International Agricultural Trade and Policy Center

CARICOM BILATERAL TRADE:
A PRELIMINARY ANALYSIS USING THE GRAVITY MODEL

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Abstract: This paper investigates the determinants of intra-CARICOM bilateral trade and the CARICOM member's trade with the North American and European countries using the gravity model. Seventeen annual cross-sections are estimated for the period 1980 through 1996. Overall, the empirical results indicate that the gravity model has considerable potential to explain intra-CARICOM bilateral trade as well as trade between CARICOM members and non-members. The evidence suggests that both the importer's GDP per capita and the exporter's GDP per capita exert strong positive effects on CARICOM trade levels. Since these effects are found to be statistically the same, we conclude that the gravity model is symmetric with respect to GDP per capita. Further, sharing a common language, colonial ties, or membership in the CARICOM all significantly contribute to larger volumes of bilateral trade, while geographic distance has the opposite effect. Both the exporting and the importing countries' populations have a positive effect on trade levels, indicating that larger economies have a wider production base and thus export and import more than would smaller economies.

Key Words: Caribbean economies, CARICOM, FTAA, Gravity model, Regional integration

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Introduction

Created in 1973 by the Treaty of Chagauramas, CARICOM is the oldest regional grouping in the hemisphere. The original Caribbean Community (CARICOM) was comprised of the 12 English-speaking countries: Antigua and Barbuda, the Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, and Trinidad and Tobago. Dutch-speaking Suriname was admitted in 1995, and The Bahamas and Haiti are in the process of being admitted. While CARICOM is the largest regional grouping in the Western hemisphere in terms of member countries, it is by far the smallest in terms of economic size. The total population of CARICOM excluding Haiti is about 6 million, and its combined gross domestic product (GDP) in 1997 was roughly $20 billion (Inter-American Development Bank, 2000).

Over the past two decades, there has been significant progress in liberalizing global trade. In addition to the Caribbean Basin Economic Recovery Act (CBERA) and its various extensions[1], the North American Free Trade Agreement (NAFTA) and the creation of the World Trade Organization (WTO), a multitude of bilateral and plurilateral trade agreements have been enacted. Additionally, rapid innovation in information technology has fostered unprecedented growth in foreign direct investment, which has served to significantly deepen economic integration within the hemisphere (European Commission for Latin America and the Caribbean, 1999).

Against this backdrop, the export performance of CARICOM has been mixed. During the past decade, the nominal value of CARICOM exports to the United States' (US) market has grown at a rate of roughly 6% per annum. This compares to an annual rate of growth of 17% for the Central American Common Market (CACM) grouping. The growth in the nominal value of CARICOM exports to the European Union (EU) over this same period was only about 3%, suggesting a decline in export performance in real terms. Exports to Canada over the past decade have grown substantially, averaging about 13% per annum in real terms. However, this growth has occurred from a small base and two countries, Jamaica and Guyana, account for virtually all of these exports (Jessen and Rodriguez, 1999).

CARICOM trade is also highly concentrated. Trinidad and Jamaica accounted for over two thirds of the value of total CARICOM merchandise exports in 1999 (FAOSTAT, 2001). Similar disparities exist in terms of agricultural trade. Three countries, Guyana, Jamaica and Trinidad, accounted for 60% of total value of agricultural exports in 1999. In contrast, the Organization for Eastern Caribbean States (OECS) accounted for only 11% of total agricultural exports in that same year. A similar story emerges in term of intra-CARICOM agricultural trade. In 1997, 75% of intra-CARICOM imports of agricultural products originated in Barbados, Guyana and Trinidad. In contrast, seven countries supplied less than 4% of agricultural products each to the regional market.

CARICOM's external trade performance is a bit disturbing in that a significant portion of exports enters external markets under preferential arrangements. Virtually all

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[1] The most recent manifestation is the Caribbean Basin Trade Partnership Act, which extended preferences to virtually all products.

of CARICOM's exports to the EU enter duty free. The corresponding figures for the US and Canada are approximately 67% and 45%, respectively (Harrington, 1997). Continued movement towards liberalized trade within the hemisphere and globally will erode existing preference margins and thereby place increasing importance on fostering export diversification and improving the competitiveness of CARICOM goods and service in external markets.

As it approaches its 30th anniversary, the Community faces significant challenges on a number of fronts including negotiation of an FTAA and Regional Economic Partnership Agreements as stipulated in the Contonou Agreement. The development of efficient and cohesive regional strategies to assure a positive outcome for the CARICOM is thus critical. Forging such strategies, however, will be challenging as there is an almost total absence of empirical analysis investigating the economic impacts of a liberalized trading environment on CARICOM countries.

To some extent, the absence of such research is understandable. Most recent empirical analyses of potential economic impacts associated with trade liberalization in the hemisphere have been based on Computable General Equilibrium (CGE) models (Burfisher, 2001; Diao, Somwaru and Roe, 2001; Valdes and Tsigas, 2001).   The technical and data requirements of CGE models generally result in CARICOM countries being subsumed into regional aggregates such a "Central America and the Caribbean" or "Latin America and the Caribbean." The size and many unique characteristics of CARICOM countries vis-à-vis other countries in these aggregates suggest that results obtained from such models may not be of great policy relevance for small island nations.

An alternative framework for analyzing the trade flows and potential impacts of trade liberalization is the use of gravity models. Developed in the early 1960s, gravity models provide a convenient framework for analyzing bilateral trade flows with much more modest data requirements than CGE models. As such, gravity models offer considerable potential for the analysis of bilateral trade flows in the framework of small developing countries.

