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# 10

## GABRIEL SIRI

# A Minimodel of External Dependence of the Central American Economies*

## 1. INTRODUCTION

This chapter describes a small econometric model showing the high degree of dependence of the Central American economies on external factors that are beyond the control of internal policy measures, such as world prices of the principal export commodities. The model is composed of extremely simple submodels of the five Central American countries that are interrelated by equations of intraregional trade.[1]

Given the prices of the main export commodities, the model "forecasts" GDP, starting from the first year of the sample period 1966–1975, with an average margin of error of 2 percent (dynamic simulation generating its own endogenous variables, given the exogenous ones). On the basis of this small model it is possible to anticipate the

short-term evolution of Central America's intraregional trade, its exports to the rest of the world, and the gross domestic product of each country, provided projections are available for the prices of the main export commodities. Although of minimum size, the model yields interesting results, notwithstanding the fact that its simplicity seriously limits its explanatory capacity. By definition, the model analyzes only the performance of exports and the domestic product of each country.

The analysis implicitly assumes that the economic system will continue to behave as it has in the past without incorporating internal economic policy measures that might alter either the countries' pattern of economic growth or possibilities of structural change. An effort has been made to present this paper in clear didactic terms. In particular, the description of the model has been kept as simple as possible, omitting some of its theoretical underpinnings.

## 2. STRUCTURE OF THE MODEL

The flow chart (Figure 10-1) shows the assumed system of operation of economic activity for a sample economy (Nicaragua). Basically, the model for each country is composed of the following six behavioral equations:

| Annual Growth | Function of | Main Exports | Exports to | (10-1) |
| of the GDP | = the Growth of | (Coffee, Cotton, | Central | |
| | | Bananas, etc. | America | |

| Exports to | | Total Exports from | Obstacles to | (10-2) |
| Central | = Function | "Other" Central | Intraregional | |
| America | of | American Countries | Trade | |
| | | | Honduras- | |
| | | | El Salvador | |
| | | | Conflict | |
| | | | (1969) | |

Exports of
Coffee, Cotton, = Function
Bananas, etc.        of

$$\left[\frac{\text{World Prices of Coffee, Cotton, etc.}}{\text{Domestic Price Level}}\right]$$

(10-3)
(10-4)
(10-5)
(10-6)

The models for each country include equations for their four most important export commodities. The products analyzed constitute a
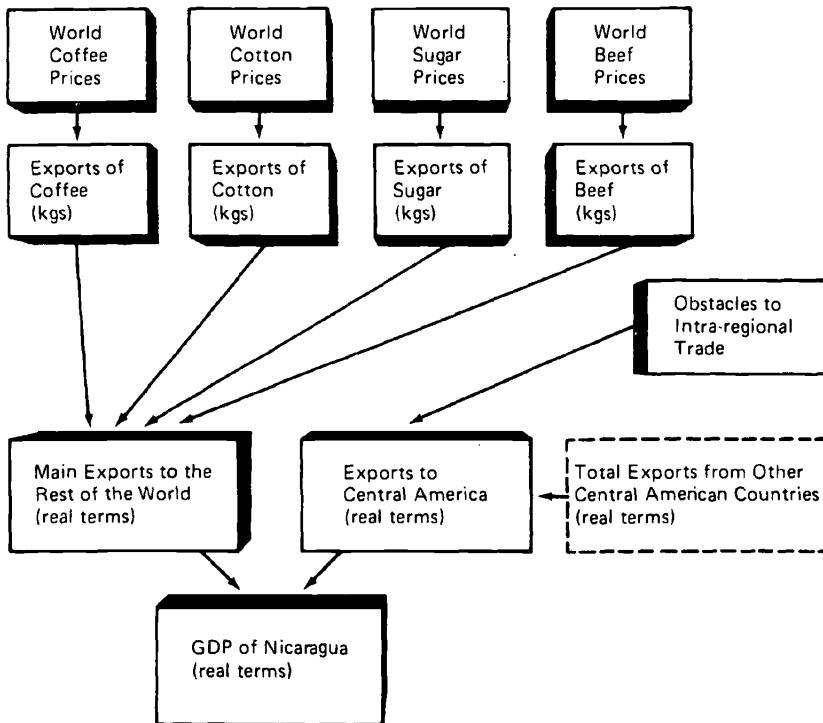
FIGURE 10-1.  Flow Chart of the Minimodel of External Dependence of the Central American Economies (chart for Nicaragua, as an example)

substantial part of the total exports of each country, as is evidenced by the percentages listed below, corresponding to the years 1971–1975:

Guatemala:      Coffee (30%), bananas (5%), cotton (11%), sugar (9%); subtotal of the four products analyzed (55%); other exports to the rest of the world (14%); exports to Central America (31%).

El Salvador:      Coffee (45%), sugar (6%), cotton (12%); subtotal of the three products analyzed (64%); other exports to the rest of the world (8%); exports to Central America (28%).

Honduras:      Coffee (18%), bananas (31%), timber (16%), beef (7%); subtotal of the four products ana-

|  | lyzed (72%); other exports to the rest of the world (21%); exports to Central America (7%). |
| Nicaragua: | Coffee (13%), beef (11%), cotton (27%), sugar (5%); subtotal of the four products analyzed (56%); other exports to the rest of the world (21%); exports to Central America (23%). |
| Costa Rica: | Coffee (26%), bananas (27%), beef (8%), sugar (5%); subtotal of the four products analyzed (66%); other exports to the rest of the world (14%); exports to Central America (20%). |

The complete model utilized in the simulation analysis comprises a total of thirty-five behavioral equations and twenty-five identities.

