may be attributed to the fact that over the past 50 years, most of the Caribbean countries have changed from agriculture to service oriented economies. Over the same period, Caribbean agriculture as a share of GDP declined from an average high of 8 percent to below 3 percent in 2009. This is because most of the Caribbean agricultural economies that were once based on a few export-oriented crops such as sugar, cotton, or banana have reduced their production significantly and, over time, tourism, offshore banking and other services have eclipsed agricultural production. At the same time however, the data for 1961-2009 showed that the Caribbean population increased at an average of about 4 percent annually. Hence, there continues to be the dependence on imported food products.

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Table 1. Descriptive Statistics for Caribbean Food Imports, 1961-2009

Commodity group	Mean	Std. Dev	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
All other agricultural products	12.0	5.9	3.6	23.5
Annual Unit Price ($/ton)				
Dairy products	531.8	208.4	112.5	934.7
Animal Products	1,322.4	343.3	712.3	1,826.9
Fruits and Vegetables	522.8	213.6	153.6	984.9
Oils	558.0	195.7	249.9	1,152.0
Staples	197.6	71.4	100.4	429.5
All other agricultural products	583.7	151.4	272.4	1,044.6
Annual Quantity (1,000 tons)				
Dairy products	450.0	173.7	227.4	836.1
Animal Products	203.1	117.6	56.1	502.2
Fruits and Vegetables	450.0	173.7	227.4	836.1
Oils	301.3	136.2	88.1	547.3
Staples	3,439.1	1,259.1	1,116.6	5,625.7
All other agricultural products	464.7	396.5	29.3	1,554.1
Annual Expenditure ($ 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
All other agricultural products	314.08	328.68	15.71	1290.66

Table 2. CBS Coefficients for Caribbean Food Imports

	Dairy	Animal Products	Fruits and veg.	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 Products		-0.072***	0.039**	0.019*	-0.006	0.012	-0.017
		(0.022)	(0.015)	(0.010)	(0.015)	(0.009)	(0.034)
Fruits and veg			-0.100***	-0.009	0.028**	0.016**	-0.008
			(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)

Asymptotic standard errors are in parentheses.

***Significance level < 0.01

 **Significance level < 0.05

  *Significance level < 0.10

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Table 3. Compensated Price and Scale Elasticities for a CBS Model of Caribbean Food Imports

	Dairy	Animal Products	Fruits and veg	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 Products	0.030	**-0.644***	0.141	0.040	-0.428***	-0.039	0.884***
	(0.098)	**(0.153)**	(0.106)	(0.067)	(0.103)	(0.061)	(0.234)
Fruits and veg.	-0.093	0.157	**-0.902***	-0.164*	-0.170*	0.004	0.940***
	(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)

Asymptotic standard errors are in parentheses.

***Significance level < 0.01

**Significance level < 0.05

*Significance level < 0.10

Table 4. Likelihood Ratio Tests of the Significance of Tourism, Income and Agriculture Caribbean Imports

	Log-Likelihood Value		LR-statistics	P[X2< LR]=0.95	P-value
	UR	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