Volume Title: Commodity Markets and Latin American Development -- A Modeling Approach

Volume Author/Editor: Walter C. Labys, M. Ishaq Nadiri, and Jose Nunez Del Arco, eds.

Volume Publisher: UMI

Volume ISBN: 0-88410-481-0

Volume URL: http://www.nber.org/books/laby80-1

Publication Date: 1980

Chapter Title: Input-Output Modeling and its Implications for Commodity Planning in Latin America

Chapter Author: James R. Simpson

Chapter URL: http://www.nber.org/chapters/c1747

Chapter pages in book: (p. 41 - 62)

3

JAMES R. SIMPSON

Input-Output Modeling and its Implications for Commodity Planning in Latin America

Input-output (I-O) analysis has become a major analytical tool in the highly complex industrialized economies since Leontief's first publication in 1936. Even though considerable methodological advances in the technique have occurred since then, there have been very few applications to commodity planning or modeling. Nonetheless, I-O modeling does appear to be a helpful technique for use in commodity analysis, and it is likely that empirical uses should be forthcoming in the next decade. The paucity of literature is not surprising for commodity modeling itself is in its infancy, with most work being done in the last five to ten years (Labys 1973 and 1978). Furthermore, while most commodity modeling has direct applicability for the public and private sector, I-O analysis is almost exclusively a public planning tool.

Given that there is a certain amount of misunderstanding, misconception, and lack of knowledge about the potential for input-output analysis in both the agricultural and nonagricultural sectors in Latin America, the objectives of this chapter are to describe several I-O techniques that may be utilized for commodity analysis in Latin America and to explain in detail how the transactions or technical coefficients matrix of existing I-O studies can be disaggregated to produce output and income multipliers for specific commodities. An example of the latter technique with application in Latin America is given for beef.

The concept of I-O analysis goes back over 200 years to Francois Quesnay's *Tableau Economique* of 1758, which described the circular flow and general equilibrium concepts of interindustry relations. More than 100 years passed before the next major advance in the 1870's which was Walras' general equilibrium model describing the interdependence between the production sectors of an economy. A lapse occurred again until 1925, when the Soviets published the first table of interindustry relations describing their economy. The first empirical application of an I-O model in the Anglo-American world was made by Wasily Leontief in 1936 when he published an I-O system of the United States. After this, there were rapid advances made in I-O analysis. In 1941 a 96-sector model of the U.S. economy was published, and by 1944 the first practical application was made (also in the United States). In 1949 a 200-sector model for the 1947 U.S. economy was made available. In 1964 an 81-sector model for the 1958 U.S. economy was published, and was then followed by a 370-sector table of the 1963 U.S. economy (available in 1969). During the 1950s and 1960s there was intense interest in I-O analysis as a technique, and models were constructed for many countries of the world. By the middle 1970s considerable advances had been made in using I-O analysis for rather specialized purposes such as natural resource planning.

POTENTIAL OF INPUT-OUTPUT MODELS FOR ANALYZING THE IMPACT OF PRIMARY COMMODITIES ON THE ECONOMY

I-O techniques can be divided into at least three major categories: the construction of national or world models, regional analysis, and techniques that make use of either one or both of the above such as impact analyses or interregional models. There is substantial potential for using I-O studies at the national level in Latin America to analyze mineral industries such as mining or processing simply because those industries figure so prominently in a country's economy. Examples are copper in Peru or Chile and tin in Bolivia. At the international level, recent work by Leontief (1977) in dividing the world into regions with individualized I-O matrices for sectors such as grain, oilseeds, and livestock, and solving the systems simultaneously, suggests that major advances can be made in linking primary commodities to world trade studies. In fact, it appears that interregional models and applications related to imports, exports, and trade hold some of the greatest potential for model builders concerned with primary commodities.

Regional I-O models (RIO) and techniques have been developed in conjunction with interregional (IRIO) models. Probably the earliest contribution was by Isard (1951), but he was quickly followed by Leontief (1953) who developed an intranational model that shows how regional interaction can be traced through a hierarchy of regions. This effort provided a fundamental link between interregional models and economic impact studies. Further work was done by Moses (1955) on a rather crude interregional model of the United States.

Regional and interregional applications of I-O analysis hold great potential for commodity planning in Latin America and thus deserve considerable attention by model builders interested in this geographic area. These researchers have a wealth of information available to them. For example, Isard and Kuenne (1953) developed a method to measure the economic impact on one region from expanding a major industry in another region. Most recent work, especially in the 1960s, has been on regional rather than interregional models as more immediate results are available. During this time most attention has been given to field surveys for collecting data to calculate technical coefficients by means of sales and purchase flows. Because data collection is expensive, much recent work has been aimed at devising improved national model adjustment techniques to derive regional coefficients.

USES OF INPUT-OUTPUT ANALYSIS AND STUDIES IN LATIN AMERICA FOR MODELING PRIMARY COMMODITIES

Over the past twenty years input-output studies have been constructed by the United Nations Economic Commission for Latin America (ECLA) dealing with numerous Latin American countries such as Argentina, Brazil, Chile, Colombia, Costa Rica, Mexico, Peru, and Uruguay.[1] The studies have been modified and updated at various times, but many policymakers and researchers still question if the relatively costly process of constructing these models is justified by the benefits received in LDCs.