## 3. CONFORMITY OF THE MODEL TO THE ACTUAL CONDITIONS FOUND IN CENTRAL AMERICA

The openness of their economies is a characteristic feature of the Central American countries, which, owing to their size and geographical position, have remained traditionally oriented toward external trade. The economic policy of the governments has adapted itself to this natural tendency of these economies. With rigid and relatively low tariff barriers,[2] stable exchange rates, and, moreover, restricted international liquidity, the growth of the Central American economies has tended to fluctuate in accordance with the increases and decreases in exports.

Balance-of-payments deficits tend to contract money supply and thus aggregate demand. In addition, the Central American countries, when faced with balance-of-payments deficits, often have played by the rules of the gold standard game contracting aggregate demand and restricting imports by means of monetary and fiscal policies designed to reduce consumption and investment. Recently, however, the governments have shown some reluctance to continue this traditional pattern of contraction of the economies in the face of trade imbalances.[3] Nevertheless, the economies continue to be very open and dependent upon exports for their growth.

Equation (10-1) reflects the hypothesis that exports constitute the driving force behind Central American economic growth. Beneath the simplistic formulation of this equation are hidden the multiple interrelationships that exist between exports and the whole economic apparatus of a country as well as the causal process through which they exert their influence.

Increases in exports represent increases in production, which generate more income in the form of profits and wages. These in turn are channeled into investment and consumption. At the same time, and perhaps even more important, exports provide foreign exchange, which permits more imports of consumer goods, raw materials, intermediate products, and capital goods, the latter largely determining the countries' future productive capacity. Thus a rise in exports has effects that spread to all sectors of the economies with direct and indirect influences on product, not only immediately, but also in subsequent years.

Equation (10-2) describes the performance of the exports of each country to the rest of Central America in terms of "the capacity to import of other countries" and the establishment of the Common Market. The equation could also have been expressed in terms of "income of other countries" (the goodness of fit of the regression coefficients is equally satisfactory). It was considered, however, that the explanatory variable "total exports of other Central American countries" in this quasi-reduced form of the equation represents not only income or purchasing power, but also the availability of foreign exchange, both of which are factors determining the capacity to import.

Equation 10-2 is a typical demand equation and should, in theory, include relative prices as an independent variable in addition to the variable representing purchasing power.[4] Unfortunately, sufficiently reliable statistical series are not available to establish the price relationships between the countries. In any case, since most of Central America's trade is "intrasectoral," this equation would have to be disaggregated into a large number of products in order to adequately measure the effect of prices.[5]

The variable representing the establishment of the Common Market is composed of the sum of the levels of customs tariffs between the countries plus the transport costs involved; both factors affecting the price of the products traded within the region.[6] Intra-area trade has grown at an accelerated pace since 1961 as a result of the elimination of the tariff barriers between the countries and the simultaneous reduction in the cost of highway transportation. Intra-area trade currently represents more than one-quarter of the total exports of the countries.

The variable DUM 1969 is a dummy variable representing the conflict between Honduras and El Salvador and, by definition, covers the years after 1969. Equations (10-3), (10-4), (10-5), and (10-6) for each country are based on the hypothesis that exports of the major commodities (coffee, cotton, bananas, sugar, beef, and timber)

to third countries depend on present and past external prices of those commodities. They are supply functions describing a situation in which small producer countries are faced with prices established externally that they cannot influence by production decisions. The specific description for each equation is presented together with the results of the statistical analysis in Section 4.3.

The model would be more realistic if production for domestic consumption were separated from that destined for export. However, as a first approximation, it has been decided to keep the model simple, taking into account that these are goods produced mainly for export, whose domestic prices mainly depend on external prices.

## 4. RESULTS OF THE
## STATISTICAL ANALYSIS

The equations in the model, with the exception of those pertaining to the supply of export products, are formulated in linear terms and were estimated, in the first instance, by the simple least-squares technique. In those cases where strong autocorrelation in the errors was suspected, the equations were estimated by the Cochrane-Orcutt iterative technique.

The dependent variables of the model form a triangular matrix that can be divided into recursive blocks. In particular the estimated model can be divided into three "completely contained" subsystems (consistent and with a single solution). The three submodels may be estimated consecutively in the following order:

   (i)   Exports of the main products (Equations [10-3] to [10-6])
         constitute a diagonal matrix that can be divided into five small
         independent national models, each "completely self-contained".
   (ii)  Given the exports to countries outside Central America, estima-
         ted in the above model, exports to Central America can be cal-
         culated as an independent model (Equation [10-2]).
   (iii) Once the results of the second model are obtained, the GDP
         can be calculated for each of the countries concerned (Equa-
         tion [10-1]).

The results of the simultaneous simulation of the three subsystems, using the estimated equations described in Sections 4.1-4.3 are given in Table 10-1. The model has been simulated dynamically using the Gauss-Seidel iterative procedure, and as shown in Table 10-1, tracks quite well.

