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AN ECONOMETRIC MODEL FOR THE ECONOMY OF SRI LANKA CONSTRUCTION AND FORECASTING ANALYSIS

by

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1. Introduction

Several attempts have been made to use statistical methods in explaining the behaviour of the Economy of Sri Lanka but only a few are based on statistical model building. In 1964, for the first time a United Nations group of experts was appointed by the Economic Commission for Asia and Far East (ECAFE, now it is known as ESCAP) to prepare a report on future economic, conditions for selected countries in the ECAFE region.

They have formulated Econometric Models for China (Thaiwan), India, Indonesia, The Republic of Korea, Malaysia, Pakistan, Philippines and Sri Lanka. The models are in two forms : ECAFE Model I and Model II which are basically the same except for one structural equation.

In estimating the Econometric models formulated for Sri Lanka, they have used the data available for period from 1950 to 1960, and have made forecasts upto 1980 using the model. The report was published in 1964 and thereafter to our knowledge no such report has been published.

The main weakness in the ECAFE model lie in the structural equations which are excessively linear to explain the complex economic pheromena. The purpose of this study is to make another attempt to model the Economy of Sri Lanka giving careful attention to the structural problems associated with the economic activities.

2. Structure of the Model :

The present model attempts to describe the functioning of the Sri Lankan Economy from 1963 to 1977 in terms of seven structural equations and an identity. These equations express relationships between observed variables and are linear both in variables and in parameters.

The number of variables employed by the model is twenty three, of which eight are endogeneus (ie, variables determined by the system). Thus the system is complete(we have as many endogenous variables as there are equations in the system). The remaining fifteen variables incorporate factors which we describe as exogenous.

With the view of making the model simple, we neglect some relationships among variables as we consider them unimportant in the system. We take into account only the most important relationships suggested by the economic theory.

3. The Model :

1. $C_{pt} = Y_t - C_{gt} - I_t - E_t + M_t$

2. $Y_{dt} = \alpha_0 + \alpha_1 \sum_{i=0}^{t-1} I_i + \alpha_2 I_t + \alpha_3 M_{in,t} + U_1$

3. $I_t = \beta_0 + \beta_1 M_{k,t} + \beta_2 \Delta Y_{dt} + \beta_3 R_t + U_2$

4. $M_{ct} = \gamma_0 + \gamma_1 F_{1t} + \gamma_2 F_{2t} + \gamma_3 \Delta Y_{dt} + \gamma_4 T_t + \gamma_5 P_t + \gamma_6 D + U_3$

5. $M_{in,t} = \partial_0 + \partial_1 F_{1t} + \partial_2 F_{2t} + \partial_3 \sum_{i=0}^{t} I_i + \partial_4 T_t + \partial_5 D + U_4$

6. $M_{kt} = \epsilon_0 + \epsilon_1 F_{1t} + \epsilon_2 F_{2t} + \epsilon_3 T_t + \epsilon_4 D + U_5$

7. $\overline{P} = \eta_0 + \eta_1 H_t + \eta_2 Y_{dt} + \eta_3 P_{mt} + \eta_4 S_t + U_6$

8. $H_t = k_0 + k_1 M_{1t} + k_2 M_{2t} + k_3 R_{1t} + k_4 (G - R) + U_7$

4. List of Variables :

4.1 Endogenous Variables :

1. Y — National Income
2. Y_d — Gross Domestic Product
3. I — Gross Domestic Investment
4. M_c — Imports of Consumer Goods
5. M_{in} — Imports of Intermediate Goods
6. M_k — Imports of Capital Goods
7. $\overline{P}$ — Price Level
8. H - Velocity of Money, clculated using the formula

$$H = \frac{\text{Gross DomesticProducts}}{\text{Money Supply}}$$

4.2 Exogenous Variables :

9. C_p — Private Consumption Expenditure

10. C_g — Government Consumption Expenditure

11. E — Exports

12. R — Rate of Interest

13. F_1 — Foreign Aid

14. F_2— Purchasing Power of Exports, calculated using the formula

$$F_2 = \frac{\text{Export Price Index}}{\text{Import Price Index}}$$

15. T — Terms of Trade

16. P — Population

17. D — Dummy Variables, UNP Government = 1,
SLFP Government = 0

18. P_m - Price Index of Imports

19. S - Subsidies

20. M_1 - Currency

21. M_2 - Demand Deposits

22. R_1 - Lending Rate of Commercial Banks and Financial Institutions

23. (G - R) - Budgetary Deficit

5. Arrow Scheme of the Model :

The above system can be illustrated in terms of Arrow Scheme to show the causal ordereing of the model (see fig.1). The endogenous variables are within square and the exogenous variables are within circles. The dependent variables of the seven structural equations are illustrated in the second row (ie.Y_d, I, M_c, M_{in}, M_k $\bar{P}$ and H).

