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SIMPLE MACRO-ECONOMETRIC MODELS FOR THE MANUFACTURING SECTOR OF DEVELOPING COUNTRIES [1]

with special reference to Argentina, Chile, Mexico and Venezuela

by

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C O N T E N T S

1. INTRODUCTION

This paper continues to provide applications of a simple prototype macro-model for the industrial sector of developing countries.[1] Four countries of Latin America are investigated. Although the countries under consideration differ in economic structure and development, there are common problems in developing the manufacturing sector.

Therefore a general model consisting of 4 behavioral equations and 1 definition was developed in chapter 2. The explanatory variables for the 4 behavioral equations - demand, imports, exports and price deflator of the manufacturing sector - are chosen according to economic theory and the availability of data. Each equation is discussed.

In chapter 3 this general model is applied to the individual countries. For each country the results of the estimation process are presented and shortly discussed. For each equation we tried several alternative formulations and selected the most interesting results. Choice criteria were both economic theory and statistical significance. For prediction purposes we computed the reduced form. Performance over the sample period is shown graphically. The results of estimation for Venezuela and a list of variables can be found in the appendix.

The estimation method used was ordinary least squares. Correlation coefficient R^2 and Durbin-Watson statistic DW are calculated for every equation. The figures in parentheses below

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1) For an earlier study of this kind see: Boehm, Frisch, Otruba, "A simple prototype macro-model for the manufacturing sector of developing countries", OEIIO 1972.

the coefficients to the standard deviations of the coefficients as a percentage of the coefficient.

Period of observation is for Chile, Mexico and Venezuela 1950-1968, for Argentina 1953-1968. This period is rather short, but the data which are all provided by UNIDO, were not available for more recent years. This fact and the lack of more appropriate data made it impossible to employ a more sophisticated theory. For these reasons there are limitations to the applicability of our results due to the underlying macroeconomic concept of the model and the political situation in the countries under investigation. One of the basic assumptions of least square regression methods is the constancy of the structure to be estimated over the observation period. As the economic and political situation of developing countries is often changing rapidly one may pose doubts to the applicability of the model. One should always note that the estimated coefficients are only an approximation of the "true" relationships.

2. GENERAL STRUCTURE OF THE MODEL

2.1. Starting from the definitional equation for the manufacturing sector,

$$(1) \qquad S = D + X - M$$

we try to explain the variables on the right hand sight of this equation, i.e. demand (D), exports (X), and imports (M). In order to get insight in the "true" relationships and to get out of the influence of the price effects, we estimated our equations in real terms (in domestic currency). This procedure is necessary, because of the enormous inflationary processes in most of the Latin American Countries.[1] For every country we took the deflator of value added of the manufacturing sector. This price variable is explained by a behavioral equation in addition to the demand-, export- and import-equation.

2.2. The demand equation

Throughout all the countries we assumed the demand for manufacturing goods, as depending on gross domestic product (GDP), price deflator of manufacturing goods (P) or the wholesale price index P_W and taxes on consumption (T); or more formally

$$(2) \qquad D = f(GDP, P \text{ or } P_W, T)$$

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1) Especially in Argentinia and Chile.

the "correct" variable in this simple demand equation should be the disposible income rather than the gross domestic product which includes taxes and give therefore not the full information about the purchasing possibilities of a society. The lack of appropriate data prohibits the use of the "proper" variable.

The influence of prices on demand is represented by P or P_W respectively. The use of P in equation (2) should be preferred on the basis of economic reasoning. Alternatively P_W was used too, but showed in most cases no better statistical results. As a proxy variable for the influence of the government sector on demand, taxes on consumption are used.

2.3. The import equation

Imports (M) are explained by demand (D), the exchange rate (XR = domestic currency per $); the ratio of import prices (= total import prices) to domestic prices for manufactured goods (P_M/P), the foreign exchange reserves (FXR) and the ratio of import duties to total imports (MD/M).

$$(3) \quad M = f(D, P_M/P, FXR, XR, MD/M)$$

As expected, in all the equations demand for manufacturing goods turned out as the main explanatory variable.[1] The ratio of P_M/P seems to be a good indicator of the substitution possibilities between imported and domestic goods although one should note two things:

(a) total import prices are only a proxy for import prices for manufactured goods,

(b) the substitution possibility is rather limited, because most of the imported goods are not produced domestically.[1]

The possibility of importing goods in developing countries depends to a large extent on the amount of foreign reserves and international credit. FXR represents foreign exchange reserves and can be interpreted as a kind of budget restriction.

The exchange rate XR (the amount of domestic currency needed to buy 1 $) gives some insights in the effects of devaluation on the amount of imports of manufactured goods. But only in the Argentinian model this variable enters significantly.

The ratio between import duties and total imports can be interpreted as an indicator of the average pressure of import duties on imports. The more appropriate indicator for the average-duty-pressure would be the ratio between import duties on manufactured goods and value of imports of manufactured goods. Only if the behavior of both indicators is running approximately parallel, the coefficient can be used as a substitute for the "true" one.