This paper provides an initial exploration into the use of gravity models to model bilateral CARICOM trade flows. The goals of this analysis are modest, seeking to assess: 1) the ability of the gravity model to explain CARICOM bi-lateral trade flows; 2) the degree in which the CARICOM grouping influences trade flows; 3) the extent to which historical colonial ties impact trade flows; and 4) the degree in which a shared common language affects bilateral trade. The plan of the paper is as follows. The next section provides a general overview of the gravity model and its use in empirical analysis. Section three develops the empirical models used in the analysis, section four discusses the data used, and section five presents the empirical results. Conclusions are presented in the final section.

The Gravity Model

The origin of gravity model analysis in international trade is generally attributed to Tinbergen (1962) and Poyhonen (1963) who argued that bilateral trade flows between countries could be modeled by appealing to the Newtonian law of gravity. The basic notion behind the gravity model is that bilateral trade flows between counties can be explained by three types of factors: 1) those that capture the potential of a country to export goods and services; 2) those that capture the propensity of a country to import

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good and services; and 3) other conditioning factors that enhance or inhibit bilateral trade. The first two sets of factors are the analogues of mass as used in the Newtonian physical law of gravitation. The third set of factors are generally geographic or economic factors argued to influence this basic "attraction" of trade between any two countries.

The gravity model has been used to analyze bilateral trade flows in a general context as well as in more specific frameworks such as the impact of regional integration, the influences of intellectual property rights, immigration, colonial ties, and geographic adjacency. For diverse applications of the gravity model in recent literature, see among others Boisso and Ferrantino (1997), Breuss and Egger (1997, 1999), Cheng and Wall (1999), Frankel and Romer (1999), Garman, Petersen, and Gilliard (1999), Head and Ries (1998), McCallum (1995), Porojan (2001), Smith (1999), and Thoumi (1989a, 1989b).

While successful empirically, the gravity model is sometimes criticized for its perceived lack of theoretical foundation and at first sight ad-hoc nature. However, research by Linneman (1966), Anderson (1979), Bergstrand (1985, 1989), Helpman and Krugman (1985) and Evenett and Keller (1997) have developed various theoretical bases for the basic gravity model as well as several variations. It has been shown that the gravity model can be derived, albeit incorporating numerous restrictions, from a partial general equilibrium framework.

In its simplest form, the gravity model can be written as follows;

(1) $T_{ij} = e^{\beta_0} Y_i^{\beta_1} N_i^{\beta_2} Y_j^{\beta_3} N_j^{\beta_4} D_{ij}^{\beta_5} e^{u_{ij}}$

where T_{ij} is the value of exports from country i to country j, Y_i, Y_j are measures of the economic sizes of countries i and j, respectively, most commonly measured by their GDP, N_i, N_j are measures of the economies' "physical" size, most often measured by their

respective populations, D_{ij} is the physical distance between the two countries, and u is a normally distributed error term capturing any random influences on bilateral trade.

Economic size, or GDP, of the exporting country measures its productive capacity and can be argued to be a proxy for the capital-labor ratio (Bergstrand, 1985). As such, it is also an indicator of the range of products varieties available for export since a richer economy would have a larger economic base. The importer's GDP serves as an indicator of what Thoumi (1989a, 1989b) refers to as the absorptive capacity of imported goods. A richer economy would have a higher demand for imported goods and would be able to absorb a wider variety of products. Naturally, both countries' incomes would have a positive effect on bilateral trade levels (Bergstrand 1985, 1989; Boisso and Ferrantino, 1997; Breuss and Egger, 1997, 1999; Geraci and Prewo, 1977; Linnemann, 1966; Thoumi, 1989a, 1989b, Tinbergen, 1962).

It is also postulated that countries with large populations tend to have a more diversified production base and would therefore be more self-sufficient, and thus trade less. However, countries with large populations also tend to have a larger industrial base and are able to capture more economies of scale in production than would smaller economies. Consequently, large countries potentially have more products to offer on the world market. Hence, the sign of the impact of physical size, or population, on bilateral trade levels is ambiguous. Distance is included as a proxy for transaction costs. The literature supports a strong negative relationship (Bergstrand 1985, 1989; Boisso and Ferrantino, 1997; Breuss and Egger, 1997, 1999; Geraci and Prewo, 1977; Linnemann, 1966; Thoumi, 1989a, 1989b; Tinbergen, 1962).

It is common to augment the gravity model with variables that either increase or reduce trade through their impact on transaction costs or the overall institutional environment. In previous research, such variables have included trade policy proxies, dummy variables for participation in regional trading agreements, for sharing a common commercial language, for sharing a common border, and common colonial ties. Defining such proxy variables as vector W, the augmented gravity model becomes

$$(2) \qquad T_{ij} = e^{\beta_0} Y_i^{\beta_1} N_i^{\beta_2} Y_j^{\beta_3} N_j^{\beta_4} D_{ij}^{\beta_5} e^{W_{ij}\gamma} e^{u_{ij}} .$$

Some recent examples of the use of such proxies include Boisso and Ferrantino (1997), Breuss and Egger (1997, 1999), Cheng and Wall (1999), Frankel and Romer (1999), Garman, Petersen, and Gilliard (1999), Head and Ries (1998), McCallum (1995), Porojan (2001), Smith (1999), and Thoumi (1989a, 1989b).

