Increased Cocoa Bean Exports under Trade Liberalization: A Gravity Model Approach

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Abstract

Gravity models were developed to estimate the potential bilateral exports of cocoa under trade liberalization by the sixteen major cocoa producing countries to the US using panel data from 1989 to 2003. The results indicate that differences between resource endowment, relative size of economies, and the sum of bilateral GDP of U.S. and exporting countries are the major determinants. Thus, as trade is liberalized, farmers share of the world price of cocoa increases and this raises exports.

Background

World cocoa exports from producing countries to the United States (U.S.) nearly doubled from 1989 to 2003. Causes for this increase can to some extent be attributed to changes in production practices and biotechnology, and increases in and changes in consumer demand. For instance, the introduction of a full-sun, high-yielding variety of cocoa to Indonesia and improved infrastructure there has led it to become a fixture in the top 5 cocoa bean exporters list (Franzen and Mulder 2007). In addition, consumer demand for chocolate increased along with exports at this time, despite demand inelasticity (Gilbert and Varangis 2003). One reason for this is a plethora of studies published showing the positive health effects from the consumption of dark chocolate (rich in antioxidant flavanols). These benefits include lower rates of heart disease, lower blood pressure, reduced rates of atherosclerosis, reduced risk of colon cancer, slower aging and reduced rates of diabetes (Carnésecchi and Schneidera, et al, 2001; Engler and Engler 2004; Fisher and Hughes, et al, 2004, and so on).

But market liberalization has been the major driving force. Market liberalization resulted in fewer taxes on producers and reductions in marketing costs (Gilbert and Varangis 2003). Commodity market liberalization in the Less Economically Developed

Countries (LEDC) since the early 1980s resulted from changes in export commodity markets, shocks associated with price declines, and changing views on the role of government. Government-run national markets have been opened up to foreign competition, and pricing in each country converged more than in pre-liberalization years. Liberalization is done by eliminating government marketing agencies and administered prices, reducing taxes on cocoa, and privatizing government-owned assets (Gilbert and Varangis 2003). These countries became members within its first 13 months when the General Agreement and Tariffs and Trade (GATT) became the World Trade Organization after the Uruguay Round of negotiations. This paper therefore, applies gravity equations to bilateral trade factors to estimate the cocoa trade potential between U.S. and sixteen major exporting countries from 1989 to 2003.

The Generalized Gravity Framework

Originally inspired by Newton's gravity equation in physics, the gravity model has become common knowledge in regional science for describing and analyzing spatial flows. Anderson (1979) was the first to draw linkages to economic theory and was pioneered in the analysis of international trade by Tinbergen (1962); Pöyhönen (1963); and Linneman (1966). The generalized framework Anderson developed incorporates the Armington assumption that goods produced by different countries are inherently imperfect substitutes by virtue of their provenance. This framework assumes Cobb-Douglas expenditure system. Under the assumption of monopolistic competition, each country is assumed to specialize in different products and to have identical homothetic preferences. Zero balance of trade is also assumed to hold in each period. Then the equilibrium trade flow from country i to j (X_{ij}^*) at any time period $\boldsymbol{t}$ can be expressed as:

$$X_{ij}^* = \theta_i Y_j$$

(1) *or*

$$\theta_i = \frac{X_{ij}}{Y_j}$$

where θ_i denotes the fraction of income spent on country *i*'s products (the fraction is identical across importers) and Y_j denotes real GDP in importing country *j*. Since production in country *i* must be equal to the sum of exports and domestic consumption of goods, country *i*'s GDP is expressed as follows:

$$Y_i = \sum X_{ij}^* = \sum \theta_i Y_j = \theta_i \left(\sum Y_j\right)$$

(2) *or*

$$\theta_i = \frac{Y_i}{\left(\sum Y_j\right)} \equiv \frac{Y_i}{Y_w}$$

Where $\sum Y_j = Y_w$ is world real GDP, which is constant across country pairs. Equating equation (1) and (2) and rearranging yields:

(3) $$X_{ij}^* = \frac{Y_i Y_j}{\left(\sum Y_j\right)} = \left(T_{ij}\right)\left(\frac{Y_i Y_j}{Y_w}\right)$$

Therefore, this simple gravity equation relies only upon the adding-up constraints of a Cobb- Douglas expenditure system with identical homothetic preferences and the specialization of each country in one good. The basic empirical gravity equation is obtained by taking a natural logarithm of both sides of (3) as follows:

(4) $$\ln X_{ij}^* = \alpha + \beta \ln Y_i + \gamma \ln Y_j + \Phi \ln T_{ij}$$

where $\alpha = \left(-\ln Y_w\right)$, and T_{ij} is a vector of time-invariant variables such as distance and border effects. Because, in reality, countries do not have identical and homothetic taste, the coefficients should not be unity, but are not significantly different from unity in aggregate level trade (Anderson 1979).

