INTER-AMERICAN INSTITUTE FOR COOPERATION ON AGRICULTURE

MEASUREMENT OF THE IMPORTANCE OF THE AGRO-AGROINDUSTRY COMPLEX IN THE ECONOMIES OF LATIN AMERICAN AND CARIBBEAN COUNTRIES

By

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I Introduction

The standard pratice of reporting the value added in agriculture as the contribution of agriculture to a national economy can seriously underestimate the importance of agriculture. Agricultural production influences other sectors of an economy in two ways. First it demands and stimulates production of agricultural inputs such as fertilizer, pesticides, tractors, and other agricultural machines and equipment. This influence on the agricultural input industry is often called a backward linkage with the economy. Second, agricultural production often leads to downstream processing of agricultural goods. The connection between agricultural production and food and beverage processing is often called a forward linkage with the rest of the economy.

In Latin America some agricultural inputs are imported thereby limiting the national importance of backward linkages. For example imports of agricultural inputs by 16 major Latin American countries rose from 320 million dollars in 1968 to 2.4 billion dollars 1980. In the wake of debt crisis these imports fell to 1.4 dollars in 1983 but rose to 1.6 billions dollars by 1986. (See Arnade, 1989)

Forward linkages, by contrast, may play a more critical role in Latin American agriculture. Industries which use agricultural goods as inputs include the food processing industry, the beverage and juice industry, the oilseed processing industry, the tobbaco processing industry, and the leather industry. The textile industry also uses cotton, wool, and other agricultural goods but cotton or other raw materials are often imported so it is difficult to include the textile industry as part of a nations agro-industrial sector. If one includes forestry as part of agriculture then the paper and wood and furniture industry also must be included as part of the agro-industrial sector.

II Methodology of Assessing the Total Agricultural Contribution to the GDP

In order to obtain the total contribution of agriculture to a countries' GDP one needs to add up the contribution of all the sectors which agriculture is responsible for. Three sets of data which are often available are value added in agriculture, value added in food and beverage manufacturing, and output of the agricultural input industry. These data can be written as:

$$(1)\ \sum_{m=1}^{N} P_m Q_m - \sum_{a=1}^{T} P_a Q_a - \sum_{m=1}^{Z} W_m X_m = VAM$$

$$(2)\ \sum_{t=1}^{T} P_a Q_a - \sum_{i=1}^{V} W_i X_i = VAAG$$

$$(3)\ \sum_{i=1}^{V} W_i X_i = VAINP$$

where P_m is the price of the mth processed food or beverage, Q_m is the quantity of the mth processed food or beverage, P_a is the price of the ath agricultural good, Q_a is the quantity of the ath agricultural good, W_m is the price of mth nonagricultural input used in manufacturing and X_m is the quantity of the nonagricultural input used in manufacturing, W_i is the price of ith input use in agricultural production and X_i is the quantity of the input used in agricultural production, VAM is the total value added to agricultural manufacturing, VAAG is the total value added to agriculture, and VAINP is the total value of inputs use in agriculture. The above equations assume that all of the T agricultural goods are used in the food or beverage processing industry and all of the V inputs used in agriculture are produced within the country.

Equation 1 writes value added in manufacturing as the sum of revenues of N agro-industrial good minus the costs of using the T agricultural goods and Z manufacturing inputs. Equation 2 writes value added in agricultural as the sum of revenues of T agricultural goods minus the costs of using V inputs. Equation three writes the value of production of agricultural inputs.

These equations, of course, simplify matters greatly. For example, agricultural processers rarely pay the same price for agricultural goods as agricultural producers receive. As similar situation holds for agricultural inputs. In reality an equation which reflects the value added to transporting and marketing agricultural goods needs to be added to the three equations.

Adding up the three equations gives the total value of agro-related sectors of the economy. When all inputs are produced domestically and all agricultural goods are processed this sum equals the revenue of the agro-manufacturing sector or:

$$\sum_{m=1}^{N} P_m Q_m - \sum_{m=1}^{Z} W_m X_m$$

Under these circumstances the ratio:

$$\left(\sum_{t=1}^{T} P_a Q_a - \sum_{m=1}^{Z} W_m X_m \right) / \left(\sum P_m Q_m \right)$$

reflects the percentage of the true contribution of agriculture to an economy that is accounted for by agricultural GDP.

Unfortunately Latin American economies are rarely as simple as the situation above. As already noted many of the inputs used by Latin American agriculture are imported. Latin America also imports many of the nonagricultural inputs used in the food processing industry such as energy inputs, and the capital equipment used in processing plants. In addition, much of the agricultural output is not used in a food or beverage processing sector, but is exported in the unprocessed form in which it was harvested. Also, some agricultural goods which are processed are imported. Finally, it is difficult to obtain data on the revenue earned by food and beverage processors. Often only value added data for agriculture or agro-industry are available.

III Agriculture's Share of the GDP

Despite the above noted difficulties, it is still posssible to get an idea of the degree of agriculture's contribution to the GDP. For example, the SIAPA system contains value added data for agriculture and industry for most Latin American and Caribbean (LAC) countries from 1968 to 1987. If most agricultural inputs are imported the agricultural contribution to GDP is typically considered to be value added as percent of GDP.

This percentage is shown in Table 1 for most IICA member countries. For most countries the value added to agriculture represents 10 to 35 percent of GDP. Haiti remains the exception where over 42% of GDP came from agriculture in the early years. However, Table 1 also demonstrates that agriculture directly contributed to less than 10% of the GDP for Argentina and Brazil (in some years), Chile, Jamaica, and Mexico and Venezuela. From these numbers alone one would be quick to conclude that agricultural represents approximately one fifth of the economy for most LAC countries and less than 1 tenth of the economy of some of the most important Latin American economies.

TABLE 1: AGRICULTURE AS % OF GDP

	1968	1970	1972	1974	1976	1978	1980	1982	1984	1986	1988
ARGENTINA	11.5	10.2	13.0	12.1	9.7	9.0	7.6	10.4	11.2	11.2	11.3
BOLIVIA	19.9	19.8	19.7	20.9	19.9	18.5	18.4	19.6	22.4	24.4	23.7
BRAZIL	11.8	10.4	11.1	11.2	11.5	10.3	9.8	7.8	10.4	10.0	11.2
CHILE	7.6	6.8	8.3	5.7	8.4	7.6	7.2	5.6	5.7	5.8	NA
COLOMBIA	26.6	25.1	24.1	24.4	23.6	23.0	19.4	18.8	17.4	17.5	18.8
ECUADOR	25.0	23.9	22.5	18.7	17.0	14.9	12.1	12.1	13.5	15.1	15.0
PARAGUAY	32.5	32.1	34.5	35.3	34.6	32.1	28.6	25.3	28.2	27.2	NA
PERU	18.6	18.7	16.8	15.9	15.3	13.1	10.2	9.5	11.0	12.0	NA
URUGUAY	11.1	11.1	14.9	14.5	9.5	9.5	9.6	7.7	10.3	10.4	9.4
VENEZUELA	5.8	6.2	5.4	4.4	4.6	4.9	4.8	5.2	5.3	6.6	NA
BARBADOS	13.2	9.7	8.7	9.8	8.8	8.2	9.1	6.1	6.0	5.6	NA
DOM REP	20.3	20.4	17.3	18.7	16.1	15.8	17.6	15.4	15.2	17.2	NA
HAITI	44.0	44.1	42.0	40.0	37.0	34.0	32.2	32.2	31.9	32.6	32.6
JAMAICA	8.6	6.6	7.4	7.1	7.9	7.9	8.3	6.7	5.8	6.2	NA
GUYANA	17.4	16.8	17.4	27.7	20.8	20.2	20.7	20.2	20.9	22.6	NA
TRIND &TO	4.8	4.9	5.1	3.2	3.9	3.5	2.3	2.3	4.5	5.2	NA
COSTA RIC	23.0	22.5	19.5	19.1	20.4	20.4	17.8	24.5	21.2	21.9	18.2
SALVADOR	26.3	28.4	25.3	25.3	28.3	26.6	27.8	23.1	19.9	20.2	NA
HONDURAS	34.6	29.3	28.0	26.6	25.5	24.9	22.2	20.6	19.4	19.8	19.3
MEXICO	11.6	11.6	10.6	11.1	10.2	9.9	8.2	7.3	8.6	9.4	NA
NICARAGUA	23.2	24.9	24.8	24.2	22.6	26.3	22.6	21.5	24.9	20.8	NA
PANAMA	16.9	14.6	13.5	11.2	11.8	11.8	9.0	8.7	9.1	9.3	NA