The remainder of this section analyzes the estimated equations. In

Table 10-1. Results of Dynamic Simulation of the Model for the Period 1966-1975

| | Total Exports (in real terms) | | | Exports to Central America (in real terms) | | | Gross Domestic Product (in real terms) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Historical | Estimated | % Error | Historical | Estimated | % Error | Historical | Estimated | % Error |
| **Guatemala** | | | | | | | | | |
| 1966 | 236.9 | 232.2 | 2.0 | 57.1 | 57.4 | -0.5 | 1429.9 | 1515.5 | -6.0 |
| 1967 | 210.7 | 211.6 | -0.4 | 67.9 | 68.6 | -1.0 | 1488.6 | 1556.0 | -4.5 |
| 1968 | 235.4 | 241.6 | -2.6 | 78.6 | 73.2 | 6.9 | 1619.2 | 1650.7 | -1.9 |
| 1969 | 255.1 | 270.5 | -6.0 | 86.2 | 87.8 | -1.9 | 1695.9 | 1749.4 | -3.2 |
| 1970 | 277.1 | 286.4 | -3.4 | 101.1 | 98.8 | 2.3 | 1792.8 | 1839.7 | -2.6 |
| 1971 | 273.8 | 265.3 | 3.1 | 92.4 | 82.9 | 10.3 | 1892.8 | 1898.1 | -0.3 |
| 1972 | 323.9 | 311.8 | 3.7 | 103.6 | 87.0 | 16.0 | 2031.6 | 2020.6 | 0.5 |
| 1973 | 368.3 | 377.4 | -2.5 | 117.3 | 110.3 | 6.0 | 2169.4 | 2161.8 | 0.4 |
| 1974 | 417.6 | 391.0 | 6.4 | 127.5 | 126.2 | 1.0 | 2307.7 | 2255.6 | 2.3 |
| 1975 | 402.3 | 400.3 | 0.5 | 119.3 | 128.3 | 7.5 | 2352.7 | 2293.3 | 2.5 |
| **El Salvador** | | | | | | | | | |
| 1966 | 184.8 | 200.5 | -8.5 | 56.2 | 57.6 | -2.5 | 825.4 | 816.4 | 1.1 |
| 1967 | 203.5 | 189.3 | 7.0 | 73.8 | 65.9 | 10.7 | 870.3 | 847.4 | 2.6 |
| 1968 | 207.5 | 202.5 | 2.4 | 83.2 | 65.7 | 21.0 | 898.4 | 882.7 | 1.7 |
| 1969 | 197.2 | 198.2 | -0.5 | 70.0 | 66.7 | 4.7 | 929.8 | 908.5 | 2.3 |
| 1970 | 219.9 | 214.4 | 2.5 | 69.8 | 68.6 | 1.7 | 957.4 | 945.2 | 1.3 |
| 1971 | 225.2 | 224.7 | 0.2 | 74.2 | 70.9 | 4.4 | 1001.7 | 980.1 | 2.2 |
| 1972 | 277.0 | 254.7 | 8.1 | 78.2 | 70.2 | 10.2 | 1058.4 | 1027.8 | 2.9 |
| 1973 | 297.4 | 297.1 | 0.1 | 88.7 | 85.2 | 3.9 | 1103.6 | 1084.3 | 1.7 |
| 1974 | 343.3 | 322.4 | 6.1 | 105.6 | 98.8 | 6.4 | 1169.7 | 1145.4 | 2.1 |
| 1975 | 342.9 | 376.6 | -9.8 | 80.6 | 98.9 | -22.7 | 1219.6 | 1216.3 | 0.3 |
| **Honduras** | | | | | | | | | |
| 1966 | 142.0 | 139.8 | 1.5 | 19.0 | 20.9 | -10.0 | 550.0 | 555.8 | -1.1 |
| 1967 | 148.9 | 140.2 | 5.8 | 20.2 | 22.2 | -9.9 | 579.8 | 584.2 | -0.8 |
| 1968 | 162.9 | 151.3 | 7.1 | 26.3 | 21.9 | 16.7 | 616.2 | 612.4 | 0.6 |
| 1969 | 152.2 | 148.5 | 2.4 | 19.6 | 16.4 | 16.3 | 621.3 | 629.2 | -1.3 |
| 1970 | 150.2 | 147.1 | 2.1 | 15.0 | 11.3 | 24.7 | 638.0 | 633.3 | 0.7 |