Model Specification

To investigate the determinants of intra-CARICOM bilateral trade flows and CARICOM trade with North America and the countries of the European Union, a gravity model is estimated for each year over the 1980 to 1996 time period. Accordingly, 17 annual cross sections are estimated. While the analysis of intra-CARICOM trade is the primary goal of this study, the strong trade relationships that the Caribbean economies have with the European Union (especially the United Kingdom, (UK)) and the NAFTA countries suggest the inclusion of these countries in the analysis.

For the purpose of this study, vector W includes three binary variables. It is postulated that there is a strong neo-colonial relationship between the CARICOM countries and the UK, since large trade volumes are exchanged between the former Caribbean colonies and the former imperial ruler. A binary variable, *Col,* is thus

introduced to account for this effect. *Col* is defined to equal 1 if the two trading partners are the UK and one of its former colonies in CARICOM, 0 otherwise. It is also postulated that trade among CARICOM members differs from trade between CARICOM members and non-member countries. To control for this effect, a binary variable, *Car*, is introduced. *Car* is equal to 1 if both trading partners are members of CARICOM, 0 otherwise.

Finally, it has been shown in previous literature that having a common language encourages trade by reducing transaction costs. Countries speaking the same language also tend to have cultural similarities, which usually lead to closer relationships and thus larger trade volumes. The variable *Lang* is defined to equal 1 if both trading partners share a common language, 0 otherwise. Note that the EU is treated as a non-English speaking entity in this regard. Even though English is an official commercial language of the EU, 13 of its members do not speak English as their native tongue.

Substituting these three binary variables into equation (2) and taking the natural logarithm of both sides, the following equation is obtained:

$$(3) \quad \begin{aligned} \ln T_{ij} = {} & \beta_0 + \beta_1 \ln Y_i + \beta_2 \ln N_i + \beta_3 \ln Y_j + \beta_4 \ln N_j + \beta_5 \ln D_{ij} + \\ & \beta_6 Col_{ij} + \beta_7 Car_{ij} + \beta_8 Lang_{ij} + u_{ij} \end{aligned}$$

where T_{ij} is the current US dollar value of bilateral exports from country i to country j in a given year, Y_i and Y_j are the GDPs of the respective economies in current US dollars for that particular year, N_i and N_j are each country's population, D_{ij} is the geographic distance in miles between their capitals, and *Col*, *Car*, and *Lang* are defined above. Arguably one of the most appealing features of the gravity model is the interpretation of the estimated coefficients as elasticities due to the double log specification. Thus, for

example, β_1 is interpreted as the exporting country's income elasticity of bilateral trade, β_4 as the importing county's population (or country size) elasticity of bilateral trade and so forth.

Note that thus far income is discussed in terms of absolute GDP. In this context, the problem of economies of varying physical size arises. For example, how should one compare the GDP of India to that of Luxembourg? Obviously India has a much larger GDP than Luxembourg, but Luxembourg's demand for imported goods will clearly be more advanced being that it is a developed economy. As can be seen, using absolute GDP in this case is misleading. Instead, if one uses GDP per capita in the gravity model rather than absolute GDP, one will better capture the impact of economic size of trading partners on bilateral trade. Specifically, GDP per capita is a much better measure of the capital labor ratio in the exporting country, and thus is a better indicator of the nature of the production base and the variety of goods available for exports. Similarly, GDP per capita for the importing country would much better capture absorptive capacity and the sophistication of demand for imported goods and services.

Inclusion of GDP per capita into the gravity model is accomplished by simple algebraic manipulation of equation (3) (Breuss and Egger, 1997). Thus, we obtain

$$(4) \qquad \ln T_{ij} = \beta_0 + \beta_1 \ln\left(\frac{Y_i}{N_i}\right) + \beta^*_2 \ln N_i + \beta_3 \ln\left(\frac{Y_i}{N_j}\right) + \beta^*_4 \ln N_j + \beta_5 \ln D_{ij} +$$
$$\beta_6 Col_{ij} + \beta_7 Car_{ij} + \beta_8 Lang_{ij} + u_{ij},$$

where $\beta_2^* = \beta_2 - \beta_1$ and $\beta_4^* = \beta_4 - \beta_3$. A similar formulation is used by Garman, Petersen, and Gilliard (1999) and Smith (1999). Also, Breuss and Egger (1997) point out that there is usually multicollinearity present between absolute GDP and population. High

collinearity would affect standard errors, but by adjusting the model such collinearity is avoided.

Another issue arises when conceptualizing the meaning of the income per capita and population parameters. By its construction, the gravity model is symmetric. That is, one data point is country i's exports to country j in period t, and another data point is country j's exports to country i in that same period t. Thus, each country is an importer at the same time as it is an exporter. As such, the elasticities should be symmetric as well, and the direction of the trade flows should not matter.[2] As Breuss and Egger (1999) point out, from a theoretical viewpoint there is really no reason why the estimated income elasticity of the exporter should be different from that of the importer. The same could be argued for the population parameters. To test for symmetry, we impose the following two restrictions to the gravity model, $\beta_1 = \beta_3$ and $\beta^*_2 = \beta^*_4$. Consequently, these restrictions are tested in the empirical section.

Data

The data used in the analysis consist of annual observations over the 1980 through 1996 period and encompass bilateral trade between 10 CARICOM members,[3] as well as their bilateral trade with the Bahamas, the US, Canada, Mexico, the UK, and the EU. To avoid double counting the UK, the EU refers to the EU (with its current members for each year) minus the UK.