CIRCULAR FLOW DIAGRAM OF THE MODEL

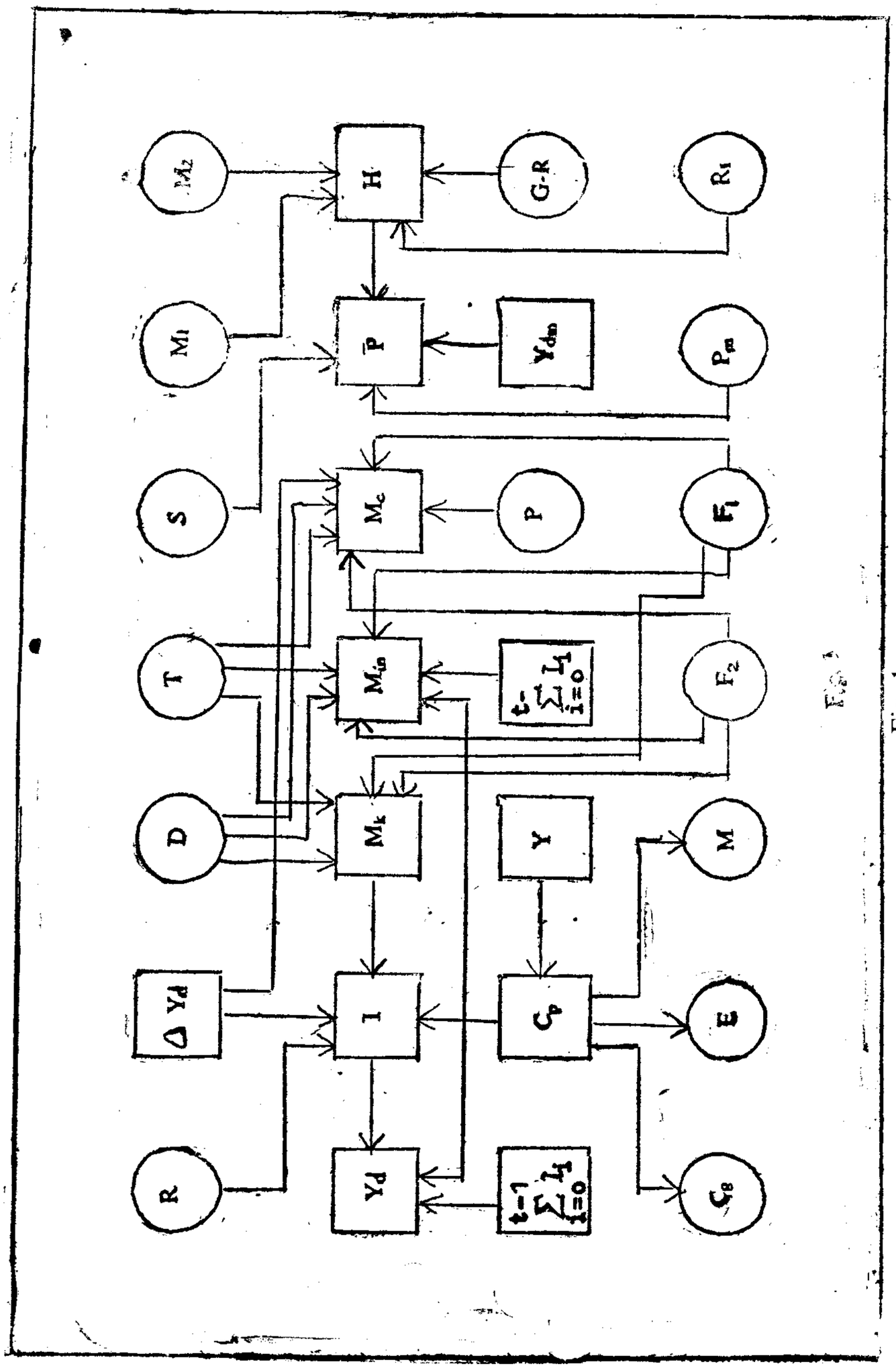

Fig. 1

6. Statistical Estimation of the Model :

The estimates are based on fifteen annual observations covering the period 1963 - 1977. (see Table 1) The main source of data is the Department of Census and Statistics of Sri Lanka. In some cases where they were not available in the Department of Census and Statistics, we have used the data collected by the Central Bank of Ceylon.

All the data we used in estimating the model has been adjusted to the 1963 Prices : so that the outcome of the model will be in 1963 constant prices.

The estimation of the parameters of the model has been carried out by the method of Ordinary Least Squares. The estimated equations are listed below·

1. $Y_{dt} = \underset{(487.04)}{2710.87^{**}} + \underset{(0.03)}{0.17^{**}} \sum_{i=0}^{t-1} I_i + \underset{(0.46)}{0.05^{**}} I_t + \underset{(0.80)}{0.13^{*}} M_{int}$; $R^2 = 0.99$, D.W. = 2.07

2. $I_t = \underset{(464.83)}{-667.38} + \underset{(1.14)}{0.61}\ M_{kt} + \underset{(0.22)}{0.32}\Delta Y_{dt} + \underset{(54.02)}{351.70^{**}}\ R_t$; $R^2 = 0.99$, D.W. = 1.82

3. $M_{ct} = \underset{(3284.08)}{-2500.08} - \underset{(0.27)}{0.39}\ F_{1t} + \underset{(6.31)}{7.65}\ F_{2t} - \underset{(0.25)}{0.12}\Delta Y_{dt} + \underset{(8.21)}{3.21}\ T_t + \underset{(0.22)}{0.22} P_t + 41.47\ D$;
$R^2 = 0.98$, D.W = 3.29

4. $M_{int} = \underset{(375.92)}{474.60} - \underset{(0.09)}{0.02}\ F_{1t} - \underset{(2.18)}{2.12}\ F_{2t} + \underset{(0.01)}{0.001} \sum_{i=0}^{t} I_i + \underset{(2.03)}{0.54}\ T_t + \underset{(47.72)}{105.16}\ D$,
$R^2 = 0{,}99$, D.W = 1.49

5. $M_{kt} = \underset{(84.44)}{44.31} + \underset{(0.04)}{0.006}\ F_{1t} - \underset{(1.60)}{0.78}\ F_{2t} + \underset{(1.13)}{2.21}\ T_t - \underset{(32.80)}{15.47}\ D$; $R^2 = 0.97$,
D.W = 1.96.

