OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

Distr.
LIMITED

ID/WG.160/1
[illegible] July 1973

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

Expert Group Meeting on Projections
of Industrial Development

Vienna, 27 - 31 August, 1973

A REGIONAL MODEL FOR THE MANUFACTURING SECTOR [1/]

with special reference to Argentina, Brazil, Colombia, Chile, Mexico and Venezuela

by

Helmut Frisch

associated with
B. Böhm, F. Haslinger, A. Knauer and M. Luptáčik
Institut für Volkswirtschaftslehre
Technische Hochschule Wien
Vienna, Austria

1/ The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

CONTENTS

Page

1. INTRODUCTION

The increasing labor-division and specialization not only *within*, but also *between* different countries on one hand, and the observable tendencies of cooperation between various groups of countries - leading to supranational unions - on the other hand, are the mainreasons for the increasing number of studies in international trade and regional economics, both theoretical and empirical, in recent years.

The aim of the present study is an attempt to analyse the structural relationships of the manufacturing sector within some Latin American countries and also their relationship to the rest of the world. In order to satisfy these needs, we have to look for both

a) a solid *theoretical* base and

b) satisfactory forecasting peculiarities for our model.

For exposition purposes we start in Chapter 2 the discussion of a very complex model based on multicountry input output approach. The advantage of this procedure lies (a) in the deep insights we can get into both the structure in international trade network and the intranational structure of particular countries and (b) in the fact that we are able to subsume each of the existing models e.g. CMEA [3] etc. as a special case of our model resulting from various aggregation procedures and some additional assumptions. Empirical applications of such a model require very detailed data, which are at present not available. Nevertheless, this model remains our theoretical base for our further analysis.

For this reason and because [illegible] interest is only [illegible] manufactur-ing sector we develop in Chapter [illegible] a multicountry model for this sector, for which we can expect to get the necessary data in most of the developed countries. However shortage of data for the manufacturing sector in the considered region forces us to further restrictions and modifications of this model. This will be discussed in Chapter 4, where a simple trade matrix approach is applied to empirical analysis. The results are presented in the last part of Chapter [illegible].

2. A MULTICOUNTRY INPUT-OUTPUT TABLE

Probably the [illegible] insight into the structure of the international trade network can be gained by means of a highly disaggregated input-output analysis model for n countries.

Output / Input			Country 1: Sectors 1	2	...	m	Country 2: Sectors 1	2	...	m	...	Country n: Sectors 1	...	m	[illegible]	GDP
Country 1	Sectors	1	x^{11}_{11}	x^{11}_{12}	...	x^{11}_{1m}	x^{12}_{11}	x^{12}_{12}	...	x^{12}_{1m}	...	x^{1n}_{11}	...	.	Y^1_1	Q^1_1
		2	x^{11}_{21}	.	...	.	.	.	...	.	...	.	...	.	.	
		.													.	.
		.													.	.
		m	x^{11}_{m1}		...	x^{11}_{mm}	.	.	...	x^{12}_{mm}	...	.	...	.	Y^1_m	Q^1_m
Country 2	Sectors	1	x^{21}_{11}	x^{21}_{12}	...	.	.		...		...	.	...	.	Y^2_1	Q^2_1
		2											.			
		.														
		.														
		m		.	...	x^{21}_{mm}	.	.	...	.	...	.	...	.	Y^2_m	Q^2_m
.		.	.	.	...	.	.	.		.	...	.	...	.	.	
.		.	.	.	...	.	.	.		.	...	.	...	.	.	.
Country n		.	.	.	...	.	.	.		.	...	.	...	.	.	.
		.	.	.	...	.	.	.		.	...	.	...	.	.	

Where x_{kl}^{ij} represents the flow of the quantity x_{kl}^{ij} of commodity k from country i to industry l in country j,[1] and let q_l^j be the gross domestic product of l-th industry in country j. Y_l^{ij} represents the final demand of country j for commodity l produced in country i.

Under the assumption of fixed technology coefficients and constant returns to scale,[2] we construct coefficients

$$a_{kl}^{ij} = \frac{x_{kl}^{ij}}{q_l^j} \qquad\qquad a_{kl}^{ij} \geq 0$$

indicating the quantity of commodity k of country i which is needed in order to produce one unit of gross product of commodity l in country j.

A formal description of the model can be given as follows:

(1) $AQ + Y = Q$

where

$$A = \begin{bmatrix} a_{11}^{11} & \cdots & a_{1l}^{1j} & \cdots & a_{1m}^{1n} \\ \vdots & & & & \\ a_{k1}^{i1} & \cdots & a_{kl}^{ij} & \cdots & a_{km}^{in} \\ \vdots & & & & \\ a_{m1}^{n1} & \cdots & a_{ml}^{nj} & \cdots & a_{mm}^{nn} \end{bmatrix} = \begin{bmatrix} A^{11} & A^{12} & \cdots\cdots & A^{1n} \\ A^{i1} & \cdots & A^{ij} & \cdots & A^{in} \\ A^{n1} & A^{n2} & \cdots\cdots & A^{nn} \end{bmatrix}$$

---

1) We assume here that each industry produces only one good (i.e. no joint production).

2) i.e. no externalities.

$$Q = \begin{bmatrix} Q^1 \\ Q^2 \\ \cdot \\ \cdot \\ \cdot \\ Q^n \end{bmatrix} \qquad Q^i = \begin{bmatrix} Q^i_1 \\ Q^i_2 \\ \cdot \\ \cdot \\ \cdot \\ Q^i_m \end{bmatrix}$$

$$Y = \begin{bmatrix} Y^{11} + Y^{12} + \ldots + Y^{1n} \\ Y^{21} + Y^{22} + \ldots + Y^{2n} \\ \vdots \qquad \vdots \qquad \vdots \\ Y^{n1} + Y^{n2} + \ldots + Y^{nn} \end{bmatrix} \qquad E = \begin{bmatrix} 1 & \ldots & 0 & \ldots & 0 \\ 0 & \ldots & 1 & \ldots & 0 \\ 0 & \ldots & 0 & \ldots & 1 \end{bmatrix}$$

One should note that A^{ii} for all i is the usual intranational input-output model for country i.