Model Specification of Gravity Models

More recently, the application of gravity models has enjoyed a big revival. However, this has not so much been driven by its more rigorous theoretical foundation (Anderson, 1979; Bergstrand, 1985, 1989, and 1990; Helpman and Krugman, 1985; and Helpman, 1987; and so on) but the opportunity to project bilateral trade relations (Hamilton and Winters, 1992; Baldwin, 1994). According to the traditional concept of the gravity equation, bilateral trade can be explained by GDP and GDP per capita figures and both trade impediment (distance) and preference factors (common border, common language, etc.). The economic framework in most cases was cross-section analysis (Wang and Winters, 1991; Hamilton and Winters, 1992; Brulhart and Kelly, 1999; and Nilsson, 2000; and so on). Only a few authors made use of (random effects) panel econometric methods (Baldwin, 1994; Gros and Gonciarz, 1996; Mátyás, 1997; and Egger, 2002). Mátyás, (1997 and 1998) provides insights in the question of proper econometric specification without dealing with the issue of trading potentials.

According to the endowment-based new trade model with Dixit and Stiglitz (1977) preferences, bilateral trade is an increasing sum of factor income *G,* relative size *S,* and the difference in relative factor endowments *R.* Additionally, bilateral trade is affected by more traditional measures of transportation cost which is represented by distance D_{ij}. AL_{ijt} quantifies exporter-to-importer land/labor ratios and lastly, the real bilateral exchange rate E_{ijt}.. AL_{jtt} was included in the model to capture the land resource base. Like all primary products, cocoa uses land more intensively than labor.

Accordingly, bilateral trade can be estimated by:

$$(5)\ \ Y_{ijt} = \beta_0 + \beta_1 G_{it} + \beta_2 S_{ijt} + \beta_3 R_{ijt} + \beta_4 AL_{ijt} + \beta_5 E_{ijt} + \varepsilon_{ijt}$$

where all variables are in real figures and expressed in natural logs, and the error term can be written as

$$(6)\ \ \varepsilon_{ijt} = u_{ij} + w_{ijt}$$

with u_{ij} as the (one-way fixed or random) unobserved bilateral effect and w_{ijt} as the remaining residual error. Using the Helpman (1987) model, the Heckscher-Ohlin bilateral trade determinants can be formulated in the following way:

$$(7)\ \ G_{ijt} = \log\left(GDP_{it} + GDP_{jt}\right)$$

$$(8)\ \ s_{ijt} = \frac{GDP_{jt}}{GDP_{it}}$$

$$(9)\ \ R_{ijt} = \left| \ln\left(\frac{GDP_{it}}{N_{it}}\right) - \ln\left(\frac{GDP_{jt}}{N_{jt}}\right) \right|$$

$$(10)\qquad AL_{ijt} = \frac{Land_{it}}{Labor_{jt}}$$

where, N denotes a country's population and GDP per capita is commonly used as a proxy for a country's capital-labor ratio.

For the panel econometric projection of potential bilateral trade, researchers have concentrated on random effects model (REM), which requires that $u_{ij} \sim (0, \sigma_\mu^2)$, $w_{ijt} \sim (0, \sigma_v^2)$, and the u_{ij} are independent of the w_{ijt}. Moreover, the X_{ijt} (i.e. the explanatory variables) have to be independent of the u_{ij} and w_{ijt} for all cross-sections (*ij*) and time periods (*t*). Whereas the fixed effects model (FEM) is always consistent in the absence of endogeneity or errors in variables, the REM is only consistent if the above-mentioned orthogonality conditions are fulfilled. Then, the REM has the advantage of more efficiency as compared to the FEM. If these conditions do not hold, only the FEM is consistent since it wipes out all the time-invariant effects (u_{ij}). The decision between FEM and REM can be based on the Hausman (1978) test.

Data and Estimation Procedures

The gravity model is applied using panel data for the period 1989 to 2003 for the export of cocoa beans to the U.S. from16 (11 Latin American, 3 West African, and 2 Asian) cocoa exporting countries. In this analysis, several variations across individual country are analyzed in the one-way FEM, the one-way REM, and two-way FEM as well as Pooled O.L.S. to see whether individual country's effects are as fixed or randomly distributed across cross-sectional units. The dependent variable, real value of cocoa exports to U.S. was regressed on factor income G_{ijt}, relative S_{ijt}, the difference in relative factor endowments R_{ijt}, distance D_{ij}, land-labor ratio AL_{ijt} and the real bilateral exchange rate E_{ijt}.. Other observable determinants impeding or inducing bilateral trade include 1) common borders (CB_{ij}), a dummy variable which equals 1 when *i* and *j* share a contiguous border and 0 otherwise; 2) language similarity (LS_{ij}), a dummy variable which equals 1 whenever nine percent or more of the population in both countries share a common language and 0 otherwise; 3) colonial heritage (CH_{ij}), a dummy variable which equals 1 if two countries have established colonial ties since 1945 and 0 otherwise.