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[2] Baldwin (1997) indirectly imposes a similar restriction in his informal discussion on estimates obtained by Gros and Gonciarz (1996). We mention this as a footnote since their model specification is slightly different from ours.

[3] The following ten CARICOM members were included in our sample: Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines, and Trinidad and Tobago. Due to poor data availability, Antigua and Barbuda, Haiti, Montserrat, and Suriname were dropped from the sample.

The data pertain to bilateral trade from country i to country j. Import values are utilized since national authorities often more properly account for these than export values. Henceforth, the trade data represents country j's imports from country i and vice versa. Bilateral trade data are obtained from the CARICOM Statistical Sub-Programme (1999). Data for GDP are obtained from the International Monetary Fund's International Financial Statistics Yearbook (2000). Population figures are obtained from the Food and Agricultural Organization (2001). GDP per capita are calculated by simply dividing a given country's GDP by its population. Distance data are obtained from Indo.com (2000) and Fitzpartrick and Modlin (1986). Finally, imperial information is obtained from the Caribbean Community Secretariat (2001).

The sample contains a total of 210 unique trading country pairs. Each country pair appears no more than once in a time period. Thus, for a given year, there can be no more than 210 trading pairs observed. Due to missing data for certain countries during the latter part of the time period, the number of pairs in the later years is slightly lower. In total there are 3454 observations in the sample.

The sample contains a total of 247 "zero observations", that is in 247 instances out of 3454 data points there is no reported bilateral trade for particular country pairs. Given the double log specification, this poses a problem econometrically since one cannot take the logarithm of zero. Just dropping these observations from the sample will result in a selectivity bias and would in turn result in biased estimates. Indeed, there are reasons why these trade flows are zero and such effects would be lost if the observations are simply dropped. Following Boisso and Ferrantino (1997) and Heid and Ries (1998),

a value of 1 is added to each observation of the dependent variable. By adding 1, define $T_{ij}{}^* = (T_{ij} + 1)$ and the model thus becomes

$$(5) \quad \ln T^*{}_{ij} = \beta_0 + \beta_1 \ln\left(\frac{Y_i}{N_i}\right) + \beta^*{}_2 \ln N_i + \beta_3 \ln\left(\frac{Y_j}{N_j}\right) + \beta^*{}_4 \ln N_j + \beta_5 \ln D_{ij} +$$
$$\beta_6 Col_{ij} + \beta_7 Car_{ij} + \beta_8 Lang_{ij} + u_{ij}.$$

Consequently, in the case where $T_{ij} = 0$, $\ln T_{ij}{}^* = \ln(1) = 0$ still indicating a zero value for trade. In the case where $T_{ij} > 0$ the dependent variable becomes $\ln T_{ij}{}^* = \ln(T_{ij} + 1)$, and empirical estimation is made possible.

Empirical Results

A total of 17 annual cross-sectional regressions are estimated using ordinary least squares. Due to data availability, the number of observations per year varies from 158 to 210. The empirical results are presented in Table 1.[4]

The initial diagnostic test is regarding our symmetry restrictions. Using F-tests we fail to reject the null hypothesis that the estimated GDP per capita elasticity for the exporting and the importing country are statistically the same for 11 out of the 17 years at the 5 percent level. When restricting the significance level to 1 percent, we are unable to reject the same hypotheses in 15 out of the 17 cases. As such, it is inferred that the estimated elasticities essentially are statistically the same. We were able to draw similar conclusions using likelihood ratio tests. Our results stand in contrast with Breuss and Egger (1999).

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[4] We also estimate the gravity model according to the right hand formulation of equation (3), results are omitted to save space. Naturally, both estimations yield the same R-squared and F-statistic values. However, we find that our chosen specification, equation (5), is preferred due to lower standard errors, further lending support for the notion that the presence of multicollinearity is greatly reduced by utilizing GDP per capita, rather than absolute GDP. Similar conclusions were drawn by Breuss and Egger (1997).

Similar F-tests were conducted to test whether or not the parameter estimates for the exporter's and importer's respective populations are statistically different. The results suggest that the parameters are indeed statistically different, even beyond the 1 percent level. In 16 out of the 17 years, we can reject the null hypothesis that the parameters for population are statistically identical. Accordingly, our gravity model is found to be symmetric with respect to the per capita GDP parameters of the exporter and the importer, but asymmetric with respect to the estimated population parameters. Consequently, these are the results presented in Table 1.

Examination of the individual parameter estimates suggests that exporter's GDP per capita and importer's GDP per capita have statistically significant and positive effects on bilateral trade, thus confirming *a priori* expectations. The effects of the exporter's productive capacity and the importer's absorptive ability of foreign goods on bilateral trade levels are in all but two years greater than unity. The point estimates of the 17 years vary between 0.96 to 1.71 in magnitude. There is no clear trend in the variation of these parameter estimates. Since the importer's income elasticity is greater than unity (in all except two years) it can be concluded that bilateral imports are luxury goods (Breuss and Egger, 1999).

The point estimates for the exporter's and the importer's populations are all statistically significant and positive for all years. The estimated exporter population elasticities of bilateral trade are all greater than unity. These estimates are rather stable and vary only marginally from year to year. Our point estimates suggest that there is some validity to the argument that an exporter with a larger physical size benefits from a

larger productive base and economies of scale and will thus have more products to offer for export, resulting in more trade than in the case of a smaller country.