Conceptually, it is probably correct that I-O analysis can be used as extensively in Latin America as in other regions. In reality the practical uses are more restricted because of constraints of budget, manpower, and computer capacity. Nevertheless, a number of realistic potential uses can be suggested:

- With Latin America's concern about economic growth, much more use could be made of impact models. These models, which have been developed by Adams and Holloway (1973) as well as by Stone and Brown (1965) among others, evaluate the impact on expansion (or decline) of one or a few sectors or introduction of new firms or industries. The techniques are fairly well known and frequently used in the industrialized countries. Zygadlo and Niehaus (1978) have used I-O analysis to determine secondary benefits for project analysis studies. This technique is relatively simple and could be used in Latin America commodity modeling.
- More techniques need to be developed that will reduce data collection time in construction of I-O models. Furthermore, there should be research in Latin America on estimating error from different data collection and model construction methods. Morrison and Smith (1974) as well as Stone, Bates, and Bacharach (1963) have provided insights into such analyses.
- As Latin American countries develop their economy, they will correspondingly be able to apply more sophisticated I-O techniques on increasingly varied problems such as environment versus land use. See Davis, et al. (1974) and Kymm (1977).
- One aspect of I-O analysis that has long been recognized but little used in Latin America is its application to various areas of marketing. Probably the greatest value from a marketing standpoint is in appraising the marketing possibilities for those industries that primarily service or supply other industries, instead of industries that sell directly to purchasers of finished goods.
- I-O analysis has important implications because of the insight that an input-output table provides on the way in which the production of a sector that sells to other processing industries is related in the final analysis to demand by consumers, government, investors, and foreign purchasers of finished goods.
- It is very likely that inordinate amounts of time have been spent in Latin America on model construction rather than utilizing the results. In all likelihood, some of the highest benefits can be obtained from researchers in Latin America familiarizing themselves with various applications and actually *using* the accumulated data and model base. Furthermore, the greatest benefits will come from applying existing procedures rather than reinventing the techniques. See Ghosh (1968), Maki (1970), and Rasmussen (1956).
- I-O analysis has particular relevance in Latin America's use of natural resources, a subject of great concern to policymakers. The demand for natural resources and evaluations of their optimal uses can be determined by estimating the demand for final goods and

services from which the natural resource demand is derived and by integrating that estimate with the structure of production whereby various inputs are combined to produce a final product. The approach by Bingham and Song Lee (1975), for example, revolves around determining the consumption of natural resources based on data for a single time period; these data are then transformed into a set of direct requirements that have been fitted into the U.S. 83-sector model. The dollar valuation of the transaction flow is replaced by natural flows, and outputs are given in physical terms.

I-O models can also be used to determine future requirements for metals and minerals in a similar manner by converting macroeconomic projections into I-O final demands. In the United States, conversion tables called demand import transformation tables (DITT) serve as the base. The vector of final demands is multiplied by the I-O inverse to generate estimates of industry outputs (Krueger 1976). In this case outputs are in dollar terms. Both of the approaches are variants of impact models that can be quite useful in Latin America for answering questions on the effect of new products or processes or the effects that increased prices will have on production costs and market inflation.

Another potential use for commodity modeling in Latin America is forecasting by projecting technical coefficients matrices. At the regional and interregional level the major uses are for predicting over-the-board changes in final demand, changes in final demand for a sector, or growth of the regional economy. See Miernyk (1975), Allen and Lecomber (1975), Allen and Gossling (1975), Almon et al. (1974), and Brody and Carter (1972). The best forecasting will take place when there is more than one I-O model available. A good reason *why* economists dealing with I-O analysis in Latin America should give considerable attention to forecasting is that their estimates can serve as an additional source of confidence to planners about the benefits from long-term policies.

A major contribution, and one that seemingly has not been explored yet, would be the definition of countries within a common market as regions with the subsequent application of interregional I-O analysis techniques. Appropriate methods are given in Isard (1951), Isard and Langford (1971), McMenamin and Haring (1974), Carter and Brody (1969), Miernyk (1965), and Richardson (1972). As is well known, common markets have not proven to be very successful because of political consideration and poor knowledge about costs and benefits of preferential treatment to products from new industries.

In the past, decisions have been based on trade-related information. Polenske (1970) has shown that employing I-O techniques would add useful information about sectoral impacts on economic growth. The regional models could also be used for projections, as was done by Tiebout (1969). A key point is that additional data requirements would be minimal as most of the data are either in the transactions matrices or macrolevel trade statistics. The major effort would have to be in determining the effect of I-O models having different base years, means of coordination between countries, setting forth procedures to incorporate trade submodels, and improving theoretical weaknesses such as the instability of trade effects. The results obtained would be a realization of effects of shifts in the location of industrial activity and employment, improvements in regional accounts that serve as the basis for multicounty impact studies, the measurement and forecasting of regional export markets, and advances in transportation planning.

DISAGGREGATED INPUT-OUTPUT STUDIES FOR ANALYZING COMMODITY IMPACT IN DEVELOPMENT PLANNING

A method of determining output and income multipliers by opening up either the transactions or technical coefficients matrix in existing input-output studies of developing countries has not been reported in the literature by other researchers. There have been a few studies such as those by Adams (1973) and Miernyk et al (1970) where this technique is used to evaluate *new* industries in developed countries, but the possibility of disaggregating existing industries into product lines does not seem to have been researched either in developed countries or LDCs. To evaluate the use of this technique a study was carried out on beef, one of the most important export commodities in Latin America.

Beef export policy and the development of a viable beef industry have been the focus of technical assistance and national planning in many Latin American countries for over twenty-five years (Breimyer 1962, Brumby 1973, U.S. Department of Agriculture 1970, and United Nations 1970). Even though at least eight input-output studies of Latin American countries have been constructed in the past fifteen years, it is often difficult to assess the impact of the beef export industry from I-O models that treat that industry as a single sector. The basic problem results from the possibility of specializing in exporting different product lines. For example, the Central American countries have traditionally shipped chilled or frozen beef and have done little processing. The South American countries, on the other hand, have exported the entire gamut; live animals, sides of beef, and canned corned beef.