In order to make this model completely clear we construct the following simplified example where the number of countries n = 2 and the number of industries in both countries is also m = 2.

We have then the following relationships:

$$A = \left[\begin{array}{cc|cc} a^{11}_{11} & a^{11}_{12} & a^{12}_{11} & a^{12}_{12} \\ a^{11}_{21} & a^{11}_{22} & a^{12}_{21} & a^{12}_{22} \\ \hline a^{21}_{11} & a^{21}_{12} & a^{22}_{11} & a^{22}_{12} \\ a^{21}_{21} & a^{21}_{22} & a^{22}_{21} & a^{22}_{22} \end{array}\right] = \left[\begin{array}{c|c} A^{11} & A^{12} \\ \hline A^{21} & A^{22} \end{array}\right]$$

$$Q = \begin{bmatrix} Q_1^1 \\ Q_2^1 \\ Q_1^2 \\ Q_2^2 \end{bmatrix} = \begin{bmatrix} Q^1 \\ \\ Q^2 \end{bmatrix} \qquad Y = \begin{bmatrix} Y_1^{11} + Y_1^{12} \\ Y_2^{11} + Y_2^{12} \\ Y_1^{21} + Y_1^{22} \\ Y_2^{21} + Y_2^{22} \end{bmatrix} = \begin{bmatrix} Y^{11} + Y^{12} \\ \\ Y^{21} + Y^{22} \end{bmatrix}$$

$$\begin{bmatrix} A^{11} & A^{12} \\ A^{21} & A^{22} \end{bmatrix} \begin{bmatrix} Q^1 \\ Q^2 \end{bmatrix} + \begin{bmatrix} Y^{11} + Y^{12} \\ Y^{21} + Y^{22} \end{bmatrix} = \begin{bmatrix} Q^1 \\ Q^2 \end{bmatrix}$$

$$A^{11}Q^1 + A^{12}Q^2 + Y^{11} + Y^{12} = Q^1$$
$$A^{21}Q^1 + A^{22}Q^2 + Y^{21} + Y^{22} = Q^2$$

$$AQ + Y = Q$$

$$(E-A)Q = Y$$

$$Q = [E-A]^{-1}Y$$

If we have e.g. forecasts of final demand, we are able to predict all international trade flows which are necessary to satisfy the estimated final demand. The matrix $[E-A]^{-1}$ gives us all direct and indirect requirements for the several commodities of the different countries.

It can be shown that a change in final demand for only one commodity in one country makes changes of GDP of all industries in all countries necessary.[1)]

The model described above is constructed under following

---

1) We do not want to go into deeper detail, see e.g. [5] etc.

assumptions:

(a) No technological [illegible] substitution possibilities [illegible]:
There exist only [illegible] in each country, [illegible] techniques.

(b) No commodity substitution possibilities:
Furthermore technology assumption [illegible] the commodity inputs of different country[illegible] fixed proportions in order to produce [illegible] commodity in a certain country.

(c) The model excludes also joint production [illegible] externalities, which might sometimes be very important in reality.

(d) There are no data available to construct [illegible] big matrix because few countries have such detailed data.[1]

(e) Even if we are able to construct such a matrix, it will be unmanageable for political purposes. In order to be the basis for political decisions we need a much more aggregative view.

---

1) If we have only national input-output and trade share data available we are able to construct the matrix under the assumption that

$$a_{ij}^{lk} = a_{ij}^{kl} = a_{ij}^{k}$$

See Chenery & Clark [9].

[illegible]

[illegible]

[illegible] above [illegible] to be [illegible] and [illegible] more manageable [illegible] general [illegible] problems.

1. The necessity to weaken [illegible] (b) [illegible] the fact that several countries [illegible] on the [illegible] market with homogeneous goods. [illegible] substitution possibilities [illegible] different countries, rather than to assume that the same commodity will be imported in fixed proportions from different countries. Now, if we accept the fixed proportion assumption [illegible] in each country we change the coefficients [illegible] i.e. in order to produce one unit [illegible] j in country [illegible] the quantity [illegible] of commodity i. [illegible] be delivered from [illegible] countries, so we can write

$$a_{ij}^{l} = \sum_{k=1} a_{ij}^{kl}$$

The remaining question is to determine how much of this unit requirement should be bought from outside and from which countries. A possible explanation [illegible] by means of a "gravitation model",

i.e. $a_{ij}^{kl} = f(P_i, D^{kl}, PP^{kl}, [illegible]^{kl}, [illegible]^{kl}, \ldots)$

where

P_i is a vector of [illegible] commodity i [illegible] countries k;

D^{kl} is the geographical distance between countries k and l;

PP^{kl} stands for political preference between k and l,

T^{kl} for tariff barriers are in k and l;

N^{kl} is an indicator of production capacity in country k, l.

In order to make such or a similar model operational, we have to specify (a) the functional form, because it is a priori not clear whether the function is e.g. multiplicative or additive or of some other form. (b) The specification and measurement of some variables may cause difficulties. Especially an important variable like political preference may create a lot of troubles.

2. Since there are not all data available to construct a multi-country input-output model we have to reduce it to a manageable degree. Therefore we have to handle a much more aggregated model.[1)]

In principle we find data which are already aggregated in four possible directions:

(a) Aggregation of inputs;

(b) Aggregation of outputs;

(c) Aggregation of importing countries into groups;

(d) Aggregation of exporting countries into groups.

Which level of aggregation seems to be appropriate depends mainly on the problems we want to solve. Also we have to note that we are now not any longer confronted with "quantities" but "values" since for aggregation procedures we need a common standard. In most of the countries prices are used as the common standard. Therefore we have not any longer a purely production oriented system but rather a value structure. One main problem is to separate the influences of quantity changes and price

---

1) For these difficult problems of aggregation see e.g. Green 12.

changes. We do not discuss this problem in this paper.

4. Since we cannot expect constancy of [illegible] input-output structure over time especially because of [illegible] choice of technique in our model and because of the influence of technical change we have to overcome these rigidities for forecasting purposes. This can be done in several ways. Since our task is not to give a survey on this subject we want to mention just a few procedures.