Table notes: For example in 1968 the value added in agriculture represent 11.5% of Argentinas GDP

Figure one ranks countries by the percent of agriculture in GDP for the year 1984. This table provides a clear progression of countries with the lowest percentage of agriculture to those countries where agriculture is most important. Southern cone and most Caribbean countries tend to lie to left of the table where agriculture is not important and Central American countries tend to lie to the right of the table indicating increasing importance of agriculture.

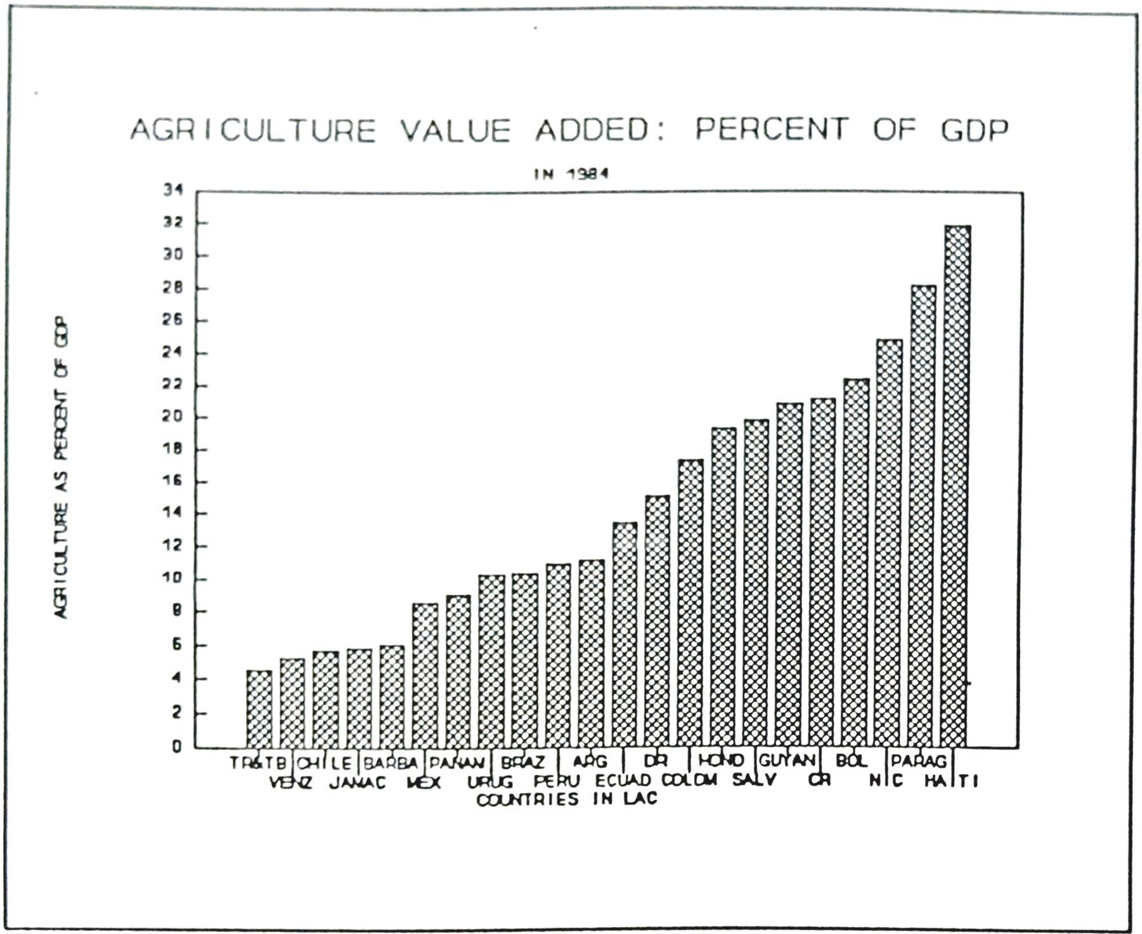

Figure 1

IV Agrodindustry in the GDP

The SIAPA system can be used to include sectors of the economy influenced by the forward linakages from agriculture. SIAPA contains data on the value added to the manufacturing of LAC countries and these data are in the same units as total GNP. SIAPA also contains data of food and beverage manufacturing and total manfacturing in units that are similar to each other. By getting the contribution of food and beverages to total manufacturing and getting total manufacturing as percent of GDP one can calculate the value added of food and beverage manfacturing to the GDP.

Since both the percent of agricultural in the GDP and the percent of agro-industry in the GDP represent value added data the two can be added together to get the total percentage contribution of the agricultural sector to the GDP. This value excludes backward linkages and implictly assumes all agricultural inputs are either imported (tractors, fertlizers) or they represent unprocessed resources (land and labor). With the exception of Brazil, most processed agricultural inputs in Latin America are imported.

Table 2 shows Food and Beverage manufacturing as percent of GDP for LAC countries from 1968 to 1984. This percentage remains fairly constant for most countries except Trinidad and Tobago which rises from near 16% in 1968 to 22% in 1980 and then falls to 15% in 1987. Venezuela also shows some variation rising almost to a high of 19% in 1974 and then falling to 14% of GDP in the 1980's. Ecuador's food and beverage gained the most in percentage terms over the 1968 to 1984 period. It grew from slightly over 7% of GDP in 1968 to over 14% of GDP in 1984.

The small change in the share of food processing as percent of GDP over time is interesting in itself. Many of the countries listed in Table 2 had rapidly growing economies throughout the 1970's. The ability of the food processing sector to grow as rapidly as the rest of the economies is a sign that food processing was a vigorous industry throughout the 1970's. This becomes even more interesting when combined with the fact that demand for food products with respect to income is often inelastic. Some food processing growth may be in response to increases in domestic demand from growing populations with higher incomes. However, even if consumers switch to more processed goods when incomes rise, it is difficult to beleive that the domestic sector could have absorbed all of the increases in supply of processed foods and beverages. It stands to reason that some of the growth in food and beverage processing was in response to international demand and many of the countries listed in Table 2 were increasing exports of processed foods and beverages.

It is interesting to compare the relative sizes of the agriculture and agroindustry. In 1980 agroindustry was a larger component of GDP than agriculture for seven out of ten countries in South America, for 2 out of 4 countries in the Carribbean for which data were available, and for Mexico. However, in all the Central American countries agriculture was a larger component of the GDP than agro-industry in 1980. The reason for this latter result is not that Central American countries food and beverage manufacturing is a significantly smaller component of the GDP than in other regions of Latin America, but because agriculture is a signficantly large component of the economy than in other regions of Latin America.

We have shown that agro-industry is an important component of the GDP. It is also important to note that agriculture plays even a more critical role within the industrial sector of an economy. Table 3 lists the contribution of the food and beverage sector to total manufacturing and demonstrates that the share of food and beverage manufacturing in total manufacturing is significant for many countries. In the Dominican Republic food and beverage processing is more than 60% of total manufacturing. In most of Central America it is above 40% of total manufacturing. With the exception of Paraguay, food and beverages play a much smaller role in total manufacturing in South America but is still remains above 20% of total manufacturing for all countries except petroleum rich Venezuela.