The study focuses on Argentina, Brazil, Paraguay, and Uruguay because of the diversity of their beef export sectors. However, the analysis should have relevance to other Latin American countries. Certainly the methodology has wide application to all types of commodities whether they are agricultural or nonagricultural. The exports studied include live cows, bone-in beef quarters, frozen boneless manufacturing beef, and cooked frozen and canned beef. The analysis is limited to cow beef since the methodological complications of including steer beef are substantial.[2]

Disaggregation of Input-Output Studies

There are two possibilities by which the endogenous portion of the transactions matrix may be expanded. The first is addition of a new industry within the framework of "impact analysis" in order to determine input requirements from other industries and economic effects on the entire area. This is perhaps more frequently done in regional rather than national analysis. The second method is disaggregation of an existing industry or subindustry with the breakdown being as limited or as detailed as necessary. This was the procedure used in the beef study where the meat processing sector (or the food processing sector in some studies) were disaggregated to obtain the multipliers[3] for the four previously mentioned export products. The livestock sector was disaggregated to obtain the multipliers for exports of live cows.

Three different methods are possible for disaggregation of one industry or sector. Given the relevant data, the first method involves computing column totals for the new industry and dividing each transaction by the column total to arrive at the technical coefficients. Multipliers are then calculated, beginning with the expanded technical coefficients matrix.

The second method is utilization of secondary data from the original source for disaggregating the sector under analysis in the transactions matrix. This technique is restricted to situations where data were available when the original matrix was constructed but the model builder was not previously interested in a high degree of disaggregation.

A third procedure, and the one primarily used here, is construction of budgets for the industries by data obtained through samples and inserting the budgets directly in the transactions matrix.[4]

Matrix Disaggregation

The first step in obtaining the product line multipliers was to interview beef packers in the four countries studied. The data obtained were sufficiently detailed to permit the construction of a cost and returns type of economic model for each of the four beef products and live cows on a product weight basis (Table 3–1). A fully integrated packing plant with a 1,400 head capacity was considered "typical" and served as the base.[5] The items in the initial models were then redistributed on an interindustry (sector) basis (Table 3–2). Total gross outlays are assumed to equal total gross output, and except for aggregating the items under "households" and "other," the budgets are ready for the various input-output studies. Since the revised cost and returns models were inserted into four different South American I-O studies, four slightly different models were required.

Two Argentine studies, one for Brazil and one for Uruguay, were chosen as base I-O studies because a general statement relevant to all of the major beef exporting countries was desired. This procedure also provided a reliability test of the disaggregation method. Because the analysis centers on beef, the adjusted budgets on an interindustry basis are based on a ton of product. However, for insertion in the I-O studies, the budgets are considered to be a year's transactions for the whole economy.

The method for expanding (opening up) the transactions matrix and inserting the coefficients for the four processed products can be described graphically and algebraically. The transactions matrix is graphically represented at the top of Figure 3–1 while the disaggregated matrix is shown below it.

Each of the transactions for all four new products were summed for one row and subtracted for the original cell value. This residual is considered as the transactions for all other products in the meat processing industry. The subtracting procedure was carried out in the same manner for all other rows, insuring that the transactions matrix remained completely balanced. That is, the gross output of sector i, x_i, of the original model is given by

$$x_i = \sum_{j=1}^{n} x_{ij} + D_i$$

where x_{ij} = sales from sector i to j and D_i = final demand for sector i's output. Then, assuming that sector n is the sector to be disaggregated, we can write the gross output of sector $i(i = 1, \ldots, n - 1)$ as

$$x_i = \sum_{j=1}^{n-1} x_{ij} + x_{in}^{*} + \sum_{j=n-1}^{n+4} x_{ij} + D_{ij}$$

where x_{n+k} = K^{th} product line sector and

$$x_{in}^{*} = x_{in} - \sum_{j=n+1}^{n+4} x_{ij}$$

Table 3–1. Estimated Pretax Costs for Bone-in Beef Quarters, Frozen Boneless Manufacturing Beef, Cooked/Frozen Beef, and Canned Beef, Product Weight and Percentage Basis

	Direct and Indirect Costs							
Item	*Bone-in Beef Quarters*	*Frozen Boneless Manufacturing Beef*	*Cooked/ Frozen Beef*	*Canned Beef*	*Bone-in Beef Quarters*	*Frozen Boneless Manufacturing Beef*	*Cooked/ Frozen Beef*	*Canned Beef*
	Dollars				Percent			
Livestock	622.78	865.15	1075.89	966.75	81.09	73.38	70.86	62.27
Fuel and electricity	16.27	24.07	22.27	15.84	2.11	2.04	1.47	1.02
Foods				4.03				.26
Meats				18.86				1.22
Textiles	8.59				1.12			
Ready-made wearing apparel	1.01	5.26	7.59	14.00	.13	.45	.50	.90
Wood		1.00	1.00	2.00		.08	.07	.13
Paper and cartons		19.67	12.23	21.73		1.67	.81	1.40
Printing and publications				2.00				.13
Chemical products				.12				.01
Metals				6.40				.41
Vehicles and machinery	3.16	5.00	7.43	10.00	.41	.42	.49	.65
Other industries		4.05	23.35	3.00		.34	1.54	.20
Commerce	13.57	26.65	41.66	38.37	1.77	2.26	2.74	2.47
Transportation and storage	11.47	17.43	18.26	9.15	1.49	1.48	1.20	.59
Other services	18.49	27.48	34.49	35.03	2.41	2.33	2.77	2.26
Labor	36.75	138.45	199.73	235.91	4.79	11.74	13.16	15.20
Depreciation	23.87	27.28	42.66	64.00	3.11	2.31	2.21	4.12
Defective cans				.50				
Imports	12.00	17.54	31.72	104.80	1.56	1.49	2.09	6.75
Total	767.96	1179.03	1518.28	1552.49	100.00	100.00	100.00	100.00

Source: Banco Central de la Republica Argentina (1964).