2.4. The export equation

The main explanatory variables in the export equation are: World exports of manufactured goods (X_W) measured in $, the ratio between total export prices to world market prices of manufactured goods (P_X/P_{WX}) and the exchange rate (XR).

$$(4) \qquad X = f(X_W,\ P_X/P_{WX},\ XR)$$

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1) cf. for example many remarks in several issues of "Economic Survey of Latin America".

X_W gives the effect of world market of manufactures on the exports. The ratio P_X/P_{WX} represents the possibility to compete in the world market of manufactured goods with respect to the prices. The correct variable would be the ratio of the export prices of manufactures to world prices of manufactures.

Similar to equation (3) ΔR represents the influence of devaluations on exports. One would expect, ceteris paribus, a positive effect of a devaluation on the value of exports.

2.5. The price equation

A common distinction to explain the reasons of a rising price level is that of cost-push and demand-pull. Therefore we tried to catch both effects. Usually in econometric models the influence of cost-push is expressed through import-prices and wage-pressure. On the demand side D is the main variable

$$(5) \quad P = f(D, P_M)$$

2.6. The reduced form of the model

In order to calculate the reduced form the structure has to be linear. Some of the equations used in the models do not meet this requirement. For simplicity we treat ratios involving a nonlinearity as exogenous.

To solve the system of 5 equations for the endogenous variables as a function of all exogenous variables, we transformed the structural equations into the reduced form. In matrix notation the 5 equations of each country can be written

$$\hat{B}Y_t + \hat{C}X_t = 0$$

where $\hat{B}$ is a square matrix of estimated coefficients of the endogenous variables (in our case 5x5), $\hat{C}$ (5x(k+1)) matrix of estimated coefficients of the exogenous variables, where k is the number of the exogenous variables; Y_t is the vector of the endogenous variables (5x1), X_t is the vector of the exogenous variables (k+1) and 0 is the vector consisting of 0(5x1).

Solving this system we get

$$Y_t = -\hat{B}^{-1}\hat{C}X_t$$

where $-\hat{B}^{-1}\hat{C}$ is called the reduced form matrix.

The elements of the reduced form matrix can be interpreted as multipliers. This means that a change of 1 unit of a specific exogenous variable induces a change of the related endogenous variable of 1 times the "multiplier", considering the interdependence of the whole equation system.

By means of the reduced form we are able

(a) to calculate estimates of the endogenous variables for the sample period, using the values of the exogenous variables of this period;

(b) to make predictions of the endogenous variables using anticipatory values of the exogenous variables.

3. COUNTRY MODELS

After the discussion of the general structure of our model we turn now to describe the structural and reduced form equations for each country.

3.1. A R G E N T I N A

3.1.1. Structural equations

(i) Demand equation

D	GDP	P	P_W	Intercept	R^2	DW
(1)	798.082 (8)	-1.052 (17)		-603.568	.982	2.29
(2)	779.498 (9)		-.923 (18)	-384.708	.981	2.11

The equations are estimated with ordinary least square single equation method. Coefficients can be interpreted as marginal propensities, e.g. 798.082 implies that an increase of GDP of one unit (= 1 billion pesos) will raise the aggregate demand for manufactured goods by 798 million pesos.

Similarly, an increase of one unit of P leads to a reduction of demand of 1.052 million pesos. Both equations show a highly significant correlation between demand of manufactured goods and GDP. Although one should note the restricted explanatory power of GDP instead of the disposable income.

For theoretical reasons (*) should be preferred because the deflator of manufactured goods prices seems more appropriate than the wholesale price index.[1] Fortunately the level of the coefficients do not differ very much and both are highly significant.

(ii) Import equation

M	D	XR	P_M	MD/M	Intercept	R^2	DW
(1)	.366 (26)	-.244 (33)			-55.692	.641	1.96
(2)	.388 (22)	-.349 (27)		-11.009 (56)	-21.270	.753	1.91
(3)	.394 (21)		-.484 (25)	-12.042 (51)	-24.967	.767	1.97

In this equations D and XR are predominating explanatory variables. The last increase in the exchange rate in the sample period is a devaluation of about 40 % in March 1967. The fact that the import price index is also increasing, guarantees that the effects of the devaluation are not paralyzed by a counteracting price behaviour in the world market. Therefore it seems that the theoretically expected effects of devaluations on imports are relatively undisturbed reflected in these equations by the size of the coefficient [2]

The import duty pressure MD/M has the expected negative effect on imports.

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1) cf. Economic Survey of Latin America 1967, p.122.

2) Although one has to be aware of other policy actions which were set in order to help domestic industry (cf. ESLA 1967, p.125).

