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A PROTOTYPE MACRO-MODEL OF THE MANUFACTURING SECTOR IN DEVELOPING COUNTRIES 1/

by

Helmut Frisch
associated with
B. Böhm and H. Otruba
Institut für Volkswirtschaftslehre
Technische Hochschule Wien
Vienna, Austria

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CONTENTS

A PROTOTYPE MACRO-MODEL OF THE MANUFACTURING SECTOR OF DEVELOPING COUNTRIES

1. GENERAL INTRODUCTION

The main purpose of this paper is to formulate a simple structural model of the manufacturing sector of developing countries. The economics of the model are founded on basic macroeconomic theory.

It is formulated as an interdependent linear equation system, the parameters of each single equation were estimated by ordinary least squares regression. Simultaneous equations estimation methods were not applied, because of the relative disadvantage in their predictive ability (C. Christ "Econometric Models & Methods, 1967, p. 623 f.). The parameters of the equations were estimated using absolute values of the variables, but experiments with first differences and logarithms of the data are also reported in the paper.

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. The availability of data has consequences for the design of the model too.

One of the basic assumptions of least square regression methods is the constancy of the structure to be estimated. This assumption may be violated by the actual situation of the developing countries, not only because of altering policies and changing environmental factors.

The period covered by the available data (1958 - 1968) is rather short to make realistic long term forecasts and the lack of data makes it impossible to employ a more sophisticated theory.

The size and the variables of this prototype model of developing countries reflects the information usually available.

2. THE THEORETICAL MODEL

The econometric model approximates the economy by a system of equations in which the unknown variables are: real income, real demand for manufactured goods, real imports, real exports and the price index of manufactured goods- whose behavior is to be analyzed. These variables are called "endogenous". The given variables of this system are for example the foreign exchange rate, the taxrate, the foreign-price-level etc. These variables are called "exogenous" variables. When anticipatory values of the exogenous variables are inserted in the equations, the system can be solved to forecast the values of the unknown endogenous variables. The model consists of the following 5 equations. The barred variables are exogenous:

$$(1) \quad D = f\,(P, \bar{Y})$$
$$(2) \quad Ex = f\,(\bar{X}^e, \bar{Y}, \bar{B}^f)$$
$$(3) \quad M = f\,(D, \bar{X}^i, \bar{B}^i)$$
$$(4) \quad P = f\,(D, \bar{B}^i, \bar{X}^i)$$
$$(5) \quad S = D + Ex - M$$

According to (1) real aggregate demand for manufactured goods (D) depends on the price-index of manufactured goods (P) and the real gross domestic product ($\bar{Y}$). In equation (2) exports (Ex) depend on GDP ($\bar{Y}$), the (export) exchange rate ($\bar{X}^{e}$) and foreign demand ($\bar{D}^{f}$). The third equation relates imports (M) to aggregate demand (D), the (import) exchange rate ($\bar{X}^{i}$) and import duties ($\bar{D}^{i}$). The price variable (P), the deflator of the value added of the industrial sector, is a function of aggregate demand (D), the (import) exchange rate ($\bar{X}^{i}$) and import duties ($\bar{D}^{i}$). The last equation defines the real net income of the manufacturing sector (S) as the sum of aggregate real expenditure on manufactured goods (D) and the difference of real exports (Ex) to imports (M).

3. THE REDUCED FORM OF THE MODEL

To solve this system of five equations for the endogenous variables as a function of all exogenous variables, we transform the structural equations into the reduced form. Since equations (1) - (5) are linear in variables and parameters, we can use matrix notation:

$By_t + Cx_t = u_t$ (where u_t is a random vector of disturbances) B is a square matrix of coefficients of the endogenous variables (in our case 5 x 5). C is a (5 x k) matrix of coefficients of the exogenous variables, where k is the number of the exogenous variables; y_t is a (5 x 1) vector of the endogenous variables, x_t is a (k x 1) vector of the exogenous variables. Solving this system we have each endogenous variable as a function of all exogenous variables:

$$y_t = -B^{-1} C x_t + B^{-1} u_t$$

In this equation the matrix product $-B^{-1} C$ is called the <u>reduced form matrix.</u>

The elements of the reduced form matrix can be interpreted as multipliers. This means, that a change of z units of a specific exogenous variable induces a change of the related endogenous variable of z times the "multiplier".

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.

4. THE ESTIMATED MODELS

A. THE PHILIPPINES

4.1 The structural equations

4.1.1. The demand equation

Table A 1

Nr.	Version	Y	P	D^i	Mm	D_{-1}	Intercept	R^2	DW
1.1	lin	+0.226 (0.027)	-4.765 (1.954)				-26.870	.981	2.35
1.2	lin	+0.157 (0.006)		-82.953 (29.034)			-32.957	.983	2.11
1.3	log	+1.659 (0.232)	-0.634 (0.298)				- 0.786	.980	2.41
1.4	log			- 0.579 (0.151)	+4.037 (0.484)		+ 6.575	.891	1.70
1.5	dif	+0.082^x (0.045)		-61.422^x (31.325)		-0.432^x (0.333)	-39.920	.747	2.43

The most important explanatory variable is the GDP (Y). Its coefficient is significant in almost each equation. The coefficient in equ. 1.1 implies that an increase of GDP of one million US $ will raise the aggregate demand for manufactured goods by 226.000 US $. The elasticity of demand with respect to GDP using average values for $\bar{Y}$ and D is approximately 1.7. This means that an increase of 1% in GDP will increase demand by 1.7%. This is nearly the same number as the coefficient of Y in equation 1.3.

The second important variable for the explanation of the behaviour of D is the price index of manufactured goods (P). Its coefficient turned out to be significant and has a negative sign, which may be expected according to common economic arguments. An increase of 1% of the prices decreases D by 0.6% (equ. 1.3). In equ. 1.2 and 1.4 we used D^i as a rather crude measure for import substitution policies to test their effects on D. Since there is a significant linear relationship between D^i and P (equ. 2.1, 2.4, 2.6) we did not use both variables as explanatory variables in one equation in order to avoid problems of multicollinearity. As an indicator for industrial demand for manufactured goods we use employement (Em) as explanatory variable in the logarithmic version (equ. 1.4). Equation 1.1 reflects exactly the structure of the theoretical model and was therefore chosen for the reduced form.