6. $\bar{P} = \underset{(33.10)}{40.05} + \underset{(5.98)}{6.75}\ H_t + \underset{(0.001)}{0.006^{**}}\ Y_{dt} - \underset{(0.08)}{0.02}\ P_{mt} - \underset{(0.01)}{0.01}\ S_t$; $R^2 = 0.99$,
D.W = 1.44.

7. $H_t = \underset{(0.34)}{5.30^{**}} + \underset{(0.0007)}{0.0002}\ M_{1t} - \underset{(0.0008)}{0.002^{*}}\ M_{2t} + \underset{(0.05)}{0.15^{**}}\ R_{1t} - \underset{(0.0002)}{0.00015}\ (G-R)_t$;
$R^2 = 0.99$, D.W = 1.36·

Note : ** indicates the 1 % level of significance
* indicates the 5 % level of significance

Below each estimated parameter within parentheses, is the standard error of the estimate which gives us a measure of statistical reliability. Each stochastic equation is assumed to have a set of mutually independent disturbances. The statistic D.W. for each estimated equation is designed to show the presence or absence of serial correlation in the disturbaces for each equation and thus provide an indicator of the degree of fulfilment of the above assumption about the disturbances. The R^2 is a measure of the proportion of the variance of the dependent variable which on the average was explained by the explanatory variables in the sample period. This can be used to judge the goodness of fit of the equations.

7. Discussion of the Estimates :

The evaluation of statistical findings is carried out under two criteria Firstly, we examine the consistency of the estimates with a priori expectation based on accepted Economic Theory. Consistency in this sense is taken to refer both to the sign and magnitude of the paramater estimates.Secondly, we consider the ability of the estimates to satisfy certain statistical ceriteria. Here we rely on the statistical measures namely coefficient of determination, the Durbin. Watson statistic and the t-ratio. The coefficient of determination measures the goodness of fit ot the estimated equations, the D. W. statistic measured the presence or absence of serial correlation of the disturbances of the structural equations and t-ratio measures the significance of the variables.

The proportion of the variation ot the dependent variables explained by the model is very good in almost all the cases. This of course does not provide us with a proof that the specification of the model is the proper one. It is however a desired property of estimates which are to be used for predictive purposes. The estimated parameters of the equations (1), (2) and (6) turned out to have the expected sign. As far as their magnitude is concerned (except the equation (1)), in view of the sizes ot the sampling emrors little can be said about the true value of the parameters. Equation (1) satisfy all the criteria we used to judge the goodness of the equations. On the average little can be said about the reliability of the equations (3), (4), (5) and (7). The computed values of D.W. statistic suggest, except in equations (1) and (2), the presence of first order positive autocorrelation in equations (4), (5), (6) and (7). Nothing can be said about the serial correlation of the equation (3).

Given the limited number of observations and even more limited variety and quality of data the scope for more ambitious work is limited. But this model can be used as a guideline for more sophisticated and useful models once we are better equipped with information.

8. Forecasting :

The main aim of this section is to use the model to make forecasts for the period from 1978 to 1990. At this point our first attempt is to find forecast values for all exogenous variables. For this purpose we use the following equation, assuming that all exogenous variables have an exponential growth as suggested by past data.

i.e. $Y = \alpha\beta^t$
where $\beta = (1+r)$, r is the rate of growth.

Using the data of the observation period (1963 - 1977) and the above equation we have obtained the forecast values of exogenous variables as given in Table 11. The data in Table 11 are then used in order to obtain the forecast values of the endogenous variables for the period 1978 to 1990 and are given in Table III.

TABLE 1

Data used to estimate the parameters of the Model

(Rs. Million, 1963 constant prices)