(iii) Export equation

X	X_W	P_X/P_{WX}	X_R	Intercept	R^2	DW
(1)		-1.004 (33)	.732 (21)	42.520	.974	1.45
(2)	.592 (04)	-1.210 (31)	.718 (31)	10.735	.638	1.51

A discussion of the influence of these explaining variables is already given in section 2.4. From the statistical point of view, R^2 and DW-statistics is not quite satisfying. Also the impact of world trade of manufactured goods on Argentinian exports is statistically not significant.

(iv) Price equation

P	D	P_M	Intercept	R^2	DW
	.141 (74)	.792 (15)	-64.891	.951	.662

The explanation of the price index gave some interesting results. The insignificancy of the demand coefficients in common with the high correlation between the price index and demand in equation (i) seems to be an indicator that causality is running from prices to demand and not in the other direction. The explanation of the price index is difficult also from another point of view. Argentina has to fight in the last years against big inflation problems. As Little et al. (p.76) remark, there is inflation observable "with manufacturing capacity and labor still under-utilized". According to them the main cause of the observed inflation is due to governmental deficit spending. The lack of data permits us no test of this hypothesis.

3.1.2. The reduced form

As already mentioned the coefficients of the reduced form are multipliers. In the model there are 6 exogenous variables: 2 policy variables (exchange rate, import duty measure) and 4 others (GDP, import prices of manufactures P_M, ratio of export prices to world market prices of manufactures P_X/i_{WX}, world trade of manufactures X_W). Consider for instance the exchange rate XR: if Argentina devaluates the peso for 10 units (i.e. from 350 to 360 pesos per US$) then exports of manufactured goods would rise by about 7.2 billions. All the other multipliers of the $D^{-1}C$ matrix can be interpreted in a similar way.

	Const.	GDP	MS/M	P_M	XR	P_X/P_{WX}	X_W
D	-690.485	812.174	0.0	-.722	0.0	0.0	0.0
M	196.665	54.418	-26.740	-.598	0.0	0.0	0.0
X	26.825	0.0	0.0	0.0	.721	-1.163	.414
P	-30.139	37.242	0.0	.814	0.0	0.0	0.0
S	-860.325	757.756	26.740	-.131	.721	-1.163	.414

Table 1:
The reduced form matrix

[illegible]

[illegible]

(i) Demand equation

R	GDP	[illegible]	P_W	[illegible]	R^2	DW
(1)	.347 (29)	-.041 (7.)		.873	.922	.150
(2)	.325 (24)		-.30 (161)	-.754	.914	.017

Both demand equations have similar results and the size of coefficients is very stable. The result shows only a marginal contribution of prices on demand.
(2) might be chosen as the "better" equation because of the reasons given in [illegible].

(ii) Import equation

R	D	P_M/P	BD/M	Constant	R^2	DW
(1)	.780 (46)	-.61 (3.)	-.02 (2.)	1.945	.915	1.551
(2)	.401 (32)	-.007 (87)		.913	.570	1.421

This equation reflects best the general reasoning given in 2.[illegible]. Imports are explained by aggregate demand and P_M/P, indicating the reaction of imports to a change of import prices to domestic prices.

(iii) Export equation

X	XR	P_X/P_{WX}	Intercept	R^2	DW
	.291 (41)	-.801 (6z)	.519	.964	2.172

Exports are explained by exchange rate and the small negative influence of variable reflecting terms of trade.

The results show that one main policy variable to influence exports, the exchange rate, has a high explanatory power in this equation. The coefficient suggests that if Chile increases exchange rate by one escudo with respect to the US$, manufacturing exports will increase by about .3 billions of escudos (ceteris paribus).

(iv) Price equation

P	P_M	XR	Intercept	R^2	DW
(1)	1.345 (2)		-20.358	.995	1.756
(2)	.701 (36)	2[illegible].014 (46)	-17.176	.997	1.429

The explanation of prices offers an interesting hypothesis, i.e. that the main influence on prices is coming from the external sector. This means a large portion of the observed inflation of Chile is imported.

This meets "the standard explanation of chronic inflation in Chile"[1]. "An excess demand for good over its domestic supply

1) See Little et al. p. 103.

[illegible] ...ing food imports or falling exports or [illegible] ...in the relative price of food. As to the rise in the relative price of food, this if allowed to occur, tends to rectify the situation by raising the farmer's share in national income and the relative profitability of investment in farming activity. Such improvement, however, in agriculture terms of trade usually creates a lot of inflation in the process, because a rise in food prices usually raises the cost of labour and so carries with it a substantial rise in the entire cost and price structure. Moreover, governments intent on preserving the primacy of manufacturing industry[1] often try to offset the shift in the terms of trade by increasing industrial protection, which will prevent the rise in the relative profitability of agricultural investment but prolong or worsen inflation."