(a) A well-known procedure is for example the RAS method. This method is described e.g. by M. Bacharach [1].1)

(b) It can also be handled by means of some kind of a gravitational model to estimate the matrix coefficients from behavioral equations which take into account demand and supply factors.2)

(c) A third method can be found in "[illegible] procedures"3) which lies in the construction of a regression model with time trend and price effects to get some kind of adaptation.

1.2. A Prototype Model

In this part we want to develop a specific model which can be constructed readily for the developed countries because the necessary data are probably available. It is nothing else than a highly aggregated version of the multicountry model described above. We consider a certain region e.g. Western Europe and try to get insights into the structure of international flows between the European countries, their trades and their relation to

---

1) For other methods see e.g. Carter-Brody [illegible], [7] and [8].
2) See [4].
3) See [2].

the rest of the world. Since we are interested only in manufacturing sector, we construct our model only for it. The disadvantage of this procedure is [illegible] that we are able to observe changes in imports and exports for manufactured goods of different countries, but not the internal structural changes within the countries which are very often the reasons for changes in import-export relations. So we loose an important insight into this structure. Since we have no data about distribution of imports into the particular sectors of the considered economies, this procedure is not possible.

We want to represent the international flow of manufactures for particular countries by the following matrix. In order to have consistent notation we list the following symbols:

x^{ij} are the exports of manufactures of country i to country j. Note that $\sum_i x^{ij} = M^j$ where M^j are the total imports of manufactures of country j and $\sum_j x^{ij} = X^i$ where X^i are the total exports of country i.

Y^i final demand of country i;

Z^i interindustrial demand in country i;

Q^i gross product of manufactures of country i;

K^i goods and services for manufacturing sector of country i;

V^i value added in manufacturing sector in country i.

The scheme of our model can be represented in the following table.

Ex- ports / Imports		Countries 1	2	...	n	X	Y	Z	Q
C o u n t r i e s	1	x^{11}	x^{12}	...	x^{1n}	X^1	Y^1	Z^1	Q^1
	2	x^{21}	x^{22}	...	x^{2n}	X^2	Y^2	Z^2	Q^2
	.	.	.		.	.	.	.	.
	.	.	.		.	.	.	.	.
	.	.	.		.	.	.	.	.
	n	x^{n1}	x^{n2}	...	x^{nn}	X^n	Y^n	Z^n	Q^n
M		M^1	M^2	...	M^n				
K		K^1	K^2	...	K^n				
V		V^1	V^2	...	V^n				
Q		Q^1	Q^2	...	Q^n				

The following definitional equations hold:

for the demand side:

(1) $Q^i = \sum_j x^{ij} + X^i + Y^i + Z^i$ for $i = 1, \ldots, n$

and the "cost" equation (or supply side)

(2) $Q^j = \sum_i x^{ij} + M^j + K^j + V^j$ for $j = 1, \ldots, n$

Assume now the following coefficients:

(3) $a^{ij} = \dfrac{x^{ij}}{Q^j}$

i.e. the proportion of imports from country i to the [illegible] product of country j for m[illegible].

It is obvious that $a^{ij} \geq$ [illegible] and that [illegible] j [illegible].

Now we are able to write the above equations in the following form:

$$Q^i = \sum_j a^{ij} Q^j + Y^i + Z^i \qquad \forall i$$

and denote $Y^i + Z^i = D^i$

D^i stands for <u>total</u> demand of country i

and $[a^{ij}] = A$

hence we can write

$$Q = AQ + D \qquad \text{where } Q = \begin{bmatrix} Q^1 \\ \cdot \\ \cdot \\ \cdot \\ Q^n \end{bmatrix} \qquad \text{and } D = \begin{bmatrix} D^1 \\ \cdot \\ \cdot \\ \cdot \\ D^n \end{bmatrix}$$

$(E-A)Q = D$ and if $|E-A| \neq 0$[1]

(4) $Q = [E-A]^{-1} D$ where E is the unit matrix.

Equation system (4) allows us - under assumption (a) - to investigate the influence of a change in total demand (i.e. interindustry and/or final demand) in particular countries on the gross product of manufacturing sector in each country.

---

1) One can prove that a necessary and sufficient condition for an economically meaningful solution is given by the welknown Hawkins-Simon condition. See e.g. Nikaido [10].

Since export results from

(5) $X = Ak$.

After substitution (4) into (5) we can write

(6) $X = A[E-A]^{-1}D$ or $X = G.D$

where $G = A[E-A]^{-1}$

i.e. the exports of each country are a function of total demand D of all countries.

In order to interpret the elements of the G-matrix consider the following example:

Suppose we have three countries and total demand is just in country 2 equal one and zero otherwise.

i.e. $D = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}$

therefore from (6) we have

$$X = \begin{pmatrix} g_{11} & g_{12} & g_{13} \\ g_{21} & g_{22} & g_{23} \\ g_{31} & g_{32} & g_{33} \end{pmatrix} \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix} = \begin{pmatrix} g_{12} \\ g_{22} \\ g_{32} \end{pmatrix}$$

that is to say g_{ij} gives us the imports from country i for one unit of total demand in country j.

Therefore the coefficients of G-matrix characterize the dependence (direct and indirect) between different countries. If $G > 0$ then there are no blocks of countries which are independent from all other countries. In other words, there exists a direct or indirect trade connection between all countries.

Imports can easily be derived:

Since $\sum_j x^{ij} = M^i$ we can determine by means of the sum vector

$e = (1, \ldots, 1)$

$$M = eA\hat{Q} \quad \text{where } \hat{Q} = \begin{pmatrix} Q_1 & 0 & 0 & \cdot & \cdot \\ 0 & Q_2 & 0 & \cdot & \cdot \\ 0 & \cdot & \cdot & \cdot & Q_n \end{pmatrix} .$$

The matrix of international flows can be represented by means of (3) by $\tilde{X} = A\hat{Q}$ where $\tilde{X} = (x^{ij})$.

A method developed by Rasmussen [11] allows us to construct coefficients which enable us to specify which countries are "importing" and which are "exporting" countries. By means of the elements of the matrix Q we can define "column coefficients ${}_*R^j$".

$${}_*R^j = \frac{n \sum_i q_{ij}}{\sum_j \sum_i q_{ij}} \qquad \forall_j$$

If ${}_*R^j > 1$, i.e. an increase of demand in country j of one unit leads to a more than proportional increase of total imports into country j. Therefore we call such a country an "importing"one.