Year	Ydt	It	Mt				R	F_1	F_2	T	P	$\bar{P}$	H	Ydm	Pm	S	R_1	G—R	D	M_1	M_2	C_p	C_g	E	Ydm
			Mc	Hk	Min	Total	(%)				(.000)	(52 = 100)			(67 = 100)		(%)								
1963	7231.4	1071.3	781	324	372	1477	4	93.5	98	129	10646	108.8	4.8014	6463.0	85	2 38.0	5.7	-381.7	0	828.4	677.7	5330.5	968.2	1903	6463.0
1964	7653.9	1113.3	1098	157	401	1656	4	107.5	105	105	10903	112.2	4.7193	6783.5	105	377.4	5.7	-461.7	0	853.0	768.8	5572.9	1030.6	1899	6783.5
1965	7891.8	1071.2	735	136	414	285	5	234.8	106	112	11164	112.5	4.5997	6848.9	100	461.8	6.1	-430.4	1	901.4	814.3	5684.1	1156.5	2014	6848.9
1966	8193.8	1140.8	1138	194	470	1802	5	234.47	85	109	11440	112.3	4.9392	7042.6	98	505.2	6.1	-566.0	1	882.5	776.4	6095.6	1161.8	1903	7042.6
1967	8709.6	1223.1	904	159	441	1504	5	289.21	80	100	11703	114.8	4.8183	7397.9	100	487.3	6.1	-606.8	1	979.9	827.7	6296.1	1150.0	2032	7397.9
1968	9280.6	1321.6	827	160	524	1521	5½	427.79	96	93	11992	121.5	4.8508	7968.7	126	610.3	5.1	-715.7	1	1066.2	849.0	6723.6	1163.2	2065	7968.7
1969	9917.1	1734.5	797	264	434	1495	5½	864.86	86	88	12252	130.5	5.2663	8559.0	134	673.6	7.4	-787.6	1	1083.9	799.2	7168.1	1184.4	2011	8559.0
1970	10618.6	1819.6	905	177	331	1413	6½	228.90	86	84	12514	138.2	5.3994	11128.0	140	622.3	9.5	-935.6	0	935.7	1031.5	7343.1	1262.0	2077	11128.0
1971	10536.5	1751.6	923	137	270	1330	6½	469.5	77	78	12699	141.9	4.9026	11488.0	150	664.9	9.8	1083.3	0	1115.3	035.8	7199.8	1328.5	2075	11488.0
1972	10807.6	1884.6	607	175	330	1112	6½	742.82	72	75	12951	150.8	4.3559	12595.0	158	785.5	9.9	1294.7	0	1202.3	1278.8	7442.8	1379.6	2129	12595.0
1973	11377.3	1917.3	1167	155	354	1676	6½	323.89	72	65	13901	165.4	4.0959	14367.0	209	756.7	9.2	990.9	0	1436.7	1341.9	7874.4	1484.5	2156	14377.0
1974	12369.2	1954.3	508	106	480	1094	6½	408..64	46	58	13294	185.8	4.1992	18544.0	370	1046.2	9.2	-1034.9	0	1539.3	1406.3	8299.8	1332.1	1941	15844.0
1975	12767.3	2068.4	500	152	472	1124	6½	850.40	45	46	13514	198.3	4.1443	20860.0	433	1962.2	9.2	-2103.1	0	1609.8	1478.4	8503.6	1238.7	2420	20860.0
1976	13340.7	2296.3	690	121	462	1273	6½	924.87	59	62	13730	200.7	3.2025	22948.0	382	091.3	9.2	-2914.4	0	2880.5	2085.1	9017.2	1314.4	2428	22948.0
1977	13620.0	2994.3	659	139	387	1185	8½	1742.42	67	81	13971	203.2	2.5382	27505.0	471	1168.5	10.7	-2075.2	0	2791.7	2574.2	10404.1	1422.3	2103	27505.0

Source : Department of Census and Statistics of Sri Lanka, Central Bank of Ceylon

TABLE II

Forecasted values of Exogenous variables

(1963 constant prices)

Year	$\sum_{I=0}^{t-1} I_i$ Rs. Million	R(%)	F_1 Rs. Million	F_2 Rs. Million	T (1967=100)	P Thousands	D	$\sum_{i=0}^{t} I_i$ Rs. Million	Mt Rs. Million	Td_m Rs. Million	Pm (1967=100)	S Rs. Million	M_1 Rs. Million	M_2 Rs. Million	R_1 (%)	(G–R) Rs. Million
1978	36699.6	8.90	1624.8	54.09	61	14292.333	1	37118.6	9.03	33852	445.9	1168.5	1329	2587	11.98	–2303
1979	37118.6	9.35	1917.3	51.65	59	14621.56	1	39634.5	9.30	38253	503.9	1068.5	2505	2846	11.71	–3487
1980	39634.5	9.81	2262.0	49.33	56	14557.34	1	42247.2	9.58	43226	569.4	1168.5	2705	3130	12.34	–4100
1981	42247.2	10.30	2669.0	47.11	54	15301.358	1	44956.8	9.87	48845	643.4	1168.5	2922	3443	12.9	–4611
1982	44956.8	10.82	3150.0	44.99	51	15653.289	1	47763.3	10.16	55195	727.1	1168.5	3155	3788	13.61	–5303
1983	47763.3	11.36	3717.0	42.96	49	16013.324	1	50667.7	10.47	52371	821.6	1168.5	3408	4166	14.29	–609
1984	50667.7	11.93	4386.0	41.03	47	16349.593	0	53667.9	10.78	70479	928.4	1168.5	3681	4583	15.00	–7013
1985	53667.9	12.55	5176.0	39.18	44	16692.934	0	56763.0	11.11	79641	1049.0	1168.5	3975	5041	15.75	–8065
1986	56765.0	13.15	6107.0	37.42	42	17043.485	0	59959.0	11.44	89994	1185.5	1168.5	4293	5545	16.34	–9275
1987	59959.0	13.81	7207.0	35.74	41	17401.398	0	63249.8	11.78	101694	1339.6	1168.5	4636	6100	17.37	–10666
1988	63249.8	14.50	8504.0	34.13	39	17766.827	0	66637.5	11.14	114914	1513.8	1168.5	5840	6710	18.24	–12266
1989	6637.5	15.23	10035.0	32.59	37	18104.396	0	70122.1	12.50	129853	1710.5	1168.5	5408	7381	19.15	–14105
1990	70122.1	15.99	11841.0	31.12	35	18448.379	1	73703.2	12.80	146734	1932.9	1168.5	5841	8119	20.11	–16221

