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Investment and Financial Behaviour of Public Limited Companies

by
K.C. SHARMA*

This paper brings out in detail the influences that determined the investment and financial behaviour of public limited companies during the period 1970-71 and 1986-87. The method utilised for the purpose is Ordinary Least Squares. The paper has made an attempt to go beyond the existing literature on the subject by focussing on the possible impact of economic and credit policies on the corporate sector's investment and financial behaviour.

Introduction

THE far-reaching changes ushered in the industrial and trade policies of the Government of India in 1991, as a part of the ongoing macro economic restructuring programmes, have marked a watershed over those pursued in the preceding decades. These developments would have a significant impact on the working of the private corporate sector in India in the nineties. In order to set in perspective the financial aspects of the working of the private corporate sector in India, an attempt is made in this paper to present a quantitative analysis of the investment and financial behaviour of the manufacturing public limited companies in this sector based on time series data covering the period 1970-71 to 1986-87. The data are drawn from the company finances studies conducted by the Reserve Bank of India[1]. In interpreting the results, reference has been made, wherever necessary, to the selected fiscal and credit policy measures adopted by the Government of India and the Reserve Bank, respectively, in specific years.

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* K.C. Sharma is presently working as Assistant Adviser in the Department of Statistical Analysis and Computer Services. The author is grateful to Shri T.R. Venkatachalam, Principal Adviser, for his guidance and valuable suggestions. He is also grateful to Shri R. Nagaraja Rao, Adviser and Shri Y.S.R. Sarma, Director, for their valuable comments on the econometric analysis included in this paper. Support rendered by Shri Anil Kumar Sharma, Research Officer, in regression analysis, is gratefully acknowledged. Thanks are also due to Shri S. Subramanian for computer assistance.

There have been quite a few studies on the subject, each covering varying periods spanning over the fifties and the early seventies. Among the earliest studies, mention may be made of that by Bagchi (1962) and another by Sastry, V.K. (1966). The former study was a cross-section analysis of 27 industries based on the combined balance sheet data of public limited companies published by the Reserve Bank of India and used yearly averages for the periods 1952-55 and 1957-59 to estimate equations while the latter was based on balance sheet data of individual public limited companies covering the period 1955 to 1960. Bagchi's study concluded that the level of investment is affected more by profits after tax than by sales while Sastry attributed it to sales, profits and the scale of exteral finance. Swamy and Rao (1974) analysed the manufacturing sector at the aggregate level for the period 1954 to 1970 and deduced that corporate investment is mainly influenced by accelerator, availability of internal and external finance and capital intensity. The study by Krishnamurty and Sastry (1975) is a cross-section analysis of public limited companies within an industry for the decade 1960-70 and is supplemented by time series analysis at the industry level. Last but not the least, the study by Venkatachalam and Sarma (1978) is a time series analysis of financial behaviour of the private corporate sector at the aggregate level and relates to the period 1958-59 to 1974-75 based on the data of public and private limited companies published by the Reserve Bank of India. The study brings out that important determinants of investment expenditures are sales, capacity utilisation, profits before tax and long term external finance.

The present study examines the phenomenon of investment and financial behaviour of the public limited companies for a further period upto 1986-87 when the Indian industry had undergone a marked change. According to this study, long term borrowings extended by the term lending financial institutions, which had largely proliferated during this period under the aegis of the RBI, emerge as the major determinant of fixed investment followed by profitability and sales. The availability of internal funds was of little consequence in influencing fixed capital investment decisions. Control on the cost of credit by the imposition of ceiling on the lending rates by the RBI facilitated large fixed capital formation. Availability of investment allowance, which substantially reduced the corporate income tax rates, also propelled new investment. The study also relates the investment and financial behaviour of the companies to selected changes in fiscal and credit policies followed from time to time.

Select Policy Framework

The investment pattern of the private corporate sector was structured by the industrial policy resolution of 1956, with areas of operation between the private sector and the public sector clearly demarcated. It was re-oriented subsequently by the changes brought about through industrial policy resolutions of 1973, 1980 and 1985, before being revamped in 1991. The earlier industrial policy resolutions had laid special emphasis on the development of basic and key industries, infrastructure sector and small scale industries, and had assigned a pivotal role to the public sector to enable it to attain 'commanding heights' of the economy.

Apart from the industrial policy, the extent of fiscal incentives and depreciation rates admissible on investment in plant and machinery were also revised from time to time to influence the pace and direction of fixed capital formation. The Government of India offered a number of fiscal incentives and tax concessions to the corporate sector to spur fresh investment particularly in the specified areas. Besides, the Government enhanced the rates of depreciation admissible on various items of plant and machinery with effect from 1983-84 and again from 1987-88 onwards for enabling speedy replacement of old plant and equipment in order to facilitate modernisation, expansion of the existing installed capacities and introduction of the latest technology.

Among the fiscal incentives, admissibility of development rebate on the installation of additional plant and machinery was quite important and was available from 1955 to 1974. A similar incentive *viz.*, investment allowance, available on the installation of new plant and machinery, was introduced in 1976, and it remained in force upto 1989-90. Tax holiday on profits at the prescribed rates was also allowed to new industrial undertakings during the first five years of their operation upto 1980-81 and for eight years thereafter. Tax reliefs were admissible on exports in the form of Export Markets Development Allowance from February 1968 to February 1983 and Export Turnover Relief from the accounting year 1982-83 to 1984-85. In the subsequent two years, 50 per cent of the profits derived from export of goods were allowed deduction from computation of taxable income provided the amount was credited to a reserve account for its utilisation for the purpose of export business. Additional fiscal incentives were available for setting up industrial units in the rural areas and backward areas separately. A few other tax concessions and incentive schemes also prevailed. These fiscal incentives and tax concessions enabled quite a

number of efficient medium and large companies to considerably reduce the incidence of high statutory corporate tax rates which ranged from 55 per cent to 59.13 per cent during 1970-71 to 1984-85 before being lowered to 52.5 per cent in 1985-86 and 50 per cent in 1986-87.

The above features of corporate tax policy and the overall industrial policy framework, *inter alia*, influenced the economic environment in which the private corporate sector had to operate during the selected period. However, amidst conditions of regulation and control, the growth of registered manufacturing segment in the private sector remained constricted in the seventies but it picked up in the eighties under the impact of several fiscal incentives and policy liberalisation initiatives. This was reflected in the sharp rise in gross capital formation in the registered manufacturing segment of the private sector which averaged (at 1980-81 prices) Rs. 2,469 crore per annum in the seventies and Rs.2,797 crore per annum in the eighties upto 1986-87 as against Rs.2,351 crore in 1969-70. The average expansion in gross capital formation in this sector increased by only Rs.57 crore per annum in the seventies and registered a negative growth of Rs.83 crore per annum in the eighties upto 1986-87 at 1980-81 prices. However, there were wide fluctuations in gross capital formation from year to year. The average annual rate of growth in gross capital formation in the registered manufacturing segment of the private sector at constant prices was 2.4 per cent in the seventies and - 2.5 per cent in the eighties upto 1986-87. Although similar data for the manufacturing segment of the privte corporate sector are not available on comparable basis for the selected period, the investment behaviour and the related financial aspects have well emerged from the following analysis of manufacturing public limited companies in the private corporate sector.

The study is divided into four sections. Section 1 is devoted to the scope, coverage and limitations of the study. The methodology adopted for quantitative analysis is given in Section II. Section III analyses the empirical results obtained in respect of the important items of sources and uses of funds and relates them, as far as possible, to selected changes in fiscal and credit policies. Section IV delineates the main conclusions of the study.

Section I
Scope, Coverage and Limitations

The scope of this study is confined to an analysis of the flow of funds of the non-financial non-government public limited companies

engaged in processing and manufacturing activity which constituted 75 per cent of the total paid-up capital of all non-government public limited companies and 56 per cent of the total paid-up capital of all public as well as private non-government companies at work as on March 31, 1987. The processing and manufacturing companies thus apparently represent a major segment of the private corporate sector and play a pivotal role in determining and spearheading the growth of this sector. An examination of sources and uses of funds of these companies at the macro level would, therefore, indicate the changing trends in their investment and financial behaviour which have a significant bearing on the overall financial pattern of companies in the private corporate sector.

The processing and manufacturing companies are engaged in the production of foodstuffs, textiles, tobacco, leather and leather products, engineering, metals and chemicals and products thereof. They also undertake some other miscellaneous manufacturing activities. The remaining companies are engaged in agricultural and allied activities, mining and quarrying, construction and utilities, trade and finance, transport and communication, storage, community and business services such as road transport, electricity generation and supply, and personal services such as hotels, restaurants and eating houses. Among the non-government public limited companies, such companies constituted only 25 per cent of the total paid-up capital as on March 31, 1987, and are excluded from the scope of this study.

The working of the companies is affected by several exogenous and endogenous factors and they have to accordingly orient their preferences or be obliged to take recourse to different sources of funds in varying measures for their planned deployment, although available funds are sometimes diverted irrespective of the avowed purposes.

Companies may raise funds by internal generation of resources through depreciation provision and retained profits and from external sources by floatation of loans, equity, debentures, deposits, trade credits, etc. These decisions of the corporate managements go hand in hand with the related decisions regarding output and sales, present and future plans of investment in fixed assets, inventory holdings, quantum, periodicity and nature of financial obligations including payment of interest, statutory and legal obligations including discharge of tax liabilities, policy of dividend disbursement and the need to build up comfortable reserves and surplus position by providing for adequate retained profits to suitably recycle them in business and industry.

These policies would ultimately impinge on the profitability of the companies through interaction of several components of their financial framework with the deployment of financial, capital and human resources.

As regards the financial health of the companies, this appears to be governed by the relative dependence on the various internal and external sources of funds and their appropriate uses as servicing of funds from different sources entails different costs. The latter part of the eighties was characterised by floatation of large issues of shares and debentures as raising of such funds became necessary for many large companies in the face of huge financial outlays of their projects and closer scrutiny of their performance by the term lending institutions while appraising the projects and the presence of convertibility clause[2] in the sanction of the institutional loans. But the companies resorted largely to the traditional sources of finance including financial institutions for financing their developmental projects in the seventies and the early eighties in the face of non-proliferation and less developed nature of the capital market. Moreover, it also depended on the loan portfolios of the companies going in for fresh borrowings as to whether their existing debt-equity ratios were within acceptable limits. The companies, therefore, part-financed their long term financial requirements through public issues but largely resorted to borrowings from development finance institutions (DFIs). An attempt is, therefore, also made to assess the shift in the investment pattern and long term borrowings of the public limited companies during the eighties as distinct from the seventies by using the dummy variable.

For building up the time series, data have been culled out from the studies on finances of public limited companies published by the Reserve Bank of India based on the profit and loss accounts and balance sheets of the selected companies and are blown up in terms of paid-up capital of all public limited companies[3] in the private corporate sector to prepare global estimates of the selected items of income and expenditure, and the major items of sources and uses of funds (Annexure) for such companies. Relatively less important items of assets of the companies, representing uses of funds such as investments and cash and bank balances, have been excluded from the analysis. While the sources and uses of funds data pertain to flow of funds during the year, the balance sheet data depict the position obtaining at the end of the year.

There are, however, a few inherent limitations in the RBI data on

company finances. Firstly, these data do not relate to a uniform set of companies. Secondly, the selected companies do not have uniform month of closing of annual accounts during each RBI study year from which the required data are extracted. Thirdly, the companies covered in the RBI company finances studies are based on purposive sample depending upon the availability of annual accounts rather than any scheme of scientific sampling and the coverage factor used for blowing up the sample data is also subject to revision for the latest three years due to changes in the population paid-up capital numbers released by the Department of Company Affairs (DCA), Government of India. Notwithstanding these limitations, the results of this study can be broadly treated as indicators of the investment and financial behaviour of the private corporate sector as the performance of the public limited companies overwhelm the performance of the private limited companies at the aggregate level.

Section II
Methodology

Ordinary least squares (OLS) method has been used in estimating the equations. This method has limited applicability whenever simultaneity or interdependence exists among the variables. In such equations, the lagged endogenous variable has been introduced as used in the Koyck-type Distributed Lag Model.

Hypotheses

Several alternative specifications have been tried for explaining the investment and financial behaviour of the companies[4] but only those are presented here which have at best satisfied the statistical criteria. The investment behaviour of the companies may be explained by sales as accelerator, capacity utilisation, availability of long term funds from development finance institutions, bank borrowings and internal sources of funds including retained profits and depreciation provision. While the existing stock of fixed capital and new investment in fixed assets is governed by sales and long term borrowings from financial institutions, inventory investment is determined mostly by change in sales, short term bank borrowings and retained profits of the companies. Profits before tax largely depend upon the extent of sales and the profit margin per unit of sales. Thus the ratio of profits before tax to sales reflects an important profitability rate. Tax provision made by the companies is determined by statutory tax rates and the available tax concessions including investment allowance, if any. Depreciation provision is

determined by the existing stock of fixed capital, fresh investment in fixed assets and the rates of depreciation allowed on plant and machinery and other assets by the Government. Dividends are influenced by profits after tax at the disposal of the corporate entity, dividend pay-outs in the preceding years, cash flow position and reserves and surplus.

The impact of investment on raising new capital issues could be captured by sales, yield on industrial securities and the existing capital stock. Alternatively, the companies resort to institutional finance. The demand for short term bank finance is affected by the level of inventories, liquidity position of the companies, availability of internal funds and cost of borrowing from alternative sources represented by the bazar bill rate. But in the absence of availability of any systematic data on bazar bill rates, it has been found that short term bank borrowings are mostly influenced by the level of inventory holdings, retained earnings and interest rate on bank advances.

Long term borrowings from the financial institutions, on the other hand, depend upon investment in fixed assets and outstanding borrowings which influence the debt-equity ratio of the companies and thereby their eligibility for further borrowings. The cost of borrowing from financial institutions did not have any material impact on the level of long term borrowings by the companies, as the country had witnessed an administered interest rate regime and also the companies had enjoyed favourable treatment of interest payments for claiming tax exemption by being able to account them as cost as against dividend payments on share capital which did not enjoy a corresponding tax advantage. All the above referred variables, whether dependent or explanatory, have been expressed as follows.

Variables and Notations

The undernoted variables and notations have been used in this paper.