Likewise for row coefficients ${}^*R^i = \dfrac{n \sum_j q_{ij}}{\sum_i \sum_j q_{ij}} \qquad \forall_i$

${}^*R^i > 1$ means that a proportional increase of total demand in all countries leads to a more than proportional increase of exports of country i; we may call each country an "exporting" one.

Now for practical purposes we are confronted with some problems, already discussed in general in Chapter 2. Because in this prototype model total demand is given exogenously we need to specify a behavioural equation for forecasting purposes. Similarly since we cannot hope that our matrix A remains constant over time, we need some kind of adaption in order to get better forecasts, e.g. RAS or modified methods which are mentioned in Chapters 2 and 4.

Finally we want to mention the relationship between our prototype model and the usual trade share matrix approach. Trade share matrix T is usually defined:

$$T = \left\{ t^{ij} \right\}$$

where $t^{ij} = \frac{x^{ij}}{M^j}$ (7) $i, j = 1, \dots, n$

This trade share matrix T can be used to derive our A-matrix. From (3) and (7) follows

$x^{ij} = a^{ij}.Q^i$ or $X = A\hat{Q}$

$x^{ij} = t^{ij}M^j$ or $X = T\hat{M}$

since $A\hat{Q} = X = T\hat{M}$ we can write

$A = T\hat{M}\hat{Q}^{-1} = T\hat{m}$ where $\hat{m} = \hat{M}\hat{Q}^{-1}$ representing the import coefficients

or $T = A\hat{Q}\hat{M}^{-1} = A\hat{m}^{-1}$

A second possibility of using this model lies in the elaboration of its dual form which might give us important insights into analysis of price-structure between different countries. This will not be further investigated in this paper.

4. [illegible]

In the preceding chapter a prototype regional model for the manufacturing sector was developed, based on data usually available in most of the developing countries. The purpose of this part of the study is the construction of a regional model for the manufacturing sector for 6 developing Latin American countries. Constructing such a model we faced a lot of data problems.

4.1. Data problems

All the data used in the study are provided by UNIDO. One of the main problems was the non-availability of trade matrices for the manufacturing sector. Intraregional data of exports and imports between the individual countries of Latin America are available, but not for the manufacturing sector, e.g. commodities of groups SITC 5-9. Therefore we had to make the strong assumption of proportionality between total exports and exports of manufactures for all the countries to find a way out of this problem.

To use the model developed in Chapter 3 we need data of the export structure, final demand, interindustrial demand, gross production and value added etc. for the manufacturing sector of the individual countries, which are not available for all the countries; e.g. we have no data of interindustrial demand and gross output data only for Brazil, Chile, and Colombia.

Period of observation of the behavioral equations in the country models[1] is 1958 - 1969, a rather short period. Ex ante forecasts of exports via demand or gross output have to

---

1) cf. the preceding studies [14] and [15].

be made for 1974 and further on. Changes in the economic structure between 1960 and 1973 are not constant so fixed forecasts are highly probable. Considering these data limitations a simple trade share approach is used to forecast exports of manufactures via imports.

4.2. Construction of a model

Taking the estimated country models for Argentina, Chile, Mexico, and Venezuela from [15] and the models for Brazil and Columbia from [14] it is possible to construct a regional model for the manufacturing sector for Latin America for simulation purposes. All other Latin American countries belong to the rest of the world.

4.2.1. Simulation model

Every country model consists of the following equations: Demand, imports, exports, deflator of value added in the manufacturing sector and supply.

The estimated export equation in the country models is replaced by the "trade matrix export equation".

i.e.:

$$X^m_{it} = f(X^m_{W_t}, P_{X_{it}}/P_{WX_t}, XR_{it}) \qquad i = 1, 2, \ldots, 6 \text{ countries}$$

$$t = \text{time}$$

X^m_i	exports of manufactures in local currency
X^m_W	world exports of manufactures
P_{X_i}/P_{WX}	price ratio: export price and world price
XR_i	exchange rate (local currency per US\$)

is replaced by

$$X^{m\$}_{it} = \sum_{j=1}^{[illegible]} a^m_{ij} M^{m\$}_{jt}$$

where

t^m_{ij} co-efficients [illegible] the manufacturing sector

$$\left(t^m_{ij} = \frac{Z^m_{ij}}{M^m_j} \qquad \begin{array}{l} i = 1, 2, \ldots, 7 \\ j = 1, 2, \ldots, 7 \end{array}\right)$$

$X^{m\$}_j$ exports of manufactures in current $

$M^{m\$}_j$ imports of manufactures in current $

and

$$X^m_{it} = \frac{X^{m\$}_{it} \cdot XR_{it}}{P_{X_{it}}}$$

To link the country models together we need one more equation.

$$M^{m\$}_{it} = \frac{M^m_{it} \cdot P_{M_{it}}}{XR_{it}}$$

$P_{M_{it}}$ deflator of imports

The so constructed regional model of the manufacturing sector for Latin America consists of 42 equations. Trend extrapolations for certain variables (e.g. rest of world imports of manufactures) are added to close the model.

The main exogenous variables of the model are:

GDP_i gross domestic product

P_{M_i} deflator of total imports

XR_i exchange rate

By help of our regional model it should be possible to answer the following questions:

- what are the effects of a devaluation in one country on exports and imports of the other countries?
- what are the effects of a rising import price level in one country on demand and via imports on the other countries?

Using the model alternative simulations are possible. However as already mentioned a lot of data problems exist (shortage of time series, lack of appropriate data). Another fact should also be pointed out. The country models contain only the manufacturing sector; so questions regarding the rest of the economy cannot be answered.

Theoretically it is possible to use the regional model for forecasting purposes. Solving the model for given values of the exogenous variables, we get forecasts of imports. These imports yield via the "trade matrix export equation" forecasts of manufacturing exports.

However some difficulties [illegible]. In every country model there are 2 - 5 exogenous variables, which have to be forecasted separately. Changes in the economic structure between the last year of the observation period and the year forecasts are made for are highly probable.

For forecasting purposes we used a trade matrix approach presented below.