Table 3–2. Estimated Cost and Sales Data for Bone-in Beef Quarters, Frozen Boneless Manufacturing Beef, Cooked/Frozen Beef, and Canned Beef, Prepared for Disaggregated 1963 Argentine Input-Output Study, Product Weight Basis

Sector Number	*Sector or Item*	*Bone-in Beef Quarters*	*Frozen Boneless Manufacturing Beef*	*Cooked/Frozen Beef*	*Canned Beef*	*Live Cow Exports*
		Dollars				
1	Agriculture	622.78	865.15	1075.89	966.75	302.11
3	Food and beverages				22.89	
4	Textiles	8.59				
5	Ready-made wearing apparel	1.01	5.26	7.59	14.00	
6	Wood		1.00	1.00	2.00	
7	Paper and cartons		19.67	12.23	23.73	
10	Chemical				.12	
11	Petroleum	16.27	24.07	22.27	15.84	
13	Metals				6.40	
14	Machinery	3.16	5.00	7.43	10.00	
17	Various		4.05	23.35	3.00	
20	Commerce	13.57	26.65	41.66	38.37	
21	Transportation and storage	11.47	17.43	18.26	9.15	23.87
23	Services	18.49	27.48	34.49	35.03	2.90
	Subtotal	695.34	995.76	1244.17	1147.28	328.88

Value added					
Households					
Labor	36.75	138.45	199.73	235.91	13.09
Profit	160.31	− 33.73	835.37	177.02	6.47
Subtotal	197.05	104.72	1035.10	412.93	19.56
Other					
Depreciation	23.87	27.28	42.66	64.00	
Customs	4.03	4.03	4.03	14.92	4.03
Defective cans				.50	
Export taxes	565.64	650.72	865.59	634.31	347.53
Subtotal	593.54	682.03	912.28	713.73	351.56
Imports	12.00	17.54	31.72	104.80	
Subtotal	12.00	17.54	31.72	104.80	
Total gross outlays	1497.94	1600.05	3223.27	2378.74	700.00
Gross output (sales)					
Major item	1448.00	1593.40	2922.00	2043.00	700.00
Extract			126.61	177.49	
High price cuts		72.40	72.40	66.61	
Trim to canning		46.26			
Fat		6.47			
Byproduct credit	49.94	69.33	86.52	77.54	
Bone credit		12.19	15.74	14.10	
Total gross output	1497.94	1800.05	3223.27	2378.74	700.00

Source: Banco Central de la Republica Argentina (1964).

	Purchasing sectors	Final demand	Total gross output
Processing sector	$x_{11} \cdots x_{1j} \cdots x_{1n}$ $x_{i1} \cdots x_{ij} \cdots x_{in}$ $x_{n1} \cdots x_{nj} \cdots x_{nn}$	$fd_{11} \cdots fd_{1j} \cdots fd_{1k}$ $fd_{i1} \cdots fd_{ij} \cdots fd_{ik}$ $fd_{n1} \cdots fd_{nj} \cdots fd_{nk}$	X_i
Final payments	$fp_{11} \cdots fp_{1j} \cdots fp_{1n}$ $fp_{i1} \cdots fp_{ij} \cdots fp_{in}$ $fp_{r1} \cdots fp_{rj} \cdots fp_{rn}$	$fe_{11} \cdots fe_{1j} \cdots fe_{1k}$ $fe_{i1} \cdots fe_{ij} \cdots fe_{ik}$ $fe_{r1} \cdots fe_{rj} \cdots fe_{rk}$	
Total gross outlays	X_j		X_{nn}

		Purchasing sectors: Original	Purchasing sectors: Added	Final Demand	Total gross output
Processing sectors	Original	x_{11} x_{i1} x_{n1}	$x_{1(n-1)} \cdots x_{1(n-4)}$ $x_{i(n-1)} \cdots x_{i(n-4)}$ $x_{n(n-1)} \cdots x_{n(n-4)}$	fd	
	Added	$x_{(n-1)1} \cdots x_{(n-1)n}$ $x_{(n-4)1} \cdots x_{(n-4)n}$	$x_{(n-1)(n-1)} \cdots x_{(n-1)(n-4)}$ $x_{(n-4)(n-1)} \cdots x_{(n-4)(n-4)}$	$fd_{(n-1)1} \cdots fd_{(n-1)j} \cdots fd_{(n-1)k}$ $fd_{(n-4)1} \cdots fd_{(n-4)j} \cdots fd_{(n-4)k}$	
Final payments		f_{p11} f_{p1j} f_{p1n} f_{pi1} f_{pr1}	$f_{p1(n-1)} \cdots f_{p1(n-4)}$ $f_{p(n-4)(n-1)}$ $f_{p(n-4)(n-4)}$	$f_{e11} \cdots f_{ei1} \cdots f_{e1k}$	
Total gross outlays					

FIGURE 3–1. Original and Disaggregated Transaction Matrix

For the new sectors, gross output can be written as

$$x_{n+k} = \sum_{j=1}^{n-1} x_{ij} + x^* in + k + \sum_{j=n+1}^{n+4} x_{ij} + D_{n+k}$$

For sector x_n^* (the residual after the product lines have been taken out) we have

$$x_n^* = \sum_{j=1}^{n+4} x_{ij}^* + D_n^*$$

$$x_{ij}^* = x_{ij} - \sum_{i=n+1}^{n+4} x_{ij}$$

$$D_n^* = D_n - \sum_{i=n+1}^{n+4} D_i$$

The well-known derivation technique for the Type I multiplier shown in Figure 3–2 was then followed to obtain the product line income and output multipliers for live cow exports except that the livestock sector was disaggregated in this case. The Type II multiplier is derived in the same manner except that households are endogenous.