K — Stock of fixed capital (i.e. gross fixed assets) at the end of the period.
S — Sales
CF — Cash flow i.e. (retained profits + depreciation provision).
DEPP — Depreciation provision
GP — Gross profits
PBIT — Profits before interest and tax
PBT — Profits before tax

PAT — Profits after tax
RP — Retained profits
DIV — Dividends
INV — Inventories at the end of the period.
BB — Bank borrowings at the end of the period.
WPI — Wholesale price index (All commodities) (1970-71 = 100).
RM — Raw materials, components, etc. consumed.
RS — Reserves and surplus.
OB — Other borrowings (from term lending and other financial institutions) at the end of the period.
INT — Interest payments
TP — Tax provision
ET — Effective tax rate i.e. $\frac{\text{(Tax provision x 100}}{\text{Profits before tax)}}$
RA — Advance rate of scheduled commercial banks.
PUC — Paid-up capital
AR — Accounts receivable at the end of the period.
AP — Accounts payable at the end of the period.
D — Dummy variable.

Values of the variables have been taken in rupees crore at current prices excepting the index numbers, interest rates and tax rates which have been taken in percentage points. A variable accompanied by subscript (-1) represents lag of period one, otherwise the current period. The sign Δ indicates the first difference of the variable. Significance at one per cent level and 5 per cent level is denoted by * and ** respectively. SR and LR stand for short run and long run elasticity respectively.

A dummy variable has also been tried in the study so as to see whether there was a shift in the investment function and the demand for external borrowings in the eighties.

The dummy variable (D) is defined as
D = 0, if the period is 1 (1970-71), 2 (1971-72), 3 (1972-73), ... 10 (1979-80), and
= 1, if the period is 11 (1980-81), 12 (1981-82) and so on.

Section III
Analysis

Stock of Fixed Capital

Stock adjustment principle postulates that there is a desired level of

capital stock which a company considers appropriate for ensuring optimal production. In actual practice, the desired level of capital stock may not be achieved due to several reasons such as financial constraints and administrative difficulties. Investment behaviour, however, could be adequately explained by Koyck in his models of stock adjustment or distributed lag wherein the stock of capital in the current year is treated as a function of capital stock in the previous year together with some other factors such as long term borrowings from external sources, sales and capacity utilisation. Capacity utilisation although important has not been employed as a separate variable in this paper because of lack of reliable data in this regard for manufacturing public limited companies at the global level. Cash flow of the companies representing their depreciation provision and retained profits also affect investment, albeit, to a lower extent. Since retained profits represent the residual after providing for tax liabilities and dividend payments from profits before tax (PBT), the impact of sales should normally be reflected in profits before tax which are derived after providing for manufacturing and non-manufacturing expenses, depreciation provision and interest cost. Therefore, inclusion of cash flow as a variable along with sales variable would diminish the impact of the latter due to the problem of multicollinearity. Hence cash flow has not been used in conjunction with sales in the following equation.

1. $K = 711.6502$	$+ 0.0964\ S$	$+ 1.2099\ OB$	$+ 0.5451\ K_{-1}$	
t-Statistic	0.77	1.62	3.16*	3.21*
Elasticity	SR	0.15	0.36	
	LR	0.33	0.79	

$\bar{R}^2 = 0.997$, D.W. = 1.95, SEE = 911.79, Mean = Rs.21033 crore

From the results of the equation, it is evident that the above specification almost entirely explains the movement in the capital stock (Graph 1) and error terms are free from autocorrelation. The standard error of the estimate of capital stock being only around 4.3 per cent of the mean capital stock, the results vindicate the above observation that long term external funds play a major role in financing the stock of fixed capital. An important outcome of this estimate is the significance of the coefficient of long term borrowings at 1 per cent level. The speed of adjustment is 0.45. The impact of accelerator (sales) variable is evident. The marginal sales coefficient is 0.21 in the long run. The elasticity of capital stock to sales in the long run is 0.33. The impact of external borrowings on capital stock is 0.36 in the short run and 0.79 in the long run.

Investment

As regards investment, it should normally be governed by sales or output, profitability of existing investment in capital stock, expectation about future profits and the ability to raise long term borrowings which, inter alia, depends on outstanding amount of borrowings as well as the repayment capacity rather than the cost of borrowing as reflected by the interest rates payable on loans and advances. The earlier system of administered interest rates in India had kept the cost of borrowing under control. The Reserve Bank of India prescribed a varying ceiling rate on advances by scheduled commercial banks from March 15, 1976 which prevailed throughout the remaining part of the reference period and controlled the lending rates charged by the financial institutions.

The prime lending rates of term lending institutions such as IDBI, IFCI and ICICI were 8.5 to 9 per cent in 1970-71, 11 to 12 per cent in 1975-76 and 14 per cent from March 2, 1981 onwards. The rates charged by the Industrial Reconstruction Corporation of India were even lower at 8.5 per cent in 1975-76, 9.15 per cent in 1980-81 and 12.5 per cent in 1985-86 and 1986-87. State Financial Corporations (SFCs) had a wide band of rates : 7.5 - 10.5 per cent in 1970-71, 8.0 - 14.5 per cent in 1975-76, 12.0 - 16.0 per cent in 1980-81 and 11.5 - 16.5 per cent from 1985-86 to 1989-90. SFCs charged even lower lending rates for small scale industries at 7.0 - 8.5 per cent in 1970-71, 8.0 - 11.0 per cent in 1975-76, 12.0 - 14.5 per cent in 1980-81 and 11.5 - 16.5 per cent from 1985-86 onwards.

To stimulate investment, banks were also advised in 1976 to provide larger term loans for periods beyond three years at the rate of interest not exceeding 15 per cent, including the incidence of about 1 per cent on account of tax on interest. The maximum lending rate by scheduled commercial banks was prescribed at 16.5 per cent, inclusive of tax on interest income, with effect from March 15, 1976. This ceiling was higher at 17.5 per cent for banks with demand and time liabilities between Rs.25 crore and Rs.50 crore. Banks with such liabilities at less than Rs.25 crore were exempted from the ceiling. Before the stipulation of ceiling rates, the Reserve Bank used to prescribe only the minimum rate of interest except for certain categories of export credit.

Extensive efforts were also made under the aegis of the RBI and otherwise to enhance the availability of medium and long term finance for promoting industrial activity in the country. This was done through

proliferation of new financial institutions and greater allocation of resources from its long term Industrial Stabilisation Fund. Several industrial finance institutions which were established in the post-independence period came of age in the seventies. These included the Industrial Finance Corporation of India (1948), State Financial Corporations (from 1952 onwards), Industrial Credit and Investment Corporation of India (1955), Industrial Development Bank of India (1964), Unit Trust of India (1964) and Industrial Reconstruction Corporation of India (1971) rechristened as Industrial Reconstruction Bank of India (1985). Thus while the cost of credit was held under check by the regulation of lending rates by the RBI, adequate availability of funds was also ensured.

The equations presented below for the selected period clearly bring out the impact of profitability, sales, long term borrowings from external sources and capital stock on investment. It is noteworthy that profitability of investment has proved to be a more important variable than sales in undertaking additional investment since profits before tax adequately reflect the extent of profit margin on sales after providing for different types of costs whereas sales even at a higher price may have a higher element of cost thus reducing the profit margin.

The concept of investment has been used in two different ways. The first concept of investment relates to the change in capital stock during the year representing the difference between the opening stock and the closing stock of capital. In the second concept, gross investment[5] ($\Delta K'$) is taken by adding depreciation provision during the year to the change in capital stock to truly reflect the total investment made during the year.

1. ΔK =	711.6502 +	0.0964 S +	1.2099 OB	- 0.4549 K-1
t-Statistic	0.77	1.62*	3.16*	2.68**
Elasticity		0.93	2.21	-2.35

$\bar{R}^2$ = 0.939, D.W. = 1.95, SEE = 911.79, Mean = Rs. 3417 crore

2. ΔK =	222.4524 +	1.2911 PBT +	1.3944 OB	- 0.4321 K-1
t-Statistic	0.26	2.62**	4.43*	2.94**
Elasticity		0.62	2.55	-2.23

$\bar{R}^2$ = 0.953, D.W. = 1.62, SEE = 803.09

3. $\Delta K = 681.6030 - 3356.7920\ D + 1.2812\ OB + 0.4783\ D\ OB + 2.4336\ PBT - 0.5767\ K_{-1}$

t-Statistic	0.81	1.92	1.45	0.74	3.94*	3.93*
Elasticity			2.34	0.70	1.16	-2.97

$\bar{R}^2 = 0.975$, D.W. = 1.92, SEE = 586.50

4. $\Delta K' = 822.2119 + 0.1018\ S + 1.3294\ OB - 0.4472\ K_{-1}$

t-Statistic	0.83	1.60	3.24*	2.46**
Elasticity		0.73	1.81	-1.72

$\bar{R}^2 = 0.955$, D.W. = 1.92, SEE = 975.51, Mean = Rs.4585 crore.

5. $\Delta K' = 310.5985 + 1.3578\ PBT + 1.4757\ OB - 0.5783\ K_{-1}$

t-Statistic	0.34	2.56**	4.50*	2.67**
Elasticity		0.48	2.07	-1.63

$\bar{R}^2 = 0.965$, D.W. = 1.61, SEE = 864.23

6. $\Delta K' = 737.1333 - 3323.8430\ D + 1.4757\ OB + 0.4400\ D\ OB + 2.4982\ PBT - 0.5783\ K_{-1}$

t-Statistic	0.77	1.67	1.45	0.60	3.55*	3.47*
Elasticity			2.01	0.48	0.89	-2.22

$\bar{R}^2 = 0.979$, D.W. = 1.90, SEE = 666.75, Mean = Rs.4585 crore

where $\Delta K' = \Delta K$ + depreciation provision made during the year.

The results of the equations without the use of dummy variable show that the speed of adjustment for fixed capital stock is in the range of 0.43 to 0.45. The standard error of the estimates is in the range of 18.8 to 21.3 per cent of the mean in the case of gross investment and range from 23.5 per cent to 26.7 per cent of the mean investment for the period 1970-71 to 1986-87. The standard error of the estimates reduces considerably to 9.1 per cent and 10.2 per cent of the mean gross investment and ranges from 11.9 per cent to 14.3 per cent of the mean investment in the eighties.

Alternatively, the results of those equations turn out to be much better in which dummy variable is introduced with a view to capturing the shift in the intercept as well as sharp change in the slope relating to other borrowings in the investment function in the seventies as distinct from the period 1980-81 to 1986-87. The results show that the speed of adjustment for fixed capital stock improves to the range of 0.58 to

0.60. The standard error of the estimate gets reduced to 14.5 per cent of the mean in the case of gross investment and 17.2 per cent of the mean investment for the period 1970-71 to 1986-87. The standard error of the estimate also gets reduced to 7 per cent of the mean gross investment and 11.9 per cent of the mean investment in the eighties. Besides these results, the structural break in the investment function from 1980-81 onwards is also evident from Graphs II and III relating to investment and gross investment respectively.

Inventories

A major factor affecting inventory investment is the change in sales. Therefore, inventory variable has to be considered with other concomitant factors such as internal funds and bank borrowings which determine the capacity to hold inventories. Another important variable which has a significant bearing on inventory investment relates to the closing stock of inventories at the end of the previous year which is carried forward to the current year. The specifications are as follows:

1. INV =	518.4261 +	0.2043 S +	0.8140 RP +	0.2066 INV-1	
t-Statistic	2.52**	7.25*	2.13	1.67	
Elasticity	SR	0.72	0.04		
	LR	0.91	0.05		

$\bar{R}^2$ = 0.997, D.W. = 1.51, SEE = 293.49, Mean = Rs. 9296 crore

2. INV =	182.4741 +	0.2821 Δ S +	0.3314 BB +	0.7642 INV-1	
t-Statistic	0.99	5.38*	1.39	5.61*	
Elasticity	SR	0.14	0.18		
	LR	0.59	0.76		

$\bar{R}^2$ = 0.996, D.W. = 1.67, SEE = 341.40

3. ΔINV =	193.2437 +	0.1039 ΔS +	1.3014 RP +	1.4649 ΔBB -	0.1302 INV-1	
t-Statistic	1.76	2.61**	5.14*	6.57*	6.52*	
Elasticity		0.38	0.52	0.83	-0.89	

$\bar{R}^2$ = 0.979, D.W. = 2.49, SEE = 163.74, Mean = Rs. 1183 crore

Values of $\bar{R}^2$ obtained in the above specifications indicate that a very high proportion of variation in inventory investment is explained by variation in sales, bank borrowings, retained profits and inventory

holdings at the end of the previous year. This may also be seen from Graphs IV and V. The speed of adjustment, however, varies widely among the functions as observed in an earlier study covering the period upto mid-seventies. The comparison of elasticities suggest that a major share of inventories is financed by bank borrowings as the short run elasticity is 0.83 with respect to change in bank borrowings and 0.52 with respect to retained profits. The role of sales as an accelerator variable is also found to be significant in the functions.

Profits Before Tax

Profits before tax of the companies are, inter alia, affected primarily by sales and cost of production. In the cost of production, the cost of raw materials, components, etc. consumed constitutes a major portion while the wage cost constitutes a smaller proportion. The share of raw materials, components, etc. consumed in the cost of production ranged from 55.2 per cent (in 1972-73) to 58.4 per cent (in 1981-82) and that of wage cost representing salaries, wages and bonus paid to the employees ranged from 11.1 per cent (in 1985-86) to 16.3 per cent (in 1973-74) during the selected period. The shares of raw material cost and wage cost in the cost of production stood at 55.5 per cent and 11.2 per cent, respectively, in 1986-87. Thus while the share of raw materials in the cost of production was more or less stable and moved only in a narrow groove, the share of wage cost showed a perceptible and almost consistent decline from 1974-75 onwards as may be seen from Table 1.

Among the other items of cost of production, the main ones were: power and fuel, stores and spares consumed and 'other expenses' including those on travelling, conveyance, vehicles, communications, advertisement, etc. The share of power and fuel in the cost of production went up sharply from 4.7 per cent in 1970-71 to 9.0 per cent in 1986-87, that of stores and spares consumed declined from 8.5 per cent to 7.6 per cent and that of 'other expenses' increased gradually from 7.5 per cent to 9.6 per cent in the respective years. The share of other expenses in the total cost of production fluctuated in the narrow range of 7.4 per cent and 8.0 per cent between 1970-71 and 1979-80 and went up thereafter. The remaining expenditure did not show any perceptible change and oscillated around 7 per cent during the selected period.