The point estimates for the importer's population elasticities are all positive (and greater than unity) indicating that a physically larger country would import more goods due to a larger consumer base even after controlling for income. This is somewhat surprising since a larger economy also tend to trade less in relative terms due to a larger degree of self-sufficiency. Clearly, in our sample, the effect of a larger consumer base outweighs the effect of self-sufficiency on bilateral trade levels. This does make sense, since small island economies face constraints larger ones do not, thus there is a natural limit to the degree of self-sufficiency that can be achieved.

However, it should be noted that the magnitudes of the point estimates for the importer's population are consistently smaller than those of the exporter's population. The difference between the respective point estimates is roughly 0.4 to 0.5 throughout the time period. Similar differences in magnitude were found by Garman, Petersen, and Gilliard (1999). In terms of magnitude, the importer's population has less of an impact on bilateral trade.

As expected, distance has a strong negative effect on bilateral trade levels. The distance elasticity of trade is generally consistent over the time period, ranging between −2.673 (for 1985) and −1.528 (for 1995). These findings are consistent with previous research, although the magnitude of the coefficients is slightly larger than, for example, Breuss and Egger (1997, 1999), Frankel and Romer (1999), and Thoumi (1989a, 1989b). Probably transportation costs have a greater impact on smaller developing island economies than bigger developed ones.

The estimated parameters for the three binary variables (colonial ties, the CARICOM regional grouping, and sharing a common language) are all statistically significant throughout the time period and the estimates are remarkably stable over time. *Ceteris paribus*, sharing colonial ties, being a member of the CARICOM, and sharing a common language all contribute significantly to higher bilateral trade levels.

Since there are three binary variables included in the model, each taking on one of two possible values, there are in theory eight different possible combinations or outcomes. Note, however, that *Car* and *Col* are mutually exclusive. If a given country pair is assigned a value of 1 for *Car*, it means that both countries are members of the CARICOM, and would thus be assigned a value of 0 for *Col*. Conversely, if a pair is assigned a value of 1 for *Col*, it means that one country is a former British colony in CARICOM and the other is the UK, and thus the country pair would be assigned 0 for *Car*. As such, the two outcomes of both *Col* and *Car* equal to 1 (with *Lang* equal to either 1 or 0) are not feasible. Accordingly, there are six possible outcomes of relevance. Define the expected intercept, taking into account the effects of the binary variables in each of the six feasible cases as $E[\alpha^*]$. Then the six outcomes of $E[\alpha^*]$ can be described with the following expressions (Kmenta, 1997: 466-7):

(6)
$$
\begin{aligned}
&i. \quad E\left(\beta_0 \mid Col = 1, Car = 0, Lang = 1\right) = \beta_0 + \beta_6 + \beta_8 \\
&ii. \quad E\left(\beta_0 \mid Col = 1, Car = 0, Lang = 0\right) = \beta_0 + \beta_6 \\
&iii. \quad E\left(\beta_0 \mid Col = 0, Car = 1, Lang = 1\right) = \beta_0 + \beta_7 + \beta_8 \\
&iv. \quad E\left(\beta_0 \mid Col = 0, Car = 1, Lang = 0\right) = \beta_0 + \beta_7 \\
&v. \quad E\left(\beta_0 \mid Col = 0, Car = 0, Lang = 1\right) = \beta_0 + \beta_8 \\
&vi. \quad E\left(\beta_0 \mid Col = 0, Car = 0, Lang = 0\right) = \beta_0
\end{aligned}
$$

Note that Case *ii* and *iv* are not relevant for our sample of countries. Case *ii* would refer to a CARICOM member's trade with its colonial ruler that is not English

speaking. All the countries in our sample are former UK colonies, and English is the official language, rendering this outcome irrelevant. Case *iv* would be a CARICOM member's trade with a fellow member with whom it would not share a common language; thus, this outcome would render itself irrelevant as well. For the remaining four cases, to get the marginal effects on bilateral trade, let us call it Ψ, one has to apply the formula

$$(8) \qquad \Psi = \frac{E[\alpha^*] - \hat{\beta}_0}{|\hat{\beta}_0|}.$$

As such, Ψ can be interpreted as the percentage change in the bilateral trade level, with *ceteris paribus* restrictions imposed on the continuous variables. Ψ's are calculated for all years in the sample and the results are presented in Table 2.

Table 2: Interpretation of Binary Variables

	$\Psi = (E[\alpha^*] - \hat{\beta}_0)/|\hat{\beta}_0|$										
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Case	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
i[a]	0.136	0.149	0.163	0.152	0.149	0.139	0.147	0.130	0.149	0.122	0.125
ii[b]	0.081	0.081	0.088	0.085	0.106	0.095	0.097	0.081	0.089	0.070	0.077
iii[c]	0.194	0.203	0.191	0.193	0.158	0.165	0.157	0.163	0.171	0.190	0.177
iv[d]	0.138	0.134	0.116	0.126	0.114	0.122	0.107	0.113	0.111	0.138	0.128
v[e]	0.055	0.068	0.074	0.067	0.043	0.044	0.049	0.049	0.059	0.051	0.048
vi[f]	0	0	0	0	0	0	0	0	0	0	0

	$\Psi = (E[\alpha^*] - \hat{\beta}_0)/|\hat{\beta}_0|$					
	1991	1992	1993	1994	1995	1996
Case	(12)	(13)	(14)	(15)	(16)	(17)
i[a]	0.125	0.157	0.139	0.117	0.096	0.112
ii[b]	0.057	0.077	0.068	0.074	0.072	0.072
iii[c]	0.205	0.208	0.207	0.187	0.172	0.175
iv[d]	0.137	0.127	0.137	0.144	0.148	0.135
v[e]	0.067	0.081	0.070	0.043	0.024	0.040
vi[f]	0	0	0	0	0	0