Because of the differences between the time the I-O studies were originally constructed and the product line budgets were prepared, the implicit I-O framework assumption of constant technology with no change in relative prices was carefully scrutinized. The conclusion was that the assumption is not a limiting factor here despite recognition that technological changes over time do affect the pattern of input requirements. The reason for the time period differences not being a constraint is that the purpose of the study is a comparison of *several* multipliers, all of which have been prepared for *one* sector, rather than comparison with original multipliers.

Multipliers

Multipliers show the indirect economic outputs from what are designated backward linkages (Figure 3–3). In other words, they show the inputs (such as labor or machinery) leading to production of an output prior to its entering final demand. Multipliers do not reflect forward linkages (such as storage or retailing) after production is complete. In addition, multipliers do not show changes in an economy's structure such as diversification or externalities caused by production changes. Finally, multipliers, like I-O models, are best utilized for analyzing small changes in final demand. Large changes imply variations in production technology, which violates assumptions about I-O analysis.

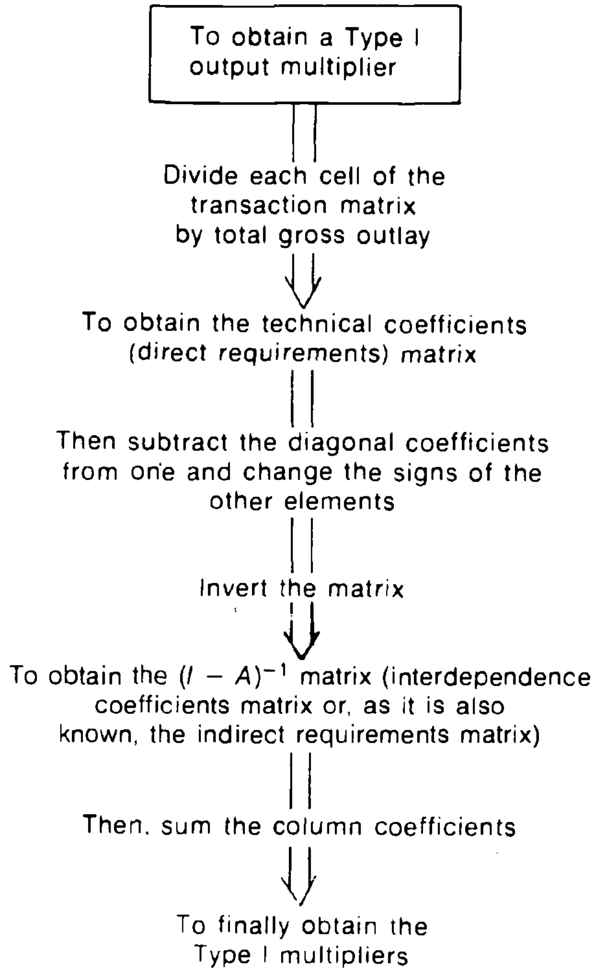

FIGURE 3–2. Steps in Obtaining a Type I Output Multiplier

The technical coefficients presented in Table 3–3 show the direct purchases per dollar of output by the five newly created sectors derived from the I-O structure described in the Argentinian study (1964). The largest purchases were from agriculture in the form of live animals. In order to produce one dollar's worth of frozen manufacturing beef, about six cents was spent on households in the form of wages, salaries, profits, dividends, interest, and similar payments. For one dollar's worth of output from the canned beef sector, on the other hand, forty-one cents had to be spent in agriculture and seventeen cents on households. The second largest category, "other," was mostly taxes levied on exports.

The Type I and II output multipliers from the four different South American I-O studies are presented in Table 3–4 for the four processed beef products as well as live cow exports. As expected, the highest multipliers are for products undergoing the greatest processing.

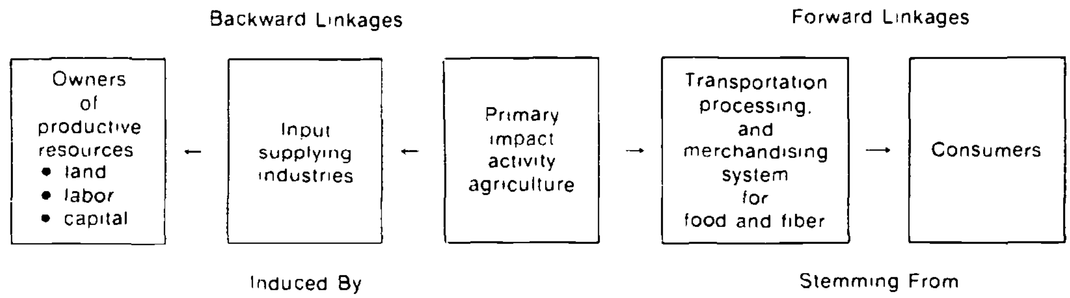

FIGURE 3–3. Secondary Market Impact Classification

Cooked frozen beef has the largest Type II output multiplier while canned beef is close behind. Exporting live cows, for example, only generates $3.33 worth of direct, indirect and induced economic activity in Argentina for every dollar's worth of sales while cooked frozen beef yields $4.87.