Much of the growth in the LAC economies in the 1970's arose from increasing industrialization which acelerated the already rapid trend towards urban based economies. It is often easy to neglect the positive role which agriculture played in this process of industrialization and migration to the urban areas. Agriculture is typically portrayed as pushing the population towards the urban areas due to increase mechanization or due to falling agricultural incomes. However a growing food processing industry can pull the population towards urbanization and thus allow agriculture to play a positive role in industrial and urban growth. Table 3 indicates that agriculture processing may be the most important component of Latin American industry. It is doubtful that other sectors of industry hold shares as large as 20%. If this is true, agriculture has played a critical role in the demographic transformation of Latin America from a rural to an urban continent.

TABLE 2: FOOD AND BEVERAGE MANUFACTURING AS PERCENT OF GDP

	68	70	72	74	76	78	80	82	84
Argentina	13.0	12.3	12.3	11.9	13.9	12.7	11.5	11.8	13.5
Bolivia	10.4	11.3	12.1	13.9	11.5	11.4	13.5	12.8	11.8
Brazil	10.7	11.3	11.5	12.2	12.2	12.4	13.0	12.5	12.4
Chile	14.4	14.5	13.2	17.1	14.0	12.6	13.1	12.4	12.2
Colombia	9.5	9.7	10.1	10.6	10.8	10.5	11.1	10.8	11.6
Ecuador	7.9	8.6	9.8	13.4	12.4	12.1	13.3	14.1	14.5
Peru	10.8	11.1	11.2	12.1	12.0	13.4	14.7	13.6	13.5
Paraguay	6.9	7.2	7.1	7.9	7.8	8.3	9.6	9.7	9.3
Uruguay	10.3	8.6	7.7	9.1	9.4	9.1	9.9	8.4	9.6
Venezuela	14.4	13.8	13.8	18.8	16.0	15.0	16.2	14.5	14.6
Barbados	6.2	6.0	6.0	6.3	6.2	6.6	6.9	6.8	7.5
Dom Rep	9.0	9.9	10.4	10.7	11.8	11.0	10.6	10.7	11.0
Trin Y To	15.7	14.6	14.9	20.7	20.6	19.2	21.9	17.5	15.0
Jamaica	14.5	14.9	13.0	13.3	12.9	13.9	13.3	11.8	13.2
Costa Ric	8.2	8.5	8.9	9.5	9.6	9.1	9.4	9.0	10.3
Salvador	8.3	8.2	8.6	8.1	7.6	7.6	7.2	7.4	7.5
Honduras	6.9	7.0	7.2	8.0	7.3	7.7	7.9	8.1	8.1
Mexico	10.2	10.3	10.2	10.5	10.4	10.7	11.5	10.9	11.7
Nicaragua	8.4	9.0	9.4	9.7	9.9	10.1	10.9	11.2	11.1
Panama	7.1	7.5	7.2	7.7	7.7	7.3	7.2	7.6	6.4

Table notes: For example food and beverage manufacturing comprised 13% of Argentina's GDP in 1968. Some countries contained in figure 1 are not contained in figure 2 because of unavailability of data.

TABLE 3: FOOD AND BEVERAGES AS PERCENT OF TOTAL MANUFACTURING

	68	70	72	74	76	78	80	82	84
Argentina	18.4	17.2	16.9	18.6	18.8	18.7	20.4	18.9	18.9
Bolivia	31.0	30.2	36.9	36.9	36.0	34.4	34.4	34.4	NA
Brazil	15.6	14.1	15.5	13.0	14.3	14.9	27.8	11.5	NA
Chile	14.4	14.0	17.0	15.0	18.9	24.4	22.4	23.7	21.7
Colombia	28.4	27.5	27.3	24.5	25.4	24.4	27.6	29.5	29.7
Ecuador	40.5	41.9	39.7	41.5	37.5	31.9	30.2	27.9	27.6
Paraguay	54.1	51.9	52.2	51.0	43.6	40.6	36.9	35.0	NA
Peru	32.7	22.3	22.7	24.7	24.7	23.7	23.0	30.7	28.2
Uruguay	27.6	27.7	30.3	27.1	25.6	23.0	20.9	35.6	25.8
Venezuela	25.4	25.8	26.0	21.0	15.6	17.2	16.9	19.3	17.0
Barbados	38.4	38.4	35.7	36.9	31.9	42.6	33.8	31.7	26.8
Dom Rep	60.2	63.5	63.5	65.6	69.0	63.9	60.6	56.7	NA
Jamaica	41.3	36.4	32.9	35.8	35.8	31.4	32.8	32.1	36.0
Trin Y To	14.6	15.6	16.4	15.1	16.9	20.0	19.3	29.5	25.2
Costa Ric	41.3	42.4	41.2	41.5	41.0	43.2	42.8	38.3	43.5
Salvador	32.4	36.4	33.9	29.4	24.4	24.3	31.4	31.3	30.3
Guatemala	36.2	37.8	36.1	32.7	38.1	42.3	37.2	37.9	37.8
Honduras	49.6	50.8	52.8	51.0	50.1	48.8	47.0	NA	NA
Mexico	26.1	27.4	27.4	27.2	26.3	22.6	23.3	21.2	22.0
Nicaragua	47.6	47.4	47.0	41.4	45.8	48.2	41.2	40.5	43.0
Panama	41.1	36.4	35.6	39.8	44.0	40.1	43.3	40.5	45.4

Table notes: For example food and beverages comprised 18.4% of the manufacturing sector of Argentina in 1968. NA stands for not available.

Figure 2 ranks countries by the importance of food and beverage manufacturing in GDP. Food and Beverage manufacturing is of little importance to countries to the left of the table and is of increasing importance for countries on the right. Notice Central American countries tend to lie on the left side of this figure.

Though the percentage of food and beverages of the GDP has not changed much over the years the combination of the percentage value added of this sector to the percentage of the value added of the agricultural sector to the GDP more than doubles the share of agricultures contribution to the GDP.

The country contributing the most to this doubling is Trinidad & Tobago where agricultural value added only represented 2.3 percent of the GDP (Table 1) but food and beverage processing represented 22% (Table 2) of the GDP in 1980. Trinidad and Tobago imports a large component of agricultural goods that go into processing. This result points out another problem with simply adding up the value added data as described in the second section of this paper. The differences in the ranking of countries between agriculture as percent of GDP and food and beverage manufacturing as percent of GDP mean that: (a) as obviously in the case of Trinidad and Tobago and Venezuela, some countries import agricultural goods to process themselves (b) as in the case of Paraguay and El Salvador, some countries do not process a large amount of their agricultural produce.

Figure 3 lists a ranking of countries by total agriculture and food and industry as percent of GDP. The figure shows that the Caribbean countries are to the left, thereby denoting that agriculture and agro-industry are of little importance tothe countries. Southern cone countries are situated towards the centre and the countries of Central America are found at the right. This signifies that agriculture and agro-industry are important to their economies.