4.1.2 The price equation (P)

Table A2

No.	Version	D	D^i_r	ET_r	X^i	X^e	Em	P_{-1}	intercept	R^2	DW
2.1	lin	+0.089 (0.008)	+19.034 (5.330)						+18.629	.936	1.51
2.2	lin	+0.083 (0.005)		+ 1.743 (0.383)		13.746 (2.199)			+ 3.163	.985	2.98
2.3	lin	+0.095 (0.008		+ 1.526 (0.595)	+10.413 (2.910)				+ 5.232	.969	2.37
2.4	log	+0.643 (0.345)	+0.268 (0.062)						- 4.241	.956	1.71
2.5	log	+0.327 (0.095)		+ 0.149 (0.086)			1.315 (0.408)		+ 2.732	.954	1.51
2.6	dif	+0.068 (0.050)	+10.196x (5.098)					-1.193x (0.113)	- 1.515	.409	2.95

The most important explanatory variable is the level of demand. An increase of D by 1 Million US $, is supposed to create excess demand in the short run which will raise P by o.o9 index points (equ. 2.1 - 2.3). Im terms of elasticities this means that a o.6% increase in P is the consequence of a 1% increase in D (of equ. 2.4). The rather low elasticity of demand as reported in equ. 2.5 may be due to the inclusion of employment, which exerts a strong influence on the prices but is multicollinear with demand (equ. 1.4). To catch the impact of the government policies to affect industrialization we included the main policy variables. In the price equation we can see the direct and indirect effects of these governmental activities. So excise taxes, import duties and foreign exchange rate controls are all positively correlated to the price index. Therefore a rise in the tax or duty rate as well as a devaluation of the peso hasa rise of the price level as its consequence.

The partial elasticity of the manufacturing price level with respect to the exchange rates calculated at the average of the sample is:

$$\frac{\partial P}{\partial X^i} \cdot \frac{X^i}{P} = + 0.208 \text{ for } X^i \text{ for imports}$$

and

$$\frac{\partial P}{\partial X^e} \cdot \frac{X^e}{P} = + 0.247 \text{ for } X^e$$

There is only little difference between these two elasticities, especially if you regard the confidence intervals, they are overlapping each other.

These values indicate that a devaluation of the peso by 1% raises the manufacturing price level by o.2%.

Excise tax rate and import duty rate were used to represent the pressure of the tax and tariff system on prices. They add significantly to the explanation. The elasticity of prices to the import-duty-rate is +0.26, to the excise tax rate 0.12.

The overall influence of these policies will become more obvious considering the reduced form coefficients in 4.2 below.

4.1.3 The import equation (M)

Table A 3

No.	Version	D	X^i	D_x^i	$P/X^i.P^2$	intercept	R^2	DW
3.1	lin	+0.264 (0.018)		-32.617 (13.373)		+20.373	.960	1.920
3.2	lin	+0.282 (0.011)	-30.178 (5.734)			+25.982	.984	1.690
3.3	lin	+0.315 (0.016)	-40.174 (5.624)		+63.991 (24.956)	-14.012	.991	1.602
3.4	log	+1.242 (0.050)	-0.429 (0.069)			- 2.734	.983	1.988
3.5	log	+1.123 (0.090)		- 0.343 (0.123)		- 2.149	.953	2.423
3.6	dif	+0.370 (0.096)	-30.140 (11.152)			- 4.154	.882	2.364
3.7	dif	+0.381 (0.072)	-34.080 (8.861)		+64.700 (27.174)	- 3.526	.939	2.927

In this equation the demand for manufactured goods is the predominating explanatory variable again. The marginal propensity to import industrial goods is about +0.28 (equ.3.2) and the elasticity of imports with respect to demand is about +1.2 (equ. 3.5).

The two major policy instruments to control industrial imports in the Philippines have been the exchange rate (X^i) and the import duty rate (D^i). Both variables are included in the estimated equations. For the exchange rate we used the import rate deflated by the wholesale price index for imported goods. Although we could not include the whole information about multiple exchange rates and the various policy actions regarding exchange control, our adopted measure for this situations seems to show very significant and commonly expected results. A devaluation by 1% will decrease real imports by 0.4% or in terms of absolute values (equ. 3.1 - 3.3) a rise of the exchange rate by one peso has the effect of restricting imports by nearly 30 million US $, cet. par.

The import duty rate also has expected negative effect on imports.

We also tried a variable representing the terms of trade. It has a positive coefficient and adds significantly to the explanation of the dependent variable. But since the terms of trade variable is nonlinear constructed we could not use equ. 3.3 in the reduced form of the model.

4.1.4 The export equation

Table A 4

o.	Version	S	X^e	P^{ex}	dum	EX_{-1}	intercept	R^2	DW
.1	lin	+0.074 (0.018)	+8.533 (7.508)				-14.918	.781	1.08
.2	lin	+0.079 (0.006)			+14.314 (2.147)		- 1.189	.960	3.41
.3	lin	+0.136 (0.012)		-1.590 (0.159)		+0.658 (0.079)	+86.345	.986	2.63
.4	log	+0.888 (0.240)	+0.375 (0.286)				- 2.067	.832	1.10
.5	dif.	+0.193 (0.081)	+8.123 (6.498)			-0.321 (0.161)	- 5.560	.571	1.61

To explain exports of manufactured goods we used the supply of manufactured goods (S) as the basic explanatory variable.

Since the protective policies always have substantial influences on exports it was rather difficult to estimate a realistic export function.

Using the export exchange rate X^c as explanatory variable we had results, which were not very satisfactory although the coefficients were positive. To explain the difficult situation between 1963 and 1969 when there were frequent changes of the exchange rates as well as other policy actions we tried a dummy variable with value 1 in these years and o elsewhere, which improved the statistical qualities of the estimates substantially.

To investigate the effect of prices, we used the unit value index of exports of developing areas of manufactured goods (P^{ex}). The coefficient turned out to be very significant with an expected negative sign. If the export-price level decreases by 1 index point, exports will increase by 1.6 million US $ (equ. 4.3).

Finally the lagged export variable was included to show the time reaction of the adjustment behavior (4.5).

4.2 The reduced form of the model

To solve the system of five equations for the endogenous variables as functions of all exogenous variables, we transform the system of structural equations into the reduced form.