TABLE 111

Forecasted Values for Endogenous Variables

(1963 Constant prices)

Year	Ydt Rs. Million	It Rs. Million	Mc.t Rs. Million	Min,t Rs. Million	Mk,t Rs. Million	Mt Rs. Million	Pt (1952 = 100)	Ht
1978	8553.5620	988.7734	7265.9333	520.7541	131.59524	7918.28	197.50688	2.3163182
1979	9059.8492	2848.3903	6140.2922	522.04138	130.90731	6793.24	210.12732	1.94499
1980	9491.7834	3002.9713	6580.5085	521.45884	128.23730	7230.20	184.22491	1.5367677
1981	9934.3669	3178.6434	6526.6281	519.88249	128.09151	7123.97	239.95619	1.0852274
1982	10411.477	3065.3701	6444.5407	515.97445	126.11542	7086.63	257.49064	0.5854089
1983	10896.071	3564.4020	6338.8965	510.54876	120.81932	6976.26	277.18295	0.0379755
1984	11412.346	3722.1752	6148.6293	397.50243	128.08148	6674.21	259.17355	1.0701838
1985	11533.301	3971.0861	6096.6991	386.20436	143.28938	6626.19	323.85724	2.8340322
1986	12468.541	4222.3636	5791.7454	372.08891	146.0536	7309.88	351.49015	0.8388327
1987	13046.092	4379.0593	5413.3258	354.51555	152.02374	5919.86	488.88061	2.763783
1988	13580.654	4412.8835	5151.2338	331.75993	156.95488	6639.94	417.34403	3.42484
1989	13928.814	4986.9445	4446.9037	303.49114	163.291534	4913.68	456.41139	4.493065
1990	14797.797	5344.7198	4004.1223	392.94066	155.8332	4552.88	500.38658	5.668124

8. 1 Summary of Forecasting Analysis

According to the past experience, a major development problem that Sri Lanka has faced is the scarcity of capital goods and intermediate goods for investment. Therefore most of the capital goods and intermediate goods have to be imported. In constructing our GDP function, we consider that the GDP is not only a function of previous investment and current year investment but also of import of intermediate goods. The estimates of this function give very significant results confirming the above facts.

According to the forecast values the GDP in 1990 should be 73% higher than the GDP in 1978. It shows a 5.5% average annual growth rate for the period from 1978 to 1990 (see table IV).

TABLE IV.

Average Annual Growth Rates in the period 1978 - 1990.

Gross Domestic Product (G.D.P.)	5.5%	Velocity of Circulation of Money	13%
Investment	2.4%	Purchasing Power of Export	4.5%
Import of Consumer Goods	4.5%	Import Price Index	13%
Import of Intermediate Goods	4.5%	Foreign Aid	18%
Import of Capital Goods	3%	Currency (M_1)	8%
General Price Level	10%	Demand Deposits (M_2)	10%