Table 10-1. continued

| Year | Total Exports (in real terms) | | | Exports to Central America (in real terms) | | | Gross Domestic Product (in real terms) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Historical | Estimated | % Error | Historical | Estimated | % Error | Historical | Estimated | % Error |
| 1971 | 160.3 | 144.9 | 9.6 | 4.2 | 3.0 | 28.6 | 666.5 | 637.5 | 4.4 |
| 1972 | 164.6 | 174.6 | -6.1 | 5.4 | 9.1 | -68.5 | 702.5 | 650.5 | 7.4 |
| 1973 | 191.1 | 218.2 | -14.2 | 9.5 | 13.4 | -41.1 | 732.0 | 694.2 | 5.2 |
| 1974 | 177.5 | 166.7 | 6.1 | 17.3 | 16.0 | 7.5 | 739.0 | 690.8 | 6.5 |
| 1975 | 206.3 | 215.9 | -4.7 | 18.0 | 17.3 | 3.9 | 743.0 | 695.0 | 6.5 |
| **Nicaragua** | | | | | | | | | |
| 1966 | 133.8 | 148.4 | -10.9 | 13.7 | 15.4 | -12.4 | 570.8 | 590.8 | -3.5 |
| 1967 | 140.9 | 152.3 | -8.1 | 16.8 | 20.5 | -22.0 | 610.6 | 635.9 | -4.1 |
| 1968 | 144.3 | 145.5 | -0.8 | 23.4 | 19.8 | 15.4 | 618.8 | 656.9 | -6.2 |
| 1969 | 139.5 | 153.6 | -10.1 | 26.5 | 30.4 | -14.7 | 657.4 | 681.4 | -3.7 |
| 1970 | 153.4 | 157.7 | -2.8 | 41.8 | 39.0 | 6.7 | 671.0 | 695.2 | -3.6 |
| 1971 | 158.7 | 163.9 | -3.3 | 40.3 | 41.3 | -2.5 | 703.4 | 725.7 | -3.2 |
| 1972 | 204.2 | 204.8 | -0.3 | 45.2 | 41.2 | 8.8 | 728.3 | 762.5 | -4.7 |
| 1973 | 191.9 | 209.0 | -8.9 | 41.6 | 37.8 | 9.1 | 750.1 | 796.1 | -6.1 |
| 1974 | 215.7 | 221.0 | -2.5 | 47.1 | 51.1 | -8.5 | 855.8 | 864.8 | -1.1 |
| 1975 | 205.6 | 185.2 | 9.9 | 57.6 | 52.1 | 9.5 | 868.6 | 879.4 | -1.2 |
| **Costa Rica** | | | | | | | | | |
| 1966 | 135.5 | 137.4 | -1.4 | 24.6 | 26.2 | -6.5 | 647.3 | 653.9 | -1.0 |
| 1967 | 140.6 | 150.4 | -7.0 | 28.9 | 25.1 | 13.1 | 683.9 | 703.8 | -2.9 |
| 1968 | 163.8 | 162.3 | 0.9 | 34.4 | 28.2 | 18.0 | 741.8 | 755.7 | -1.9 |
| 1969 | 173.9 | 167.5 | 3.7 | 31.6 | 32.8 | -3.8 | 782.6 | 804.4 | -2.8 |
| 1970 | 197.4 | 172.5 | 12.6 | 39.6 | 38.0 | 4.0 | 841.2 | 851.3 | -1.2 |
| 1971 | 196.0 | 183.5 | 6.4 | 38.4 | 37.6 | 2.1 | 898.3 | 898.1 | 0.0 |
| 1972 | 243.5 | 230.1 | 5.5 | 41.4 | 46.7 | -12.8 | 971.8 | 952.4 | 2.0 |
| 1973 | 266.0 | 283.3 | -6.5 | 50.9 | 56.4 | -10.8 | 1046.7 | 1017.3 | 2.8 |
| 1974 | 305.3 | 305.7 | -0.1 | 65.6 | 56.4 | 14.0 | 1103.8 | 1084.4 | 1.7 |
| 1975 | 292.3 | 263.0 | 10.0 | 53.7 | 55.9 | -4.1 | 1140.5 | 1134.3 | 0.5 |

general, the series of observations used cover fifteen to twenty-five years; that is, at least the period 1960–1975. In some cases the sample periods are shorter, owing to lags in the independent variables. Moreover, some of the series have been shortened in order to analyze their most recent behavior.

The data on the GDP and export commodity prices were taken from the publications of the central bank of each country. The source of foreign trade figures is the Department of Statistics of SIECA.

The following abbreviations are used throughout the presentation of the statistical results:

( )    "*t*" coefficient

$R^2$    Multiple correlation coefficient of the regression

*SE*    Standard error

*DW*    Durbin-Watson coefficient

*DF*    Degrees of freedom

*    Equation that has been estimated by the Corchrane-Orcutt iterative method because high serial correlation of the error term was suspected (unsatisfactory Durbin-Watson statistic). All other equations were estimated by ordinary least squares. To simplify the presentation, the coefficients of the Corchrane-Orcutt adjustment are omitted in the description of the regression analyses.

### 4.1 Annual Change in the Gross Domestic Product—Estimates of Equation (10-1)

$$\text{Annual Change in Real GDP} = \alpha \begin{bmatrix} \text{Annual} \\ \text{Change} \\ \text{in Total} \\ \text{Exports} \end{bmatrix} + \beta \begin{bmatrix} \text{Annual} \\ \text{Change} \\ \text{in Total} \\ \text{Exports} \end{bmatrix}_{-1} + \delta \begin{bmatrix} \text{Annual} \\ \text{Change} \\ \text{in Total} \\ \text{Exports} \end{bmatrix}_{-2} + \text{Constant}$$

| | | $R^2$ | *SE* | *DW* | *DF* |
|---|---|---|---|---|---|
| $\Delta(\text{GDP})$ * | $= 1.04 \, \Delta(X/po)$ | 0.64 | 22.1 | 1.78 | 17 |
| (Guatemala) | (4.9) | | | | |
| | $- 42.58 \, DM60 + 65.0$ | | | | |
| | (-2.1)   (7.2) | | | | |
| $\Delta(\text{GDP})$ * | $= 0.38 \, \Delta(X/po)$ | 0.61 | 11.6 | 1.85 | 16 |
| (El Salvador) | (2.5) | | | | |
| | $+ 0.32 \, \Delta(X/po)\text{-}1$ | | | | |
| | (1.9) | | | | |

$$+ 0.36 \, \Delta(X/po)\text{-}2$$
$$(1.9)$$
$$- 33.1 \, DM58 + 27.2$$
$$(-2.7) \qquad\quad (8.8)$$

| | | | | | |
|---|---|---|---|---|---|
| $\Delta(\text{GDP})$ (Honduras) | $= 0.67 \, \Delta(X/po)$ (4.8) | 0.67 | 6.8 | 2.32 | 10 |

$$+ 0.18 \, \Delta(X/po)\text{-}1$$
$$(1.0)$$
$$+ 0.26 \, \Delta(X/po)\text{-}2$$
$$(1.6)$$
$$+ 0.16 \, \Delta(X/po)\text{-}3$$
$$(1.1)$$
$$- 21.7 \, DM74 + 12.8$$
$$(-2.4) \qquad\quad (4.6)$$