Since the individual country's effects were included, there was a need to decide whether these effects should be treated as fixed or random. The Hausman test was conducted to examine the model that was most efficient. The other observable determinants impeding or inducing bilateral trade were dropped out in the final models together with distance as they are all time-invariant variables. Already, the number of the cross-sectional units exceeds that of the time series therefore, the introduction of such variables significantly reduces the predicting power of the model.

Data on cocoa exports are from U.S. International Trade Center Interactive Tariff and Trade DataWeb (http://dataweb.usitc.gov/). Exchange rate of each country's currency to the U.S. dollar was obtained from the USDA Economic Research International Data Sets (http://www.ers.usda.gov/data/macroeconomics/). The distances, measured in nautical miles were obtained using the World News Network's World Ports Distances Calculator. Real GDP and population data for each country were obtained from IMF World Economic Outlook Database for April 2007 (http://www.imf.org/external/pubs/ft/weo/2007/01/data/index.aspx). Information about arable land and labor came from the United Nations, Food and Agricultural Organization's *FAOSTAT* ResourceSTAT and ProdSTAT databases (http://faostat.fao.org/site/348/default.aspx).

The descriptive statistics of the variables in the model are presented in Table 1 while Table 2 presents the estimation results for the two-way fixed effect panel estimator. According to the test statistics we cannot ignore the cyclic and cross-sectional effects as the F-test for the two-way FEM is significant at ($P < 0.0001$) with R^2 of 0.85. Thus, the probability that there are no effects in the model is 0.

Also, the intercepts of all the first fourteen years (i.e. 1989 to 2002) are all positive and significant relative to 2003. This informs us that export trend is positive and significant as depicted in Figure 1.

The coefficients of sum of factor income and resource factor endowment differences are all positive and statistically significant at ($p < 0.0001$) and ($p < 0.0088$). Thus, the larger the per capita GDP difference between U.S. and a cocoa exporting country, the larger the exports. The income of exporting countries represents the country's production capacity, and the income of importing countries represents the country's purchasing power, both of which are positively related to trade flows. A higher level of income in the exporting country indicates a high level of production of which increases the availability of products for export, while a high level of income in the importing country suggests higher imports. The elasticity of 7.6% implies a 1% change in the sum of bilateral trade GDP will change exports by 7.6% or $2,5million.

Our empirical result -- with positive coefficients for relative factor endowment differences lends to support the H-O explanation of trade. Heckscher-Ohlin (H-O) theory leads one to expect that cocoa trade would be positively related to the exporter-to-importer per capita GDP differences. Cocoa production is relatively land-intensive but the harvesting and through shipping to the ports are highly labor intensive. The elasticity of 0.562 implies a 1 percent change in the level of resource endowment differences will raise imports by about 0.56 percent or $0.201 million.

The relative size of the economies is also statistically significant with a consistent sign. The negative sign of the coefficient implies that the smaller the size of a cocoa exporting economy relative to that of U.S., the larger the volume of exports to the latter. The elasticity of 2.007 informs us that 1 percent decrease in the GDP ratio increases exports of cocoa beans to the U.S. by about 2 percent or $0.67 million.

Exchange rates and the exporter-importer land-to-labor ratios variables are however, not significant. These are not surprising results especially with respect to exchange rates, these countries are developing and most developing countries practice managed exchange rates. With regard to land-labor ratios, cocoa production, though very land-intensive, labor expenses from harvesting, drying, bagging, and hauling to the nearest purchasing agency are extremely labor-intensive. Therefore, the resource endowment differences variable, which is measured as differences in per capita income or GDP-to employment ratio, dwarfs this variable.

Conclusions

Economic theory informs us that at the individual country level, border relaxation reduces domestic prices that help local consumers and increases the profit for low-cost exporters through increased sales in the foreign market. At the global level, free trade causes demand and supply to expand, both of which improve price signals and improves world welfare.

Theory also teaches us that there are many other socio-economic and political-institutional determinants of cross-border trade, including market size, resource endowments, geographical proximity, tastes and preferences, cultural ties, and financial linkages. This paper used the two-way fixed effect panel estimation to determine the influence of the various factors driving the volume of U.S. imports from major cocoa exporting countries.

One noteworthy finding is that the relative factor endowment differences matters. The per capita difference between the importer and exporter was positive and statistically significant. By contrast, the exchange rate relative to the U.S. dollar does not matter. But as producers' share of world price of cocoa through trade liberalization grows, production increase and the volume of export rises. Another important finding was that as the GDP of the U.S. grows relative to that of a cocoa exporting country the volume of exports into former increases.