Besides the cost of production, depreciation provision and some other appropriations (other than tax) are also excluded from income for deriving gross profits. While depreciation provision made by the

Table 1 : Structure of Total Cost of Production

(Per cent)

Year	Cost of raw materials	Salary, wages and bonus	Stores and spares	Power and fuel	Other expenses*	Remaining expenditure**	Total cost
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1970-71	57.1	15.7	8.5	4.7	7.5	6.5	100.0
1971-72	57.2	15.3	8.6	4.5	7.7	6.7	100.0
1972-73	55.2	15.8	8.9	4.5	7.9	7.7	100.0
1973-74	55.5	16.3	8.8	4.3	7.4	7.7	100.0
1974-75	56.8	15.4	8.7	4.9	7.4	6.8	100.0
1975-76	56.1	14.7	8.9	5.7	7.8	6.8	100.0
1976-77	56.3	13.7	8.8	6.3	8.0	6.9	100.0
1977-78	56.9	13.8	8.5	6.0	7.9	6.9	100.0
1978-79	56.9	13.6	8.7	6.1	7.7	7.0	100.0
1979-80	56.2	13.4	8.9	6.3	7.9	7.3	100.0
1980-81	57.5	12.5	8.5	6.7	8.1	6.7	100.0
1981-82	58.4	11.8	8.2	7.2	8.1	6.3	100.0
1982-83	57.9	11.7	7.8	7.5	8.6	6.5	100.0
1983-84	56.4	12.0	7.7	8.0	9.0	6.9	100.0
1984-85	56.7	11.5	7.5	8.3	9.3	6.7	100.0
1985-86	56.6	11.1	7.7	8.3	9.3	7.0	100.0
1986-87	55.5	11.2	7.6	9.0	9.6	7.1	100.0

* Include expenses on travelling, conveyance, communications, advertisement, rent, research and development, etc.

** Remaining expenditure includes managerial remuneration, employees welfare expenses, provident funds, royalty, selling commission, repairs to buildings, repairs to machinery, other manufacturing expenses and bad debts.

companies is very sizeable, other appropriations made by them are relatively negligible. Interest payments made on borrowings have to be excluded from gross profits and non-operating surplus/deficit included therein to derive profits before tax. Since interest payments made by the companies have been wiping out more than half of the gross profits of the companies from 1982-83 onwards and the contribution of non-operating surplus/deficit to the profits of the companies has remained insignificant, it is important to consider the impact of interest payments on profits before tax[6].

The relative impact of sales, cost of production and its constitutents, and interest payments on profits before tax of the companies may be observed from the annual growth rates (compound) of these items presented in Table 2.

Table 2 : Annual Rates of Growth (Compound) of Selected Items Affecting Profits Before Tax

(Per cent)

Item	1970-71 to 1979-80	1980-81 to 1986-87	1970-71 to 1986-87
(1)	(2)	(3)	(4)
1. Sales*	12.5	14.5	13.4
2. Total cost of production (excluding interest), of which,	12.7	14.8	13.6
(a) Raw materials, components, etc.	12.6	14.6	13.4
(b) Salary, wages and bonus	10.8	12.0	11.3
(c) Stores and spares	13.2	12.3	12.8
(d) Power and fuel	16.1	20.9	18.0
(e) Other expenses	13.3	18.2	15.3
3. Depreciation provision	7.8	20.2	12.7
4. Gross profits	12.7	10.5	11.8
5. Interest payments	13.3	22.5	17.0
6. Profits before tax	12.6	0.4 (5.1)**	7.4

* Sales are net of 'rebates and discounts' and 'excise duty and cess'.

** For the period 1980-81 to 1985-86. Annual compound rate of growth of profits before tax for the period 1980-81 to 1986-87 sharply declined to 0.4 per cent due to a substantial fall in the level of profits before tax in 1986-87.

The annual growth rates (compound) of sales and cost of production have shown similar trends. The growth rate of sales and cost of production were around the same at 12.5 per cent and 12.7 per cent in the seventies, 14.5 per cent and 14.8 per cent in the eighties upto 1986-87 and 13.4 per cent and 13.6 per cent, respectively, during the period 1970-71 to 1986-87. Of the various constituents of the cost of production, while the growth rates of power and fuel and 'other expenses' increased sharply from 16.1 per cent and 13.3 per cent in the seventies to 20.9 per cent and 18.2 per cent, respectively, in the eighties upto 1986-87, the growth rate of stores and spares decelerated from 13.2 per cent to 12.3 per cent. Two features are evident from these developments. Firstly, the total cost of production, despite different trends *inter se* among its constituents, has risen in step with sales which clearly brings out that the increased cost of production has been by and large passed on to the consumers. Secondly, the growth rate of cost of production has maintained a slight edge over the growth rate of sales. This has emanated from the basic characteristics of the RBI data on sales which are presented on 'net' basis after excluding 'rebates and discounts' and 'excise duty and cess' and are measured in nominal terms. Refunds, duty drawback and subsidies obtained on certain products, particularly fertilisers and export-oriented engineering goods, etc., although add up to the surplus of the companies and therefore their profits before tax, yet these do not get reflected in their sale proceeds and to that extent the level of sales is understated. Moreover, prices reflected in the sales data are invariably lower than those actually paid by the consumers.

Even though the rates of growth of sales and cost of production have commensurately risen, side by side, the annual growth rate of gross profits had marginally declined from 12.7 per cent in the seventies to 10.5 per cent in the eighties upto 1986-87 mainly because of the accelerated pace of depreciation provision made by the companies which increased sharply from 7.8 per cent per annum in the seventies to 20.2 per cent per annum during the period 1980-81 to 1986-87. However, the growth rate of profits before tax fell sharply from 12.6 per cent to 0.4 per cent (5.1 per cent from 1980-81 to 1985-86) on account of the sharp rise in interest payments whose growth rate went up from 13.3 per cent to 22.5 per cent per annum during the corresponding periods and also due to the subdued performance of the private corporate sector in 1986-87.

The dependence of the companies on long term borrowings for undertaking investment in fixed assets galloped by fourteen times and on

short term bank borrowings for financing inventories, etc. rose sharply by more than seven times during the selected period which augmented the companies' interest payments burden at a sharp pace. On the other hand, the companies' dependence on paid-up capital for meeting their long term financial requirements for fixed investment increased only by about four times. In this connection it is noteworthy that while interest payments are treated as cost and are deductible for computing taxable profits, dividend payments by the companies do not enjoy this tax benefit. Therefore, relative tax advantage acted as an incentive for the companies to raise long term loans for fixed investment than to opt for equity capital. As a result, heavy interest payments had to be made by the companies, which consequentially acted as a drag on their net profitability. Therefore, interest payments have to be taken as an explanatory variable in explaining the behaviour of profits before tax.

Similarly it is important to consider the cost of raw materials, components, etc. consumed and wage cost to truly capture the impact of cost of production on the profitability of the companies. These variables were tried along with interest payments individually as well as collectively in a few formulations but the results were not found to be encouraging. Although capacity utilisation also affects the profitability of the companies, this variable could not be tried due to non-availability of reliable data. Therefore, the equations given below present the impact of sales as an accelerator on gross profits (GP), profits before interest and tax (PBIT), and profits before tax (PBT) separately as well as PBT in conjuction with interest payments and wholesale price index (WPI) for all commodities which is taken as a proxy for raw material cost for want of a better alternative since index numbers of raw materials[7] are not available for the entire selected period. This procedure is adopted because cost increases are generally passed on to consumers. In particular the post-budgetary increases in the prices of commodities are higher than the incidence of taxes and duties levied in the budgets mainly because of the prevailing practice of marking up prices of goods in response to budgetary imposts.

1. GP = 263.7078 + 0.0825 S

t-Statistic	3.16*	38.73*
Elasticity		0.91

$\bar{R}^2$ = 0.990, D.W. = 1.64, SEE = 181.85, Mean = Rs.2978 crore

2. PBIT = 507.3029 + 0.0809 S
t-Statistic 5.40* 33.76*
Elasticity 0.84

$\bar{R}^2$ = 0.987, D.W. = 1.15, SEE = 204.50, Mean = Rs.3168 crore

3. PBT = 750.8033 + 0.0268 S
t-Statistic 4.74* 6.64*
Elasticity 0.54

$\bar{R}^2$ = 0.74, D.W. = 1.13, SEE = 344.57, Mean = Rs.1633 crore

4. PBT = 178.4412 + 0.0758 S - 1.1082 INT + 2.8801 WPI
t-Statistic 0.66 3.78* 4.33* 1.11
Elasticity 1.53 -1.04 0.41

$\bar{R}^2$ = 0.909, D.W. = 1.40, SEE = 203.70

5. PBIT = 159.9877 + 0.0683 S + 3.3067 WPI
t-Statistic 0.62 7.50* 1.44
Elasticity 0.71 0.24

$\bar{R}^2$ = 0.988, D.W. = 1.49, SEE = 197.17

The above equations present three measures of profitability *viz.*, gross profits, profits before interest and tax, and profits before tax in order to explain the impact of sales on the profitability of the companies. Considering the equation where interest payments are included as an explanatory variable, the coefficient of interest payments is negative as well as very significant. This amply proves that high interest payments have been significantly affecting the pre-tax profits of the companies.

The first equation shows that the total elasticity of gross profits with respect to sales is 0.91 i.e. a 10 per cent increase in sales leads to 9.1 per cent increase in gross profits. Similarly the second and third equations reveal that a 10 per cent increase in sales leads to 8.4 per cent and 5.4 per cent increase in profits before interest and tax, and profits before tax respectively. But since the third equation does not consider some concomitant factors affecting profits before tax, an alternative specification has been taken where interest payments and wholesale price index have been brought into the relationship. The fourth equation, therefore, gives much better results with substantial

improvements in $\bar{R}^2$, D.W. and low standard error of estimate and all the functions turn out to be statistically significant. The fourth equation reveals that if interest payments and WPI (as a proxy for raw material cost) were to be held constant, elasticity of sales would improve considerably to 1.53, implying thereby that a 10 per cent increase in sales would lead to 15.3 per cent increase in profits before tax. The fifth equation shows that if profits before interest and tax (PBIT) is taken as a dependent variable and only WPI is pegged at a constant level, a 10 per cent increase in sales would lead to 7.1 per cent increase in profits before interest and tax. Thus there is a substantial fall in the elasticity of PBT to sales on account of heavy interest payments from 1.53 in the fourth equation to 0.71 in the fifth equation. These results show that gross profits or surplus generated by the companies has been increasingly appropriated by interest payments, resulting in reduction in the level of profits before tax. Further, the small differential between the elasticity of sales to PBIT obtained in the second equation at 0.84 and that observed in the fifth equation at 0.71 reveal that the impact of WPI (as a proxy for raw material cost) is of low order which could presumably be indicative of the phenomenon that the companies mark up the prices of their products slightly higher than the level of increased costs with a view to reaping a small additonal profit margin than what would have otherwise accrued. Statistical parameters obtained in the above specifications also indicate that the influence of sales as an accelerator is significant.

Distribution Pattern of Profits Before Tax

The allocation of tax provision and dividend payments is made out of profits before tax and profits after tax respectively. Details are set out in Table 3.

It would be observed from Table 3 that the amount set aside by the companies for tax provision had maintained more or less a rising trend inspite of large fluctuations in profits before tax which shows that the companies were careful enough to adequately provide for payment of tax liabilities.

The impact of major changes in the tax policy of the Government is clearly identifiable by the sharp variations in the ratio of tax provision to profits before tax in specific years. For instance, the percentage of tax provision to profits before tax had shown a marked rise from 50 per cent in 1974-75 to over 61 per cent in 1975-76 because an

Table 3 : Distribution Pattern of Profits Before Tax

(Amount in Rs. crore)

Year	PBT	PAT	TP	Ratio to PBT of		DIV	RP	Ratio to PAT of	
				PAT	TP			DIV	RP
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1970-71	627	334	293	53.2	46.8	175	158	52.6	47.4
1971-72	674	337	338	50.0	50.0	188	149	55.7	44.3
1972-73	743	378	365	50.8	49.2	210	168	55.6	44.4
1973-74	963	490	473	50.9	49.1	199	292	40.5	59.5
1974-75	1310	655	655	50.0	50.0	192	463	29.3	70.7
1975-76	993	384	610	38.6	61.4	237	146	61.9	38.1
1976-77	1024	393	632	38.3	61.7	271	122	69.0	31.0
1977-78	1142	487	656	42.6	57.4	302	185	62.0	38.0
1978-79	1613	821	792	50.9	49.1	365	456	44.5	55.5
1979-80	2075	1126	949	54.3	45.7	414	712	36.8	63.2
1980-81	1979	1097	882	55.4	44.6	429	668	39.1	60.9
1981-82	2261	1308	953	57.8	42.2	502	806	38.4	61.6
1982-83	2160	1367	793	63.3	36.7	531	836	38.8	61.2
1983-84	1694	925	770	54.6	45.4	537	388	58.0	42.0
1984-85	2122	1247	875	58.8	41.2	646	600	51.8	48.2
1985-86	2976	1856	1120	62.4	37.6	837	1019	45.1	54.9
1986-87	2394	1342	1052	56.1	43.9	938	404	69.9	30.1

important tax concession relating to development rebate had been withdrawn with effect from June 1, 1974 and the new tax concession of investment allowance became available only from April 1, 1976. Therefore, the effective tax rate paid by the companies substantially went up during the interregnum. Similarly the impact of another tax concession of export turnover relief introduced with effect from 1982-83 was witnessed in the decline in effective tax rate from over 42 per cent in 1981-82 to 36.7 per cent in 1982-83. In yet another case, reduction in statutory corporate income tax rate by 5.25 percentage points from 57.75 per cent in 1984-85 to 52.50 in 1985-86 was reflected in the decline in effective tax rate from over 41 per cent to 37.6 per cent in the corresponding years.

Profits after tax had to be utilised for making dividend payments and for ploughing back retained profits into business. It is noteworthy that the amount of dividend payments generally recorded a steady growth from Rs.175 crore in 1970-71 to Rs.414 crore in 1980-81 and further to Rs.938 crore in 1986-87 depending upon profits after tax and the rising level of share capital to be serviced. The steady growth in dividends proves that at any given levels of profits after tax and share capital the companies could ill-afford to disburse dividends less than that in the earlier year except under very difficult circumstances. On the other hand, retained profits registered wide fluctuations from year to year in keeping with profits after tax, thus suggesting that movements in the former were only a shadow of movements in the latter. Retained profits had risen sharply from Rs.158 crore in 1970-71 to Rs.463 crore in 1974-75 and then declined steeply to Rs.146 crore and Rs.122 crore in the next two years before shooting up to Rs.712 crore in 1979-80 and Rs.836 crore in 1982-83 before falling again to Rs.388 crore in 1983-84. Retained profits were as high as Rs.1019 crore in 1985-86 but fell steeply to Rs.404 crore in 1986-87. This behavioural pattern of dividend payments and retained profits confirms the Lintner hypothesis which underscores the stability of dividend behaviour and maintains that retained profits are merely a residual of profits after tax after making dividend payments.