For the actual procedure we selected the demand equation no. 1.1, the price equation no. 2.5, the import equation no. 3.2 and the export equation no. 4.5. To these behavioural equations we added the definition of supply:

$$S = D + Ex - M$$

A block diagram of the causal structure of the model of the manufacturing sector of the Philippines is presented in fig. A 1.

Using our estimates of the coefficients of the parameters of the structural equations we get for the endogenous matrix B:

Table A 5

The endogenous matrix B

D	P	M	Ex	S	
1.o	4.765	o.o	o.o	o.o	D
-.95	1.o	o.o	o.o	o.o	P
-.282	o.o	1.o	o.o	o.o	M
o.o	o.o	o.o	1.o	-.136	Ex
-1.o	o.o	1.o	-1.o	1.o	S

and for exogenous matrix C:

Table A 6

The exogenous matrix C

const.	Y_x	ET rate	X^i	P^{ex}	EX_{-1}
26.87o	-.226	o.o	o.o	o.o	o.o
- 5.232	o.o	- 1.526	- 10.415	o.o	o.o
-25.982	o.o	o.o	+ 30.178	o.o	o.o
-86.345	o.o	o.o	o.o	+ 1.59o	-.658
o.o	o.o	o.o	o.o	o.o	o.o

After inversion of B and multiplication by C we get the reduced form matrix $-B^{-1}C$:

Table A 7

The reduced form matrix

	const.	Y	ETrat.	X^i	p^{ex}	EX_{-1}
D	-35.658	.156	-5.005	-34.156	0.0	0.0
P	1.844	.015	1.050	7.168	0.0	0.0
M	15.926	.044	-1.411	-39.810	0.0	0.0
Ex	91.816	.018	-.565	.889	-1.840	.761
X	40.231	.129	-4.159	6.543	-1.840	.761

All coefficients of the reduced form matrix have the expected signs. Their magnitude as compared with those of the structural parameters show additional information with regard to the interdependencies of the endogenous variables in the structural form.

4.5 Forecasts of the endogenous variables

To get an impression of the predictive performance of this model we computed the estimates of the endogenous variables from the reduced form, for the period under observation. These estimates are presented in figs. A 2 - A 6.