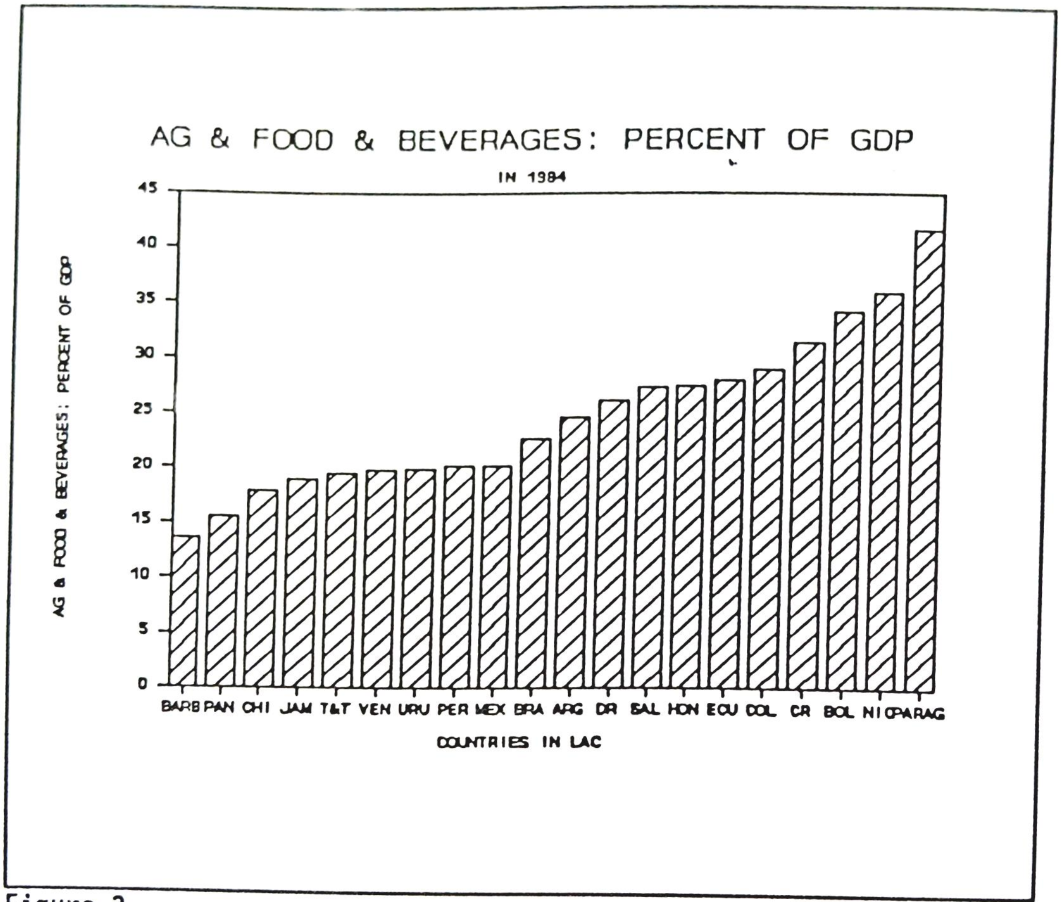

Figure 3

Including food and beverage manufacturing as part of the agriculture sector changes how several LAC countries can be viewed relative to each other. Table 4 ranks several LAC countries by the percent of agricultural contribution to GDP, the percent food and industry processing to GDP, and the combined sectors contribution to GDP. In the agriculture and agriculture and agroindustry ranking Paraguay clearly comes out as the leading agricultural country. Yet the ranking changes slightly for other countries. Honduras which ranks fourth when only agriculture is considered falls to sixth when agroindustry is included. The largest changes in the ranking are Trinidad and Tobago and Veneuzela. Both countries, which have the economies with the least agriculture, move up towards the mid range in the ranking when agro-industry is included. These countries clearly have more interest in the health of agriculture than is commonly thought.

TABLE 4: RANKING OF COUNTRIES BY AGRICULTURE AND AGROINDUSTRY SHARE OF GDP

AGRICULTURE AS PERCENT OF GDP 74/84 AVG		AG INDUS AS PERCENT OF GDP 74/84 AVG		AG & AGINUS AS PERCENT OF GDP 74/84 AVG	
30.5	PARAGUAY	19.1	TRIND &TOB	39.3	PARAGUAY
25.4	SALVADOR	15.9	VENEZUELA	34.0	NICARAGUA
23.6	NICARAGUA	13.3	ECUADOR	32.9	SALVADOR
23.1	HONDURAS	13.2	PERU	32.2	BOLIVIA
21.2	COLOMBIA	13.1	JAMAICA	32.1	COLOMBIA
20.7	COSTA RICA	12.5	ARGENTINA	30.9	HONDURAS
19.7	BOLIVIA	12.5	BOLIVIA	30.2	COSTA RICA
16.4	DOM REP	12.5	BRAZIL	27.8	ECUADOR
14.5	ECUADOR	11.5	CHILE	27.4	DOM REP
12.4	PERU	11.0	DOM REP	25.7	PERU
10.4	PANAMA	10.9	MEXICO	22.7	BRAZIL
10.2	BRAZIL	10.9	COLOMBIA	22.3	TRIN & TOB
9.9	URUGUAY	10.5	NICARAGUA	22.1	ARGENTINA
9.6	ARGENTINA	9.5	COSTA RICA	20.8	VENEZUELA
9.1	MEXICO	9.2	URUGUAY	20.4	JAMAICA
8.0	BARBADOS	8.8	PARAGUAY	20.1	MEXICO
7.3	JAMAICA	8.8	BARBADOS	19.1	URUGUAY
6.8	CHILE	7.8	HONDURAS	18.3	CHILE
4.9	VENEZUELA	7.6	SALVADOR	17.7	PANAMA
3.2	TRIND &TOB	7.3	PANAMA	16.8	BARBADOS

Table notes: Averages represent the geometric means from 1974 to 1984. Geometric means are always used when average percentages

V Food and Manufacturing Exports

Little aggregate breakdown between trade of processed and unprocessed agricultural goods is available in SIAPA. Therefore these data must be obtained by aggregating across individual commodities. Since this process is time consuming and subject to possible errors, a detailed description of how to break agricultural trade into processed and unprocessed good is provided. After this description, an example is provided for two countries: Chile and Mexico.

SIAPA contains FOA data on values and quantities of exports and imports of most agricultural commodities for each LAC country. These data are highly detailed and a country trade file may contain upwards to 600 to 700 variables. The bottom component of each file has data on trade of aggregated agricultural categories such as: grains, vegetables, fruits etc. However, it is not clear what specific products are contained in each category so it is best to work with the dissaggregated data.

Having deleted aggregate categories of data to avoid double counting, the data must then be divided into processed and unprocessed goods. In some cases the division of data is clear cut and obvious. For example wheat exports represents exports of an unprocessed good while flour, bread, and pastry export represent exports of a processed good. However, in other cases the division between processed and unprocessed goods is less clear. For example, should boneless meat be considered a processed good?

Clearly a great deal of subjectivity comes into account when categorizing exports. Once the data are categorizied, it is simply a matter of adding up both sets of data to obtain the total value of agricultural exports of processed and unprocessed goods. However, it is important that the resulting numbers are not over interpreted because (a) it is not clear if missing observations truly represent missing observations or represent zero data points (b) some processed agricultural goods (such as leather goods) may not be included in this file.

Owing to the tedious, time consuming, and inexact manner of obtaining processed and unprocessed agricutural goods only two countries were chosen for reporting: Mexico and Chile. These countries were chosen because they represent major agricultural producers with large industrial sectors but have not faced as severe inflation problems as Argentina or Brazil. The values of processed and unprocessed agriculture goods were obtained and are listed in percentage terms for Mexico and Chile in tables 5 and 6.

Table 5 clearly demonstrates that the share of processed exports for Mexico has steadily increased from 1968 to 1987. This share rises from 7.5% of total exports in 1968 to 18% in 1980. It falls slightly after 1980 in the wake of the debt crisis and rises rapidly throughout the 1980 s until it reaches 29.5% of total agricultural exports in 1987. This trend is clearly illustrated in Figure 3 which graphs the share of processsed agricultural exports for Mexico from 1968 to 1987. On the other hand, the share of processed agricultural imports rose from 17.5% to almost 26% of agricultural imports in 1973 and then fell rapidly in the wake of the OPEC oil shock. Since that time it has gradually risen from 10% of agricultural imports to slightly above 16% in the 1982 and fluctuated as much 5 percentage points since then.