| | | | | | |
|---|---|---|---|---|---|
| $\Delta(\text{GDP})$ * (Nicaragua) | $= 0.30 \, \Delta(X/po)$ (1.5) | 0.66 | 13.8 | 2.0 | 18 |

$$+ 0.16 \, \Delta(X/po)\text{-}1$$
$$(.7)$$
$$+ 1.11 \, \Delta(X/po)\text{-}2$$
$$(4.4)$$
$$- 30.2 \, DM58.9 + 18.9$$
$$(-2.9) \qquad\qquad (4.3)$$

| | | | | | |
|---|---|---|---|---|---|
| $\Delta(\text{GDP})$ (Costa Rica) | $= 0.65 \, \Delta(X/po)$ (1.4) | 0.61 | 13.3 | 1.61 | 7 |

$$+ 0.81 \, \Delta(X/po)\text{-}1$$
$$(1.8)$$
$$- 36.9 \, DM64$$
$$(-2.4)$$
$$- 40.4 \, DM72 + 27.2$$
$$(-2.3) \qquad\quad (2.5)$$

where


$\Delta(\text{GDP})$   Annual change of GDP in millions of $CA (approximately equal to one U.S. Dollar) at constant prices.

$\Delta(X/po)$   Annual change in total exports in millions of $CA divided by the GDP deflator.

   $\Delta(X/po)\text{-}1$, $\Delta(X/po)\text{-}2$, $\Delta(X/po)\text{-}3$   Annual change in total exports of previous years.

$DM60$   Dummy variable representing political disturbances in Guatemala in the year 1960.

*DM*58    Dummy variable representing the political disturbances in
         El Salvador in the year 1958.
*DM*74    Dummy variable representing Hurricane Fifi, which devas-
         tated the Atlantic coast of Honduras in September 1974.
*DM*64    Dummy variable representing the eruption of the Irazú vol-
         cano in Costa Rica in 1964.
*DM*72    Dummy variable representing the eruption of the Arenal
         volcano in Costa Rica in 1972.

The *t*-values for most of the variables are acceptable. The low
multiple correlation coefficients obtained in some cases, however,
suggest the omission of additional explanatory variables.

An estimate of the total effect of a change in the value of exports
on the growth of the GDP can be calculated by adding the regression
coefficients $\alpha$, $\beta$, and $\delta$. The total obtained represents a measurement
of the increase in the GDP (in $CA) that may be expected as the
result of a permanent increase of one unit ($CA) in exports: The
results for the individual countries are: Guatemala 1.0, El Salvador
1.1, Honduras 1.3, Nicaragua 1.6, Costa Rica 1.5.

Obviously, the coefficients obtained from this type of reduced-
form equations, with highly aggregated components, must be treated
with great caution. One of the most difficult problems to overcome
lies in the possibility of omitted explanatory variables that may be
collinear with those included in the equations, which would intro-
duce a bias in the estimates of the regression coefficients. Since in
this case, however, the "changes in exports" fluctuate substantially
from year to year, it is unlikely that this variable will be strongly
correlated with other variables that may affect the domestic product
(such as productivity increases).

### 4.2 Exports to Central America—Estimates of Equations 10-2

$$
\begin{matrix}
\text{Exports to} \\
\text{Central} \\
\text{America}
\end{matrix}
= \alpha
\begin{bmatrix}
\text{Sum of Total} \\
\text{Exports of} \\
\text{"Other" C.A.} \\
\text{Countries}
\end{bmatrix}
+ \beta
\begin{bmatrix}
\text{Cost of} \\
\text{Intra-} \\
\text{Regional} \\
\text{Trade}
\end{bmatrix}
+ \delta
\begin{bmatrix}
\text{Dummy} \\
\text{Honduras-} \\
\text{El Salvador} \\
\text{Conflict}
\end{bmatrix}
+ \text{Constant}
$$

| | | | $R^2$ | *SE* | *DW* | *DF* |
|---|---|---|---|---|---|---|
| X CA (*G*) * | = 0.165 *XOTH*-1 | −3.26 *CACM* | 0.95 | 8.8 | 1.79 | 10 |
| (Guatemala) | (9.6) | (−1.9) | | | | |

$$+ 19.8 DM69 \quad - 10.4$$
$$(2.2) \qquad (-0.6)$$

| | | | | | |
|---|---|---|---|---|---|
| $X$ CA $(S)$ * (El Salvador) | $= 0.095\ XOTH\text{-}1$ (3.2) | 0.86 | 10.7 | 1.62 | 12 |

$$- .76\ CACM - 6.5\ DM69$$
$$(-2.1) \qquad (-0.5)$$
$$+ 11.3$$
$$(0.6)$$

| | | | | | |
|---|---|---|---|---|---|
| $X$ CA $(H)$ * (Honduras) | $= 0.017\ XOTH\text{-}1$ (2.8) | 0.80 | 2.8 | 1.76 | 12 |

$$- 2.2\ CACM - 12.5\ DM69$$
$$(-3.7) \qquad (-3.6)$$
$$+ 12.0$$
$$(2.9)$$

| | | | | | |
|---|---|---|---|---|---|
| $X$ CA $(N)$ * (Nicaragua) | $= 0.067\ XOTH\text{-}1$ (39.2) | 0.99 | 2.2 | 1.55 | 11 |

$$+ 13.2\ DM69 - 25.2$$
$$(13.0) \qquad (-20.5)$$

| | | | | | |
|---|---|---|---|---|---|
| $X$ CA $(CR)$ * (Costa Rica) | $= 0.64\ XOTH\text{-}1$ (8.6) | 0.96 | 3.7 | 1.90 | 11 |

$$- 0.15\ CACM + 5.1\ DM69$$
$$(-1.9) \qquad (1.8)$$

$$- 16.9$$
$$(-2.7)$$

where the value of exports to Central America and the sum of total exports of the "other Central American countries" are in millions of $CA and have been divided by the implicit price of the GDP. Total exports of the "other" countries comprise exports to Central America plus exports to the rest of the world of the four main products considered for each country, plus a residual comprising other exports to the rest of the world (all divided by the GDP deflator of the corresponding country). The Common Market variable, CACM, comprises the incidence of tariffs on the price of the traded goods, plus the incidence of transportation costs. The dummy variable represents the period following the Honduras-El Salvador conflict in August 1969.