4.2.2. Trade matrix approach[1]

The trade matrix for Latin America is constructed in the

---

1) In this section we change the position of the indices denoting the countries since we are dealing with the manufacturing sector only (denoted by superscript m). Symbols without superscript refer to the whole economy.

following way:

Let x_{ij} be the volume of total exports from country i to country j; where

$$\sum_j x_{ij} = X_i \text{ is the total export volume of country i,}$$

and

$$\sum_i x_{ij} = M_j \text{ is the total import volume of country j.}$$

In our model we consider six countries (Argentina, Brazil, Chile, Columbia, Mexico, and Venezuela) and the rest of the world. The international trade flows are given by the following (7 x 7) matrix (Table 1).

For our analysis we use the trade share matrix $T = t_{ij}$ which is derived as follows:

$$(1) \quad t_{ij} = \frac{x_{ij}}{M_j} \quad \text{for } i, j = 1, \ldots, 7$$

or in matrix notation:

$$(1a) \quad T = \mathbf{X} \cdot \hat{M}^{-1}$$

where $\mathbf{X}$ = trade flow matrix

$\hat{M}$ = diagonal matrix of imports

Therefore t_{ij} denotes the share of country i's exports to j, to total imports of country j.

Table 2 presents the T-Matrix for our model in 1969.

Exports to / from	ARG	BRAZ	COL	CHIL	MEX	VEN	RW	TOTAL (Exp.)
ARG	0	159.9	5.7	92.4	12.4	12.6	1329.1	1612.1
BRAZ	174.5	0	3.0	31.5	11.5	5.7	2084.77	2310.97
COL	9.4	2.0	0	7.0	.6	7.1	581.9	608.0
CHIL	71.6	29.5	4.8	0	8.3	5.1	948.6	1067.0
MEX	21.5	21.0	26.9	21.2	0	24.1	1315.3	1430.0
VEN	38.4	60.8	9.7	36.0	4.1	0	2744.7	2893.7
RW	1255.3	1933.83	630.9	715.8	2041.0	1509.2		232181.33
Total (Imp.)	1570.7	2263.03	655.0	903.9	2077.9	1563.8	233035.67	242104.0

Table 1: Trade Flow Matrix 1969 (current mill. U$S)

	ARG	BRAZ	COL	CHIL	MEX	VEN	RW
ARG	0	.068900	.0142	.1017	.006	.008	.0357[illegible]3
BRAZ	.1111	0	.0044	.0347	.0055	.0036	.00[illegible]45
COL	.0059	.000884	0	.0077	.000269	.0045	.002437
CHILE	.0456	.013	.007	0	.004	.0033	.004[illegible]71
MEX	.0137	.0093	.0393	.0233	0	.0154	.00[illegible]44
VEN	.0245	.0269	.0142	.0397	.002	0	.011778
RW	.799200	.831016	.920900	.792900	.93[illegible]	.9[illegible]	.9[illegible]

Table 2: T = Trade Share Matrix 1969

From the given trade share matrix and import volumes we can derive export volumes for each country:

$$(2) \qquad X = T.M$$

Since our interest in this study is only in the industrial sector of these Latin American economies, we have to apply this framework to this particular sector.

With a known trade share matrix for the manufacturing sector there would be no difficulty for this problem. But unfortunately there were no data of this kind available to us. Consequently we tried to find some kind of approximation. We used the information about the proportions of trade volumes in the manufacturing sector of each country to their total trade volumes. The regional distribution of the trade flows is treated as given in the forementioned matrix T (see Table 2). Now define the following coefficients for each country:

$$(3) \quad \left. \begin{aligned} \alpha_i &= \frac{X_i^m}{X_i} \\ \beta_i &= \frac{M_i^m}{M_i} \end{aligned} \right\} \quad i = 1, \ldots, 7$$

X_i^m = exports of the manufacturing sector in country i

M_i^m = imports of the manufacturing sector in country i

These coefficients give us the proportions of exports (imports) of the manufacturing sector to total exports (imports) for each country.

Substituting for X and M in equation (2) using (3) yields (in matrix notation)

$$(4) \quad \hat{\alpha}^{-1} X^m = T.\hat{\beta}^{-1} M^m.$$

Therefore [illegible] reads for each country

(5) $X^m = \hat{\alpha} \cdot T \cdot \hat{B}^{-1} M^m$

where X^m and M^m are vectors and $\hat{\alpha}$ and $\hat{B}$ [illegible] matrices of the respective coefficients.

For forecasting purposes we have now to investigate the influence of a constant trade share matrix T [illegible] correct for the errors caused by it.

All export and import figures as well as the α_i and B_i are given for the time period 1958 – 1969. The trade share matrix T we know only for 1969.

Having calculated the equation

(6) $\hat{X}^m_t = \hat{\alpha}_t T_{69} \hat{B}_t^{-1} M^m_t$ for t = 1958, ..., 1969

one gets the results shown in Figure 1, where the differences between actual and calculated values are due to the constancy of matrix T.

To use this equation to forecast exports in future years, one has to have estimations of $M^m_{i,t+1}$, $\alpha_{i,t+1}$, and $B_{i,t+1}$. As mentioned above we can get estimations of $M^m_{i,t+1}$ as a result of the individual country models, but for the $\hat{\alpha}_i$ and $\hat{B}_j$ we would need again [illegible] behavioral equations explaining these structural coefficients or we treat them as given, exogenously having a priori information.

To make the approach as simple as possible we choose the following procedure:

Starting from equation (6) we use only the most recent value of $\hat{\alpha}_t$ and $\hat{B}_t$, thus assuming a constant international and national structure.

Therefore we compute:

$$(6) \quad \tilde{X}^m_t = \hat{\alpha} \ldots \qquad t = 1958, \ldots, 1969$$

yielding calculated values of X^m_t denoted by $\tilde{X}^m_t$, where the differences $X^m_t - \tilde{X}^m_t$ are due to this constant structure. The $\tilde{X}^m_t$ are shown graphically in the diagrams in Figure 1.

As one possible way to get out of the difficulties of a constant trade matrix and to improve the performance of the calculations over the observation period and for forecasts we estimate the following type of equation for each country:

$$(7) \quad \hat{X}^m_{it} = \tilde{\alpha}_i + \tilde{\beta}_i \tilde{Y}^m_{it} + \tilde{\varepsilon}_t \qquad i = 1, \ldots, 7; \quad t = 1958, \ldots, 1969$$

These equations could be specified also to take into account factors which influence the proportion of industrialization in each country as well as substitution possibilities among the sectors of the economy.