GROWTH OF GDP IN THE FORECASTED PERIOD

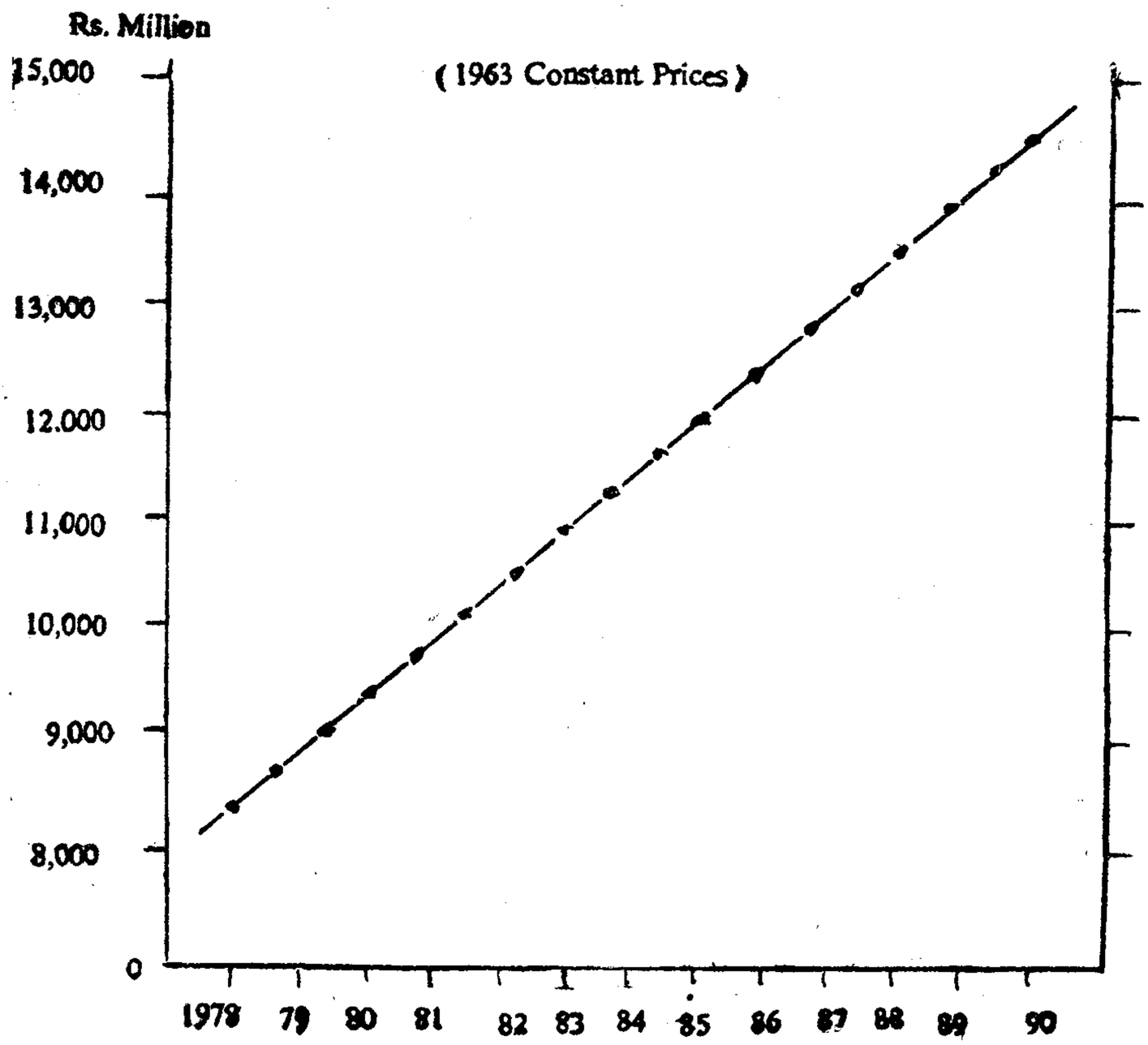

Fig. II.

As illustrated in Fig. II this high increase of GDP may be the result of 2.4% average annual growth of investment (see Fig. III)

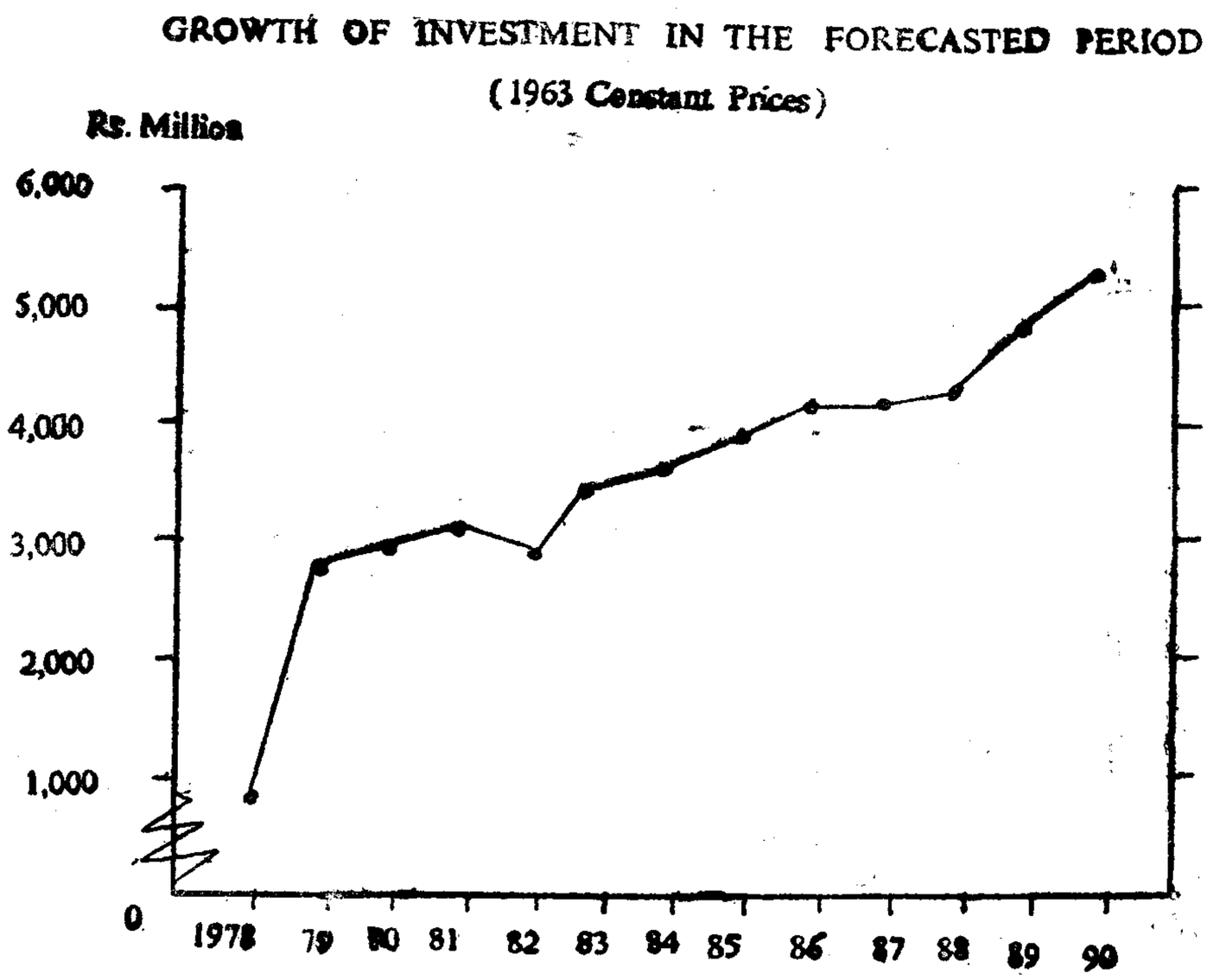

Fig. III.