Tax Provision

The extent of tax provision made by the companies depends on the amount of profits before tax and the available tax concessions actually availed of by the companies which together determine the effective corporate income tax rates as against the statutory corporate income tax rate levied by the Government. The data on various tax concessions

actually availed of by the companies during the year are generally not published by the companies in their annual accounts. However, companies publish the necessary data on one of the erstwhile tax concessions namely development rebate/investment allowance. Since development rebate on new investment in plant and machinery was available upto May 31, 1974 and substituted by investment allowance later with effect from April 1, 1976, the impact of this tax concession on the tax provision can be captured. But in the RBI company finances studies investment allowance is adjusted for utilisation of investment allowance as against its actual provision made during the year. As a result, these data actually reflect variation in investment allowance during the year which is much less than the actual investment allowance provision made during the year.

Initially an equation taking into account investment and profits before tax as explanatory variables was tried for estimating tax provision in order to derive the impact of development rebate/investment allowance. But since D.W. was low at 0.95, that equation has not been considered. Another equation including an additional variable of effective tax rate which denotes the rate of taxation actually paid by the companies and represents tax provision as a percentage of profits before tax has, therefore, been tried. It is presented below.

1. TP =	- 519.5820	- 0.0073 ΔK	+ 0.4498 PBT	+ 11.6454 ETR
t-Statistic	6.06	1.88*	20.37*	8.13*
Elasticity		-0.03	0.99	0.74

$\bar{R}^2$ = 0.984, D.W. = 2.34, SEE = 30.31, Mean = Rs.740 crore

The above formulation shows that the marginal rate of taxation on taxable profits of the companies was 45 per cent and the rate of development rebate/investment allowance (net of utilisation) was one per cent of new investment. It may be further observed that the intercept term in the equation is negative and significant which shows that there are several other tax concessions affecting the tax provision. However, these could not be quantified due to non-availability of the requisite data.

Dividends

Among the leading works on dividend behaviour, Tinbergen took into account current profits, lagged profits and lagged surplus. Dobrovolsky explained dividends in terms of savings represented by

profits after tax plus depreciation provision, besides considering lagged dividends. The Lintner model imbibed current profits and lagged dividends to explain dividend payments. Brittain had contended that since cash flow represented earnings of a company, it determined their capacity to pay dividends. It is thus more appropriate to incorporate cash flow composed of profits after tax and depreciation provision as a variable in the model. Some other authors like Dobrovolsky (1951) and Dhrymes & Kurz (1967) have laid emphasis on impact of investment and external finance, respectively, on the dividend decisions. The empirical analysis in the instant case considers lagged dividends alternatively in the cash flow model taking profits after tax plus depreciation provision on the one hand and profits after tax and reserves and surplus of the companies on the other as about one-fourth of the loss-making companies in the RBI sample paid dividends by taking recourse to reserves and surplus in the absence of current profits.

1. DIV	=	20.2610 +	0.0833 (PAT + DEPP) +		0.6185 DIV-1
t-Statistic		1.07	3.81*		4.09*
Elasticity	SR		0.40		
	LR		1.05		

$\bar{R}^2$ = 0.985, D.W. = 1.40, SEE = 28.46, Mean = Rs.425 crore

2. DIV	=	30.9306 +	0.0209 RS +	0.0690 PAT +	0.6282 DIV-1
t-Statistic		1.41	3.70*	2.41**	4.80*
Elasticity	SR		0.23	0.14	
	LR		0.62	0.38	

$\bar{R}^2$ = 0.987, D.W. = 1.47, SEE = 26.79

The empirical results reveal that the dividend pay-out ratio was 8 per cent in the short run and 22 per cent in the long run in the cash flow model. The function which takes into account reserves and surplus of the companies reveals that this variable also played a significant role in determining the dividend pay-out ratios. Investment and external borrowings were also tried as explanatory variables but their impact on dividend behaviour was found to be insignificant. The cash flow model, which includes current profits, depreciation provision and lagged dividends, explains 98 per cent of the variation in the dividends and is presented in Graph VI. The speed of adjustment is 0.38. By substituting the depreciation provision by reserves and surplus in the equation, the coefficient of determination and the speed of adjustment have been found to be 0.99 and 0.37, respectively, which are almost

the same as observed in the first equation. Hence, it confirms that dividends are equally well explained by reserves and surplus along with profits after tax and lagged dividends. The intercept term in both the equations is positive which also corroborates the Lintner hypothesis that corporate managements have a tendency to raise dividend pay-outs over time.

Depreciation Provision

Companies provide for depreciation on their existing fixed capital stock at the prescribed rates generally according to the written down value method which allows greater quantum of depreciation on investment in the initial stage and reduces gradually in the subsequent years. Therefore, any new investment is able to attract a higher depreciation rate than that accruing on the existing stock of fixed capital. This fact is borne out by the results of the following equation.

1. DEPP	= -	0.1865 +	0.0785 ΔK +	0.0511 K-1
t-Statistic		0.004	4.51*	10.26*
Elasticity			0.23	0.77

$\bar{R}^2$ = 0.991, D.W. = 1.70, SEE = 88.19, Mean = Rs.1168 crore

The results show a good fit where opening capital stock i.e., at the beginning of the period, depreciates at the rate of 5 per cent and additional investment during the current year at 8 per cent. Both the variables are significant at one per cent level.

In absolute terms, the estimated depreciation provision rose by over nine times from Rs.355 crore in 1970-71 to Rs.3,274 crore in 1986-87. It stood at Rs.928 crore in 1979-80. The sharp rise in depreciation provision in the eighties partly reflects the impact of the significant increase in investment in gross fixed assets and partly the enhancement in the admissible rates of depreciation with effect from 1983-84. Depreciation provision as a percentage of gross fixed assets, which had ranged between 5.2 and 5.8 per cent from 1970-71 to 1982-83, went up to 6.2 per cent in 1983-84 following enhancement in the admissible rates of depreciation. The effect of enhanced rates of depreciation is further brought out by the fact that while the amount of estimated additional investment in fixed assets had remained at about the same level of Rs.5,200 crore (at current prices) both in 1982-83 and 1983-84, depreciation provision had gone up sharply by Rs.572 crore to Rs.1,915 crore in 1983-84 from Rs.1,343 crore in 1982-83 as

compared with a rise of Rs.241 crore in 1982-83 from Rs.1,102 crore in 1981-82.

Paid-up Capital

The stock adjustment model explains that the desired level of stock of capital issues is governed by sales. This is brought out in the following equation.

1. PUC =	417.7305 +	0.0309 S +	0.6673 PUC -1
t-Statistic	2.96**	5.07*	6.54*
Elasticity	SR	0.28	
	LR	0.84	

$\bar{R}^2$ = 0.999, D.W. = 1.67, SEE = 51.26, Mean = Rs.3648 crore

This specification explains a high proportion of variation in paid-up capital as may be seen from the value of $\bar{R}^2$. The error terms are not serially correlated. The standard error of estimate of the dependent variable is 1.4 per cent of its mean value. The elasticity of raising new capital issues in relation to the accelerator (i.e. sales) is 0.84 in the long run which emerges as the most important factor impelling fresh capital issues. New investment and gross yield on industrial securities have also been tried as additional variables but their impact has been found to be insignificant.

Bank Borrowings

Demand for short term bank borrowings is affected mainly by the level of inventory holdings of the companies. Higher the inventory holdings, higher the demand for bank borrowings and vice versa. The other factors affecting the demand for bank finance include earnings of the companies in the form of retained profits and advance rate of scheduled commercial banks besides conditions obtaining in the money market and the bazar bill rate which signifies the cost of credit charged by the suppliers of raw materials and other inputs from the companies. No systematic data are, however, published on bazar bill rate which were earlier released by the Reserve Bank of India upto 1975-76. The remaining explanatory variables have, therefore, been employed in the following formulations for deriving the empirical results.

1. BB = 384.5966 - 65.8221 RA + 0.2992 INV + 0.6367 BB-1

t-Statistic	1.20	2.46**	4.45*	4.46*
Elasticity	SR	-0.19	0.57	
	LR	-0.52	1.57	

$\bar{R}^2$ = 0.996, D.W. = 1.55, SEE = 198.69, Mean = Rs.4920 crore

2. BB = 329.7861 - 47.4500 RA + 0.4191 INV - 0.6167 RP + 0.3927 BB-1

t-Statistic	1.10	1.76	4.48*	1.72	2.02
Elasticity	SR	-0.14	0.79	-0.06	
	LR	-0.23	1.30	-0.10	

$\bar{R}^2$ = 0.997, D.W. = 1.40, SEE = 184.20

These equations fully bring out the impact of inventory holdings on the demand for short term bank finance. It is also evident from Graph VII. At the given rise of 10 per cent in the inventories, the demand for short term bank finance increases by around 8 per cent in the short run and 13 per cent in the long run which shows paramount impact of inventory holdings by the companies on their taking recourse to short term bank finance. Secondly, higher retained earnings which augment the availability of funds internally, alleviate to some extent the dependence on short term bank borrowings. The rise in retained profits by 10 per cent reduces the demand for short term bank finance nominally by about 1 per cent.

Further, investment was also tried as an explanatory variable in order to investigate its impact on short term bank borrowings. While some impact was observed, its coefficient was not found to be significant. It is noteworthy that advance rate of scheduled commercial banks has the expected negative sign and is also statistically significant. This brings out the impact of monetary policy on inventory investment through the instrument of interest rate mechanism and proves that a rise in the interest rate would reduce the demand for short term bank finance for inventory holdings. It can, however, be seen from the above equations that there is a two-way causation between the level of inventory holdings and the demand for bank borrowings. It thus violates the assumption made in the OLS method that the explanatory variables should be truly exogenous. This brings in the simultaneity problem which may render the single equation model using OLS method of limited use.

The above result, however, is in keeping with the companies'

general policy of efficient fund management whereby they try to reduce their interest burden on short term debts which are utilised for inventory holdings rather than for building up capital assets which require long term finance. The companies, therefore, take recourse, as much as possible, to internal sources of finance and ingenious handling of their inventory portfolio in the case of a hike in interest rates on short term bank borrowings.

Other Borrowings

The long term borrowings of the companies from financial institutions are generally governed by the stock of fixed capital and the availability of funds from internal sources, mainly the retained profits or cash flow (i.e. retained profits plus depreciation provision). The internal funds of the companies are not enough for meeting their long term requirements for undertaking investment in fixed assets. This generates demand for external finance. The extent of outstanding borrowings also acts as a determinant of the ability of the companies to borrow. During the eighties, large doses of institutional finance were released to the private corporate sector which had speedily built up its outstanding position on repayment of loans. In order to highlight this aspect, a dummy variable has been introduced. This feature becomes explicit from the functions given below. The cost of credit, however, seems to have influenced the long term borrowings for fixed investment only in a small measure as an administered interest rate structure prevailed in India during the selected period with enforcement of ceiling lending rates, which artificially restricted the cost of credit[9].

The flow of institutional credit at controlled lending rates galloped during the selected period as the financial institutions were setting increasingly ambitious targets of extending project finance to the industrial sector. The project costs were also rising sharply over the years in the wake of inflationary spiral which would have spurred many an investor to undertake investment expeditiously so as to avoid, as far as possible, undue cost escalation. Obviously in such an economic environment of controlled nominal lending rates of the financial institutions and low real interest rates in view of inflationary trends, the cost of institutional borrowing could not have acted as a deterrent to undertaking fresh fixed capital investment. The impact of cost of borrowing on investment was, therefore, not perceptible while the availability of funds did matter.

1. OB =	- 739.1586 +	641.9775 D +	0.1360 K +	0.1625 RP +	0.7475 OB -1
t-Statistic	3.76*	2.13	1.89	0.29	2.98**
Elasticity	SR		0.46	0.012	
	LR		1.82	0.05	

$\bar{R}^2$ = 0.998, D.W. = 1.71, SEE = 288.85, Mean = Rs. 6238 crore

2. OB =	- 733.4609 +	781.8045 D +	0.1768 K -	0.1957 CF +	0.6424 OB-1
t-Statistic	3.74*	2.72**	2.52**	0.48	3.37*
Elasticity	SR		0.60	-0.05	
	LR		1.68	-0.14	

$\bar{R}^2$ = 0.998, D.W. = 1.72, SEE = 287.00

3. OB =	- 265.6867 +	0.1207 K +	0.0617 D K +	0.1181 RP +	0.5901 OB-1
t-Statistic	1.16	2.08	3.22	0.26	2.60
Elasticity	SR	0.41	0.15	0.01	
	LR	1.00	0.37	0.02	

$\bar{R}^2$ = 0.998, D.W. = 2.09, SEE = 246.30

4. OB =	- 206.3456 +	0.1511 K +	0.0692 D K -	0.1578 CF +	0.4907 OB-1
t-Statistic	0.89	2.66	3.79	0.48	2.81
Elasticity	SR	0.51	0.17	-0.04	
	LR	1.00	0.33	-0.08	

$\bar{R}^2$ = 0.998, D.W. = 2.13, SEE = 244.49

The traditional concept of higher the retained profits, lower the long term borrowings which was witnessed in the sixties and the early seventies has not been upheld during the subsequent period due to a phenomenal rise in the long term borrowings for undertaking additional investment for expansion of existing capacities, diversification of industrial activity and setting up of new projects. The trend was accentuated with increased dependence of the various business houses and large corporate sector giants on all-India term lending financial institutions for financing their projects. Greater reliance on long term borrowings than on paid-up capital raised through floatation of new issues was actuated by quite a few considerations.

Firstly, long term borrowings enabled the companies to claim tax exemption on interest payments which reduced the actual monetary

burden of interest rate to about one-half of the nominal rate. Even this reduced nominal interest rate burden was almost wiped out by the persistent inflationary situation over a period, rendering borrowed funds almost free from any real interest burden.