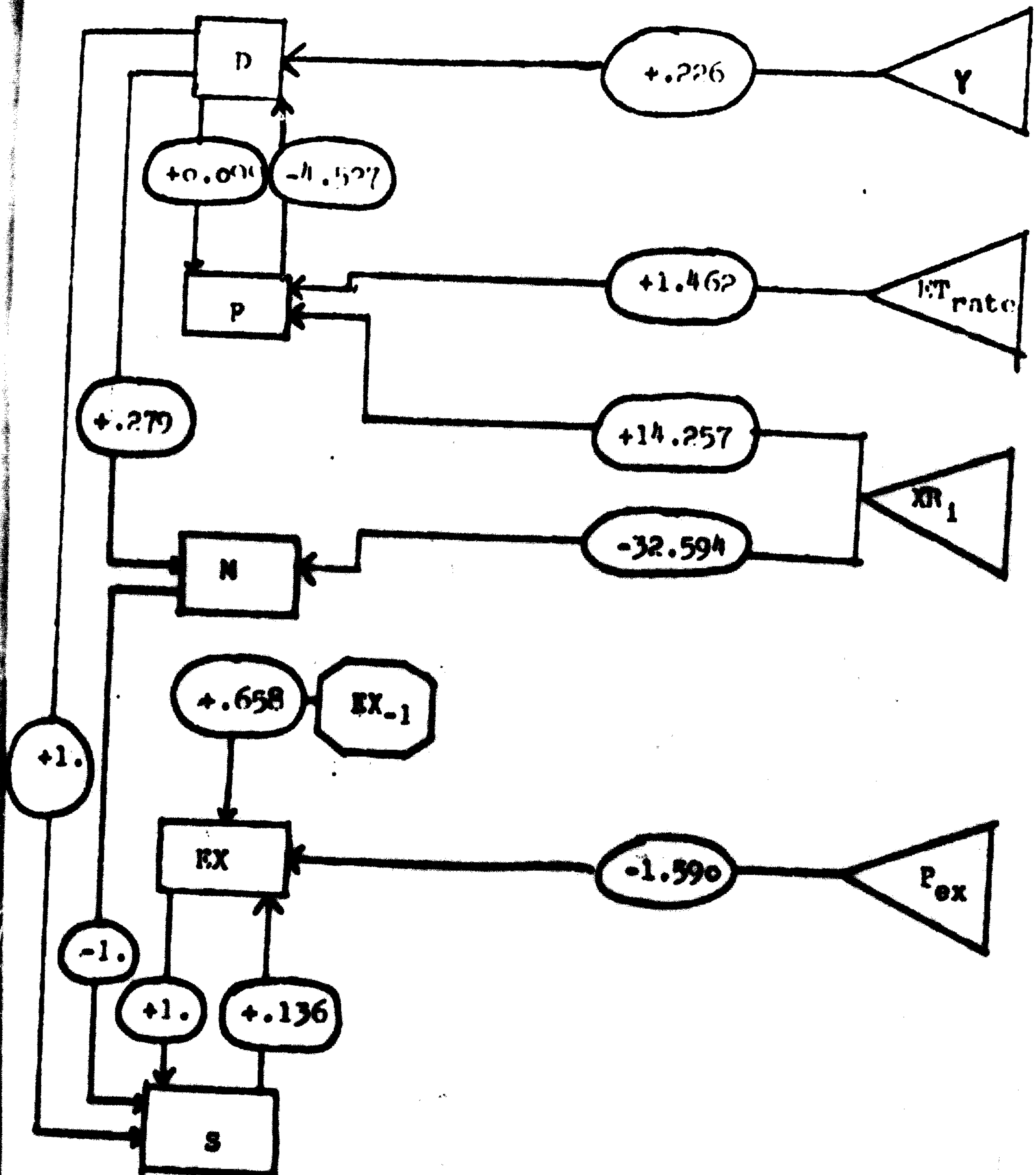


Fig. A1

Block diagram of the structural equations used in the reduced form of the model

= endogenous variables

= lagges endogenous variables

= exogenous variables

+.13 = value of the coefficient

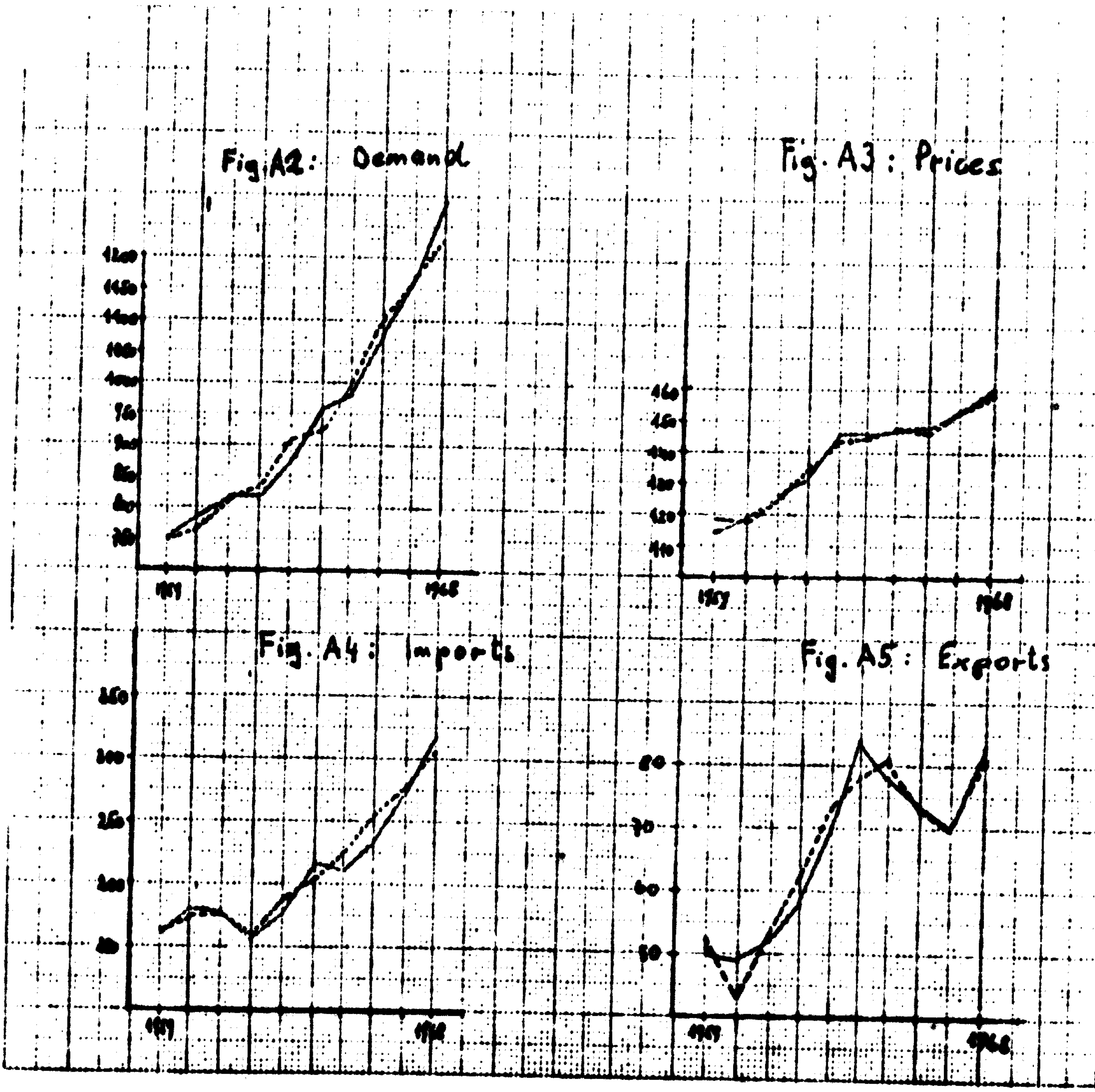
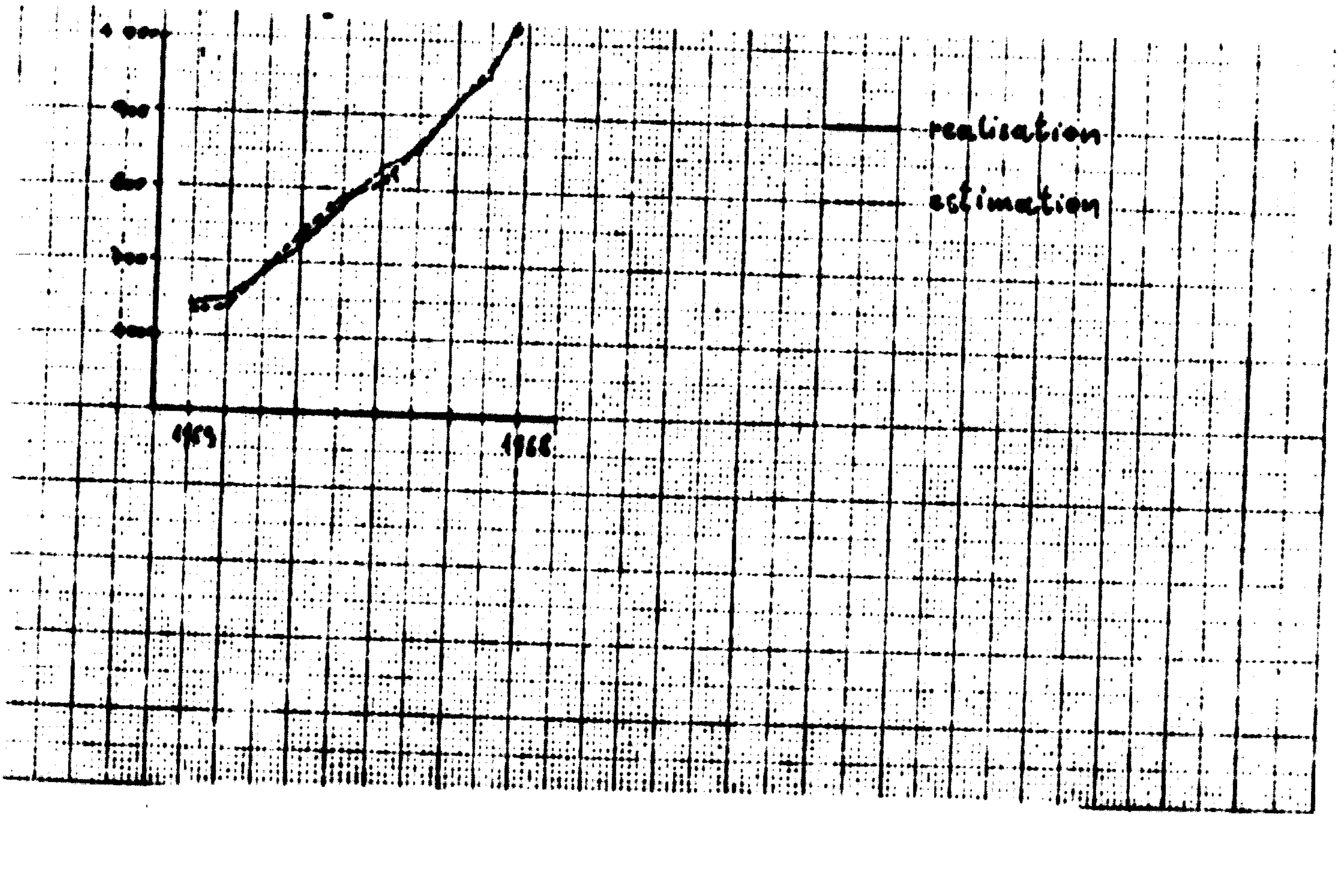