Parameter estimates used obtained from regression output, see Table 1.
Description of trade:
a) CARICOM member trade with the UK
b) NA for our sample
c) Intra-CARICOM Trade
d) NA for our sample
e) CARICOM member trade with the US and Canada
f) CARICOM member trade with Mexico and the EU

Due to the sample and the definition of the binary variables, the $E[\alpha^*]$ for Case *vi* would

be the actual intercept, which would correspond to trade between a CARICOM member

and Mexico or the EU. Looking at the calculated values, a given CARICOM member

would trade about 10-16% more with the UK (Case *i*) than they would with Mexico or

the EU *ceteris paribus*. Intra-CARICOM trade for a typical member (Case *iii*) is 15-20%

higher than their trade with Mexico or the EU *ceteris paribus*. Finally, Case *v* conveys

that a typical CARICOM member would trade roughly 4-7% more with the US and Canada than with Mexico or the EU *ceteris paribus*.

Concluding Remarks

The empirical results suggest that the gravity model has considerable potential to explain intra-CARICOM bilateral trade as well as trade between CARICOM members and non-members. The results suggest that the income levels of both the exporting and the importing countries have a large positive and symmetric effect on bilateral trade. It is also shown that the CARICOM regional trade agreement, and the sharing of a common language and historical colonial ties have positive impacts on bilateral trade levels after controlling for the economic size and the physical size of the trading countries and the distance between them.

The results indicate that exporters with larger populations have a larger productive base and more opportunities for scale economies and thus have a greater ability to export goods on the world market than does a smaller country. This is consistent with the pattern of CARICOM exports, which have been dominated by the larger member countries. The effect of the importing country's population was surprisingly enough positive. This is harder to generalize, since a larger economy would indeed have a larger consumer base demanding imports, but large countries also tend to be more self-sufficient. Clearly, our results suggest that the first effect dominates over the latter.

REFERENCES

Anderson, James E. (1979) 'A Theoretical Foundation for the Gravity Equation' *American Economic Review* 69 (1), 106-116.

Baldwin, Richard E. (1997) 'Comment on Groz and Conciarz' *European Journal of Political Economy* 13 (1), 187-188.

Bergstrand, Jeffrey H. (1985) 'The Gravity Equation in International Trade: Some Microeconomic Foundation and Empirical Evidence' *Review of Economics and Statistics* 67 (3), 474-481.

Bergstrand, Jeffrey H. (1989) 'The Generalized Gravity Equation, Monopolistic Competition and the Factor-Proportions Theory in International Trade' *Review of Economics and Statistics* 71 (1): 142-153.

Boisso, Dale, and Michael Ferrantino. (1997) 'Economic Distance, Cultural Distance, and Openness in International Trade: Empirical Puzzles' *Journal of Economic Integration* 12 (4), 456-484.

Breuss, Fritz, and Peter Egger. (1997) 'Use and Misuse of Gravity Equations in European Integration Research', WIFO (Austrian Institute of Economic Research) Working Paper 97/1997.

Breuss, Fritz, and Peter Egger. (1999) 'How Reliable are Estimations of East-West Trade Potentials Based on Cross-Section Gravity Analyses' *Empirica* 26 (2), 81-94.

Burfisher, M. E., ed. (2001) *The Road Ahead: Agricultural Policy Reform in the WTO— Summary Report*. Market and Trade Economics Division, Economic Research Service, USDA, Agricultural Economics Report No. 797.

Caribbean Community Secretariat, 2001, http://www.caricom.org.

CARICOM Statistical Sub-Programme, 1999, http://www.caricom.org/statistics/sect0lst.htm.

Cheng, I-Hui, and Howard J. Wall (1999) 'Controlling for Heterogeneity in Gravity Models of Trade' Federal Reserve Bank of St. Louis Working Paper 1999-010B

Diao, X., A. Somwaru, and T. Roe. (2001) 'A Global Analysis of Agricultural Reform in WTO Member Countries' *Background for Agricultural Policy Reform in the WTO: The Road Ahead.* Washington, D.C. USDA, Economic Research Service, ERS-E01-001.

European Commission for Latin America and the Caribbean. (1999) 'Trade Policy in CARICOM: Overview of Trade Policy Measures' Report LC/CAR/G.591.

Evenett, S. and W. Keller. (1997) 'On Theories Explaining the Success of the Gravity Equation' National Bureau of Economic Research Working Paper Series, No.6529, Cambridge, MA: NBER.

FAO Statistical Databases, Food and Agricultural Organization, 2001, http://apps.fao.org/page/collections.

Fitzpatrick, Gary L, and Marilyn J Modlin. (1986) *Direct-line Distances*. Metuchen NJ: Scarecrow Press Inc.

Frankel, Jeffrey A., and David Romer. (1999) 'Does Trade Cause Growth' *American Economic Review* 89 (3), 379-399.

Garman, George, Janis Petersen, and Debora Gilliard. (1999) 'Economic Integration in the Americas' *Journal of Applied Business Research* 14 (3), 1-12.

Geraci, Vincent J., and Wilfred Prewo. (1977) 'Bilateral Trade Flows and Transportation Costs' *Review of Economics and Statistics* 59 (1): 67-74.