3.2.2. The reduced form

	Const.	GDP	M_t/P	P_M/P	XR	P_X/P_{WX}	P_M
D	-.857	.330	0.0	0.0	-.025	0.0	0.0
M	1.705	.095	-.022	-.01[illegible]	-.007	0.0	0.0
X	.539	0.0	0.0	0.0	.[illegible]71	-.001	0.0
P	-17.196	0.0	0.0	0.0	26.0[illegible]4	0.0	.750
S	-2.023	.245	.022	.012	.273	-.003	0.0

Table 2:

The reduced form matrix.

1) See also Survey p. 155, (1967).

3.3. M E X I C O

3.3.1. Structural equations

(1) Demand equation

D	GDP	P	T	P_W	Intercept	R^2	Dw
(1)	442.441 (13)	-.517			11.600	.999	1.324
(2)	470.355 (16)	-.529 (51)	-.727 (167)		12.377	.995	1.450
(3)	384.507 (14)			-.370 (95)	10.599	.994	1.111

For Mexico three demand equations are offered. The central explanatory variables in all three models are GDP and P (respectively P_W in equation (3)). The preparations for the olympic games 1968 caused a great increase in demand, which also might have had an important influence on the price level.[1)]

The influence of T - which is an important policy variable - on demand is given in demand equation (2), but its coefficient is statistically not significant.

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1) See survey p. 168 f. (1967).

(ii) Import equation:[1]

M	D	MD/M	EXP	Intercept	R^2	DW
(1)	.215 (5)			[illegible]	.988	2.088
(2)	.218 (4)	-.121 (60)		1.427	.989	2.160
(3)	.219 (10)	-.122 (59)	4.284 (98)	2.370	.987	2.386

The dominating variable in this equation is the demand of manufactured goods. The inclusion of some other variables have no substantial increase in the explanation.

The reason for that seems to lie in the general observation, that a large part of demand for manufactured goods is satisfied by imports.[2]

Equation (2) contains also the negative influence of the average duty pressure (MD/M)[3] on imports.

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1) Since export and import price indices of Mexico were not available, we used proxies to deflate imports and exports. For imports we took the unit value index of manufactured exports of developed and developing areas to developing areas (UVIM). For exports the unit value index of manufactured exports of developing areas to developed and developing areas (UVI) was used.

2) See survey p. 172 f. (1967).

3) But see 2.3.

(iii) Export equation:[1)]

X	XW	S	UVI/P_{WX}	Intercept	R^2	DW
(1)	.059 (18)		-.128 (29)	12.401	.871	1.676
(2)		.113 (25)	-.128 (41)	12.447	.789	1.412

Two alternative versions for the export equation were estimated. In both equations a proxy variable for the export price ratio shows the expected negative coefficient, although one has to consider that the ratio is constructed out of global price indices.[1)]

In the second equation value added (S) was used as an indicator of supply possibilities whereas in (1) world trade volume of manufacturing appears as a factor of demand for Mexican exports.

(iv) Price equation:

P	D	P_W	Intercept	R^2	DW
(1)	.664 (6)		67.139	.964	.762
(2)	.135 (06)	1.156 (21)	-22.540	.990	1.991

The price deflator is explained by demand for manufacturing goods and the wholesale price index. Demand as the only explaining variable has a good explanatory power but DW statistics is unsufficient, indicating that more explanatory variables are required.

1) See footnote 1) on page 16.

One would expect a good explanation by export of services because of foreign visitors caused by the close location to the USA and the preparations for the olympic games in the last years of our observation period which induces higher demand for manufacturing goods. The lack of suitable data prevented a test of that hypothesis. The inclusion of the wholesale price index only exhibits the parallel behavior of both indices but contributes little in further explanation.

3.3.2. The reduced form

	Const.	GDP	FXR	MD/M	XW	UVI/P_{WX}
D	-15.634	329.367	0.0	0.0	0.0	0.0
M	-1.063	72.351	4.284	-.122	0.0	0.0
X	12.403	0.0	0.0	0.0	.058	-.127
P	96.953	216.783	0.0	0.0	0.0	0.0
S	-2.166	257.015	-4.284	.122	.058	-.127

Table 1:

The reduced form matrix

APPENDIX

1. Model for Venezuela

We briefly state the results of the estimated equations for Venezuela.

1.1. Demand equation

$$D = \underset{}{11.470} + \underset{(52)}{.600}\ GDP - \underset{(60)}{.266}\ P_M \qquad R^2 = .441,\ DW = 1.451$$

Since the explanatory power of this equation is rather low an alternative approach was undertaken using per capita magnitudes:

$$\frac{D}{POP} = \underset{}{-293.813} + \underset{(20)}{1.699}\ \frac{GDP}{POP} - \underset{(19)}{2.887}\ P_M \qquad R^2 = .803,\ DW = 2.204$$

1.2. Import equation

$$M = \underset{}{-1.266} + \underset{(13)}{.797}\ D + \underset{(54)}{.745}\ FXR \qquad R^2 = .940,\ DW = 1.537$$