Secondly, there is a distinct evidence of the companies utilising their limited retained profits for meeting the short term financial requirements for inventory investment and depending on long term borrowings for investment in fixed assets.

Thirdly, recourse to long term borrowings rather than fresh issue of equity enabled the business houses to have safety and security of ownership and control of their industrial empires which could have been threatened by prospective take-over bids by interested parties through cornering of existing and new equity share holdings. This phenomenon was witnessed in the mid-eighties. The stake of large business houses in the equity share holdings of their companies ranged from less than 19 per cent to 40 per cent. With the expansion of equity base resulting from floatation of new issues, they would have had to invest large sums for maintaining their overall stake in the equity share holdings in order to retain a tight grip on and full control of the management of their companies. Any reduction in their share in the equity base could have rendered their position vulnerable to external pressures. Hence greater resort to long term institutional finance than additional equity was considered a safer bet than the convertibility clause of the financial institutions which was exercised more in exception than as a rule. Moreover raising of public issues had its own limitations of Government permission, capacity to pay dividends on fresh capital, liability of servicing the existing share capital, etc.

In view of these basic considerations, companies resorted to large long term borrowings irrespective of the rise in retained profits.

The results in the second equation bear out that the demand for long term finance is positively correlated to increase in investment over a long period and negatively correlated to cash flow of the companies. Growth in the stock of fixed capital is found to be significant at 5 per cent level. The dummy variable marks the shift in the demand for long term borrowings. The significance of the coefficient of the dummy variable is also evident which, *inter alia*, indicates a major shift in the long term borrowings of the companies during the eighties. This is also confirmed by Graph VIII. Likewise the significance of the coefficient of outstanding borrowings reveals that some companies would have

resorted to fresh borrowings in order to partly square up their repayment liabilities. The elasticity of external borrowings with respect to stock of fixed capital is in the range of 0.40 to 0.60 in the short run and 1.00 to 1.80 in the long run. Availability of funds from internal sources only marginally reduces the dependence on external borrowings as its coefficient is not significant. This behaviour is explained by the fact that internal funds are mainly used for inventory formation rather than long term investment. A rise in cash flow by 10 per cent reduces the external borrowings by 1 per cent. The standard error of the estimate is in the range of only 3.9 per cent to 4.6 per cent of the mean and error terms are free from autocorrelation.

Accounts Receivable

Accounts receivable from sundry debtors denote the use of funds and accounts payable to sundry creditors relate to the source of funds for the companies and are also known as trade debt and trade credit respectively. In times of tight money market and a general liquidity crunch, when the trade finds it difficult to make prompt payments for goods purchased from the companies, sales on credit by the companies gain buoyancy and their debtor balances go up. Accounts receivable are also affected by the extent of dues payable by the companies to their own creditors in a given credit policy framework which affect the companies' own access to bank credit and the time limit available to them for discharging such short term debts to sundry creditors. Accounts receivable are, therefore, determined by sales, level of bank finance available to the companies which is affected by their access to bank borrowings and credit regulation measures, the advance rate of commercial banks as a part of the credit policy and accounts payable by them. A few statistical fits are presented below.

1 AR = - 817.0887 + 0.0183 S + 0.7731 BB + 0.2436 AR-1					
t-Statistic		7.02*	1.00	4.19*	1.72
Elasticity	SR		0.13	0.84	
	LR		0.17	1.11	

$\bar{R}^2$ = 0.998, D.W. = 0.98, SEE = 148.58, Mean = Rs. 4507 crore

2. AR = 417.9966 + 0.1071 S - 83.3565 RA + 0.4699 AR-1					
t-Statistic		1.64	6.55*	3.66*	3.93*
Elasticity	SR		0.78	-0.27	
	LR		1.47	-0.51	

$\bar{R}^2$ = 0.998, D.W. = 1.46, SEE = 160.33

3. $AR = -100.4065 + 0.0551\ S - 60.2269\ RA + 0.5941\ BB + 0.1971\ AR\text{-}1$

t-Statistic	0.52	3.64*	4.06*	4.58*	2.09**
Elasticity	SR	0.40	-0.19	0.65	
	LR	0.50	-0.24	0.81	

$\bar{R}^2 = 0.999$, D.W. = 1.44, SEE = 98.17

4. $AR = 778.5856 + 0.1211\ S - 122.9686\ RA + 0.3364\ AP\text{-}1$

t-Statistic	2.64	6.38*	5.05*	2.64**
Elasticity		0.88	-0.39	0.34

$\bar{R}^2 = 0.997$, D.W. = 1.16, SEE = 192.93

The empirical results indicate that dues receivable are mainly affected by the level of bank finance as determined by the credit policy, the advance rate of commercial banks and the sales. This is also corroborated by Graph IX. Accounts payable in respect of materials purchased by the companies also affect their ability to sell goods on credit as can be seen from its statistical significance. The advance rate has the predictable negative impact. Credit regulation measures did have the desired impact on the level of dues receivable during the reference period. It would be observed from the third equation that short run and long run elasticities of short term bank finance are 0.65 and 0.81 respectively. Likewise the short run and long run elasticities of dues receivable to sales are 0.40 and 0.50 respectively. The standard error of the estimates is low in the range of 2 to 4 per cent.

Accounts Payable

Companies have been meeting the gap in their short term financial requirements by keeping outstanding trade dues even higher than the level of bank borrowings since 1979-80. Trade dues were equivalent to 65 per cent of the bank borrowings in 1970-71 and 1971-72 but gathered momentum in the subsequent years to reach as much as bank borrowings in 1978-79. The practice of resorting to trade credits has, therefore, assumed considerable significance particularly in the late seventies as it enabled the companies to secure their raw material requirements without too much dependence on bank credit in the face of acute credit discipline and generally restrictive credit policy pursued by the Reserve Bank of India as a part of the overall policy of demand management to contain inflationary pressures. Trade dues representing free credit on the purchase of materials from various sources for a short span thus mounted.

Accounts payable to sundry creditors are influenced by sales, value of materials purchased, which may also be reflected by wholesale price index as a proxy for the cost of raw materials[10], level of bank borrowings as determined by access to bank credit as laid down in the credit policy, and accounts receivable from sundry debtors. The advance rate of scheduled commercial banks representing cost of credit is relatively of lesser significance than the level of bank borrowings. These factors are captured in the equations presented below. Another important variable relating to cost of borrowing from alternative sources of short term finance could not be used due to non-availability of reliable data on the bazar bill rate.

1. AP = - 319.3646 + 0.1407 S + 0.2178 AP-1

t-Statistic	4.28*	9.63*	2.20
Elasticity	SR	0.87	
	LR	1.11	

$\bar{R}^2$ = 0.998, D.W. = 1.09, SEE = 149.97, Mean = Rs. 5292 crore

2. AP = - 485.8490 + 0.1374 S + 1.5368 WPI + 0.2001 AP-1

t-Statistic	2.31**	9.00*	0.85	1.95
Elasticity	SR	0.85	0.07	
	LR	1.06	0.09	

$\bar{R}^2$ = 0.998, D.W. = 1.20, SEE = 151.60

3. AP = - 375.4769 + 0.1402 S + 4.8908 RA + 0.2184 AR-1

t-Statistic	1.58	9.15*	0.25	2.12
Elasticity		0.87	0.01	0.19

$\bar{R}^2$ = 0.998, D.W. = 1.08, SEE = 155.69

4. AP = - 224.9343 + 0.1889 S - 0.3019 BB + 0.2090 AR-1

t-Statistic	1.71	9.13*	1.45	1.31
Elasticity		1.17	-0.28	0.15

$\bar{R}^2$ = 0.998, D.W. = 1.25, SEE = 167.75

5. AP = 73.3956 + 0.2670 RM - 0.3202 BB + 0.4987 AR

t-Statistic	0.30	10.43*	1.25	2.09
Elasticity		0.86	-0.30	0.42

$\bar{R}^2$ = 0.999, D.W. = 1.49, SEE = 135.17

It may be seen from the second equation that against a rise of 10 per cent in wholesale price index, the short term demand for purchase of raw materials on credit increases by 0.7 per cent and the long run demand by about one per cent. All the specifications explain a high proportion of variation in the accounts payable and the standard error of the estimates is only 2.5 to 3 per cent.

Among the above specifications, the fifth equation has the highest $\bar{R}^2$, relatively better statistical significance of the coefficients and the lowest standard error of estimate. Thus based on the usual statistical criteria, the value of raw materials purchased which is itself influenced by the volume of sales, accounts receivable from sundry debtors and the level of bank borrowings emerge as the main determinants of accounts payable. It is also evident from Graph X. The negative sign with bank borrowings was expected, as higher the bank borrowings, lower the dependence on trade credits. The negative impact of bank borrowings on accounts payable is obvious as larger bank borrowings would lower the demand for the suppliers' credit by way of accounts payable and vice versa. It may be seen from the last equation that a fall in bank borrowings by 10 per cent results in a decline in the suppliers' credit for the purchase of raw materials by 3 per cent. Therefore, in times of credit squeeze, accounts payable by the companies show a bulge on account of their increased dependence for the purchase of raw mateial requirements on credit. This phenomenon clearly underlines the important role played by the RBI credit policy in controlling short term credit to the private corporate sector and its impact on the flow of funds of the companies.

In this context, it needs to be noted that in a sample of several companies, the intercorporate lending and borrowing in the form of accounts receivable and accounts payable do exist. Therefore, the volume and value of these transactions would not capture to that extent the sensitivity of interest rate mechanism as the overall availability of credit which was critical, particularly in the Indian conditions of controlled interest rates during the selected period. Moreover, each industry follows different practices in this regard which may even vary from year to year depending upon the availability of credit. Further the volume of trade credit as well as the period for which it is offered would vary from party to party. These limitations need to be borne in mind while interpreting the overall data on accounts receivable and accounts payable at the macro level.

Impact of Credit Policy on Accounts Payable/Receivable

It is noteworthy that there is a two-way causation between accounts receivable and accounts payable. Whenever accounts receivable by the companies increased sharply, accounts payable by them went up even more steeply, albeit with some fluctuations, as may be seen from Table 4. The accounts receivable as a proportion of accounts payable ranged from 85 to 95 per cent from 1970-71 to 1972-73, in 1976-77 and 1977-78 and again from 1983-84 to 1986-87. This proportion was between 74 and 81 per cent in the remaining years. In absolute terms, the differential between accounts payable and accounts receivable in respect of manufacturing companies, which stood at Rs.56 crore in 1970-71 increased sharply to Rs.595 crore in 1974-75. It reduced in the next three years from 1975-76 to 1977-78 but again increased sharply to Rs. 744 crore in 1978-79, Rs. 1,013 crore in 1979-80, Rs. 1,051 crore in 1980-81 and further to Rs. 1,459 crore in 1981-82 and Rs.1,476 crore in 1982-83. The differential fell to Rs.1,108 crore in 1983-84 but increased to over Rs.1,250 crore in 1984-85 and 1985-86 before plummeting to Rs.615 crore in 1986-87. The impact of restrictive credit policy observed in specific years is, therefore, discernible in terms of the unusually high differential between accounts receivable and accounts payable. Thus restrictive credit policy was seen to have been pursued in 1974-75 and from 1978-79 to 1981-82 and more or less continued in 1982-83 when the accounts payable had far exceeded the accounts receivable. The existence of almost the same differential between accounts payable and accounts receivable in 1982-83 as in 1981-82 and in 1985-86 as in 1984-85 would reveal that the preceding year's credit policies would have been continued in the next year too with some adjustments.

The above observations are borne out by facts. For instance, the extraordinary fiscal measures taken in the form of presentation of a supplementary Central Budget at the end of July 1974 to raise additional resources and the subsequent introduction of a supplementary Railway Budget with a view to enhancing freight rates and passenger fares for financing increasing expenditure in the railways were reinforced by monetary measures to contain inflationary pressures. The credit policy in 1974-75 exhorted banks to liquidate their obligations to the Reserve Bank. The minimum Statutory Liquidity Ratio (SLR) was raised from 32 to 33 per cent of the total demand and time liabilities. A general hike in the structure of lending and deposit rates was announced on July 22, 1974. The Bank Rate was raised from 7 to 9 per cent and the minimum lending rate on bank advances from 11 to 12.5

Table 4 : Accounts Payable and Accounts Receivable by Public Limited Companies

(Amount in Rs. crore)

Year	Accounts payable	Accounts receivable	Differential between col.(2) and col.(3)	Percentage of col.(3) to col.(2)
1.	2.	3.	4.	5.
1970-71	1144	1088	56	95.1
1971-72	1294	1208	86	93.3
1972-73	1447	1285	162	88.8
1973-74	1770	1406	364	79.4
1974-75	2302	1707	595	74.2
1975-76	2446	1987	459	81.2
1976-77	2637	2303	334	87.3
1977-78	3035	2572	463	84.8
1978-79	3573	2829	744	79.2
1979-80	4331	3318	1013	76.6
1980-81	4843	3792	1051	78.3
1981-82	6463	5004	1459	77.4
1982-83	7791	6305	1476	81.0
1983-84	8207	7099	1108	86.5
1984-85	9372	8121	1251	86.6
1985-86	11700	10426	1274	89.1
1986-87	13470	12855	615	95.4

per cent. The minimum rate on advances against commodities covered by selective credit controls was also raised by 2 percentage points. The minimum lending rates applicable to export credit and food procurement advances were also increased. These interest rates were further revised upwards after the imposition of tax on interest. The overall impact of these measures was that the increase in bank credit considerably decelerated to about 14 per cent in 1974-75 as against over 22 per cent in 1973-74. The impact of this development was also reflected in the sharp increase in trade dues of the companies to sundry creditors and the consequent substantial increase in the differential between accounts receivable and accounts payable.