Fig. A2: Demand
Fig. A3: Prices
Fig. A4: Imports
Fig. A5: Exports
80
70
60
50

Fig. A6: Supply



B. BRAZIL

5.1 The structural equations

5.1.1 The demand equation

Table B1

No.	Version	Y	Em	Tr	P	P/P^y	intercept	R^2	DW
1.1	lin.		2 353.813 (816.934)	233.087 (67.105)	-1.425 (0.958)		-1 566.195 (206.673)	.934	2.026
1.2	lin		3 103.441 (504.809)			-200.795 (46.859)	-1 692.398 (220.906)	.912	2.058
1.3	dif		1 544.984 (639.748)			- 70.743 (63.449)	144.682 (242.152)	.581	1.802
1.4	log		0.933 (0.186)	0.298 (0.058)	-0.059 (0.026)		3.253 (0.012)	.971	2.418
1.5	log	1.261 (0.261)			-0.037 (0.028)		1.983 (0.016)	.942	2.012

From the 5 versions of the demand equation, we used no. 1.1 for the reduced form model, real demand is a function of employment (Em), time trend (Tr) and the price index of manufactured goods (P).

An increase of employment of one worker will rise aggregate demand by 2.350 US $ p.a., the autonomous increase in demand per year is 255 million US $; a rise of prices of manufactured goods by one index point will reduce real demand by 1,4 million US $. Using the data of 1968 a 10% increase of the price index would reduce real demand by 2%. All coefficients (except the price coefficient) are statistically significant.

Employment is the dominating explanatory variable; it is significant in all 4 versions of the equation. Introducing employment and time-trend together in equation 1.4 shows that an increase of employment by 1% will increase demand by o.953%. The two elasticities, employment (o.953%) and time-trend (o.298) in equation no. 4, together, are approximately equal to the elasticity of demandwith respect to GDP (1.26%) in equation no. 1.5. This elasticity shows the growing share of industrial production of the GDP.

The price coefficients have - according to the argument of economic theory - the expected negative signs but they are all not very significant.

In version 1.2 and 1.3 instead of P an index of relative prices (the ratio of industrial price to GDP deflator) was used. The coefficient is significant in the linear version; it supports the hypothesis that faster rising prices of manufactured goods decrease real demand for them. It should be mentioned that we did not find statistically significant effects on aggregated demand for industrial goods of various variables representing public expenditure.

5.1.2 The price equation

The development of industrial prices in Brazil shows a very irregular pattern. From 1960 - 1962 price rose at an annual rate between 16% - 47% from 1962 - 1966 at an annual rate of 63% - 90% and from 1966 to 1968 at a rate that declined from 40% to 30%.

For an accurate approximation of the very high speed of inflation in 1962 - 1966 the use of a dummy variable, representing the changes in policies after President Kubitschek left office 1960, was necessary. Nevertheless fitting a linear function remained troublesome and lead to an underestimation of price development in the early and late 1960's.

Table B2

No.	Version	D	X^{i^x}	M	dum	intercept	R^2	DW
2.1	lin	0.228 (0.059)	0.058 (0.025)		-175.518 (45.678)	-896.871 (61.492)	.972	1.786
2.2	log	1.655 (1.177)	0.990 (0.521)		- 0.852 (0.249)	- 7.031 (0.109)	.975	1.810
2.3	log	8.578 (1.489)		-1.710 (0.964)		- 24.967 (0.265)	.828	0.841

The price level is considered to be a function of real demand (D) and the import exchange rate (X^{i^x}, including discrimination) (equ. 2.1). An increase of demand by 1 million US $ will in the short run increase the price level by 0.228 index points. Using the data of 1968 a 10% increase of demand increases the price level by approximately 18%. In terms of elasticities (equ. 2.2) the results are: A 1% increase in demand will raise the price index by 1.65%. During the period of investigation the import exchange rate was one of the most important instruments of the government to control imports. A devaluation of the Cruzeiro has a positive influence on the price level. According to equation 2.2 a devaluation of 1% will increase industrial prices by approximately 1%. Although the fit of the equation is very good (R^2 = .975) each single coefficient is not statistically significant.