The results of the regression analysis are satisfactory. The goodness of fit coefficients are adequate and appear to confirm the hypotheses that served as a basis for formulating the equations. The

average standard error of the estimated values obtained through the dynamic simulation of the model in the ten-year sample period is approximately 9 percent.

The following average elasticities are derived from the estimated coefficients (percentage change in exports to Central America, resulting from a percentage change in total exports of the "other" Central American countries): Guatemala 1.38, El Salvador 1.01, Honduras 0.83, Nicaragua 1.83, Costa Rica 1.47. As may have been expected, Honduras has a lower coefficient because its industrial park is much less developed than that of the rest of the countries.

The DUMMY 1969 coefficient is negative for El Salvador and Honduras and positive for the other countries, which reflects the fact that the other countries, particularly Guatemala, have partially absorbed the reduction of the flow of trade between Honduras and El Salvador.

### 4.3 Main Exports to the Rest of the World-
### Estimates of Equations (10-3) to (10-6)
### 4.3.1 Exports of Coffee

$$\log \begin{bmatrix} \text{Export of} \\ \text{Coffee} \end{bmatrix} = \alpha \log \left[ \frac{\text{Price Coffee}}{\text{GDP Deflator}} \right]_{-i} + \beta \log \left[ \frac{\text{Price Coffee}}{\text{GDP Deflator}} \right]_{-j} + \delta \text{ Time}$$
$$+ \text{ Constant}$$

|  | | $R^2$ | $SE$ | $DW$ | $DF$ |
|---|---|---|---|---|---|
| X COFFEE (Guatemala) | = 0.306 $PC$ - 2 (2.1) 0.396 $PC$ - 9 (3.6) 0.040 TIME (8.8) - 0.176 $D67$ + 3.76 (-2.5)        (42.8) | 0.88 | 0.068 | 2.07 | 15 |
| X COFFEE* (El Salvador) | = 0.789 $PC$ - 3 (5.5) + 0.170 $PC$ - 9 (1.3) + 0.293 $PC$ - 10 (4.9) + 0.109 $PC$ - 11 (1.1) | 0.79 | 0.071 | 2.47 | 10 |

$$+ 2.25 \text{ AREA} - 9 \quad - 6.34$$
$$(11.1) \qquad\qquad (-7.3)$$

X COFFEE* = $0.491\, PC - 2$     0.91  0.112  2.28  12
(Honduras)   (3.1)
    + $0.173\, PC - 9$
    (1.1)
    + $0.167\, PC - 10$
    (2.5)
    + $0.305\, PC - 11$
    (5.4)
    + $0.208\, PC - 12$
    (4.3)
    + 2.51 AREA - 9    - 7.36
    (6.8)       (4.1)

X COFFEE   = $0.335\, PC - 1$     0.92  0.062  2.31  14
(Nicaragua)   (4.2)
    + $0.199\, PC - 7$
    (2.0)
    + 0.050 TIME
    (10.1)
    - 0.223 D59 + 2.37
    (-3.5)     (25.5)

X COFFEE   = $0.362\, PC - 2$     0.93  0.055  2.16  11
(Costa Rica)   (1.7)
    + $0.373\, PC - 8$
    (3.1)
    + 1.44 AREA - 8
    (11.2)
    - 0.0039 CYCLE
    (-2.1)
    - $0.299\, D64 - 1.67$
    (-6.9)     (-3.4)

where exports of commodities are the natural logarithm of variables in thousands of metric tons, the prices of export products are the natural logarithm of the commodity price actually accruing to each country in thousands of $CA per metric ton, the GDP deflator is the index relating the GDP at current prices with the GDP at constant prices (1962 = 100), time is the series of consecutive cardinal members corresponding to the year of the sample period, and where called for, weather dummies were included in the equations.

These supply equations, as specified, assume that world prices affect short- and long-term exports:

In the first place, recent prices influence the intensity of the production of the crop (amount of fertilizer and insecticides, care in pruning, etc.). It should be noted that coffee is exported no earlier than the year following the harvest year, which helps to explain the lag observed in the first independent variable.

Moreover, in view of the fact that coffee is a perennial crop and the bush takes from four to six years to reach maturity, it is reasonable to expect that prices of seven to twelve years ago affect current output. Former prices affect both the intensity of cultivation and the planting of new trees. The natural logarithm of this last variable (AREA) is included in some regressions as a separate variable.

Coffee exports to Costa Rica are assumed to depend on two additional variables: a dummy corresponding to the eruptions of the Irazú Volcano during the period 1964–1966, and the often cited two-year coffee cycle. No evidence of the existence of this cycle was found for the other countries.