Gros, Daniel, and Andrzej Gonciarz. (1996) 'A Note on the Trade Potential of Central and Eastern Europe' *European Journal of Political Economy* 12 (4), 709-721.

Harrington Jr, J. M. (1997) *Impact of Tariff Preferences on Caribbean Exports* (mimeo), Integration, Trade and Hemispheric Issues Division, IDB Integration and Regional Programs Department.

Head, Keith, and John Ries. (1998) 'Immigration and Trade Creation: Econometric Evidence from Canada' *Canadian Journal of Economics*, 31 (1), 47-62.

Helpman, E. and P. Krugman. (1985) *Market Structure and Foreign Trade, Increasing Returns, Imperfect Competition and The International Economy*. Cambridge, MA & London, The MIT Press.

Indo.com, 2000, http://www.indo.com/distance

InterAmerican Development Bank. (2000) *Periodic Note on Integration and Trade in the Americas*. December 2000.

International Monetary Fund. (1998) *International Financial Statistics Yearbook.* Washington DC: International Monetary Fund

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Jessen, A. and E. Rodriguez. (1999) *The Caribbean Community: Facing the Challenges of Regional and Global Integration*. InterAmerican Development Bank Occasional Paper 2.

Kmenta, Jan. (1997) *Elements of Econometrics*. Ann Arbor, MI: The University of Michigan Press.

Linneman, H. (1966) *An Econometric Study of International Trade Flows.* Amsterdam: North Holland Publishing Company.

McCallum, John (1995) 'National Borders Matter: Canada-U.S. Regional Trade Patterns' *American Economic Review* 85 (3), 615-623.

Porojan, A. (2001) 'Trade Flows and Spatial Effects: The Gravity Model Revisited'. *Open Economies Review* 12 (3), 265-280.

Poyhonen, Pentti. (1963) 'A Tentative Model for the Volume of Trade Between Countries', *Weltwirtschaftliches Archiv* 90 (1): 93-99.

Smith, Pamela J. (1999) 'Are Weak Patent Rights a Barrier to U.S. Exports?'. *Journal of International Economics* 48 (1), 151-177

Thoumi, Francisco E. (1989a) 'Trade Flows and Economic Integration Among the LDCs of the Caribbean Basin'. *Social and Economic Studies* 38 (2), 215-233.

Thoumi, Francisco E. (1989b) 'Bilateral Trade Flows and Economic Integration in the Latin American and the Caribbean' *World Development* 17 (3), 421-429.

Tinbergen, Jan. (1962) *Shaping the World Economy: Suggestions for International Economic Policy*, New York: The Twentieth Century Fund, Inc.

Valdes, C. and M. Tsigas. (2001) *Multilateral Trade Negotiations in the Latin American and Caribbean Region: Economy-Wide and Sectoral Impacts*. SP/SAC-OMC/Di No. 21.

Table 1: Regression Estimates

Dependent Variable: ln(exports from county i to country j)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Variable											
Constant	-37.885**	-35.329**	-35.591**	-34.762**	-33.912**	-40.017**	-37.038**	-35.026**	-29.466**	-38.154**	-42.646**
	(4.168)	(3.907)	(4.042)	(4.295)	(4.144)	(4.775)	(4.358)	(4.355)	(4.446)	(4.335)	(4.921)
ln(GDPi/Popi)	1.336**	1.145**	1.347**	1.045**	1.176**	1.384**	1.401**	1.257**	0.967**	1.046**	1.356**
	(0.250)	(0.227)	(0.227)	(0.231)	(0.207)	(0.241)	(0.216)	(0.200)	(0.211)	(0.191)	(0.216)
ln(Pop i)	1.660**	1.622**	1.594**	1.791**	1.723**	1.881**	1.754**	1.671**	1.608**	1.791**	1.909**
	(0.116)	(0.105)	(0.115)	(0.115)	(0.107)	(0.115)	(0.110)	(0.109)	(0.101)	(0.100)	(0.112)
ln(GDPj/Popj)	1.336**	1.144**	1.347**	1.045**	1.176**	1.385**	1.401**	1.257**	0.967**	1.046**	1.356**
	(0.250)	(0.227)	(0.227)	(0.231)	(0.207)	(0.241)	(0.216)	(0.200)	(0.212)	(0.191)	(0.216)
ln(Pop j)	1.203**	1.270**	1.192**	1.358**	1.379**	1.474**	1.370**	1.280**	1.319**	1.474**	1.559**
	(0.125)	(0.113)	(0.123)	(0.124)	(0.113)	(0.122)	(0.116)	(0.114)	(0.105)	(0.104)	(0.116)
ln(Distance)	-1.851**	-1.846**	-2.070**	-2.230**	-2.440**	-2.673**	-2.630**	-2.238**	-2.270**	-2.049**	-2.628**
	(0.288)	(0.263)	(0.288)	(0.295)	(0.277)	(0.302)	(0.286)	(0.287)	(0.265)	(0.263)	(0.294)
Colonial	3.054**	2.852**	3.139**	2.954**	3.596**	3.806**	3.611**	2.837**	2.635**	2.682**	3.287**
	(0.887)	(0.822)	(0.898)	(0.911)	(0.858)	(0.918)	(0.867)	(0.850)	(0.789)	(0.781)	(0.863)
Caricom	5.237**	4.755**	4.134**	4.382**	3.883**	4.871**	3.964**	3.971**	3.265**	5.290**	5.481**
	(0.742)	(0.688)	(0.735)	(0.769)	(0.734)	(0.823)	(0.769)	(0.759)	(0.732)	(0.722)	(0.806)
Language	2.119**	2.419**	2.656**	2.328**	1.487*	1.746*	1.847*	1.732*	1.765**	1.964**	2.061**
	(0.712)	(0.649)	(0.750)	(0.753)	(0.692)	(0.759)	(0.735)	(0.720)	(0.656)	(0.638)	(0.706)