Chile presents quite a different evolution of the share of processed goods in agricultural exports. Processed goods comprised over 33% of agricultural exports in 1968 and this share gradually rose to as high as 50% of agricultural exports in 1975. However, the share of processed exports steadily declined from this point onwards and hit a low of approximately 22% in 1985. It has risen slightly since. This trend is clearly demonstrated in Figure 4 where the share of processed exports forms a neat parabola from 1968 to 1987.

TABLE 5: PERCENTAGE BREAKDOWN OF AGRICULTURAL TRADE
MEXICO 1968-1987

	EXPORTS UNPROCESSED	EXPORTS PROCESSED	IMPORTS UNPROCESSED	IMPORTS PROCESSED
1968	92.5	7.5	82.5	17.5
1969	92.1	7.9	83.7	16.3
1970	91.8	8.2	84.6	15.4
1971	91.2	8.8	70.6	29.4
1972	90.2	9.8	74.6	25.4
1973	88.3	11.7	74.3	25.7
1974	83.0	17.0	78.9	21.1
1975	83.5	16.5	90.0	10.0
1976	84.5	15.5	82.8	17.2
1977	83.1	16.9	87.5	12.5
1978	83.9	16.1	87.0	13.0
1979	83.2	16.8	85.7	14.3
1980	82.0	18.0	86.2	13.8
1981	83.6	16.4	88.6	11.4
1982	79.6	20.4	83.7	16.3
1983	79.1	20.9	88.9	11.1
1984	77.5	22.5	87.2	12.8
1985	75.1	24.9	84.4	15.6
1986	80.0	20.0	78.4	21.6
1987	70.5	29.5	83.6	16.4

Table notes: For example processed agricultural goods reprsents 7.5% of Mexico s agricultural exports in 1968.

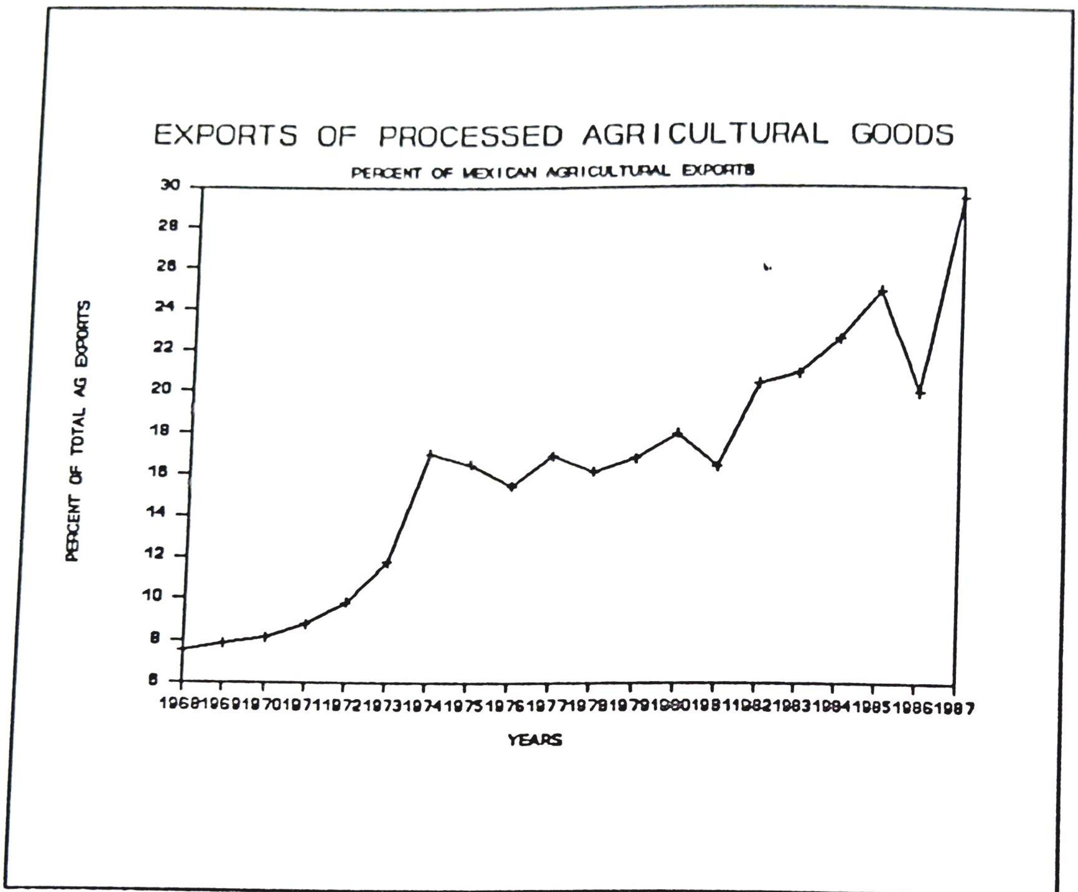
EXPORTS OF PROCESSED AGRICULTURAL GOODS
PERCENT OF MEXICAN AGRICULTURAL EXPORTS
PERCENT OF TOTAL AG EXPORTS
30
28
26
24
22
20
18
16
14
12
10
8
6
1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987
YEARS

Figure 4

TABLE 6: PERCENTAGE BREAKDOWN OF AGRICULTURAL TRADE
CHILE 1968-87

	EXPORTS UNPROCESSED	EXPORTS PROCESSED	IMPORTS UNPROCESSED	IMPORTS PROCESSED
1968	66.4	33.6	72.3	27.7
1969	69.9	30.1	73.6	26.4
1970	65.2	34.8	67.7	32.3
1971	64.9	35.1	65.8	34.2
1972	48.6	51.4	66.9	33.1
1973	66.9	33.1	73.2	26.8
1974	63.0	37.0	76.9	23.1
1975	49.7	50.3	75.5	24.5
1976	56.8	43.2	86.5	13.5
1977	51.0	49.0	64.4	35.6
1978	62.6	37.4	66.3	33.7
1979	65.3	34.7	62.9	37.1
1980	63.2	36.8	58.9	41.1
1981	68.9	31.1	52.5	47.5
1982	71.6	28.4	56.8	43.2
1983	73.9	26.1	57.0	43.0
1984	75.7	24.3	54.7	45.3
1985	78.3	21.7	56.3	43.7
1986	76.5	23.5	54.2	45.8
1987	74.0	26.0	51.2	48.8

Table notes: For example processed agricultural goods reprsents 33.6% of Chile s agricultural exports in 1968.