According to our findings of the study countries the dependency on imports should decline in future. The value of total imports will decrease from Rs. 7918 million in 1978 (in 1963 constant prices) to Rs. 4552 million in 1990 (see table III). This is mainly due to the declining tendency of imports of consumer goods (see Fig. IV).

Both curves in Fig. IV show a 4.5 % average annual decline throughout the forecast period.

GROWTH OF IMPORTS IN THE FORECASTED PERIOD

(1963 Constant Prices)

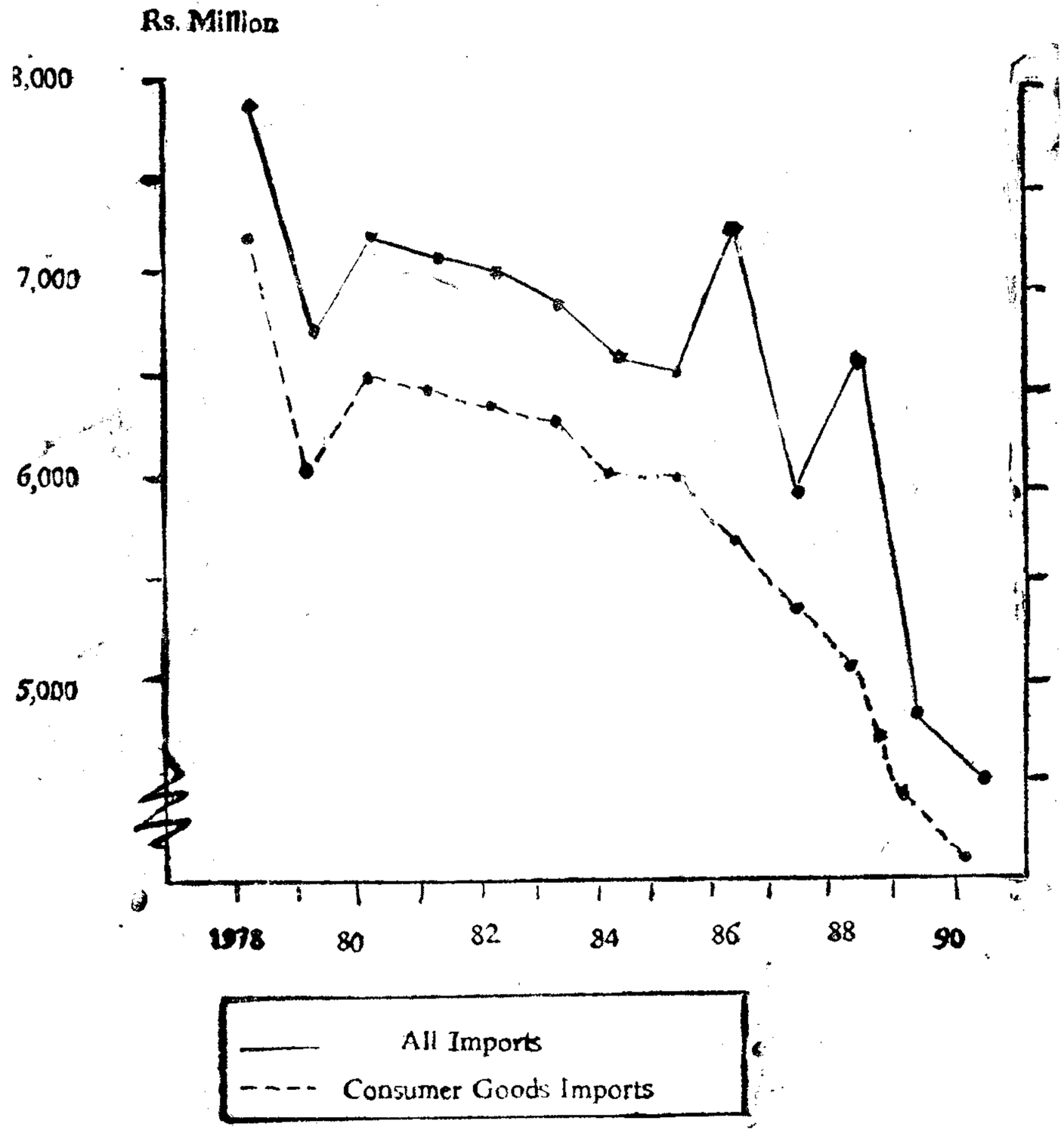

Fig. IV

But this will not improve the balance of payment situation, as the growth rate of purchasing power will decline annually in future. The import price index too will increase by 13% annually. The forecast values indicate 10% average annual growth of the general price level throughout the forecast period (see Fig. V).