5.1.3 The import equation

Table D 3

No.	Version	D	X^{i^x}	dum	intercept	R^2	DW
3.1	lin	0.184 (0.036)	-0.066 (0.014)	-99.656 (27.820)	-311.410 (37.412)	.834	1.499
3.2	dif	0.201 (0.058)	-0.039 (0.031)	-77.408 (37.857)	- 18.898 (44.770)	.735	1.985
3.3	log	2.657 (0.570)	-0.347 (0.048)	- 0.202 (0.079)	- 6.065 (0.034)	.911	2.004

Imports are explained by aggregate demand (D), and the foreign exchange rate for imports, including discrimination by tariffs and import taxes (X^{i^x}). For the same reason as in the price equation a dummy-variable is introduced. The coefficient of D in equ. 3.1 is the marginal propensity to import, its value is 0.184. If demand rises by one million US $, imports will rise by 0.184 millions US $; the import elasticity dM/dD.D/M is very high, a 1% increase in demand will increase imports by 2.26%. The regime of import substitution, which was the main idea of the Brazilian economic policy until 1968 led to a system of discrimination against imports based on taxes, tariffs and the control of the foreign exchange rate. These three components are expressed by the variable X^{i^x}. A devaluation of the exchange rate by 10 Cruzeiros will decrease imports by 0.66 mill. US $; in terms of elasticities: a 1% devaluation of the Cruzeira will decrease imports by 0.347%. As can be seen from tablo B 3, this version of the import equation gives also an appropriate explanation of first absolute differences of the variables.

5.1.4 The export equation

Table B 4

No.	Version	X^e	D^f	EX_{-1}	dum	intercept	R^2	DW
4.1	lin	o.o17 (o.oo1)		-o.3o9 (o.126)	-1o.525 (1,727)	86.191 (2.313)	.99o	3.o41
4.2	lin	o.o15 (o.oo1)				61.946 (5.2o8)	.936	2.52o
4.3	lin		o.2o1 (o.o34)			-37.567 (8.772)	.817	2.7o2
4.4	dif	o.o15 (o.oo5)		-o.348 (o.161)	-12.827 (3.256)	o.868 (4.129)	.9o5	2.811
4.5	log	o.149 (o.o15)			- o.o92 (o.o16)	1.5o2 (o.o2[illegible])	.955	2.oo7

The export equation contains only exogenous variables as explanatory ones; it is a reduced form equation. Exports are explained by the foreign exchange rate for exports (X^e), the foreign demand (D^f) and the exports lagged by one period (EX_{t-1}). According to the linear version (equation 4.1) which is used for the reduced form real exports would increase by o,17o mill. US $ as a consequence of a devaluation of 1o Cruzeiros, in terms of elasticities this means (equation 4.5) a 1% devaluation will increase exports by o.149%. The autoregressiv scheme explains exports of period t, by exports of period t-1. The negative coefficient expresses the policy of import-substitution. According to this concept the government tried to restrain exports, a high level of exports of year t, would cause government actions to curb this development and to decrease exports in poriod t + 1.

5.2 The reduced form of the model

As in the model for the Philippines we transform the structural equations in the reduced form. We use demand equation no. 1.1, the price equation no. 2.1, the import equation no. 3.1, the export equation no. 4.1, and the definition: S = D + E - M. Table 5 shows the matrix of coefficients of endogenous variables: The logical structure of the model is presented in fig. B 1.

Table B 5

	D	P	M	EX	S
D	1	1.425	o	o	o
P	-o.228	1	o	o	o
M	-o.184	o	1	o	o
EX	o	o	o	1	o
S	-1	o	+1	-1	+1

For the exogenous matrix C we get:

Table B 6

	Abs.term.	E	trend	X^{i}	X^{e}	EX_{-1}	dum
D	1 566.195	-2 353.813	-233.087	o	o	o	o
P	896.871	o	o	-o.o58	o	o	+175.518
M	311.41o	o	o	o.o66	o	o	+ 99.856
EX	-86.191	o	o	o	-o.o17	o.3o9	+ 1o.525
S	o	o	o	o	o	o	o

The reduced form matrix $-B^{-1}C$ is shown in table B 7:

Table B 7

	X^{i^x}	X^e	Tr	Em	EX_{-1}	dum	const.
D	-0.062	0	+175,9	+1.776.6	0	188,8	-217.5
P	0.0435	0	+ 40.1	+ 405.0	0	-132.5	-946,5
M	-0.0776	0	+ 32,3	+ 326.2	0	- 65,2	-351.3
EX	0	0.16	0	0	-0.310	- 10.5	86,2
S	0.0156	0.0166	+143.6	+1 450.4	-0,309	243.5	220.6

Alc already mentioned the coefficients of the reduced form are multipliers; i.e. they express the end effect of a change of an exogenous variable on the endogenous variables, after simultaneous reaction of the system. These multipliers together with anticipatory values of the exogenous vaiiables are used for the forecast of the endogenous variables. In the model there are five exogenous variables: three policy variables (instruments), two foreign exchange rates (X^{i^x}, X^e) and a measure of discrimination, included in the exchange rate for imports; two data variables: the time trend (Tr), employment in the manufacturing sector (Em) and one predetermined variable, the lagged exports (EX_{t-1}).