R-squared	0.639	0.663	0.643	0.644	0.670	0.659	0.663	0.626	0.633	0.665	0.655
F-stat	44.544	49.445	45.199	45.543	50.918	48.569	49.294	42.187	43.284	49.793	47.791
N	210	210	210	210	210	210	209	210	210	210	210

Standard errors in parenthesis

*) Statistically significant at the 5 percent level

**) Statistically significant at the 1 percent level

[a]) Binary variable: 1 if one of the trading countries is the UK and the other a former British colony in the CARICOM, 0 otherwise

[b]) Binary variable: 1 if both trading partners are members of CARICOM, 0 otherwise

[c]) Binary variable: 1 if the trading countries share a common language, 0 otherwise

Table 1 (continued)

Dependent Variable: ln(exports from county i to country j)

	1991	1992	1993	1994	1995	1996
	(12)	(13)	(14)	(15)	(16)	(17)
Variable						
Constant	-39.743**	-28.553**	-35.832**	-35.393**	-44.632**	-43.992**
	(5.166)	(4.364)	(5.146)	(4.416)	(5.066)	(5.968)
ln(GDPi/Popi)	1.195**	0.953**	1.129**	1.202**	1.712**	1.597**
	(0.206)	(0.191)	(0.229)	(0.201)	(0.251)	(0.270)
ln(Pop i)	1.753**	1.466**	1.650**	1.568**	1.528**	1.657**
	(0.115)	(0.094)	(0.105)	(0.094)	(0.109)	(0.130)
ln(GDPj/Popj)	1.195**	0.953**	1.129**	1.202**	1.712**	1.597**
	(0.206)	(0.191)	(0.229)	(0.201)	(0.251)	(0.270)
ln(Pop j)	1.241**	1.126**	1.203**	1.186**	1.086**	1.147**
	(0.121)	(0.099)	(0.111)	(0.099)	(0.114)	(0.141)
ln(distance)	-1.773**	-1.805**	-1.839**	-1.783**	-1.528**	-1.782**
	(0.295)	(0.239)	(0.273)	(0.245)	(0.281)	(0.267)
Colonial	2.289**	2.195**	2.445**	2.621**	3.203**	3.175**

	(0.904)	(0.745)	(0.829)	(0.743)	(0.866)	(0.863)
Caricom	5.471**	3.621**	4.913**	5.090**	6.588**	5.964**
	(0.852)	(0.690)	(0.788)	(0.684)	(0.775)	(1.041)
Language	2.682**	2.314**	2.522**	1.519*	1.065	1.745*
	(0.731)	(0.591)	(0.660)	(0.604)	(0.714)	(0.733)
R-squared	0.607	0.620	0.596	0.634	0.598	0.630
F-stat	35.408	38.625	36.276	42.271	33.452	31.768
N	192	198	204	204	189	158

Standard errors in parenthesis
*) Statistically significant at the 5 percent level
**) Statistically significant at the 1 percent level
[a]) Binary variable: 1 if one of the trading countries is the UK and the other a former British colony in the CARICOM, 0 otherwise
[b]) Binary variable: 1 if both trading partners are members of CARICOM, 0 otherwise
[c]) Binary variable: 1 if the trading countries share a common language, 0 otherwise

Table 2: Interpretation of Binary Variables

| | $\Psi = (E[\alpha^*] - \hat{\beta}_0) / |\hat{\beta}_0|$ | | | | | | | | | | |
| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
Case	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
i[a]	0.136	0.149	0.163	0.152	0.149	0.139	0.147	0.130	0.149	0.122	0.125
ii[b]	0.081	0.081	0.088	0.085	0.106	0.095	0.097	0.081	0.089	0.070	0.077
iii[c]	0.194	0.203	0.191	0.193	0.158	0.165	0.157	0.163	0.171	0.190	0.177
iv[d]	0.138	0.134	0.116	0.126	0.114	0.122	0.107	0.113	0.111	0.138	0.128
v[e]	0.055	0.068	0.074	0.067	0.043	0.044	0.049	0.049	0.059	0.051	0.048
vi[f]	0	0	0	0	0	0	0	0	0	0	0

| | $\Psi = (E[\alpha^*] - \hat{\beta}_0) / |\hat{\beta}_0|$ | | | | | |
| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
Case	(12)	(13)	(14)	(15)	(16)	(17)
i[a]	0.125	0.157	0.139	0.117	0.096	0.112
ii[b]	0.057	0.077	0.068	0.074	0.072	0.072
iii[c]	0.205	0.208	0.207	0.187	0.172	0.175
iv[d]	0.137	0.127	0.137	0.144	0.148	0.135
v[e]	0.067	0.081	0.070	0.043	0.024	0.040
vi[f]	0	0	0	0	0	0

Parameter estimates used obtained from regression output, see Table 1.
Description of trade:
a) CARICOM member trade with the UK
b) NA for our sample
c) Intra-CARICOM Trade
d) NA for our sample
e) CARICOM member trade with the US and Canada
f) CARICOM member trade with Mexico and the EU