Similarly, the restrictive credit policy measures taken in 1978-79, *inter alia*, included the raising of SLR from 33 to 34 per cent with effect from December 1, 1978, stipulation of the incremental non-food gross credit-deposit ratio for the period December 1, 1978 to end-March 1979 at within 40 per cent, imposition of penalty for default in maintaining SLR and Cash Reserve Ratio (CRR) and exhortation to banks to keep their reliance on RBI, call money market and Participation Certificates to the minimum. In June 1979, the Reserve Bank asked commercial banks to keep credit expansion in 1979-80 (July-June) less than in 1978-79 (July-June) both in absolute and percentage terms. Banks were required to curtail advances to manufacturers and traders utilising stocks of sensitive and scarce commodities and to restrict the limits of cash credit and inland bills of large borrowers to 80 per cent of the peak levels of actual utilisation during the preceding two-year period ended June 1979. This apart, the cost of credit was also increased in September 1979 and refinance facilities tightened. With the exception of a few specified categories, the ceiling rates on short term advances were also raised from 15 to 18 per cent in respect of scheduled commercial banks with demand and time liabilities of Rs. 25 crore and above and from 16 to 19 per cent in the case of those banks which had such liabilities below Rs. 25 crore. Banks were also advised to keep the absolute increase in their non-food credit during the 15-month period from March 31, 1979 to June 30, 1980 upto that during the 15-month period from March 31, 1978 to June 30, 1979. By and large the same credit policy was pursued in 1980-81. However, in order to slightly improve the banks' resources position, the busy season policy announced on October 30, 1980, exempted banks from the requirement of maintaining additional cash reserves of 10 per cent of the incremental net demand and time liabilities accrued since January 14, 1977.

Dear money policy was again in evidence in 1981-82 with a hike in the Bank Rate from 9 to 10 per cent, fixation of a uniform maximum lending rate of 19.5 per cent for all banks irrespective of their size with effect from March 2, 1981 and a hike in the discount rate of the State Bank of India to the higher band of 13-19.5 per cent from 13-15 per cent. In 1982-83, the economy suffered a setback with severe drought conditions and a sharp decline in industrial production resulting in subdued demand for commercial credit. The guideline for credit expansion in 1982-83, given in July 1982, indicated that expansion in non-food credit in 1982-83 could be around the same as in 1981-82, implying continuation of credit restrictions during that year. Thus the high differential between accounts receivable and accounts payable witnessed in those years when the Reserve Bank had particularly persued a

restrictive credit policy, explicitly brings out the impact of credit control measures on the payments position of the companies and trade dues payable by them to sundry creditors showed a sizable increase.

Likewise relaxation in credit policy implemented in specific years was also reflected in improvement in the payments position of the companies and the consequent decline in the differential between accounts receivable and accounts payable. For instance, following subdued demand for commercial credit by the end of March 1983 and low rate of inflation, lending rates were lowered across-the-board and the earlier lending rate of 19.5 per cent was reduced to 18 per cent effective April 1, 1983. This led to a sharp decline in the differential between accounts receivable and accounts payable in 1983-84. Again a relatively cautious stance was adopted in the credit policy in 1984-85 and 1985-86 with a view to mopping up excess liquidity in the banking system. SLR was raised from 35 to 36 per cent in two stages from July 28 and September 1, 1984 and again from 36 to 37 per cent in two stages in June and July 1985. Bank credit witnessed a deceleration in both absolute and percentage terms in 1985-86 as the objective of credit policy in that year was to contain overall growth of liquidity to a rate lower than that for 1984-85. The impact of these measures was visible in the differential between accounts receivable and accounts payable which rose in 1984-85 as well as in 1985-86 from the level reached in 1983-84.

A sharp decline in the differential between accounts receivable and accounts payable to Rs.615 crore in 1986-87 from Rs.1,274 crore in 1985-86 was the result of several relaxations in credit policy announced during 1986-87. These relaxations included the release of an instalment of impounded cash balances, rationalisation of selective credit controls, lowering of the cost of export credit by 2.5 to 4.5 percentage points in March and August 1986, reduction in the refinance rate of the Reserve Bank from 10 to 9 per cent in August 1986, liberalisation of availability of export refinance, softening of Credit Authorisation Scheme (CAS) by extending large discretionary powers to the banks and also by substantially reducing the number of cases subject to CAS approval, reduction in all lending rates above 15 per cent by one percentage point with fixation of ceiling rate at 16.5 per cent instead of 17.5 per cent earlier, promotion of bill acceptances as a mode of financing by banks, etc.

The above interaction between the credit policy pursued by the Reserve Bank of India from time to time and the corresponding high fluctuations in the differential between accounts receivable and accounts payable by the companies clearly outlines the impact of varying

credit policy measures on the payments position of the companies.

Section IV

Main Conclusions

The major results emanating from the foregoing analysis of investment and financial behaviour of manufacturing public limited companies in the private corporate sector are listed below :

(i) The impact of sales as accelerator on stock of fixed capital and new investment is noticeable. The phenomenal increase in investment can be attributed to liberal depreciation rates and other fiscal concessions ushered in the eighties to boost new investment and the companies' recourse to large long term borrowings from development finance institutions. The problem of lag between fixed investment and output or sales is also evident reflecting rather long gestation periods. Long term borrowings from external sources emerge as a major determinant of fixed investment followed by profitability and sales whereas the role of internal funds is limited.

(ii) Cost of borrowing reflected by interest rates payable by the companies to financial institutions did not seem to act as a deterrent in determining investment in fixed assets due to continuous inflationary situation and the consequently rising project costs on the one hand and moderately prescribed ceiling rates on term loans given by the development finance institutions within the framework of administered interest rate regime on the other. The term lending institutions have played a crucial role in the fixed capital formation of the private corporate sector in India. It was facilitated by the RBI which was instrumental in controlling the cost of credit by the imposition of ceiling lending rates and also in the establishment of a wide spectrum of institutional framework for providing medium and long term institutional finance. Availability of investment allowance, which was used as an instrument of tax reduction, also augmented new investment activity.

(iii) The importance of accelerator principle in inventory investment is explicit. A major share of inventory investment is financed by short term bank borrowings followed by retained earnings. The impact of interest rate variations as an instrument of monetary policy for regulating short term bank finance for inventory investment has been well confirmed.

(iv) The burden of mounting interest payments has severely affected the net profitability of the companies inspite of the substantial tax benefit enjoyed by them under the given corporate tax structure.

(v) Sales has an important role in determining profitability. The impact of tax provision on net profitability of the companies has perceptibly declined since 1979-80.

(vi) The influence of increases in raw material cost and wage cost on profits constituted a relatively lesser proportion of the total cost of production during the eighties. While the share of cost of raw materials, components, etc. in the total cost of production moved within a narrow range and remained more or less stable over the selected period, the share of wage cost declined perceptibly. This reflects technological upgradation of the plant and machinery in the selected industries in the eighties and marks a turning point in the Indian industry which became increasingly capital intensive rather than retaining its traditionally labour-intensive character.

(vii) Dividend payments are largely governed by cash flow of the companies reflected by retained earnings and depreciation provision. Reserves and surplus available with the companies play an equally significant role in determining their dividend policies.

(viii) The demand for short term bank borrowings is determined primarily by the level of inventory holdings. This is followed by other factors such as the advance rate of scheduled commercial banks, the availability of internal funds and the volume of outstanding borrowings. The cost of borrowing from alternative sources may also affect the demand for short term bank finance. On an average, the annual demand for short term bank borrowings had gone up almost three-fold during the period 1980-81 to 1986-87 as compared with that in the decade of seventies.

(ix) New capital issues are governed basically by sales rather than the cost of raising them in the capital market which has in any case been within reasonable limits.

(x) The demand for long term borrowings is determined largely by proposed investment in fixed assets and outstanding borrowings at the beginning of the year. It is not much influenced by the availability of internal funds.

(xi) The level of short term bank finance available, the advance rate of scheduled commercial banks and sales are the major determinants of accounts receivable. Credit regulation measures affecting the flow of credit did impinge to a large extent on the demand for bank borrowings while the advance rate of commercial banks played a subsidiary role. The volume of sales and accounts payable proved to be significant in influencing accounts receivable.

(xii) Accounts payable were determined mainly by value of raw materials purchased which in turn depended upon sales, the level of bank borrowings and accounts receivable from sundry debtors. Thus accounts receivable by the companies and accounts payable by them are closely interconnected and they have both risen sharply over the years. The differential between accounts receivable and accounts payable by the companies touched new highs in those years when Reserve Bank pursued a particuarly restrictive credit policy and as a result trade dues payable by them to sundry creditors increased substantially.

Notes

1. The latest comprehensive study on the finances of small, medium and large public limited companies published by the Reserve Bank of India pertains to the year 1987-88. Since 1987-88 was not a normal year in terms of corporate performance, being a drought year, it has not been taken as terminal year for the econometric analysis.

2. Financial institutions have been incorporating a mandatory convertibility clause in the agreements for term loans sanctioned by them to the industrial concerns, and this was in fact in force upto August 1991.

3. Separate data on paid-up capital of all manufacturing public limited companies in the private corporate sector corresponding to the RBI classification of industries have not been estimated for the eighties. Therefore, the data of manufacturing public limited companies figuring in the RBI studies on company finances have been bloated in terms of all public limited companies in the private corporate sector.

4. The methodology is to a large extent inspired by the study on econometric analysis of financial behaviour of the private corporate sector in India for the period 1958-59 to 1974-75, prepared by T.R. Venkatachalam and Y.S.R. Sarma (1978).

5. Refer for details Hayashi, Fumio and Inoue Tohru (1991), pp. 731-753.

6. Excluding interest payments from gross profits gives operating profits which are adjusted for non-operating surplus/deficit for arriving at profits before tax (PBT).

7. Although an index number of raw materials would have been ideal for capturing the value of materials purchased by the companies, it is not available for the entire selected period. The index number of selected items of raw materials was earlier published by the RBI upto 1974-75 and discontinued later. In the absence of relevant data on raw materials alone, wholesale price index for all commodities (1970-71 = 100) has been used as a proxy for the cost of raw materials consumed by the companies. Alternatively, cost of raw materials, components, etc. consumed has also been tried in some functions.

8. Imposition of tax on the interest income from bank loans at the rate of 7 per cent in August 1974 pushed up the cost of credit by about 1 per cent as effective lending rates were increased by the banks. The step was taken to induce reduction in demand for credit. The Government of India abolished this tax in the 1978-79 budget and required the banks to pass on the benefit of this relief to the borrowers. Reimposition of tax on the interest income of banks for the year 1980-81 pushed up the ceiling rate to 19.4 per cent and 20.5 per cent on advances by banks with demand and time liabilities of Rs.25 crore and above, and below Rs.25 crore respectively. Banks were advised to shift the incidence of the interest tax to borrowers on pro-rata basis. The companies seem to have well absorbed the increased incidence of interest tax in 1980-81 as it did not perceptibly change their profitability rate during that year.

9. For more detailed discussion, please refer to Krishnamurty, K., and Sastry, D.U. (1975). They observed : "In addition to investment expenditures and internal flows, cost of raising funds is a determinant of the demand for external finance. The importance of this factor may not be strong where interest rates are below their shadow rates on account of regulation and control. When quantitative controls predominate relative to interest rate mechanism, availability of funds may become primary while the cost of borrowing takes a subsidiary role. Also, when the rates do not move according to the free play of market forces on account of regulation and control, their temporal variability may be small and, therefore, may not register their influence". (p.78).

10. Same as note 7.

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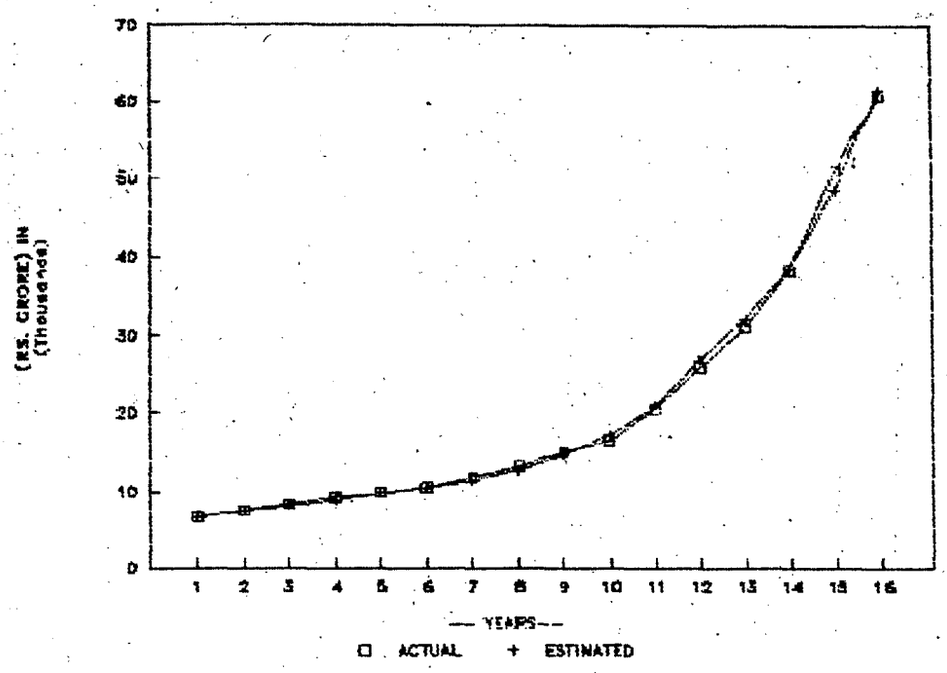
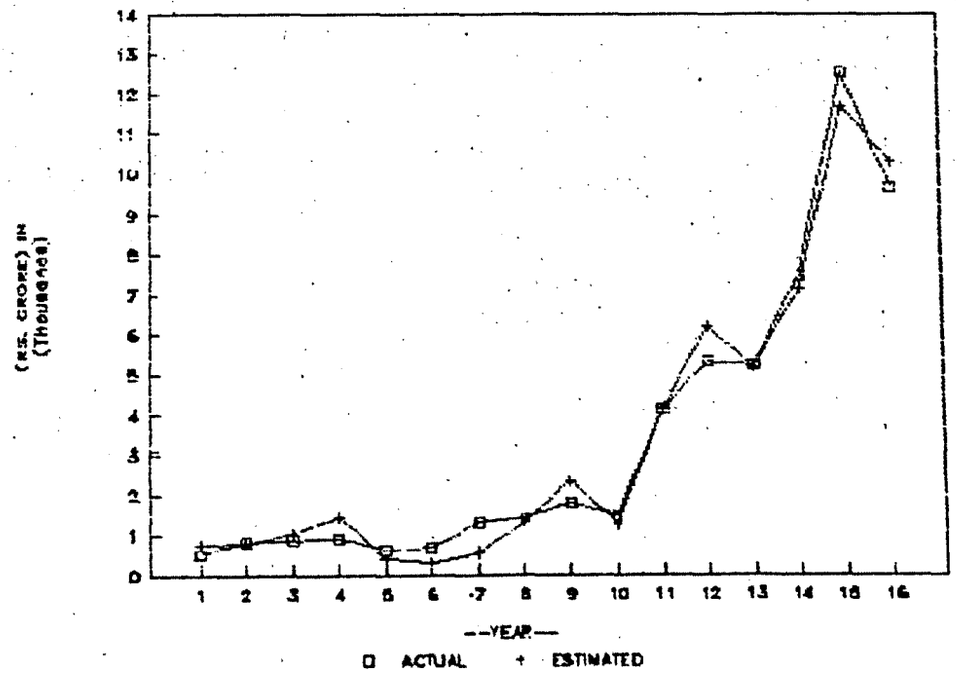
ANNEXURE : SOURCES AND USES OF FUNDS OF PUBLIC LIMITED COMPANIES