This may be partly a result of increasing currency (M_1) and demand deposits (M_2) by 8% and 10% respectively (see Table I V).

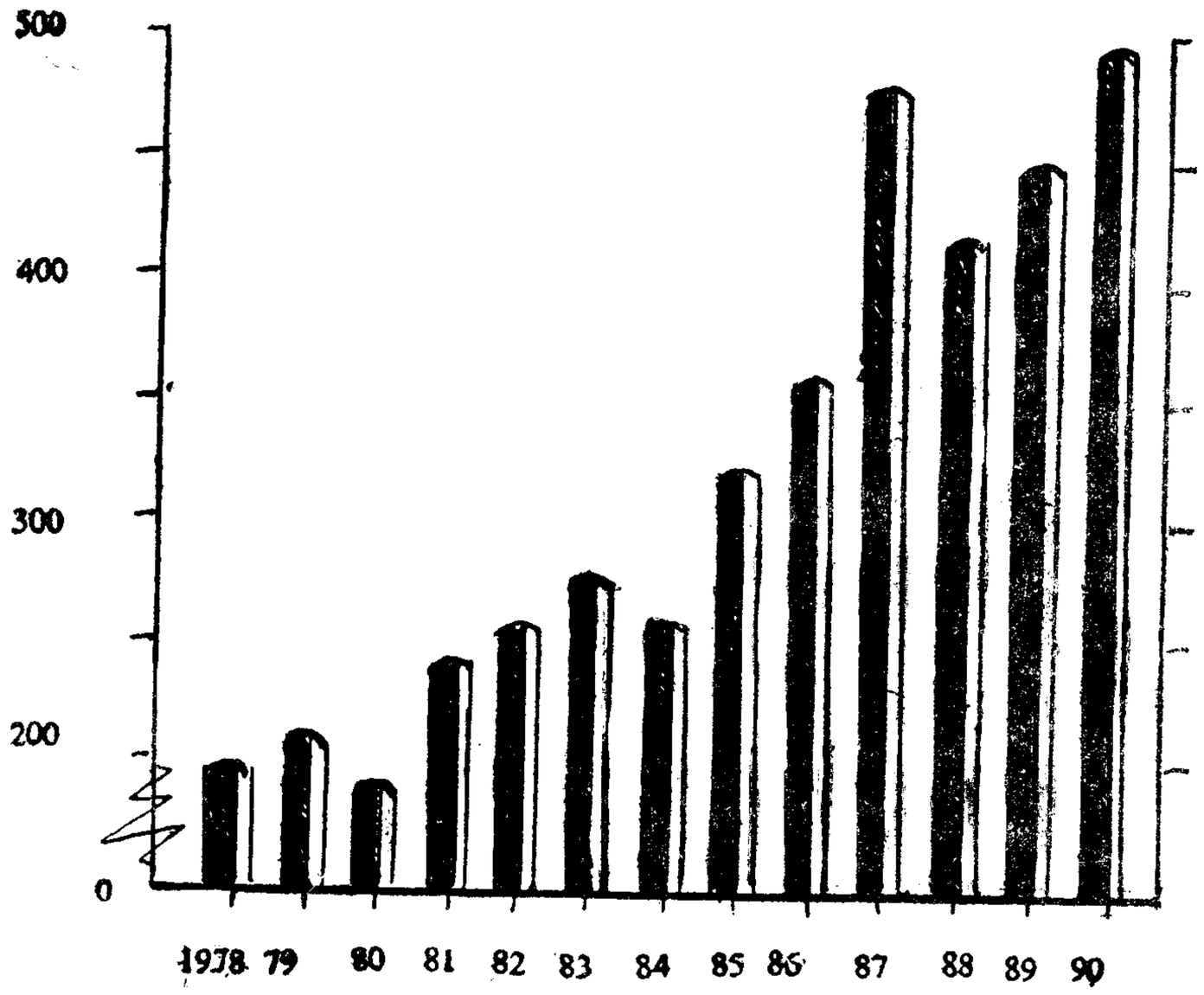

Fig. V.

9. Concluding Remarks

In this exercise an attempt has been made to construct a simple Econometric Model in respect of the Economy of Sri Lanka. We have done this in three steps. The formulation of mathematical relationships to structure the economy of Sri Lanka, derivation of statistical results through that model with the aid of information collected by us and prediction of the behaviour of the economy in the future

Although we have attempted to construct an improved model than which is now available, our model also has its own limitations as some of the variables that influence the movement of the economy have not been considered due to the lack of data

Econometric models of this nature can be used both for the analysis and understanding the structure of the economy of the observation period and for studying the behaviour of the economy for the future. In order to test the validity of the model the forecasting power of the model is also very important, because obtaining reliable forecasts is one of the main objectives of constructing this type of a model. The forecasted values suggest that the economy may have the following trends:

1. A continuous upward trend in the Gross Domestic Product without major fluctuations.
2. The investments would increase with some fluctuations.
3. A agradual fall in the import of consumer goods causing also a fall in total imports (may be a result of increased local production of consumer goods).
4. The general price level will increase with minor fluctuations towards end of the forecast period. (1978 to 1990).

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