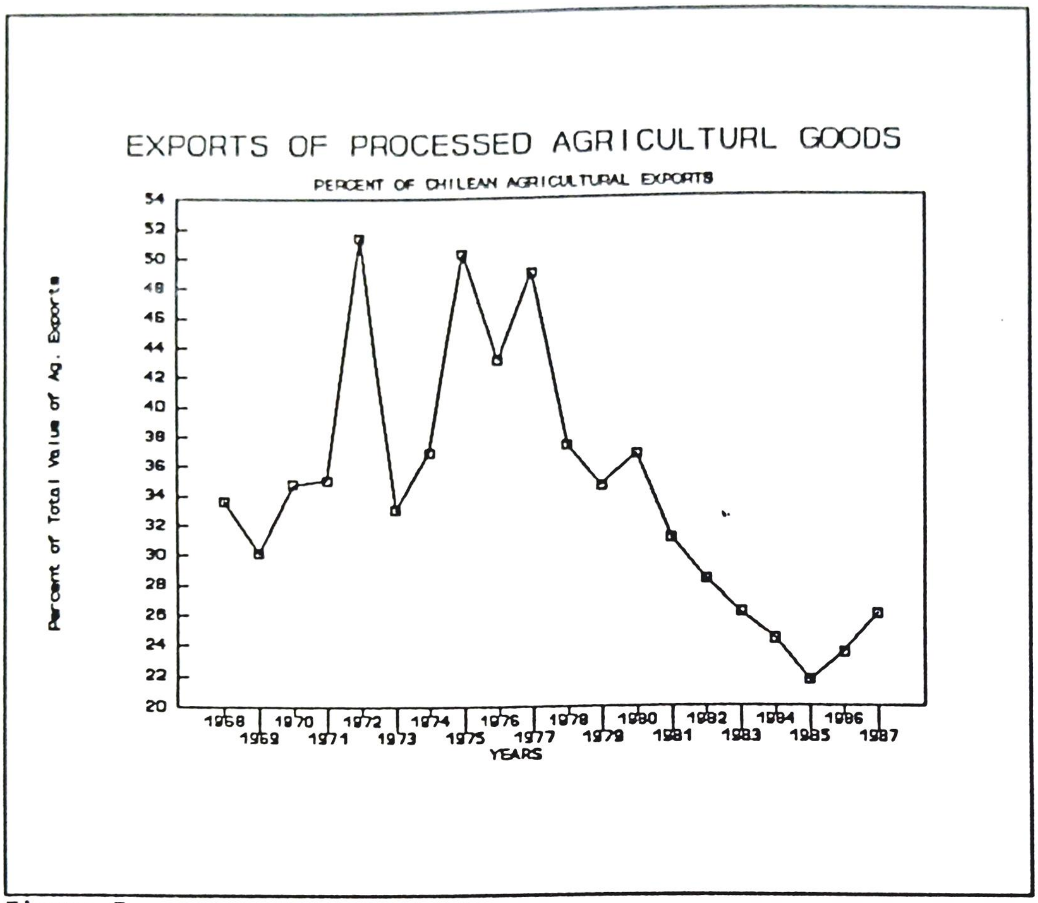
EXPORTS OF PROCESSED AGRICULTURL GOODS
PERCENT OF CHILEAN AGRICULTURAL EXPORTS
Percent of Total Value of Ag. Exports
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
YEARS

Figure 5

VI. RELATIVE PRICES OF PROCESSING AND UNPROCESSED GOODS

Price and Quantity indicies of processed and nonprocessed agricultural trade were created for Chile and Mexico. To obtain a price index for each category we summed to total value of exports for the each year or:

$$(5)\ \sum_{a=1}^{N} P_{ai}\ EX_{ai} \quad = Ai$$

For N goods in year i.

To obtain a quantity index for each category we summed exports weighted by the 1968 price or:

$$(6)\ \sum_{a=1}^{N} P_{a,68}\ EX_{a,i} \ = Ci$$

An agricultural export price index is represented by the ratio of equation (5) to equation (6).

Tables 7 and 8 list price indicies for both processed and unprocessed agricultural exports and imports and an index of the agricultural terms of trade (the ratio of export to import price) for both agricultural categories. Export price indices of processed and unprocessed goods varied considerably over the period. In Chile processed export prices shifted upwards in wake of the 1973 and 1979 oil shocks. Mexico's price shifts reflect that country's choppy trade pattern. For example sugar exports are a major component of agricultural exports in some years and then in other years Mexico did not export unprocessed sugar. Therefore the weight given to the sugar price in the unprocessed price index changes considerably from year to year (Exports are the weight on prices in equations 5 and 6).

Chile's agricultural import prices generally rose for both processed and unprocessed agricultural goods. Mexico's import price of processed goods rose significantly in the late 1970's and early 1980's after Mexico devalued it's currency. However the import price of Mexico's unprocessed agricultural goods shows no increase.[1] As a result, the terms of trade moves heavily in Mexico's favor for unprocessed goods despite Mexico's major currency devaluations in the 1980's. In contrast the terms of trade does not follow any major trends for processed goods.

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[1] Corn is heavily weighted in the Mexican imports of unprocessed agricultural goods. Therefore a falling corn price in the early 1970's is a major factor in the decline of the price of Mexican unprocessed agricultural imports.

TABLE 7: PRICE INDEX OF MEXICAN AGRICULTURAL TRADE CATEGORIES

YEAR	EXPORTS PROC.		IMPORTS PROC.		TERMS OF TRADE PROC	
	PROC.	UNPROC	PROC.	UNPROC	PROC	UNPROC
1968	1.00	1.00	1.00	1.00	1.00	1.00
1969	1.03	1.03	0.88	1.08	1.17	0.96
1970	1.04	1.13	0.90	0.70	1.16	1.63
1971	1.02	1.18	1.28	0.98	0.79	1.21
1972	1.11	1.23	1.37	1.00	0.81	1.24
1973	1.37	1.47	1.31	1.09	1.05	1.35
1974	1.79	1.81	2.18	1.53	0.82	1.13
1975	1.89	1.87	1.56	1.22	1.21	1.53
1976	2.06	2.36	1.61	1.24	1.28	1.90
1977	1.93	2.48	1.52	1.21	1.27	2.05
1978	2.03	2.39	1.59	1.25	1.28	1.92
1979	2.45	2.79	2.07	1.74	1.18	1.61
1980	2.58	2.94	1.89	1.74	1.36	1.69
1981	2.57	2.76	2.64	1.80	0.97	1.53
1982	2.51	2.40	2.00	1.41	1.26	1.70
1983	2.18	2.24	3.18	1.18	0.68	1.90
1984	2.22	2.66	1.77	1.27	1.26	2.09
1985	1.87	2.34	1.37	1.26	1.37	1.85
1986	2.37	3.40	2.23	1.00	1.06	3.40
1987	2.32	2.28	2.39	0.91	0.97	2.49

VARIANCE UNPROCESSED PRICE INDEX: .48
VARIANCE PROCESSED PRICE INDEX: .31
COVARIANCE BETWEEN BOTH INDICIES: .35

notes: the terms of trade represent the processed price over the unprocessed price

TABLE 8: PRICE INDEX OF CHILEAN AGRICULTURAL TRADE CATEGORIES

YEAR	EXPORTS PROC.	EXPORTS UNPROC	IMPORTS PROC.	IMPORTS UNPROC	TERMS OF TRADE PROC	TERMS OF TRADE UNPROC
1968	1.00	1.00	1.00	1.00	1.00	1.00
1969	1.19	1.16	0.98	0.84	1.21	1.38
1970	1.21	1.18	1.17	1.16	1.03	1.02
1971	2.07	1.31	1.48	1.02	1.39	1.28
1972	5.69	1.09	1.83	1.16	3.12	0.94
1973	4.60	1.34	1.43	1.46	3.22	0.92
1974	4.47	1.87	2.22	1.79	2.02	1.05
1975	3.04	1.67	2.65	1.95	1.15	0.86
1976	1.42	1.68	1.98	1.94	0.72	0.86
1977	1.84	1.65	2.48	1.32	0.74	1.25
1978	2.97	1.90	2.26	1.38	1.31	1.37
1979	2.97	2.25	2.72	1.82	1.09	1.23
1980	3.57	2.41	3.47	2.07	1.03	1.17
1981	3.74	2.32	3.80	1.90	0.98	1.22
1982	3.56	2.43	2.22	1.36	1.61	1.79
1983	3.26	1.90	2.03	1.44	1.61	1.31
1984	3.45	2.16	2.40	1.60	1.44	1.35
1985	3.14	2.59	2.95	1.76	1.06	1.47
1986	4.26	2.56	2.24	2.29	1.90	1.12
1987	4.53	3.00	2.30	2.38	1.97	1.26

VARIANCE UNPROCESSED PRICE INDEX: .32
VARIANCE PROCESSED PRICE INDEX: 1.62
COVARIANCE BETWEEN BOTH INDICIES: .19

VII. EXPORT RESPONSE

The shift towards exports of processed goods by both countries does not appear to be a response to changing prices. [2] For example, the relative price index of processed agricultural exports (see figure 7) does not rise over the period when Mexico's share of processed agricultural exports rose (see figure 5).[3] The apparent lack of export supply response to prices may reflect a long period required for supply of processed goods to adjust to relative prices changes. For example a food processing industry may need to import, or design and build capital equipment after having made a decision to increase supply. When there is a long period between planning and establishing a processing plant exports will not be related to current changes in export prices. (Processed agricultural exports would be related to an average of prices over several years in the past.)