The results of the estimations are reported in Table 3. Only for two countries, Argentina and Venezuela, the results are not very satisfactory, and therefore an inclusion of additional variables, as mentioned above, would be desirable.

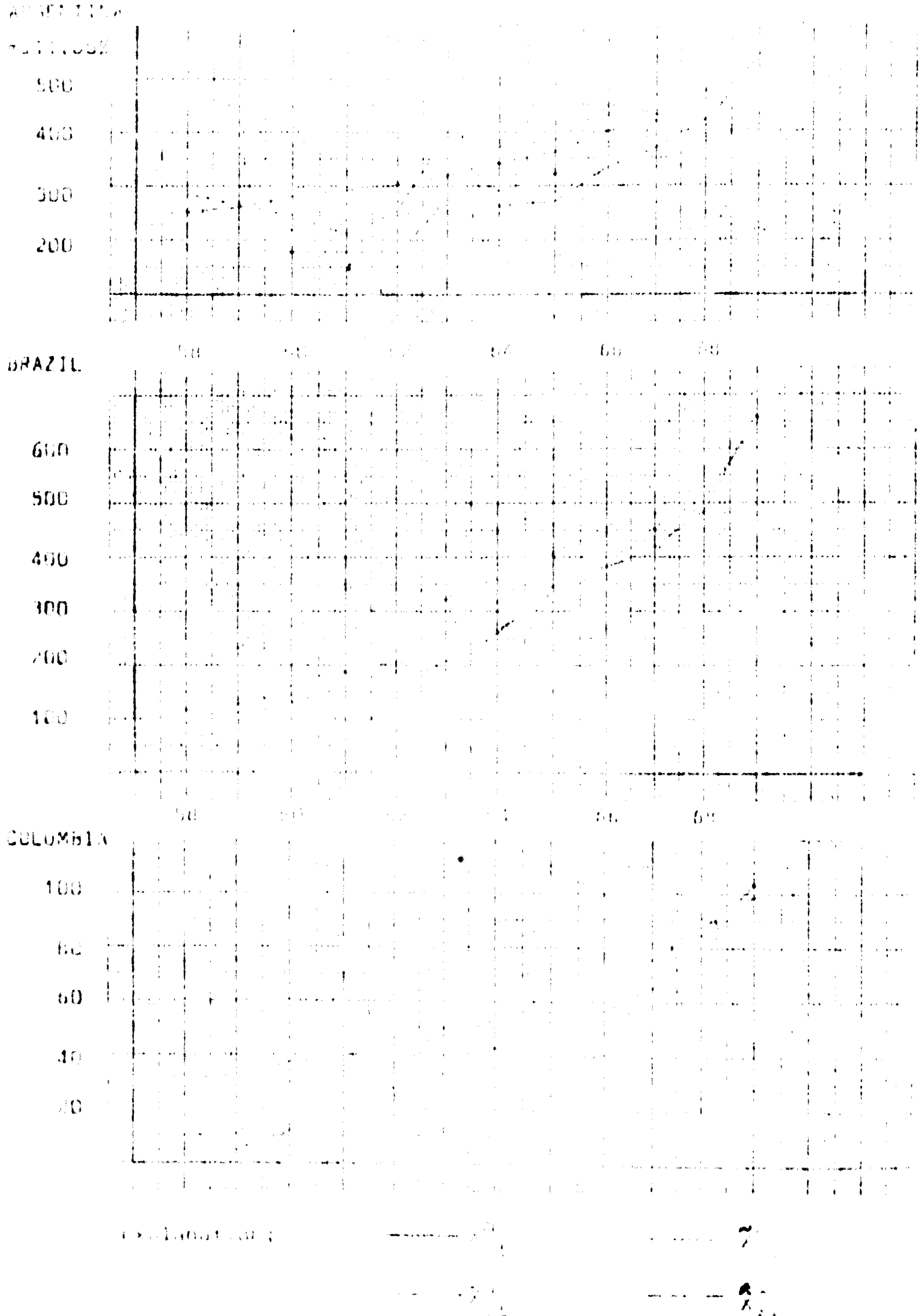
The goodness of fit over the period 1958 - 1969 can be seen on the diagrams in Figure 1.