This equation was estimated with FXR as a budget constraint, alternatively the following equation shows the marginal influence of a price-ratio variable:

$$M = \underset{}{-.634} + \underset{(10)}{.900}\ D - \underset{(121)}{.006}\ P_M/P \qquad R^2 = .932,\ DW = 1.748$$

1.3. Export equation

$$X = \underset{}{-1.242} + \underset{(28)}{.028}\ XW + \underset{(74)}{.421}\ XR \qquad R^2 = .921,\ DW = 2.168$$

A slightly better explanation can be derived by using only the export-price ratio variable

$$X = \underset{(6)}{12.063} - \underset{}{.106}\ P_X/P_{WX} \qquad \begin{matrix} R^2 = .912 \\ DW = 2.665 \end{matrix}$$

1.4. Price equation

$$P = \underset{}{25.500} + \underset{(27)}{2.402}\ U + \underset{(21)}{.431}\ P_M + \underset{(29)}{.745}\ MD/M + \underset{(39)}{3.165}XR \qquad \begin{matrix} R^2 = .983 \\ DW = 3.47 \end{matrix}$$

1.5. Supply identity

As usual supply is given by

$$S = U + X - M.$$

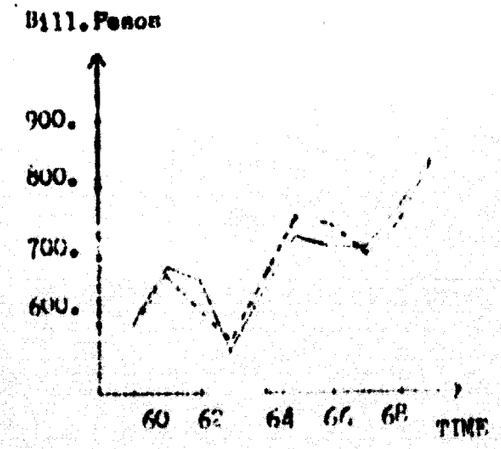
2. List of Variables

S	Value added in manufacturing (domestic supply), constant prices (1963)
D	Domestic demand of manufacturing, constant prices (1963)
X	Manufacturing exports, const. prices
M	Manufacturing imports, const. prices
P	Deflator of manufacturing value added (1963=100)
GDP	Gross domestic product, const. prices
P_W	Wholesale price index
P_M	Deflator of total imports (1963=100)
P_X	Deflator of total exports (1963=100)
P_{WX}	Deflator of world manufacturing exports (1963=100)
FXR	Foreign exchange reserves (deflated by the import price index)
XR	Exchange rate
MD/M	Effective import duty rate
X_W	World trade in manufacturing
T	Taxes on consumption
UVI	Unit value index of manufacturing exports of developing areas to developed and developing areas (1963=100)
UVIM	Unit value index of manufacturing exports of developed and developing areas to developing areas (1963=100)
POP	Population

Prediction-Realization Diagrams

ARGENTINA (1960 - 1969)

DEMAND



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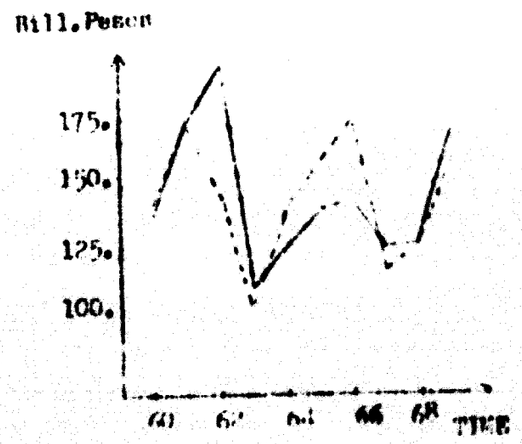

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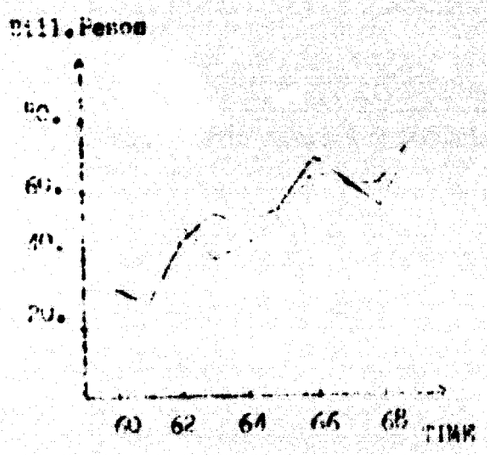

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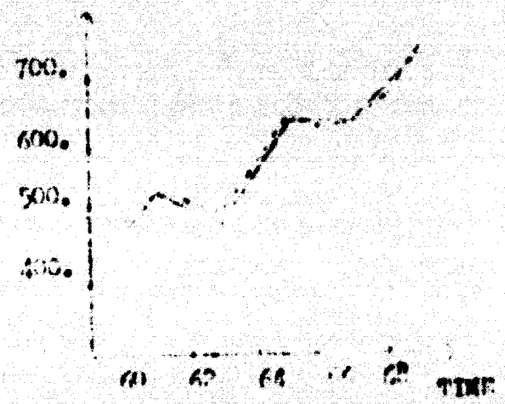