Sources of funds	Uses of funds
A. Internal sources	1. Gross fixed assets
1. Paid-up capital	(Fixed investment)
2. Reserves and surplus	2. Inventories
3. Depreciation provision	3. Tax on profits
B. External sources	4. Dividends
4. Paid-up capital raised from new issues	5. Loans and advances
5. Borrowings from	6. Sundry debtors
(i) Banks	(Accounts receivable)
(ii) Indian financial institutions	7. Investments
(iii) Others	8. Cash and bank balances
6. Trade dues to sundry creditors	9. Other assets
(Accounts payable)	
7. Other liabilities	
Total sources (A+B)	Total uses (1 to 9)

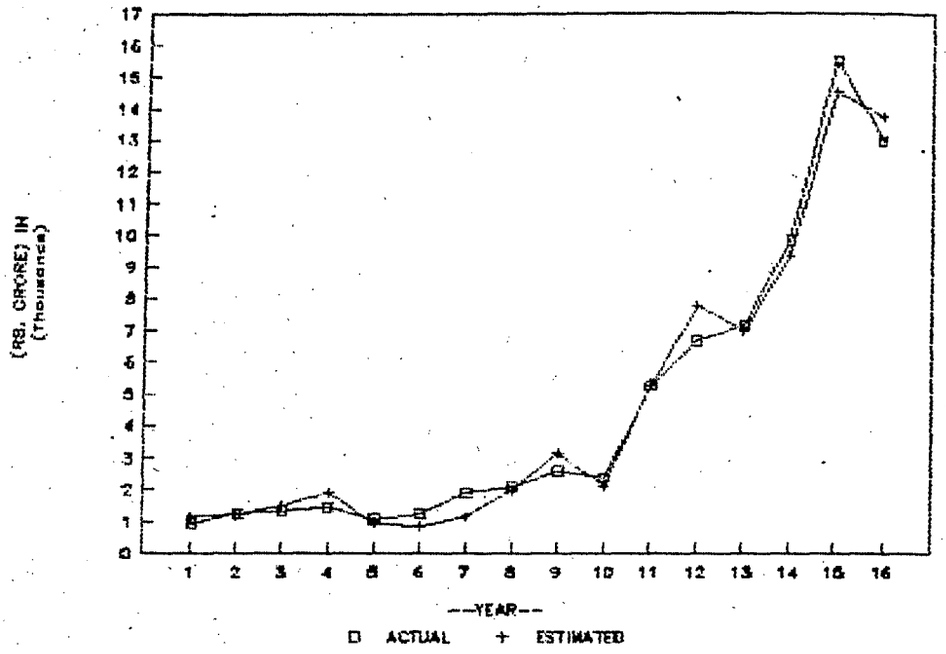
GRAPH I: STOCK OF FIXED CAPITAL (K)



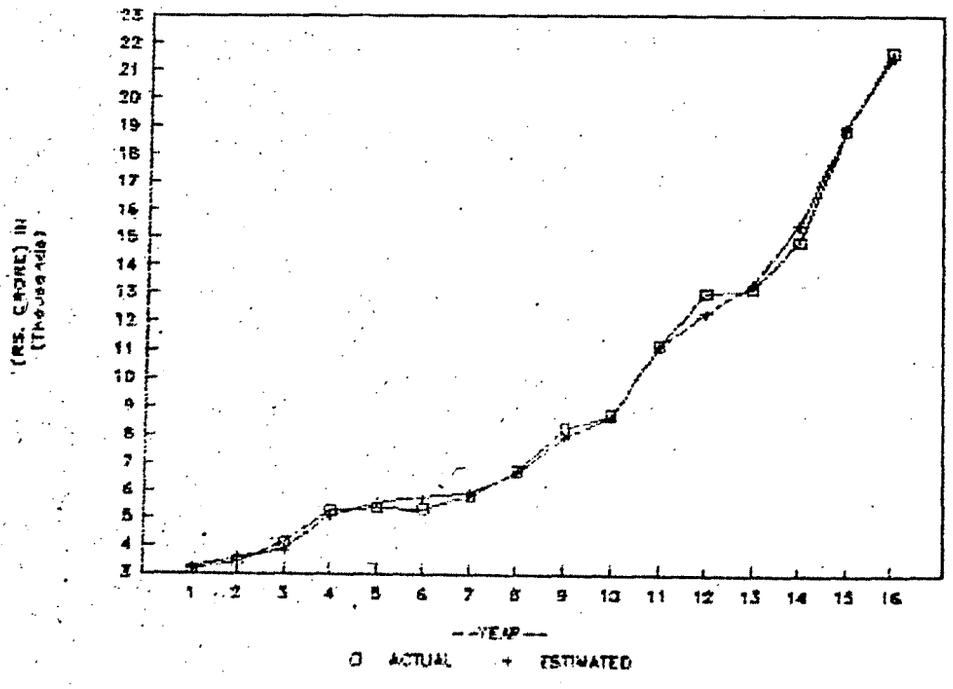
GRAPH II: FIXED INVESTMENT (ΔK)



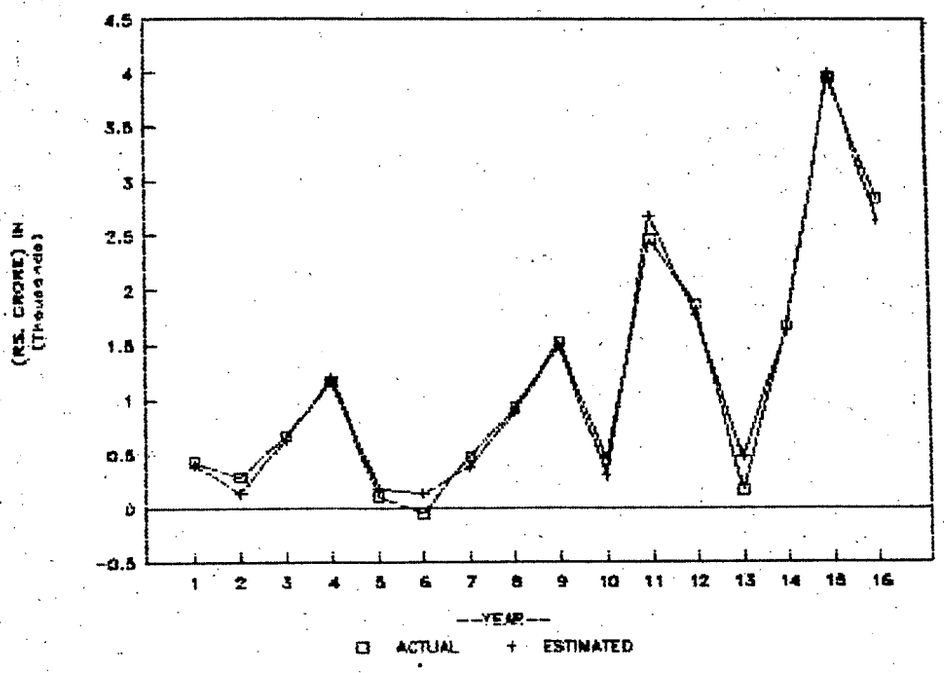
GRAPH III: GROSS INVESTMENT ($\Delta K'$)



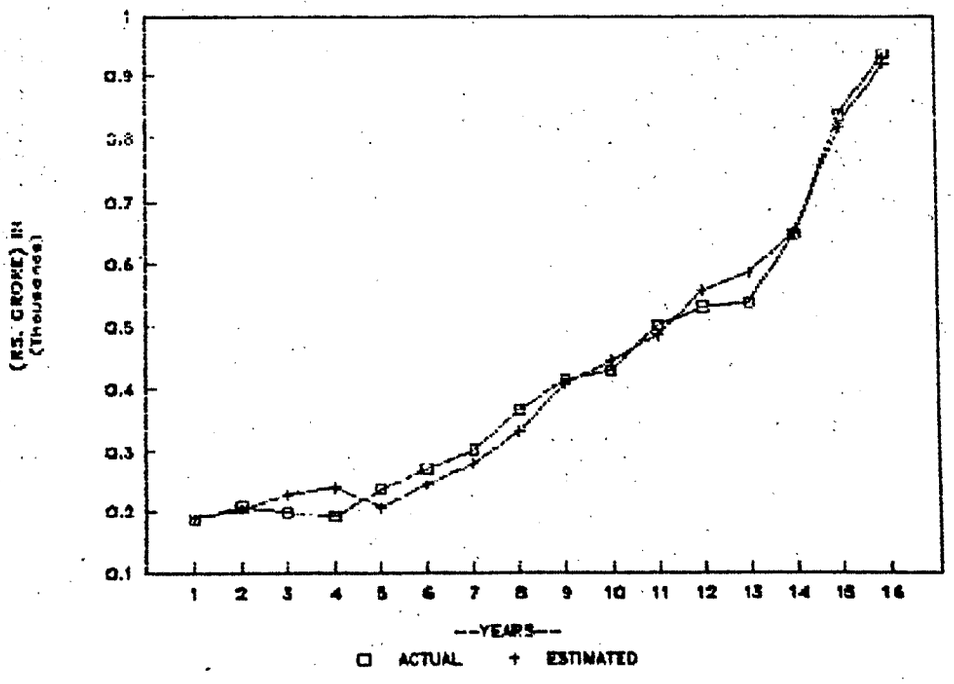
GRAPH IV: STOCK OF INVENTORIES (INV)



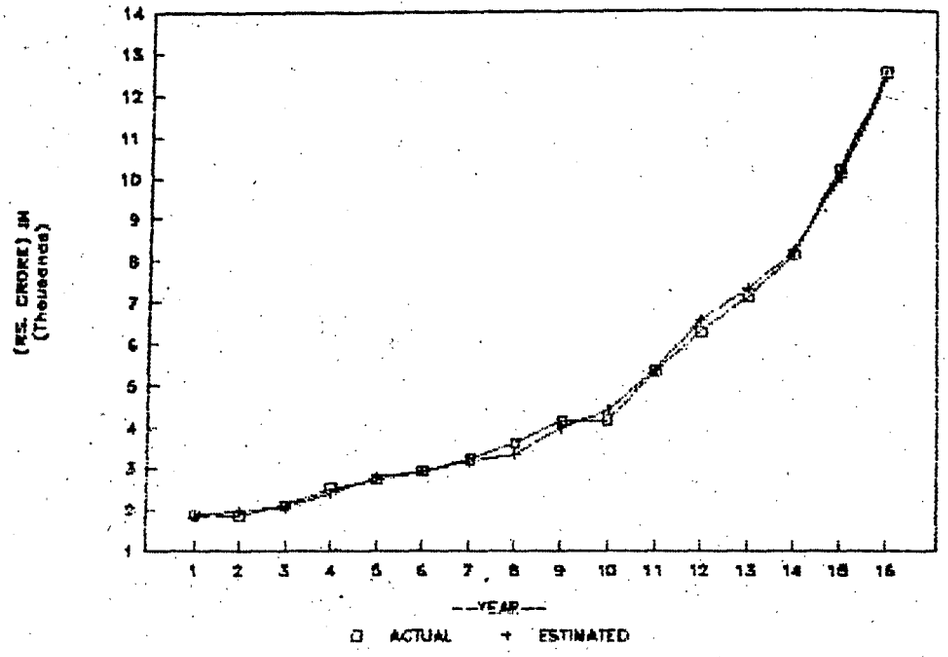
GRAPH V: FLOW OF INVENTORIES (ΔINV)



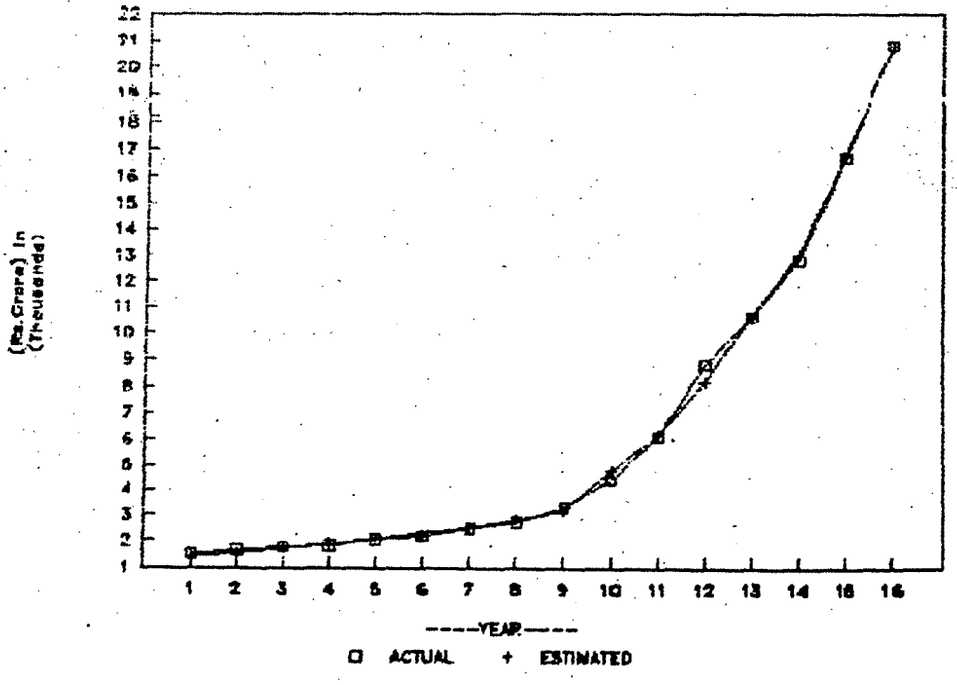
GRAPH VI: DIVIDENDS (DIV)