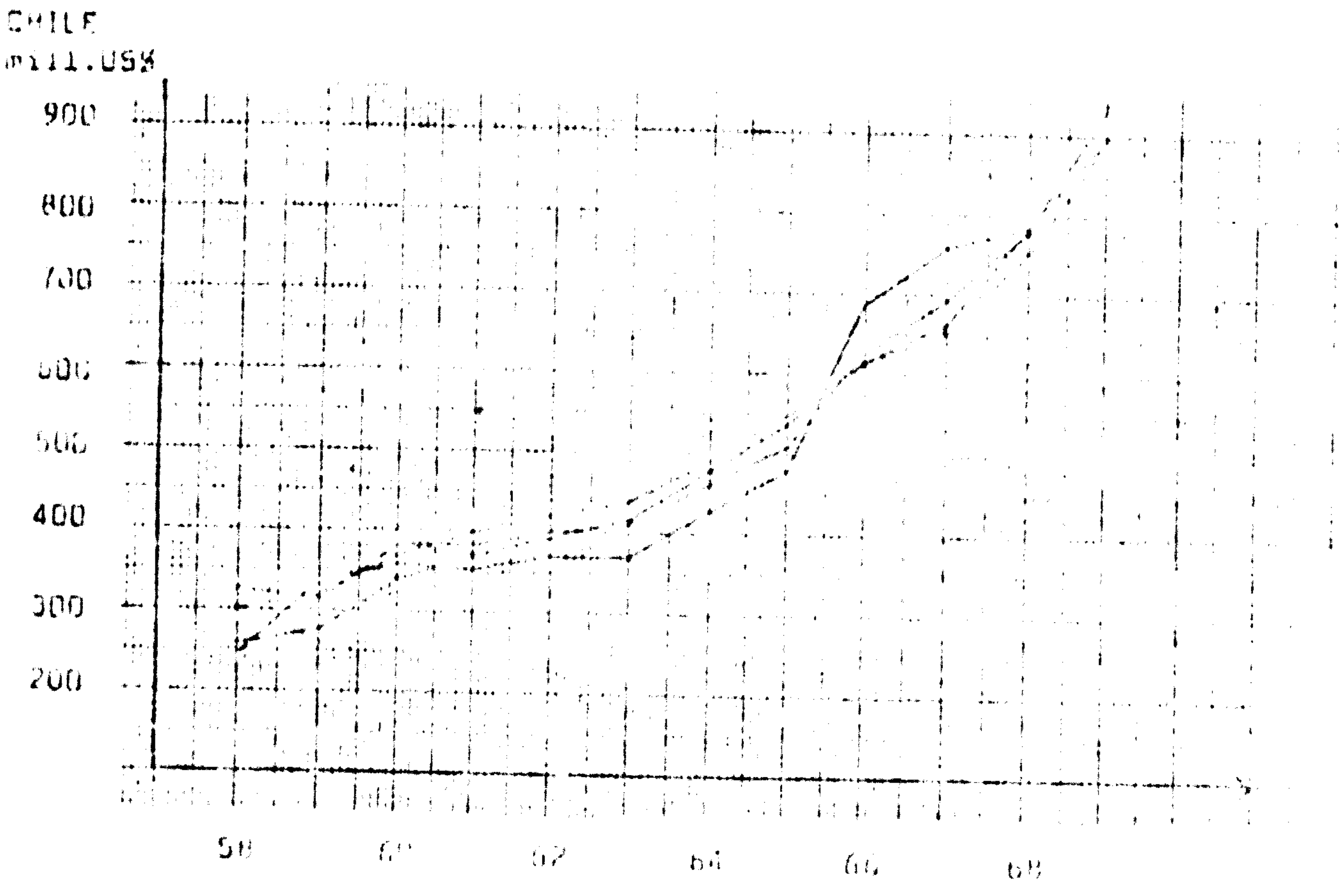
MANUFACTURING EXPORT ESTIMATIONS ([illegible] - [illegible])

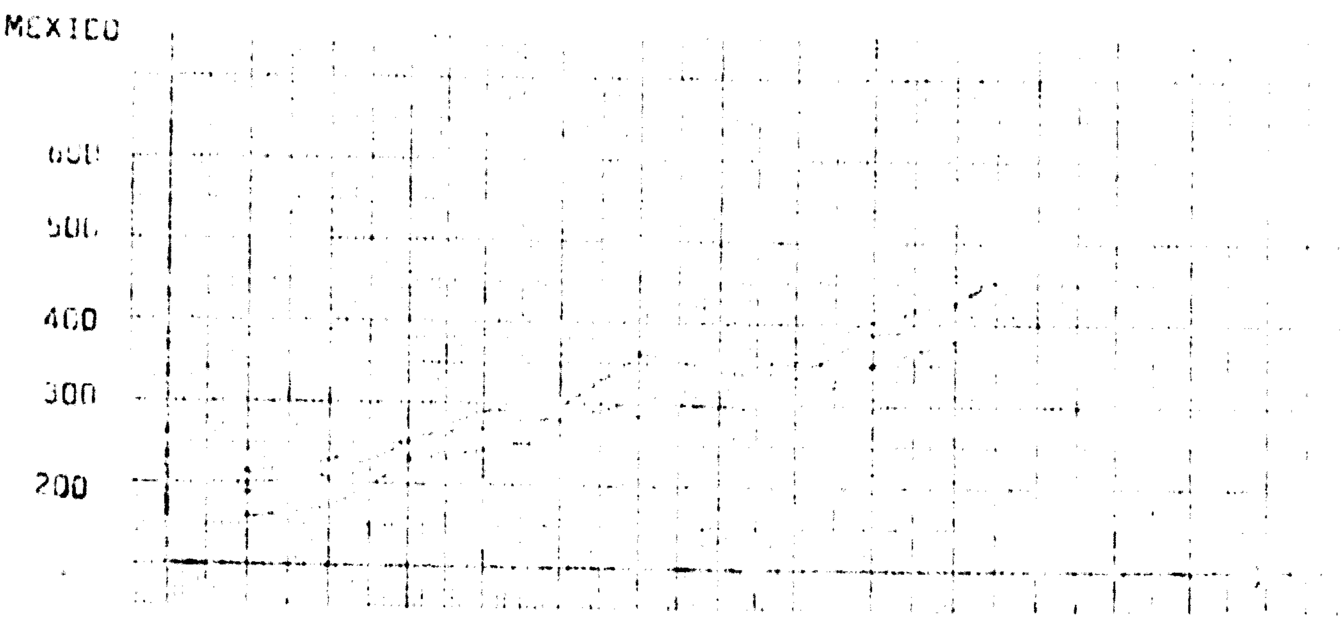
i	$\tilde{\pi}_i$	$\tilde{E}_i$	$\tilde{\gamma}_i$	R^2_i
ARG	.110 (42)	.78663 (18)		.757
BRAZ	.295 (106)	1.47452 (11)	-.00886 (66)	.990
	-.180 (9)	1.24475 (4)		.987
COL	-.034 (9)	1.44587 (4)		.983
	-.126 (57)	1.16644 (26)	.00160 (79)	.986
CHIL	-.088 (56)	1.13021 (8)		.946
MEX	.052 (46)	.87841 (8)		.941
VEN	.423 (12)	.38888 (13)		.726
RW	0.062 (28)	1.0[illegible] (6)	-.14032 (41)	.999

Table 3

(Numbers in brackets refer to the standard deviation expressed as percentage of the value of the respective coefficient).