The results of the regression analysis indicate that coffee exports tend to increase (or decrease) as follows, in line with the stimulus of prices:

|  | *Export-price Elasticity Corresponding to Recent Prices* | *Export-price Elasticity Corresponding to "Former" Prices* |
|---|---|---|
| Guatemala | 0.31 | 0.40 |
| El Salvador | 0.79 | 0.98 |
| Honduras | 0.49 | 0.45 |
| Nicaragua | 0.34 | 0.20 |
| Costa Rica | 0.36 | 0.37 |

## Exports of Cotton

$$\log \begin{bmatrix} \text{Exports of} \\ \text{Cotton} \end{bmatrix} = \alpha \log \begin{bmatrix} \dfrac{\text{Price of Cotton}}{\text{GDP Deflator}} \end{bmatrix}_{-i} + \beta \text{ Weather Dummies} + \text{Constant}$$

|  | $R^2$ | $SE$ | $DW$ | $DF$ |
|---|---|---|---|---|
| X COTTON* = 0.851 $PA - 1$ | 0.93 | 0.157 | 1.04 | 13 |

X COTTON* = 0.851 *PA* – 1
(Guatemala)　(1.6)
　　　　　　–0.484 *DM*67/71 –5.52
　　　　　　(–4.0)　　　　　(12.9)

X COTTON* $= 1.593\ PA - 1$                           0.64   0.219   2.16   15
(EL Salvador)   (3.0)
               $-0.567\ DM67/9 + 4.81$
               (-3.2)                  (15.5)

X COTTON* $= 0.945\ PA - 2$                           0.86   0.140   2.07   12
(Nicaragua)     (2.0)
               $-0.343\ DM70/1 + 5.51$
               (-3.0)                  (14.8)

Except in the case of El Salvador, the supply response to price changes appears to be low. The function requires further study to discover the determinants of export supply. It would be useful to analyze not only the effect of prices, but also that of the costs of factors of production and inputs and, in particular, of fertilizers and pesticides.

The dummy variables referring to the years following 1967 correspond to the decline in the area sown in Guatemala and El Salvador as a result of agricultural plagues in both countries. Both insect plagues and a heavy drought explain the sharp drop in production of cotton in Nicaragua during the period 1970-1971.

### Exports of Bananas

$$\log \begin{bmatrix} \text{Exports of} \\ \text{Bananas} \end{bmatrix} = \alpha \log (\text{GNP/Capita USA}) + \text{Constant}$$

|  |  | $R^2$ | $SE$ | $DW$ | $DF$ |
|---|---|---|---|---|---|

X BANANA*   $= 3.39\ Y$ US                            0.85   0.283   2.20   12
(Guatemala)    (3.2)
               $-1.24\ DM65/7 - 23.51$
               (-5.7)                  (-2.6)

X BANANA*   $= 3.07\ Y$ US                            0.89   0.133   2.18   12
(Honduras)    (12.3)
               $-0.43\ DM63/4$
               (-4.7)
               $-0.59\ DM74/5 - 19.29$
               (-6.3)                  (-9.2)

X BANANA*   $= 5.12\ Y$ US $- 36.93$                  0.92   0.172   1.52   15
(Costa Rica)   (6.6)          (-5.6)

Since the foreign companies that transport and market bananas

are generally also producers, the export prices have often been internal to the firms and therefore not treated as determinants of supply decisions. It is interesting to note that local producers receive barely over 10 percent of the final price of the product.[7]

The equations, as specified, show the high supply elasticity that exists with respect to GNP per capita of the United States, Central America's main export market (the variable is given in natural logarithms). The dummy variable DM 74–75 corresponds to the years following Hurricane Fifi, which devastated the Atlantic coast of Honduras in October 1973.

### Exports of Sugar

$$\log \begin{bmatrix} \text{Exports of} \\ \text{Sugar} \end{bmatrix} = \alpha \log (\text{GNP/Capita USA}) + \text{Constant}$$

|  |  | $R^2$ | SE | DW | DF |
|---|---|---|---|---|---|
| X SUGAR* (Guatemala) | = 3.42 $Y$ US (2.7) + 1.24 $DM75/6$ – 24.77 (5.0)   (–2.3) | 0.87 | 0.258 | 1.64 | 11 |
| X SUGAR* (El Salvador) | = 7.36 $Y$ US (15.7) – 1.36 $DM65$ – 58.24 (–5.5)   (–14.7) | 0.93 | 0.239 | 2.21 | 12 |
| X SUGAR* (Nicaragua) | = 2.90 $Y$ US (5.3) – 1.06 $DM66$ + 0.40 $DM75/6$ (–6.1)   (2.3) D75/6 – 20.43 (–4.5) | 0.91 | 0.185 | 1.92 | 15 |
| X SUGAR* | = 5.76 $Y$ US (13.0) –0.38 $DM75/6$ –44.68 (–2.1)   (–12.0) | 0.87 | 0.250 | 1.72 | 14 |

Preliminary results of statistical analyses indicated a low *t*-value for sugar prices. The reason for this may be that part of the sugar crop is consumed locally under a price system that is not the same as that of the world market. Perhaps more important is the fact that the international sugar market is highly regulated and fragmented,

and exports from the Central American countries have been very dependent for most of the period under consideration on a quota system established by the United States.

The results of the statistical analyses presented show a high elasticity of exports of sugar to variations of GNP per capita of the United States, the countries' main export market.