As a means of investigating the general applicability of the multipliers, a sensitivity test was made by inserting the budgets in the Grubb (1973) I-O study for the state of Texas, hypothesizing that this would represent an extreme situation. Texas exports large amounts of bone-in beef, but it is part of a developed interdependent economy. The multipliers turned out 25 percent lower than the Argentina studies, probably because of the leakage from imports of cattle and materials from other states. Cooked and canned beef differed less from the manufacturing beef reference point while quarters varied more; however, the *ordering* of the multipliers was essentially the same.[7]

CONCLUSIONS AND DISCUSSION

After reviewing hypothetical I-O model applications, a technique was presented in this chapter that demonstrates how statistical information from personal interviews with processors can be combined with existing disaggregation techniques to develop I-O models based on product lines. An application was made to the beef export industry of Latin America, but the technique is relevant for any type of commodity, ranging from copper to coffee.

One ramification of the study is the recognition that it may be possible to prepare and insert budgets for industrywide feasibility studies for one country in the input-output study for another country to obtain comparative multipliers. In other words, if an investigator, say in the Dominican Republic for which there is no I-O study, wanted to determine whether oranges from the citrus industry should be exported raw, as canned juice, as frozen concentrate, or packaged as powder, the investigator could develop the budgets and insert them in

Table 3–3. Direct Purchases per Dollar of Output; Live Cow Exports, Processing of Bone-in Beef Quarters, Frozen Boneless Manufacturing Beef, Cooked/Frozen Beef and Canned Beef, Disaggregated 1963 I-O Study

Sector Number	*Sector*	*Live Cow Exports*	*Bone-in Beef Quarters*	*Frozen Boneless Manufacturing Beef*	*Cooked/Frozen Beef*	*Canned Beef*
1	Agriculture	0.43157	0.41578	0.48067	0.33379	0.40643
2	Food					0.00963
3	Textiles		0.00574			
4	Clothes		0.00067	0.00294	0.00236	0.00589
5	Wood			0.00056	0.00031	0.00084
6	Paper and Printing			0.01094	0.00378	0.00996
7	Petroleum		0.01082	0.01339	0.00692	0.00664
8	Metals					0.00269
9	Machinery		0.00207	0.00278	0.00230	0.00420
10	Electric machinery			0.00222	0.00723	0.00126
11	Commerce		0.00908	0.01478	0.01294	0.01614
12	Transportation	0.03414	0.00768	0.00967	0.00568	0.00387
13	Service	0.00414	0.01235	0.01528	0.01070	0.01472
	Household	0.02786	0.13158	0.05817	0.32113	0.17360
	Other	0.50229	0.39622	0.37889	0.28303	0.30006
	Imports		0.00801	0.00972	0.00983	0.04406
	Total	1.00000	1.00000	1.00000	1.00000	1.00000

Source: Banco Central de la Republica Argentina (1964).

Table 3–4. Output and Income Multipliers for Export of Live Cows, Bone-in Beef Quarters, Frozen Boneless Manufacturing Beef, Cooked/Frozen Beef and Canned Beef from Five Different Disaggregated Input-Output Studies

Input-Output Studies	*Type of Beef Export Product*									
	Live Cows		*Bone-in Quarters*		*Frozen Boneless Manufacturing*		*Cooked/ Frozen*		*Canned*	
Output Multiplier	*Type I*	*Type II*	*Type I*	*Type II*	*Type I*	*Type II*	*Type I*	*Type II*	*Type I*	*Type II*
1963 Argentina	1.73	3.33	1.72	4.04	1.86	4.00	1.60	4.87	1.76	4.41
1970 Argentina			1.76	4.04	1.90	4.02	1.63	4.84	1.79	4.40
1959 Brazil	1.62	3.19	1.62	3.76	1.75	3.67	1.52	4.75	1.66	4.17
1961 Uruguay	1.66	3.02	1.65	3.47	1.78	3.44	1.54	4.18	1.68	3.79
1967 Texas			1.81	3.07	1.96	3.15	1.67	3.37	1.83	3.24
Income Multiplier										
1963 Argentina	9.66	20.38	2.78	6.25	5.82	13.10	1.61	3.62	2.41	5.43
1970 Argentina			2.81	6.06	5.90	12.74	1.62	3.49	2.43	5.25
1959 Brazil	8.08	21.83	2.47	6.44	4.90	12.79	1.49	3.90	2.14	5.60
1961 Uruguay	8.98	20.18	2.62	5.51	5.44	11.44	1.56	3.28	2.30	4.84
1967 Texas			3.08	5.18	6.57	11.07	1.70	2.86	2.60	4.39

Sources: Banco Central de la Republica Argentina (1973); Republica Argentina (1973); Universidad de la Republica Uruguay (1969); Ellis (1969); and Grubb (1973).

an I-O matrix for another country. Wilkins (1978) also points this out. Naturally, considerable judgment would be necessary in selecting a country with similar conditions, but the five I-O analyses in which data for cow beef exports were studied show that the multipliers were fairly stable between countries. Furthermore, the multipliers for each product were stable when inserted in I-O studies for different periods for the same country.

More research in other industries is needed employing the disaggregation method to determine problems not uncovered here. In addition, as McKusick and Zygadlo (1978) have observed, extreme care must be used in applying I-O multipliers in isolation from the parent models as interregional flows (import-export balances) and other leakages out of the region can bias the multiplier approach. But they also suggest conducting more tests to compare broad geographical or sectoral multipliers to more specific regional multipliers. Certainly, a good point of departure is application of I-O analysis to the common market approach suggested earlier in the chapter.

The disaggregation technique presented in this chapter offers commodity model builders a shortcut technique to projecting the impact of a new industry if it can be assumed that the new industry will act in a similar fashion to an existing one. The technique is also an efficient tool for answering the question, which is the best subindustry, x or y? While other techniques only deal with new industries or subindustries, the disaggregation method offers the researcher an ideal way of dealing with existing situations. Finally, it provides a means of comparing and evaluating the effect on the economy from a projected new subindustry (such as a palm oil project) to an existing subindustry such as the manufacture of oil from soybeans.