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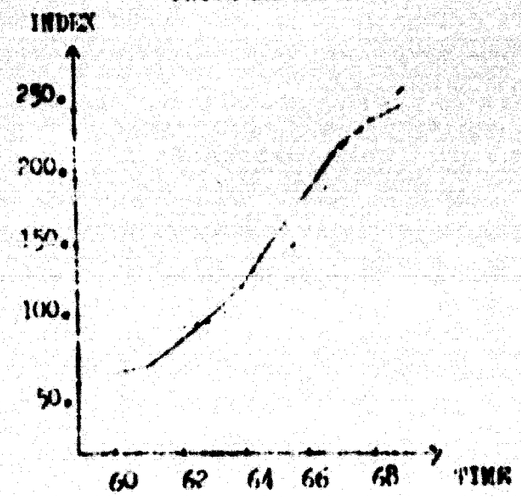
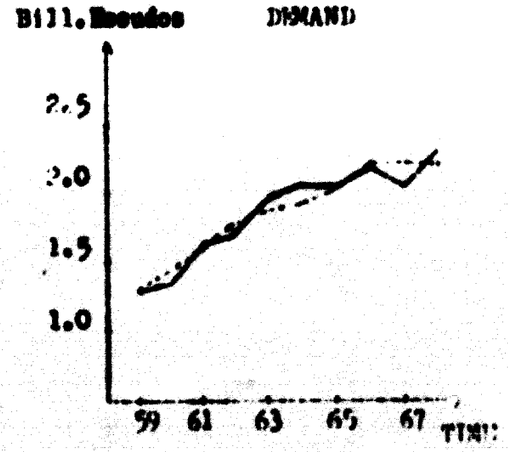


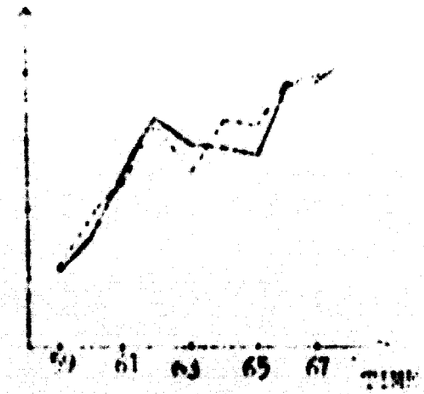
Prediction-Realization Diagrams

CHILE (1959- 1968)

Bill. Escudos DEMAND



Bill. Escudos IMPORTS



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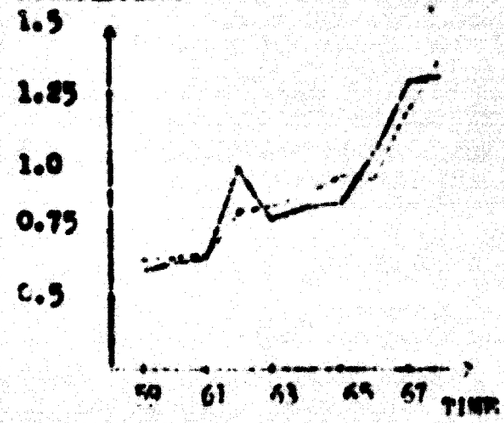
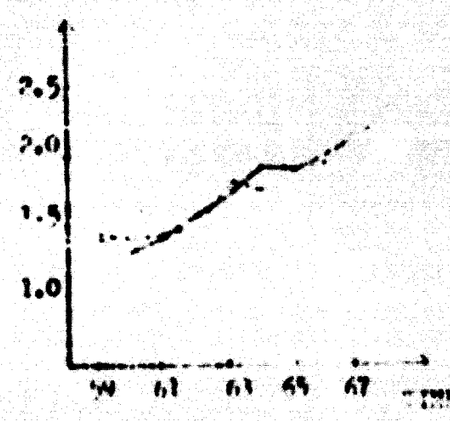