### Exports of Beef

$$\log \begin{bmatrix} \text{Exports} \\ \text{of Beef} \end{bmatrix} = \alpha \log \begin{bmatrix} \dfrac{\text{Price of Beef}}{\text{GDP Deflator}} \end{bmatrix}_{-i} + \text{Constant}$$

|  |  | $R^2$ | $SE$ | $DW$ | $DF$ |
|---|---|---|---|---|---|
| X BEEF* (Honduras) | = 2.12 $PB - 1$ (4.4) + 0.137 TIME (16.1) − 1.05 $DM74/5$ + 0.54 (−7.1)               (1.8) | 0.96 | 0.111 | 2.36 | 9 |
| X BEEF* (Nicaragua) | = 0.70 $PB - 1$ (2.7) + 1.65 $PB - 3 - 0.44$ $DM65$ (6.4)              (−3.4) −0.56 $D74/5$ + 3.50 (−2.3)              (38.6) | 0.81 | 0.177 | 1.79 | 10 |
| X BEEF* (Costa Rica) | = 1.70 $PB - 1$ (2.9) + 1.51 $PB - 2$ (2.7) − 0.55 $DM65$ + 3.24 (−2.3)              (18.2) | 0.85 | 0.259 | 1.52 | 12 |

The results of the regression analysis generally indicate high short-term supply price elasticity for exports of beef: Honduras, 2.1; Nicaragua, 2.3; Costa Rica, 3.2. In the case of Honduras the regression results also show a steady trend of export growth (14 percent per year), which appears to be independent of price variations.

### Exports of Timber

$$\log \begin{bmatrix} \text{Exports} \\ \text{of Timber} \end{bmatrix} = \alpha \text{ Time} + \text{Constant}$$

|  | $R^2$ | SE | DW | DF |
|---|---|---|---|---|
| X TIMBER  = 0.094 TIME | 0.95 | 0.090 | 1.66 | 12 |

X TIMBER   = 0.094 TIME
(Honduras)   (15.8)
           − 0.606 $DM76$ + 3.74
           (−5.9)          (33.2)

Regression analysis does not indicate a positive supply price elasticity of exports of timber. This result probably reflects the efforts of the Government of Honduras to regulate the excessive exploitation of conifers in the past decade, particularly since the establishment of the Honduran Forest Development Corporation (COHDEFOR) in 1973. In particular, measures of export control explain the sharp drop in exports of timber in 1976. The TIME variable represents the historical growth trend of exports (about 9 percent) and dominates price effects.

## 5. CONSIDERATIONS ON THE POSSIBLE USE OF THE MODEL IN SHORT-TERM PLANNING

The model basically illustrates the situation of vulnerability that characterizes the Central American economies with respect to fluctuations in world prices of a few export commodities. Given this situation, the most desirable objective that could be achieved would be for the model (with the simplistic structure with which it is conceived) to function less accurately in the future.

However, in spite of the success that may have been obtained toward reducing the degree of external dependence of the economies through the integration process, the Central American countries are certainly not becoming less open. On the contrary, situations such as the deterioration in the terms of trade, the sudden rise in oil prices, and the increasing imports of raw materials required for the industrial development process may well have accentuated the vulnerability of the economies.

The model presented illustrates the magnitude of the dependence of the economies, and in particular, it analyzes in quantitative terms the effects of fluctuations in world prices. In this respect, the model could—until the time that more complete models become available—provide some general guidelines for the formulation of operative plans.

There is a series of measures that the Central American Governments can adopt—and in fact are adopting—to counteract the fluctuations deriving from the external sector. In view of the fact, however,

that policy measures such as those affecting public investment, the production of "importable commodities," export diversification, external indebtedness, and so on, produce results in the medium term, any possibility of forecasting the fluctuations of economic activity some years in advance—if only roughly—is obviously useful.

To sum up, these are small economies that are highly dependent on an eminently unstable external sector; they are also characterized by their limited capacity to mitigate the fluctuations in world prices of their main export commodities and to effect the necessary internal adjustments as rapidly as might be desired. Econometric models that relate the external sector to the product of the economies are useful in that they make possible the forecasting of the effects of sharp drops in exports and, consequently, the formulation of timely measures that can attenuate recessions in economic activity.

## NOTES

1. The specification of the model is based on the experience acquired in the formulation of a much more comprehensive model currently being developed by the author for SIECA's Study Unit for Integration and Development.

2. See *La revisión de la política arancelaria centroamericana*, SIECA/75/FIA/24/I/A. June 3, 1975.

3. The governments have adopted the following internal measures designed to reduce the countries' external dependence:

  (i)   Progressive reduction of the fiscal system's dependence upon the tariff revenue accruing to the governments, which favors the adoption of anticyclical public investment policies in periods of contraction of the external sector. The share of tariffs in total tax income has dropped from 49.6 percent in 1960 to 23.6 percent in 1974. See SIECA, *La revisión de la política arancelaria centroamericana*, op. cit.
  (ii)  Attempts to attain some degree of self-sufficiency in basic grains.
  (iii) Import substitution of manufactures (one of the primary objectives of the integration process).

Moreover, the governments have not confined themselves to the adoption of internal measures, but have made use of external measures and those related to international liquidity.

  (i)   An increase of approximately 30 percent in the Central American common external tariff (San José Protocol for the Defense of the Balance of Payments, 1968).                                    ⊙
  (ii)  Increase in external loans to finance public investment (the annual amount of external loans increased fivefold during the period 1969–1974).

4. There is no reason to assume at first glance that the variable representing "exports of other countries" is correlated with the excluded "relative prices" variable, thus causing errors in the estimated coefficients.

5. It can be pointed out here that in open economies such as those of the Central American countries, domestic prices are largely determined by world prices. Therefore, the inclusion of price equations in the model would probably confirm even further the high degree of external dependence of the Central American economies.

6. G. Siri, *El precio del transporte como arancel implícito en el comercio centroamericano*, SIECA/Brookings, 1974.

7. UNCTAD, *Sistema de comercialización y distribución del banano*, Committee on Commodities, eighth session, February, 1975, Tables 7 and 8.