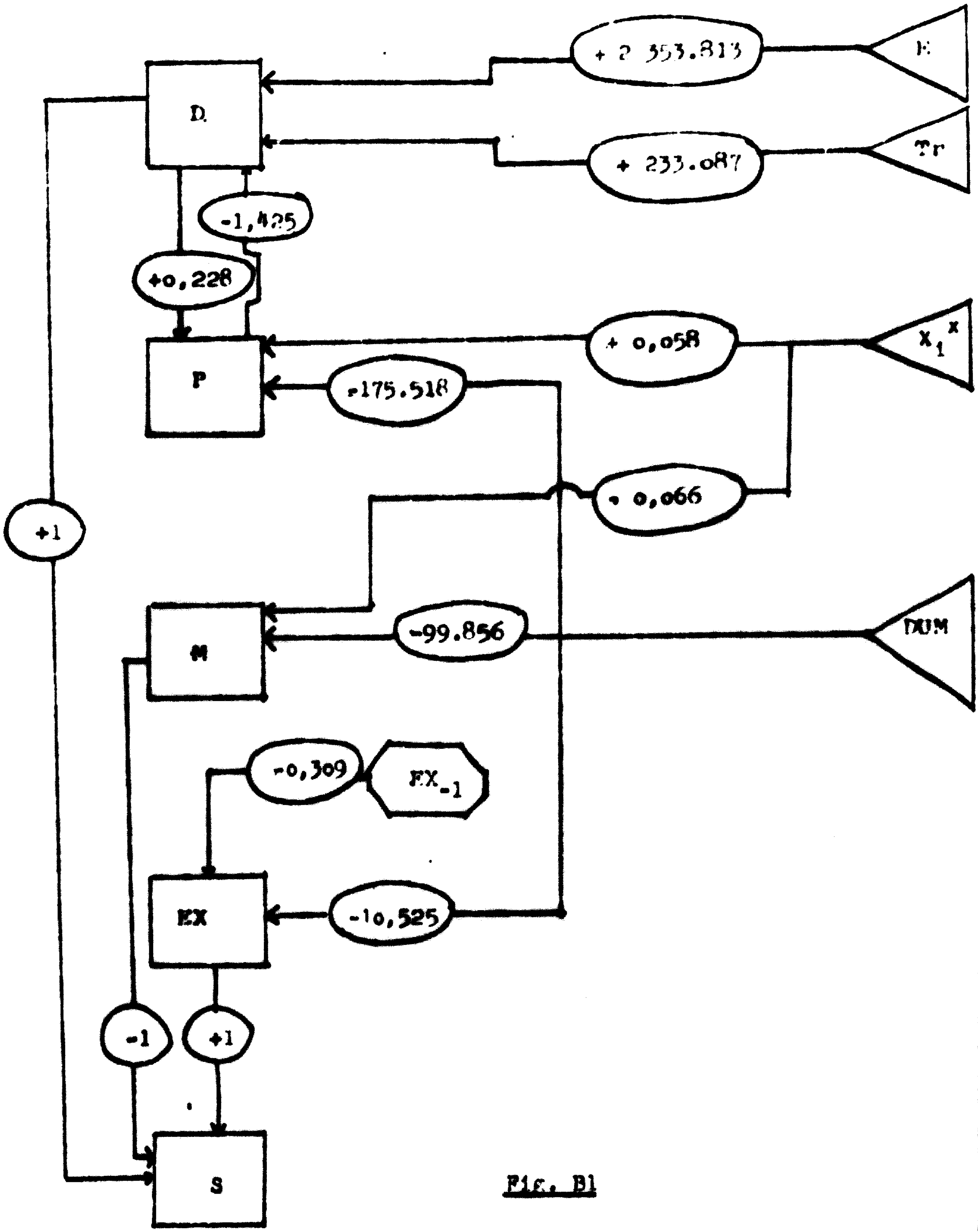
Consider the demand equation: demand is a function of the import exchange rate (-0.062), the autonomous addition to demand, "timetrend", (175 9) and employment (1 776.6) and a dummy variable (188.8). Comparing these figures we find that these coefficients are smaller than in the structural demand equation, where f.i. the coefficient of employment is 2 353.8 and the coefficient of autonomous addition to demand is 233.09. The coefficients of the structural equation overestimate the effect of a change of Em or Tr; the simultaneous working of the model will produce some compensating forces, which are represented in the reduced form coefficients.

We recognize that the import exchange rate, employment and time trend are the dominating exogenous variables, which determine the endogenous. The signs of the coefficients are expected by a priori reasoning: A devaluation (X^{i^x}) will reduce demand, increase the price level, reduce imports and stimulate the total supply, the export exchange rate (X^e) only influences exports and supply positively; the column (Tr) measures the influence of time on the endogenous variables, these are autonomous developments (addition to demand, addition to import, addition to supply, autonomous trend of the price level).

The coefficients of the Em column are all positive while the lagged export has a delaying influence on exports and total supply. The dummy variable measures the effects of the crisis after President Kubitschek left office.

5.3 Forecasts of the endogenous variables

Having set up the reduced form of the model, we are now able to calculate predictions of the endogenous variables, using the known values of the exogenous variables, to test the predictive performance of the reduced form of the model. Therefore we calculated estimates of the endogenous variables for the whole period under investigation. The results are presented below in figs. no. B 2-6.



D.
P
M
EX
S
E
Tr
X_1^x
DUM
EX_{-1}
+ 2 353.813
+ 233.087
-1,425
+0,228
+ 0,058
-175.518
+ 0,066
-99.856
-0,309
-10,525
+1
-1
+1