Bill. Escudos SUPPLY



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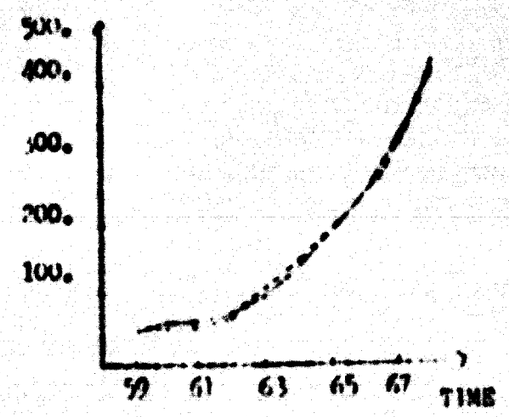
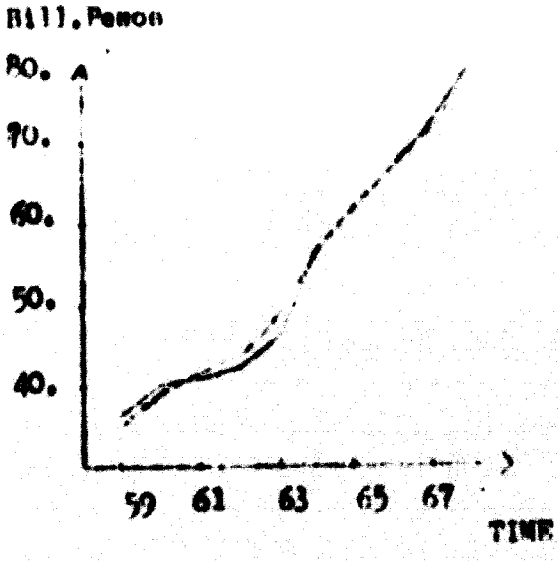


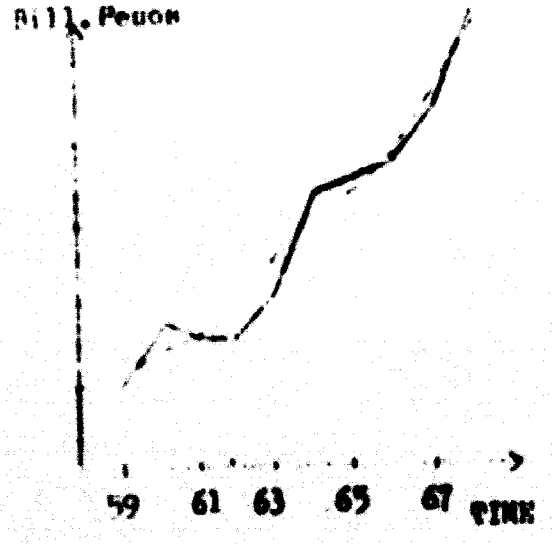
Prediction-Realization Diagrams

MEXICO (1959- 1968)