Another explanation for the apparent lack of a relationship between processed exports and relative export prices is that countries may have encouraged the establishment of a food processing industry as part of an import substitution policy. This argument makes more sense for Mexico than it does for Chile. For example in Mexico the relative price of processed imports rises dramatically after 1972 (perhaps reflecting the use of energy in food processing.) To prevent foreign exchange expenditures on increasing expensive processed goods Mexico could have encouraged the expansion of a domestic food processing industry. As this industry grew it could have spilled over into the export market.

VII. VARIANCE OF INCOME

Risk averse firms may want to process agricultural goods to reduce income varibility. A reduction in the variability of export earnings could be viewed as a major benefit for many LAC countries. For example many Latin American countries took out short term loans, at high and variable interest rates, to overcome unexpected shortfalls in foreign exchange in the late 1970's and early 1980's. This short term borrowing to overcome liquidity constraints proved to be a major cause of Latin America debt crisis. (Arnade & Grigsby). If a country's foreign exchange earnings do not fluctuate widely about a mean or trend then firms in those countries can smooth out the import of goods and inputs

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[2] In both countries the relative price variable was significant and the wrong signs when the volume of processsed exports was regressed on the processed and unprocessed export price indicies.

[3] One must be careful not to make generalizations from these indicies. However indicies are constructed so that their initial value is one so that the ratio of indicies is always one in the first period. The absolute price of processed goods could have been above the price of unprocessed goods throughout the whole period.

without resorting to the costly practice of short term borrowing. [4]

It is generally beleived that the price variability is greater for unprocessed rather than processed agricultural goods. The main reason for this is that processed goods can be stored by distributers so that inventory accumulation and reduction is used to smooth out price fluctations. A shift to processing therefore, should be considered a means to reduce income variability for producers and exporters. However the bottom of Table 7 indicates that the variance of Mexico's price index of processed goods is only slightly lower than its price index of unprocessed goods. The bottom of Table 8 indicates that the variance of Chile's price index of processed goods is higher than the variance of the price index of unprocessed goods.

Diversifying into processed agricultural exports can reduce the variablility of exports earnings even when processed good prices are more variabile than the prices of unprocessed goods Before demonstrating this, two cases of diversifaction must be distinguished. In the first case diversification simply is an increase in the number of agricultural products exported. In the second case diversification is a result of a transformation of unprocessed into processed products. The number of exports products is not simply increased but a new product is created by processing a traditional export product. This second case, in particular, should reduce income variability because the prices of a processed product should not be subject to the same cycles of the unprocessed product (because it can be stored longer) and thus should have a low covariance with the price of it's unprocessed counterpart.

Tables 9 and 10 provide a diversification index of Chilean and Mexican agricultural export products. The index is created by summing the square of the shares of export values in each category and then multiplying by 100. [5] If only one agricultural good is exported this index equals 100. The greater the diversity of goods the closer this index lies to zero. For example consider the case where only two goods are produced and each has a fifty percent market share. The sum of the squares of the market share is .5 (.25+.25) and the index value is 50. Consider the case where one good has a 90 percent market share and the other has a 10 percent market share. In this case the index value is 82 (.81+.01). Finally consider the case where there are there goods one with a fifty percent market share and two others with a 25 percent market share. The of the squares of market share is .375 leading to an index value of 37.5.

The diversification index was calculated for four categories: unprocessed agricultural exports, processed agricultural exports, total agricultural exports, and a fourth category which measures what the diversifaction would be if there had been no processing. To obtain a diversification index for this later category

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[4] This ability to acquire foreign exchange at low costs is particularly critical for firms (or countries) making long run investments.

[5] The formula for the index is: $100* \Sigma(x_i/\Sigma x_i)^2$. Where x_i is the value of exports of good i.

all processed goods were lumped into the same category as their unprocessed counterpart. For example the value of wheat exports includes the value of flour and pastry exports [6] Comparing the hypothetical case of where all exports are unprocessed (the fourth column of table 9) with the diversification index of all agricultural goods (the third column of table 9) gives some indication of how processing has increased the diversification of agricultural exports.

TABLE: 9 INDICIES OF CONCENTRATION OF AGRICULTURAL EXPORTS: CHILE

	UNPROCESS EXPORTS	PROCESS EXPORTS	TOTAL EXPORTS	HYPOTHETICAL NO PROCESSING
1968	11.1	15.2	7.02	10.05
1969	17	14.2	9.55	11.49
1970	11.9	17.1	7.21	9.03
1971	12.9	14.7	7.19	8.54
1972	19.5	42.2	16.08	17.47
1973	18.9	21.21	10.69	13.50
1974	15.5	18.3	8.72	9.84
1975	11.7	22.7	8.66	9.82
1976	10.6	10.7	5.44	7.84
1977	9.9	8.96	4.92	6.38
1978	12.4	8.66	6.36	8.33
1980	12.9	13.2	7.26	10.72
1981	14.5	11.5	7.44	9.54
1982	17.4	11.3	9.50	11.60
1983	21.6	11.6	12.30	15.30
1984	25.5	15.4	15.33	18.28
1985	26.7	12.1	16.31	18.86
1986	28.9	13.6	19.09	21.75
1987	24	10.4	15.39	18.02
1988	25.8	10.1	16.06	19.15

1/An index number of 100 implies that all trade in concentrated in one crop. The greater the diversity of exports the closer the index lies to zero. The first column of table's 9 and 10 measures the diversity of unprocessed agricultural exports, the second column meausurs the diversity of processed agricultural exports, the third column measures the diversity of total agricultual exports, while the fourth column measures what the concentration of agricultural exports would have been had no agricultural exports been processed.

[6] The later index is not perfect because it assumes the value added to processing is unimportant. For example wheat, flour, and bread were considered one good of equal value. However it is obvious that the value of flour and pastry exports is not equal to the value of their underlying wheat component. Therefore this last index is only an approximation of what the diversification of exports would have been without processing.

TABLE 10: INDICIES OF CONCENTRATION OF AGRICULTURAL EXPORTS: ~~CHILE~~ MEXICO

	UNPROCESS EXPORTS	PROCESS EXPORTS	TOTAL EXPORTS	HYPOTHETICAL NO PROCESSING
1968	13.6	13.5	11.7	13.7
1969	13.7	15.4	11.6	13.5
1970	12.6	17.7	10.7	12.6
1971	11.2	12.6	9.4	11.3
1972	11.2	11.4	9.2	10.7
1973	12.2	13.9	9.7	11.4
1974	14	12.6	10	12.2
1975	14.6	11.7	10.5	11.4
1976	19.9	9.2	14.4	16.7
1977	20.6	9.7	14.5	17.1
1978	14.1	9.0	10.2	12.3
1979	18.6	8.9	12.9	14.8
1980	14.8	8.2	10.2	11.5
1981	14.5	10.9	10.47	11.2
1982	15.1	8.3	9.9	11.7
1983	16	8.6	10.4	12.3
1984	16.26	10.8	10.3	12.3
1985	19	7.9	11.2	14.2
1986	23	10.1	15.2	18.3
1987	15.8	15.2	9.2	10.9

1/An index number of 100 implies that all trade in concentrated in one crop. The greater the diversity of exports the closer the index lies to zero. The first column of table's 9 and 10 measures the diversity of unprocessed agricultural exports, the second column meausurs the diversity of processed agricultural exports, the third column measures the diversity of total agricultual exports, while the fourth column measures what the concentration of agricultural exports would have been had no agricultural exports been processed.