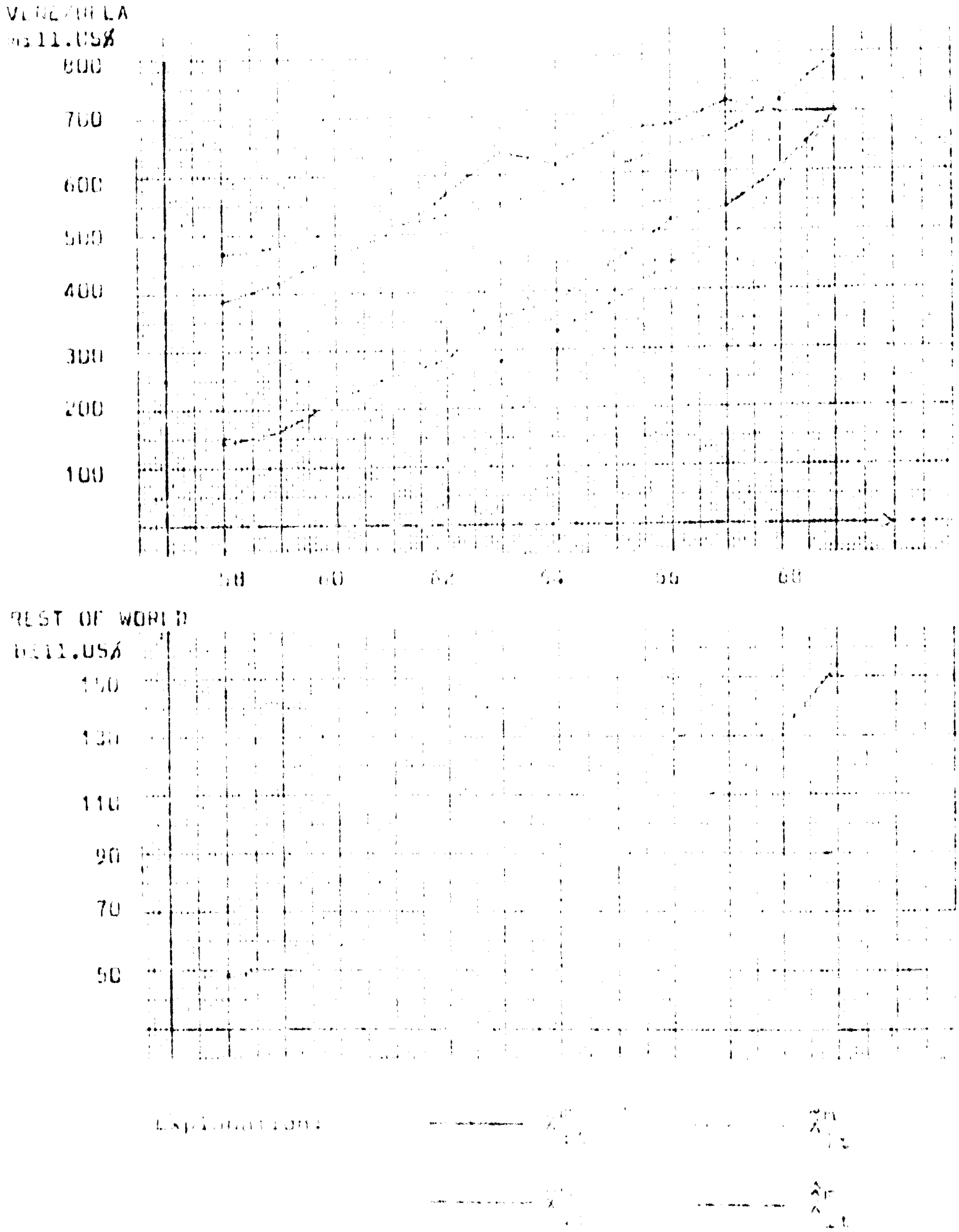

500
400
300
200
BRAZIL
600
500
400
300
100
COLUMBIA
100
60





Explanation: ——— X^{n}_{it} .... $\tilde{X}^{n}_{it}$

— — — X^{n}_{it} — · — · — $\hat{X}^{n}_{it}$


VENEZUELA
mill.US$
800
700
600
500
400
300
200
100
58
60
62
64
66
68
REST OF WORLD
mill.US$
150
130
110
90
70
50

5. CONCLUSIONS

Applying our model [illegible] lot of difficulties. For [illegible] not available or only for [illegible] very short period. In addition we were not provided with the most recent [illegible], thus changes in the economic [illegible] during the last years are not contained. Furthermore we had to approximate the trade matrix for the manufacturing sector.

For these reasons the model established in Chapter 4 is kept at a rather simple level. To use the model for practical purposes e.g. for policy simulations and forecasting, further studies concerning the dynamic structure of the trade share matrix and the interdependencies with the other sectors of the economy are necessary.

A further problem is the analysis of the price structure of the manufacturing sector of the different countries. A possible approach could be the analysis of the dual form of an extended model.

Our study should be regarded only as a first step in applying this kind of structural models to [illegible] regions of [illegible]-developed countries.

REFERENCES

[1] [illegible] Data, [illegible] Vol. VI (1965).

[2] L. Klein, [illegible], World Trade Forecasts, 1971 - 1972, Retrospect and Prospect, Paper presented at LINK Conference, Vienna, Aug. 1972.

[3] J. Glowacki, Medium Term Model of CMEA Trade, Paper presented at LINK Conference, Vienna, Aug. 1972.

[4] ECE, Methods for International Trade Projections for a Network of Countries, Vol. I and Vol. II., ad hoc meeting of experts, Geneva, June 1970.

[5] W. Leontief, Input-Output Economics, Oxford 1966.

[6] A. Carter - A. Brody (ed), Contributions to Input-Output Analysis, Amsterdam-London 1970.

[7] -------------------------, Applications of Input-Output Analysis, Amsterdam - London 1970.

[8] -------------------------, Input-Output Techniques, Amsterdam - London 1972.

[9] H. Chenery - P. Clark, Interindustry Economics, New York 1959.

[10] H. Nikaido, Convex Structures and Economic Theory, New York - London 1968.

[11] P. Rasmussen, Studies in Intersectoral Relations, Amsterdam 1957.

[12] H. Green, Aggregation in Economic Analysis, Princeton 1964.

[13] UN (ECLA), Economic Survey of Latin America 1970, New York 1971.

[14] B. Boehm, H. Frisch, [illegible], A Prototype Macromodel of the Manufacturing Sector of Developing Countries, UNIDO 1972

[15] B. Boehm, F. [illegible], A. [illegible], Simple Macroeconometric Models for the Industrial Sector of Developing Countries, UNIDO 1971.

17. 7. 74