Overall, the disaggregation of I-O studies used in the LDCs seems to have considerable usefulness for planning. The scope and application depends, of course, on the imagination and innovativeness of both theoretical and applied commodity model builders.

NOTES

1. A complete discussion of I-O models in Latin America was prepared in 1973 by ECLA in Santiago, Chile. Preliminary findings are reported in United Nations (1973). For more detail see the reference to Barna (1963).

2. The problem is that steers, although comprising the majority of all the above beef exports, are almost always broken down into numerous wholesale cuts that depend on market conditions and customers' orders at the time of slaughter. In contradistinction an entire cow is frequently directed to one of

the four product forms listed. Thus restricting the analysis to cow beef is a vehicle for simplicity in preparation of the budgets.

3. For a detailed discussion on multiplier derivation see Hirsch (1959); Leontief (1953): Simpson and Adams (1975).

4. Rather than inserting the budgets in the transactions matrix, each item can be divided by the total to obtain the technical coefficients matrix. This procedure has been used by Adams (1973); in this study it is done for the 1970 Argentina study in which the technical coefficients matrix was updated from the 1963 study by a dynamic procedure.

5. For more information about South American packing plants see Simpson and Farris (1975).

6. The two Argentine studies are listed in the bibliography under Banco Central de la Republica Argentina (1964) and Republica Argentina (1973); the Brazil study is found in Ellis (1969); the Uruguay study is under Universidad de la Republica (1969).

7. The effects of changes in final demand on output and income, as well as application of the model to planning in Uruguay, are presented in Simpson and Adams (1975).

BIBLIOGRAPHY

Adams, John. 1973. "The Economic Impact of Selected New or Expanding Industries on the Economy of the Lower Rio Grande Region of Texas." Department of Agricultural Economy, Texas A & M University. Unpublished.

Adams, John W., and Milton L. Holloway. 1973. "The Economic Impact of Selected New or Expanding Industries on the Economy of the Lower Rio Grande Region of Texas." Texas Agricultural Experiment Station and Office of Information Services. College Station: Texas A & M University.

——. n.d. "An A Priori Estimate of the Economic Impact of Selected Industrial Changes on a Regional Economy," Technical Article 11024 of the Texas Agricultural Experiment Station. College Station: Texas A & M University.

Allen, R.I.G., and W.F. Gossling, eds. 1975. *Problems of Estimating and Projecting Input-Output Coefficients.* London: Input-Output Publishing Company.

Allen, R.I.G., and J.R.C. Lecomber. 1975. "Some Tests on a Generalized Version of RAS." In R.I.G. Allen and W.F. Gossling, eds., *Problems of Estimating and Projecting Input-Output Coefficients.* London: Input-Output Publishing Company.

Almon, Clopper, Jr.: Margaret B. Buckler: Lawrence M. Horowitz: and Thomas C. Reimbold. 1974. *Interindustry Forecasts of the American Economy*, Lexington, Mass.: Heath Lexington Books.

Banco Central de la Republica Argentina. 1964. *Transacciones Intersectoriales de la Economia Argentina.* Buenos Aires, April.

Barna, Tibor, ed. 1963. *Structural Interdependence and Economic Development.* New York: St. Martins Press.

Bingham, Tayler H., and Bun Song Lee. 1975. "Estimates of the Interrelationships Between Consumer Expenditures and National Resource Consumption." Research Triangle Institute, Research Triangle Park, North Carolina. Unpublished.

Breimyer, Harold F., et al. 1962. "Agricultural Development and Economic Growth." Report to the United States and Argentina government. Buenos Aires. Unpublished.

Brody, A., and A.P. Carter, eds. 1972. *Input-Output Techniques*. New York: North Holland/American Elsevier.

Brumby, P.J. 1973. "International Lending for Livestock Development." *World Animal Review* 5.

Carter, A.P., and A. Brody, eds. 1969. *Applications of Input-Output Analysis*. Amsterdam: North Holland Publishing Company.

Davis, R.M., et al. 1974. "Development of an Economic-Environmental Trade-off Model for Industrial Land-Use Planning." Paper presented at the Southern Regional Science Association meeting, Washington, D.C., April 4–5.

Ellis, Howard, ed. 1969. *The Economy of Brazil*. Berkeley: University of California Press.

Ghosh, A. 1968. *Planning, Programming and Input Output Models: Selected Papers on Indian Planning*. Cambridge: Cambridge University Press.

Grubb, Herbert W. 1973. *The Structure of the Texas Economy*. Vols. I and II. Austin, Texas: Office of the Governor, March.

Hirsch, Werner. 1959. "Interindustry Relations of a Metropolitan Area." *The Review of Economics and Statistics* 41 (November): 360–69.

Isard, Walter. 1951. "Interregional and Regional Input-Output Analysis: A Model of a Space Economy." *The Review of Economics and Statistics* 35, no. 4: 318–28.

Isard, Walter, and R.E. Kuenne. 1953. "The Impact Upon the Greater New York–Philadelphia Urban Industrial Region." *Review of Economics and Statistics* 35: 289–301.

Isard, Walter, and Thomas W. Langford. 1971. *Regional Input-Output Study*. Cambridge, Mass.: MIT Press.

Krueger, Paul K. 1976. "Modeling Future Requirements for Metals and Minerals." Washington, D.C.: Federal Preparedness Agency. Unpublished.

Kymm, Kern O. 1977. "Interindustry Energy Demand and Aggregation of Input-Output Tables," *The Review of Economics and Statistics* 61, no. 3 (August): 317–74.

Labys, Walter C. 1973. *Dynamic Commodity Models: Specification, Estimation and Simulation*. Lexington, Mass.: Heath Lexington Books.