The difference between the fourth and third columns of Tables 9 and 10 indicates that the introduction of a food processing industry did diversity agricultural exports. In every year the diversification index of the hypothetical case (where all goods are exported are unprocessed products) is greater than the total diversification index in column 3 which represents what actually occurred.

Processing agricultural exports and increasing their diversity does not guarantee a reduction in income varability. This is particularly true when prices of processed goods are more variable than the price of unprocessed goods as Table 7 shows is the case in Mexico. To determine if income variability has been reduced we divided agriculture into two aggregate goods: a processed good and a nonprocessed good. If a country does not process any agricutural exports and it's export earnings are

(7) $P_u \, EX''_u$

where P_u is the price of the aggregate unprocessed good and EX''_u is the level of exports of the aggregate unprocessed good in the first scernario where all exports are unprocessed.

On the other hand if a country chooses to process some of it's exports it earnings are

(8) $P_u \, EX'_u + P_p EX'_p = P_u \, EX'_u + P_p G(Y'_u, z)$ where $EX''_u = EX'_u + Y'_u$

where EX'_u and EX'_p are the levels of unprocessed and processed exports in the second scenario, P_p is the price of the aggregate processed goods, $G(Y'_u, z)$ is the processing function that uses inputs z to convert the amount Y'_u of the unprocessed good into EX''_p units of the processed good. Note that it is assumed that the amount of unprocessed exports under the first scenario is equal to the sum of the amount exported and amount used in the production of processed exports in the second scenario.($EX''_u = EX'_u + Y'_u$)

If the export price is considered to be a random variable the variance of export revenues in the first scenario is:

(9) $Var(P_u)*(EX''_u)^2$

where Var stands for variance of the variable in parenthesis.

The variance of export earnings in the second scenario is:

(10) $Var(P_u)*(EX'_u)^2 + Var(P_p)*(EX'_p)^2 + 2*Cov(P_u,P_p)$

where Cov stands for the Covariance of the variables in parenthesis.

The difference between the two, therefore is:

(11) $Var(P_u)*[(EX''_u)^2-(EX'_u)^2]-[Var(P_p)*(EX'_p)^2 + 2*Cov(P_u,P_p)]$

If equation 11 is greater than zero then diversification into processing reduces the variability of export earnings. Since Chile and Mexico have followed the second stragtegy we do not know what the level of unprocessed exports from following the first strategy would be (EX''_u is unkown). Nevertheless, EX''_u can be approximated by assumming the quantity of the processed good is a constant proportion of it's raw ingredient. We call this factor of proportionality between a processed and it's raw ingrediant "B". (See appendix for futher discussion) Table 11 lists the calculated reduction in income variance for Chile and Mexico which can be attributed to processing under varying assumpions regarding B. As the parameter is varied the calculated reduction in the variance of Mexican agricultural export earnings due to processing changes from 1.5% to almost 62% of what the variance would have been if all exports had been unprocessed.

TABLE 11: CACULATED PERCENT REDUCTION IN INCOME VARIANCE FROM FOOD PROCESSING (BASED ON AVERAGE EXPORTS DATA FROM 1968 TO 1987)

IF	CHILE	MEXICO
B=1.25	-17.8	1.5
B=1.1	-12.5	5.4
b=1	-7.5	8.5
B=.9	1.1	12.1
B=.75	6.9	20.2
b=.5	28.3	34.5
B=.4	39.8	43.5
B=.25	61.6	61.6

1/ For example if the parameter B had equaled .5 the variance of Mexican's export revenues was reduced by 34.5% of what it would have been if only unprocessed goods had been exported.2/ In order to calculate the reduction in variability in percentage terms we had to estimate equation 9. To do this we used the assumption that $EX''_u = EX'_u + Y'_u$. The appendix discusses how we approximated Y'_u.

Table 11 demonstrates that processing reduced the variability of Mexican agricultural export earnings under every assumption concerning the parameter B. Under the assumption that four units of unprocessed good produces one unit of processed good income variability was reduced by 62% in Mexico. In Chile the variability of agricultural export earnings was reduced by diverification into processing if the parameter B equal or was less than .9. Most likely B is less than 1 (there is a loss in quantity when a good is processed). Therefore the introduction of processed agricultural exports most likley reduced the variance of export earnings in both countries. Any reduction in income variance would have occurred despite the fact that the estimated price variance of the processed good (reported at the bottom of the tables 7 and 8) is much greater than the price variance of the unprocessed good for Chile and not much smaller than the variance of the unprocessed good in Mexico.

VIII CONCLUSIONS

This paper has shown that the agricultural sector makes a greater contribution ito the GDP than is revealed by the data on agricultural production. It has shown that agricultural processing is important in most Latin American countries but the size of this sector enlarges agriculture's contribution to the GDP. The paper presented an ideal way of capturing agriculture's contribution to the economy when inputs are imported and all agricultural goods are processed. Unfortunately, Latin America and very few other countries fit this ideal world.

The paper then demonstrated that including the food and beverage processing sector in calculating agriculture's contribution to GDP almost doubles the share of agriculture in a country's economy. The results also indicated that several LAC countries, not commonly thought to be agricultural, had large food and beverage processing sectors and therefore, have an interest in agriculture.

Finally, the paper found that Mexico's share of processed agricultural exports have steadily increased from 1968 to 1987, with a slight decline in 1980 in the wake of the debt crisis. By contrast, Chile's share of processed agricultural exports rose to a maximum in 1975, but fell steadily until 1985. Since then it has rised slightly. It was determined that in neither country was the growth of processed export related to export prices. In fact prices of processed exports fell in relative terms when Mexico's exports of processed goods rose.It would be hard to believe that either Chile or Mexico is not a price taker for their exports of processed agricultural goods. Therefore factors other than market power must be used to explain why exports of agricultural products rise when export prices of those goods fall.

A desire of countries to reduce the variability of agricultural export earnings may explain the growth of food proccessing. It was found that under every assumption concerning the relation between a processed product and it's raw agricultural ingredient, the variability of Mexican agricultural export earnings declined with processing. The variability of Chiliean agricultural export earnings declined in most cases.

The main purpose of this paper was to provide a decriptive overview of the role the food processing plays in Latin American agriculture. Suggested lines of analysis to be pursued are: (1) tests to determine if the growth of food processing reflects import substitution or export promotion policies, (2) determing the productivity of the food processing industry across Latin American countries (3) determining the true contribution of the food processing industry by including multiplier effects of of food processing on the rest of the economy.

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APPENDIX

Equation 11 in the text represents the difference in the variance of agricultural export earnings between two scenarios. In the first scenario there is no processing of agricultural export goods while in the second scenaro there is. There difference between the variance under these scenarios was written as:

$$(1A)\ Var(P_u)*[(EX''_u)^2-(EX'_u)^2]-[Var(P_p)*(EX'_p)^2 + 2*Cov(P_u,P_p)]$$

Using the relationship that

$$(2A)\ EX''_u = EX'_u + Y'_u$$

equation 2a can be rewritten as:

$$(3A)\ Var(P^u)*[(EX'_u + Y')^2 - (EX'_u)^2]-[Var(P_p)*(EX'_p)^2 + 2*Cov(P_u,P_p)]$$

If processed exports are a constant proportion of their unprocessed counterpart then the production relationship for processsing can be written as:

$$(4A)\ EX'_p = G(Y', z) = B*Y' \quad \text{where B is a constant.}$$

Using equation 4A and squaring the term in parenthesis, equation 3A can be written as:

$$(5A)\ Var(P^u)*[(2*EX'_u *EX'_p/B) +(EX_p/B)^2]-[Var(P^p)*(EX'_p)^2 + 2*Cov(P_u,P_p)]$$

For both Chile and Mexico the only factor in equation 5A that is not available is the coefficient B.

Therefore the estimated average reduction in the variance of agricultural export earnings was caculated under a variety of assumptions of what the average B had been throughout the 1968 to 1987 time period.