Fig. B1

Fig. B2 : Demand

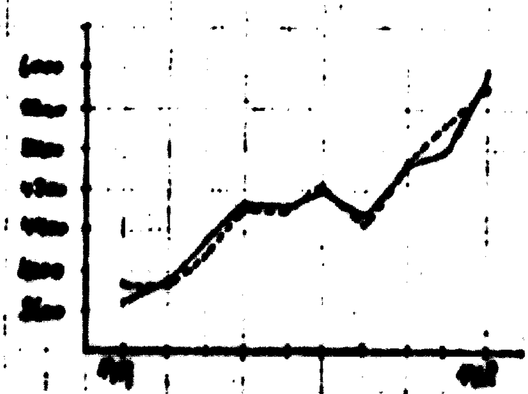


Fig. B3 : Prices

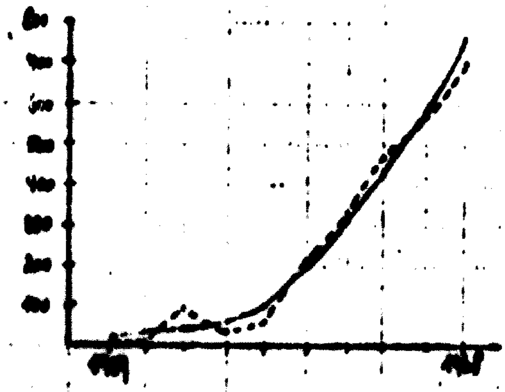


Fig. B4 : Imports

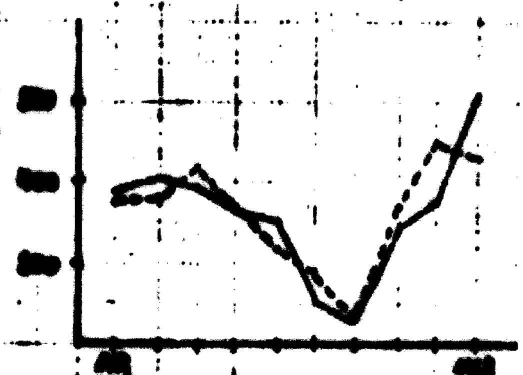


Fig. B5 : Exports

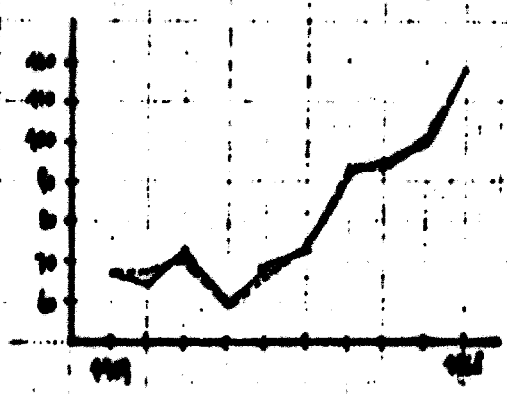
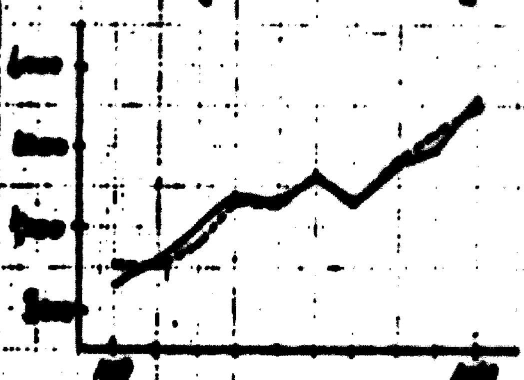


Fig. B6 : Supply



realization

estimation

APPENDIX A:

A MODEL FOR THE MANUFACTURING SECTOR OF THE COLOMBIAN ECONOMY

As an example for the applicability of the theoretical model of the industrial sector of an economy we briefly state the results of estimations for Colombia:

1. The structural form:

1.1 Demand (D)

Again demand is seen as a function of GDP at factor costs but hevy influence of the government can also be recognized. Subsidies have a significantly positive coefficient and taxes on households or corporations have negative coefficients (both are measured in units of pesos).

(1) $$D = -343.726 + \underset{(8)}{.325}\, Y + \underset{(31)}{.310}\, Sub - \underset{(22)}{75.676}\, T^{h}$$

$R^2 = .994$ DW = 1.670

(2) $$D = -438.179 + \underset{(11)}{.356}\, Y + \underset{(27)}{.389}\, Sub - \underset{(26)}{158.110}\, T^{c}$$

$R^2 = .992$ DW = 2.070

1.2 Price index (P)

Here the same approach as in the model for the Philippines has been adopted and shows the expected results.

$$P = -122.473 + \underset{(17)}{.245}\, D + \underset{(14)}{3.080}\, X^{i} + \underset{(69)}{25.482}\, D^{i}_{r}$$
(51)

$R^2 = .986$ DW = 1.077

1.3 Imports (M)

The basic variable again is demand. Also the exchange rate for imports is including as before. Additionally we show the influence of the foreign exchange reserves on the imports of manufactured goods.

$$(1)\quad M = -70.494 + \underset{(22)}{.289}\ D - \underset{(30)}{6.650}\ X^{i} + \underset{(67)}{.195}\ FX_{Res}$$

$$R^2 = .776 \qquad DW = 2.713$$

Instead of the exchange rate one could also use the rate for import duties.

$$(2)\quad M = 25.798 + \underset{(13)}{.171}\ D - \underset{(16)}{.804}\ D_r^{i}$$

$$R^2 = .882 \qquad DW = 2.592$$

1.4 Exports (EX)

In this equation the only significant variable turned out to be the exchange rate for exports with the right sign and a high degree of explanation.

$$EX = 2.963 + 1.241\ X^{e} \qquad R^2 = .896 \qquad DW = 1.595$$

1.5 Supply (S)

This is again defined by the definition

$$S = D + EX - M$$

Remark: The numbers reported in parenthesis below the estimated parameters give the standard deviation of the coefficient as a percentage of its value.

2. The reduced form

Equations: D (1), P, M(1) and EX together with the definition for S yield the following reduced form:

	const.	sub.	T^h	X^i	D^i_r	FX_{Res}	X^e	Y
D	-343.727	.310	-75.767	0.0	0.0	0.0	0.0	.325
P	-206.999	.076	-18.631	3.080	25.482	0.0	0.0	.079
M	-169.981	.089	-21.929	-8.850	0.0	.195	0.0	.094
EX	2.963	0.0	0.0	0.0	0.0	0.0	1.241	0.0
S	-170.782	.220	-53.837	8.850	0.0	-1.95	1.241	.231

3. As a test for the forecasting ability we give the ex post prognosis for the year 1968

variable	estimated	observed	difference
D	1 272.664	1 273.270	- .605
P	269.200	271.000	- 1.799
M	181.705	193.110	- 11.404
EX	23.910	26.840	- 2.920
S	1 114.878	1 107.000	+ 7.878

APPENDIX B

LIST OF VARIABLES

D ... real domestic demand for manufactured goods
D^f ... real foreign demand for manufactured goods
D^i ... import duties levied on manufactured goods
D^i_r ... rate of import duties levied on manufactured goods
Em ... employment in the manufacturing sector
ET_r ... excise tax rate
Ex ... real exports of manufactured goods
FX_{Res} ... foreign exchange reserves
M ... real imports of manufactured goods
P ... price index of manufactured goods (implicit deflator of value added in the manufacturing sector)
P^{ex} ... export price index of developing countries
P^w ... whole-sale-price index
P^y ... GDP deflator
S ... supply of manufactured goods (real income of the manufacturing sector)
sub ... subsidies
T^h ... taxes on households
T^c ... taxes on consumption
Tr ... time trend
X^e ... foreign exchange rate for exports
X^i ... foreign exchange rates for imports
X^{i*} ... foreign exchange rate for imports including discrimination with tariffs and taxes
dum ... dummy variable

Use of tables A 1 - A 4, B 1 - B 4:

lin denotes that the regression was calculated with absolute values of the variables

log denotes that the regression was calculated with logarithms of the variables

dif denotes that the regression was calculated with first differences of the variables

starred coefficients indicate, that absolute values and not differences of the variable were used.

The numbers in brackets under the coefficients are their standard deviations. We consider a coefficient statistically significant, if it is greater than two times its standard deviation.

R^2 is a measure of the goodness of fit

DW Durbin Watson d-statistics: provides a test of autocorrelation of the residuals.

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