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Table 1. Descriptive Statistics of Variables (N=196)

Variable	Units	Mean	Standard Deviation	Minimum	Maximum
Value of Exports	Actual $	33522927	59761580	0	344179130
Population of U.S.	Millions	269.485	13.73994	247.286	291.194
Bilateral Trade GDP	Billion $	8.978	0.222097	8.610	9.359
Differences in Endowment	Ratio	28.585	5.143	18.541	37.534
Land-Labor	Ratio	51.498	35.422	13.041	147.847
Exchange Rate	Ratio	2.951	7.056	-9.681	18.941

Table 2: Results of the Two-Way Fixed Effect Panel Estimation Procedure

Variable	Estimate	Standard Error
Intercept	-7.3301***	1.8500
Exchange Rate	-0.0974	0.2141
Bilateral Trade GDP	7. 6988***	1.9423
Differences in Endowment	0.5623***	0.2123
Size of the Economy	-2.0079***	0.6576
Land – Laborer Ratio	-0.0654	0.0581
Brazil	18.18804***	5.9885
Costa Rica	-7.39335***	1.5676
Cote d'Ivoire	1.64011	1.2156
Dominican Republic	-1.25447	1.6887
Ecuador	-0.50496	1.7049
Ghana	-0.22234	1.2853
Haiti	-6.22682***	2.2896
Indonesia	28.99004***	7.0207
Jamaica	-9.56241***	2.0466
Mexico	10.08523***	3.2077
Nigeria	14.37397***	3.8487
Panama	-8.87509***	2.3862
Papua New Guinea	-4.24195	2.6019
St. Lucia	-14.2198***	3.8958
Trinidad and Tobago	-7.24419***	2.3346
R^2	0.85	
F(29, 186) Test for No Fixed Effects	25.69	P < 0.0001

*** Indicates significance at 1% confidence level
** Indicates significance at 5% confidence level

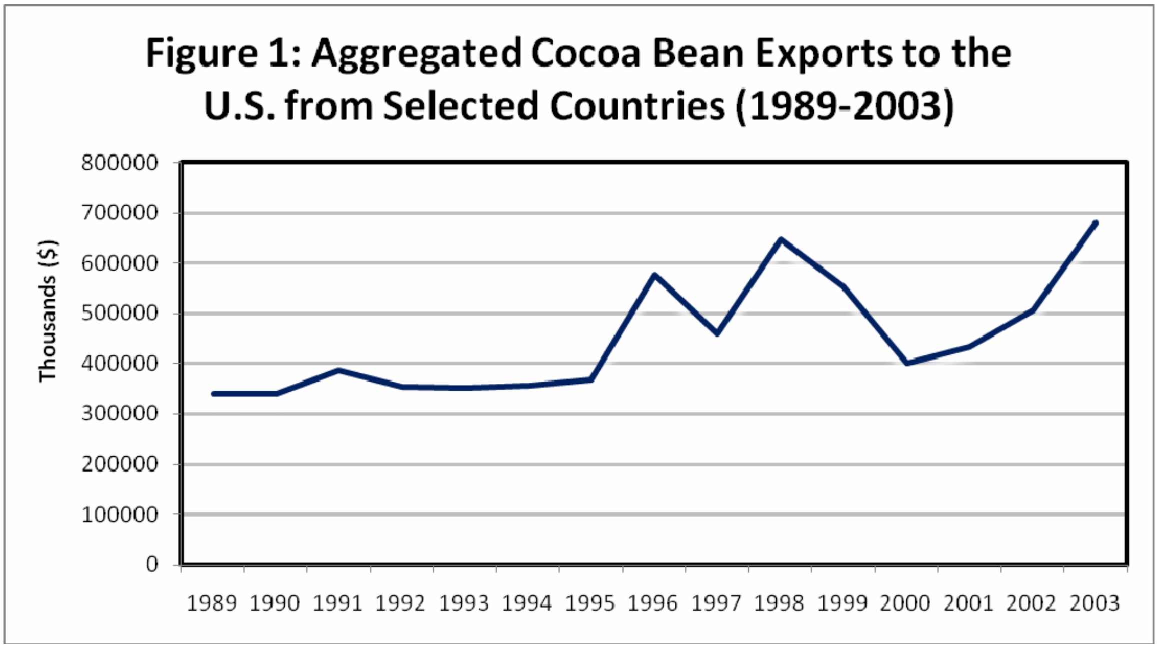
Figure 1: Aggregated Cocoa Bean Exports to the
U.S. from Selected Countries (1989-2003)
Thousands ($)
800000
700000
600000
500000
400000
300000
200000
100000
0
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003