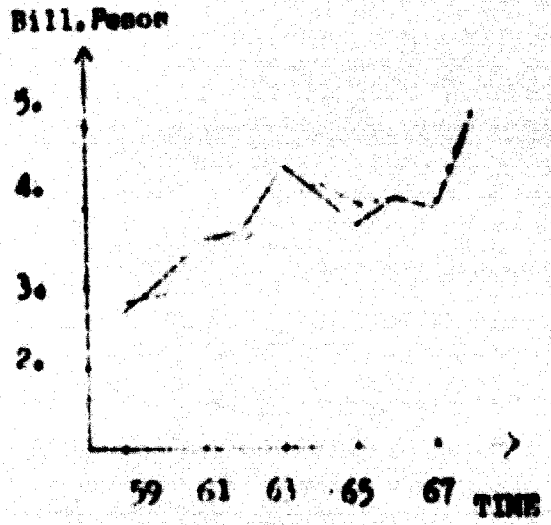
DEMAND



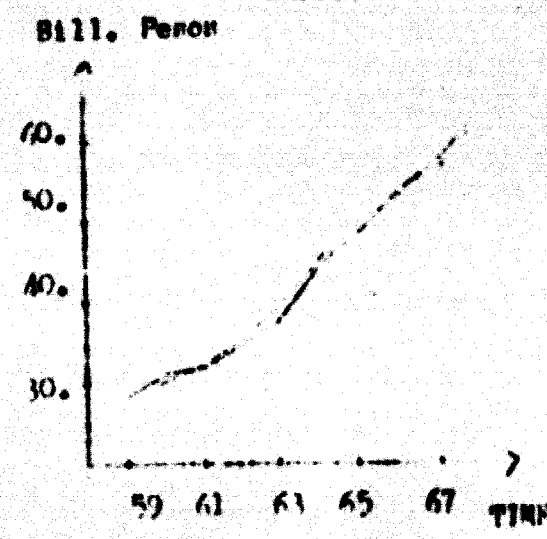
IMPORTS



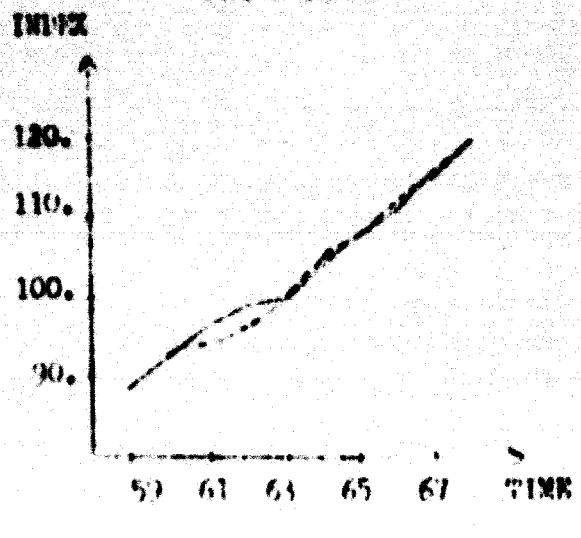
EXPORTS



SUPPLY



PRICE DEFLATION



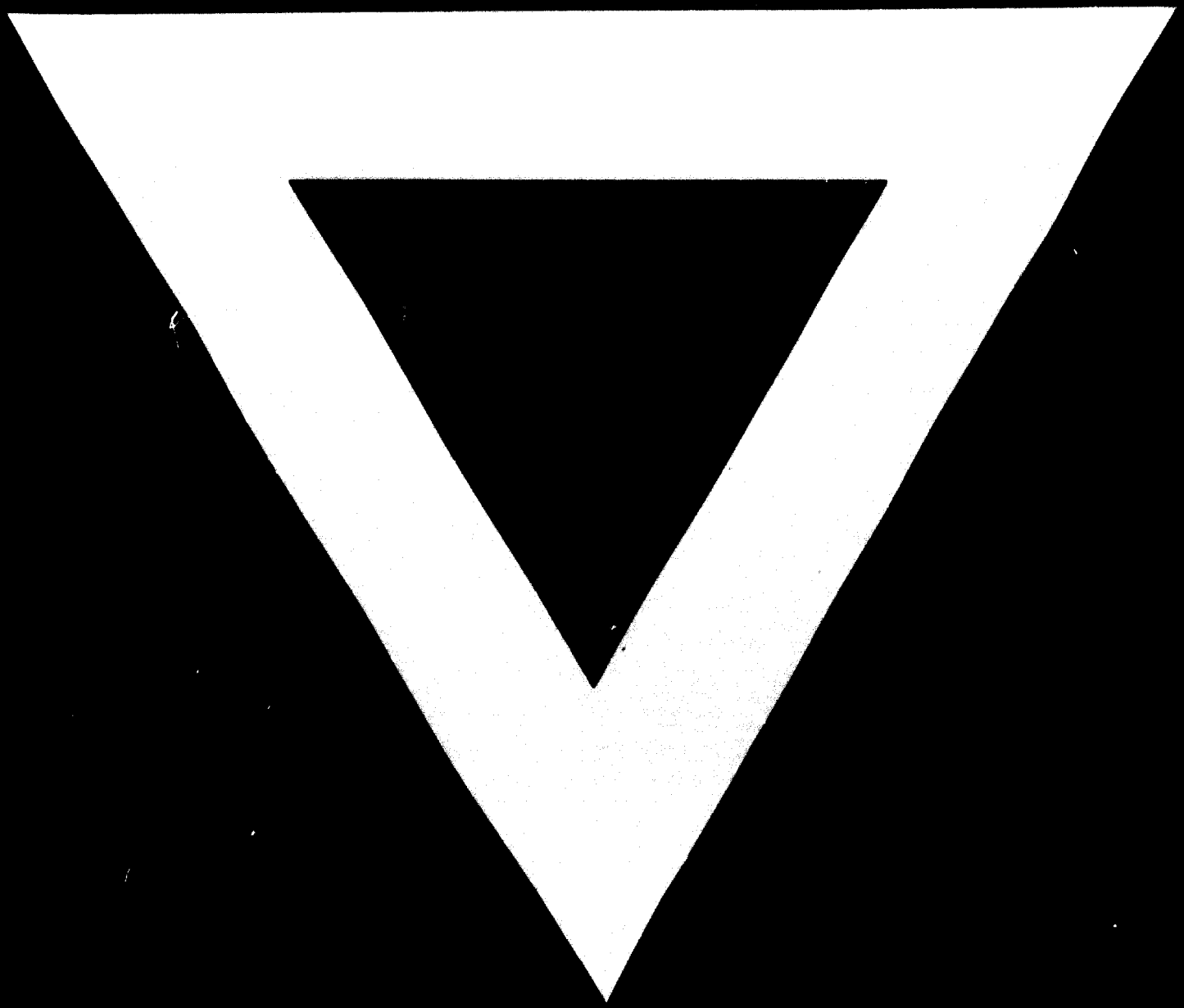
References

1. I. Little, T. Scitovsky, M. Scott,
"Industry and Trade in Some Developing Countries",
OECD 1970.

2. L.R. Klein,
"What Kind of Macroeconometric Model for Developing Economies?"
Econometric Annual of the Indian Economic Journal, Vol.11, No. 3, 1965, pp. 313-324.

3. UN (ECLA), "Economic Survey of Latin America 1967",
New York 1969.

4. B. Boehm, H. Frisch, H. Utrubia,
"A simple prototype macro model for the manufacturing sector of developing countries",
UNIDO 1972.



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