——. 1978. "Commodity Markets and Models: The Range of Experience." In F.G. Adams and S. Klein, eds. *Stabilizing World Commodity Markets: Analyses, Practice and Policy*. Lexington, Mass.: Heath Lexington Books.

Leontief, W. 1953. "Interregional Theory." In Leontief, et al., *Studies in the Structure of the American Economy*, pp. 53–90. New York: OUP.

——. 1966. *Input-Output Economics*. New York: Oxford University Press.

——. 1977. *The Future of the World Economy*. Oxford: Oxford University Press.

Leontief, W., and A. Strout. 1963. "Multiregional Input-Output Analysis." In T. Barna, ed., *Structural Interdependence and Economic Development*, pp. 119–49. London: MacMillan.

Maki, Wilbur R. 1970. "Small Area Applications of Input-Output." Minneapolis: University of Minnesota, Department of Agricultural Economy. Staff Paper, December.

McKusick, Robert, and Linda Zygadlo. 1978. "Conclusions and Recommendations." In *Regional Development and Plan Evaluation: The Use of Input-Output Analysis*. ESCS Agriculture Handbook 530, Washington, D.C.: U.S. Department of Agriculture, May.

McMenamin, David G., and Joseph E. Haring. 1974. "An Appraisal of Nonsurvey Techniques for Estimating Regional Input-Output Models." *Journal of Regional Science* 14 (August): 191–205.

Miernyk, William H. 1965. *The Elements of Input-Output Analysis*. New York: Random House.

——. 1969. "Sampling Techniques in Making Regional Industry Forecasts." In A.P. Carter and A. Brody, eds., *Applications of Input-Output Analysis*, pp. 305–21. Amsterdam: North-Holland.

——. 1975. "The Projection of Technical Coefficients for Medium-Term Forecasting." In W.F. Gossling (ed.), *Medium Term Dynamic Forecasting*. London: Input-Output Publishing Co.: 29–41.

Miernyk, W.H., and others. 1970. *Simulating Regional Economic Development*. Lexington, Mass.: Heath Lexington Books.

Morrison, W.I., and P. Smith. 1974. "Nonsurvey Input-Output Techniques at the Small Area Level: An Evaluation." *Journal of Regional Science* 14 (April): 1–3.

Moses, L. 1955. "The Stability of Interregional Trading Patterns and Input-Output Analysis." *American Economic Review* 45: 803–32.

Mulkey, David, and James Hite. 1974. "A Two-Stage Heuristic Model for Intermediate-Run Sectorial Petroleum Allocation in a Multi-Regional Setting." *Review of Regional Studies* 4 (Winter): 1–18.

Polenske, Karen R. 1970. "Empirical Implementation of a Multi-Regional Input-Output Gravity Trade Model." In *Contributions to Input-Output Analysis,* A.P. Carter and A. Brody, eds. Amsterdam: North-Holland Publishing Co.

Rasmussen, P.N. 1956. *Studies in Inter-Sectoral Relations*. Amsterdam: North-Holland Publishing Co.

Republica Argentina, Secretaria de Planeamiento y Accion de Gobierno Subsecretaria de Desarrollo. 1973. *Modelo Economico Sectorial Dinamico*. Buenos Aires, May.

Richardson, Harry W. 1972. *Input-Output and Regional Economics*. New York: John Wiley & Sons.

Shulman, A.A. 1972. "DITT Data Estimates and Input-Output Review." IST-103 MCL. Washington, D.C.

Simpson, James R. 1975. "Proyecciones de Produccion y Consumo de Carne Vacuna en America Latina." *La Hacienda* 70 no. 1 (Enero): 25–28.

Simpson, James R., and John W. Adams. 1975. "Disaggregation of Input-Output Models Into Product Lines as an Economic Development Policy Tool." *Am. J. Agr. Econ.* 57, no. 4 (November): 584–90.

Simpson, James R., and Donald E. Farris. 1975. "The Benefits for Economic Development from Selected South American Beef Exports." *World Animal Review* 13: 9–15.

Stone, Richard, and Alan Brown. 1965. "Behavioral and Technical Change in Economic Models." In E.A.G. Robinson, ed., *Problems in Economic Development*, pp. 428–443. London: Macmillan & Company Ltd.

Stone, Richard; John Bates; and Michael Bacharach. 1963. *Input-Output Relationships, 1954–1966.* Cambridge, Mass.: MIT Press.

Tiebout, Charles M. 1969. "An Empirical Regional Input-Output Projection Model: The State of Washington 1980." *Review of Economics and Statistics* 51: 334–40.

United Nations, Economic Commission for Latin America. 1970. *Development Problems in Latin America.* Austin: University of Texas Press.

——. 1973. Economic Commission for Latin America, "El Sector Externo en las Experiencias de Insumo-Producto de America Latina." Paper presented at the Seminario Internacional Sobre Estadisticas de las Relaciones Economicas Internacionales, Santiago, August.

Universidad de la Republica, Instituto de Economia. 1969. *Uruguay: Estadisticas Basicas.* Montevideo.

U.S. Department of Agriculture. 1970. *Argentina Agriculture: Trends in Production and World Competition.* ERS-Foreign 216, Washington, D.C., July.

Wilkins, John. 1978. "General Application of I-O Analysis and its Multipliers." In *Regional Development and Plan Evaluation: The Use of Input-Output Analysis.* ESCS Agriculture Handbook 530. Washington, D.C.: U.S. Department of Agriculture, May.

Zygadlo, Lynda, and Robert Niehaus. 1978. "Regional Development and Plan Evaluation." In *Regional Development and Plan Evaluation: The Use of Input-Output Analysis.* ESCS Agriculture Handbook 530. Washington, D.C.: U.S. Department of Agriculture, May.