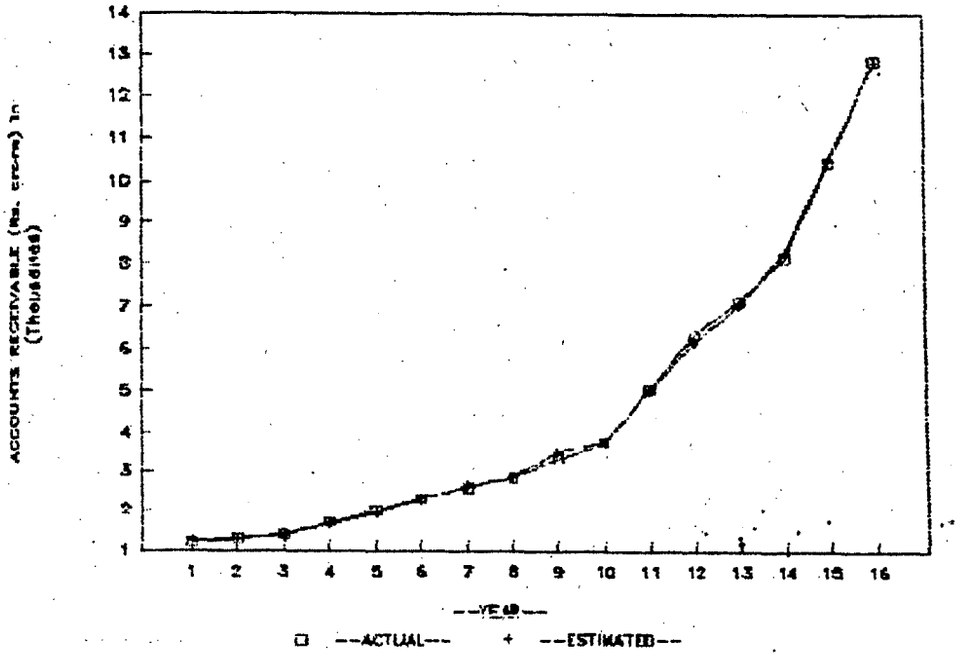
GRAPH VII: BANK BORROWINGS (BB)



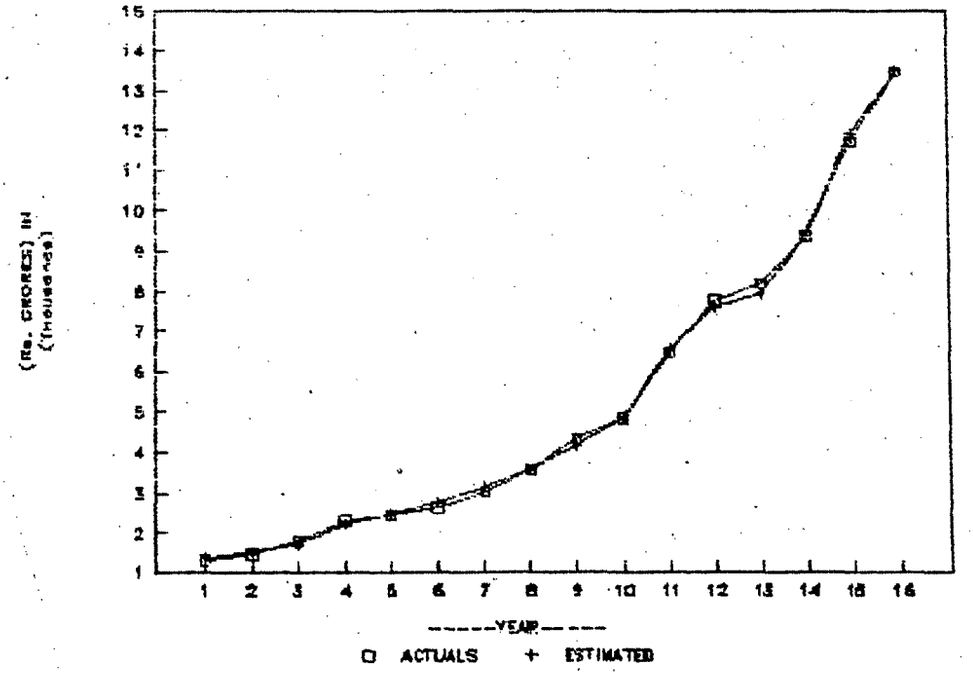
GRAPH VIII: OTHER BORROWINGS (OB)



GRAPH IX: ACCOUNTS RECEIVABLE (AR)



GRAPH X: ACCOUNTS PAYABLE (AP)



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Deterministic and Stochastic Simulation of a Non-Linear Macroeconometric Model : Methodologies & Comparative Performance

by
BALWANT SINGH and A.K. MOHAPATRO*

This study endeavours to present methodological aspects of deterministic simulation using Gauss-Seidel or Newton-Raphson method; stochastic simulation using M. McCarthy's or Nagar's method and also covers static versus dynamic aspects of simulating a non-linear model. By considering the Gauss-Seidel method and using M. McCarthy's method for generating random shocks, the study analyses the empirical relevance of two types of simulations viz., deterministic and stochastic simulation with the help of a small econometric model, wherein alternative versions of *proper* and *improper* specifications of one of the structural equations of the model are assumed. The empirical evidence suggests that the collective performance of the model is sensitive to the mis-specification of any of the structural equations, the degree of sensitivity being sharper in the case of 'dynamic' simulation as compared to the 'static' simulation.

Introduction :

SIMULATION techniques are put to widespread use in econometric model building. Once an econometric model is estimated, a problem that arises is: how to evaluate or test the goodness of fit of the model. In case of single-equation regression models, there exist a number of statistical tests(R^{-2}, F test, t-test, etc.) for judging the nature and appropriateness (in a statistical sense) of the model, the significance of its individual estimated coefficients and the underlying assumptions of the model. Evaluation of simultaneous models, however, is a complex

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process. Even if all the equations of the model fit the data well and are statistically significant, there is no guarantee that the collective performance of the model would be satisfactory.

Although econometricians in general are well acquainted with the use of simulation, literature on the same is only briefly touched upon in their studies. This paper, therefore, presents an account of the methodological and procedural aspects of simulation and highlights the empirical relevance of the two different types of simulations *viz.*, the deterministic and stochastic simulation in model building. The paper is divided into four sections. Section I deals with the general procedures adopted for simulating an econometric model and discusses in particular the two important mathematical procedures for simulating an econometric model. Section II illustrates the empirical relevance of one of these procedures under the alternative versions of proper and improper specifications of one of the structural equations of a small econometric model. Section III is devoted to analysing the comparative performance of the different simulation procedures based on the results obtained. Section IV gives the broad conclusion of the study.

Section-I
Mathematics of Deterministic and Stochastic Simulation

Simulation of an econometric model is in fact a numerical/iterative method of solving a system of simultaneous equations for its endogenous variables. Given a model whose structural parameters have been estimated, the estimation of the solution vector for the endogenous variables is obtained by starting with a given set of initial values for the endogenous variables and using the actual values of the exogenous variables. The model is then 'solved' for each time period using the method of successive iterations. Each iteration yields a set of values for each time point. The vector of values thus obtained is then compared with the initial values. The process is carried further as long as the differences between the current and preceding values is less than a given predetermined value say 'ϵ' which is negligible. This procedure is repeated for obtaining the solution vectors for other time points as well. The simultaneous solution of all equations of the model which yield the time paths for each of the endogenous variables is referred to as the "simulation" solution.

In general, simulation involves the simultaneous determination of the values of the endogenous variables taking into account the

interacting and interdependent behaviour of the system. The system's numerical behaviour is then determined (simulated) for the given values of the exogenous variables and stochastic disturbance error terms. The latter can either be specified *a priori* at given levels (e.g. at their expected values of zero) or chosen through random drawings from a distribution which closely approximates to the data under consideration. If the disturbance terms have zero values, the simulation is referred to as a 'deterministic' simulation. In all other cases where the values of the disturbance terms are either chosen at predetermined levels or drawn through random sampling methods, it is known as 'stochastic' simulation.

Simulations may be classified as dynamic or static. A dynamic simulation is one where historical values are provided for the endogenous vaiables as starting values. Thereafter, the lagged values of the endogenous variables are determined by the simulation solution for the earlier periods. This technique may result in cumulation of errors, i.e. errors associated with the lagged values of endogenous variables. In case these errors tend to become larger as the iterative process continues, the model will diverge in all such simulations. A successful dynamic simulation is, therefore, considered a more stringent test of a model's reliability.

The discussion so far provides a brief general introduction to the basic methodology followed in simulation exercises involving estimation of simultaneous equation system. However, there may be variants to these procedures. The important among these procedures are discussed below.

The generally used procedures for simulating an econometric model are (a) Gauss-Seidel method and (b) Newton-Raphson method. These procedures are applicable in respect of both 'deterministic' and 'stochastic' simulations. Stochastic simulation could be carried out either with respect to (i) error terms of the regression equations or (ii) error terms of the regression coefficients or (iii) a combination of (i) and (ii).

(a) Gauss-Seidel Method

To explain the Gauss-Seidel method, consider the following general representation of a non-linear econometric model :

$$Y_{1t} = f_1 (Y_{2t}, Y_{3t}, \ldots\ldots, Y_{nt}, \bar{X}_{1t}, \ldots, \bar{X}_{mt}) + e_{1t}$$

$$Y_{2t} = f_2 (Y_{1t}, Y_{3t}, \ldots\ldots, Y_{nt}, \bar{X}_{1t}, \ldots, \bar{X}_{mt}) + e_{2t}$$

$$\vdots$$

$$Y_{nt} = f_n (Y_{1t}, Y_{2t}, \ldots\ldots, Y_{n-1t}, \bar{X}_{1t}, \ldots, \bar{X}_{mt}) + e_{nt} \qquad (1)$$

This representation is written with a specific 'normalisation' in mind. The first equation is regarded as explaining the endogenous variable Y_{1t}, the second Y_{2t}, and so on. In the interest of clarity of exposition, the distinction between the lagged endogenous variables and the current and lagged exogenous variables has been suppressed - all the predetermined variables are embraced by X_{it}. The bars over the X_{it} are designed to emphasise that they stand for the particular values of the predetermined variables for which the solution is being generated; f_1, f_2, ..., f_n stand for specified numerical functional forms. In general, all are non-linear, in practice, however, many will be linear.

Like all iterative solution procedures, the Gauss-Seidel method calls for a set of 'starting-values' for each endogenous variable of the system. These take the form of a set of guesses about the solution values of the endogenous variables. Most often, the guess for a particular endogenous variable will be its observed or historical value in period t. When the observed value is not available, a lagged value is used. Denote the starting values for the endogenous variables in period t by :

$$\overset{o}{Y}_{1t}, \overset{o}{Y}_{2t} \ldots\ldots, \overset{o}{Y}_{nt}$$

The Gauss-Seidel iterations proceed from these starting values according to :

$$Y_{1t}^{i+1} = f_1 (Y_{2t}^{i}, Y_{3t}^{i}, \ldots\ldots, Y_{nt}^{i}, \bar{X}_{1t}, \ldots, \bar{X}_{mt}) + e_{1t}$$

$$Y_{2t}^{i+1} = f_2 (Y_{1t}^{i+1}, Y_{3t}^{i}, \ldots\ldots, Y_{nt}^{i}, \bar{X}_{1t}, \ldots, \bar{X}_{mt}) + e_{2t}$$

$$Y_{nt}^{i+1} = f_n (Y_{1t}^{i+1}, Y_{2t}^{i+1}, \ldots\ldots, Y_{n-1\,t}^{i+1}, \bar{X}_{1t}, \ldots, \bar{X}_{mt}) + e_{nt} \qquad (2)$$

Initially, i is set at zero and for subsequent iterations its value is successively 1,2,3...

The iterative process continues until the values of the endogenous variables in successive iterations converge to a pre-set level of tolerance. That is, iteration ceases when :

$$\left| \frac{Y_{jt}^{i+1} - Y_{jt}^{i}}{Y_{jt}^{i}} \right| < \varsigma \text{ for all } j = 1, 2 \ldots\ldots n$$

(If any of the endogenous variables can have a solution value of zero, the denominator is replaced by $Y_{jt}^{i} + 0.0001$ to ensure that the division is always defined). It is conventional to set the tolerance level at one-tenth of 1 per cent ($\varsigma = 0.001$). Thus iterations continue until the proportionate change between successive iterations is smaller than 0.001 for every endogenous variable.

(b) Newton-Raphson Method

An alternative representation of the general non-linear macro econometric model is called for to explain the Newton-Raphson method of solving non-linear systems.

This takes the following form :

$$\begin{aligned}
&f_1(Y_{1t}, Y_{2t}, \ldots\ldots, Y_{nt}, \bar{X}_{1t}, \ldots, \bar{X}_{mt}) + e_{1t} = 0 \\
&f_2(Y_{1t}, Y_{2t}, \ldots\ldots, Y_{nt}, \bar{X}_{1t}, \ldots, \bar{X}_{mt}) + e_{2t} = 0 \\
&\vdots \\
&f_n(Y_{1t}, Y_{2t}, \ldots\ldots, Y_{nt}, \bar{X}_{1t}, \ldots, \bar{X}_{mt}) + e_{nt} = 0 \qquad (3)
\end{aligned}$$

Here too, no distinction is made between the three categories of predetermined variables - all are covered by the $\bar{X}_{it}$. Likewise, f_1, $f_2, \ldots, f_n$ again stand for specified numerical functional forms. In this case, however, no particular normalisation is used in the representation of the system, an advantage that this method has over the Gauss-Seidel method.

A more compact representation of the non-linear system is possible if we define the (1 x n) vector :

$Y = (Y_{1t}\ Y_{2t} \ldots Y_{mt})$

the (1 x m) vector :

$\bar{X} = (\bar{X}_{1t}\ \bar{X}_{2t} \ldots \bar{X}_{mt})$

and the (n x 1) vector-valued function :

$$f(Y, \bar{X}) = \begin{bmatrix} f_1(Y, \bar{X}) \\ f_2(Y, \bar{X}) \\ . \quad . \\ . \quad . \\ . \quad . \\ f_n(Y, \bar{X}) \end{bmatrix}$$

The system is then :

$f(Y, \bar{X}) + e = 0$

where e is the (n x1) vector of residuals.

The next step is to define the so-called 'Jacobian matrix' of the system. The elements of the first row of the Jacobian matrix are the partial derivatives of the first equation with respect to the first endogenous variable, the second endogenous variable, and so on. Similarly, the elements of the second row are the partial derivatives of the second equation of the system with respect to the first endogenous variable, the second endogenous variable, and so on. The remaining rows of the Jacobian matrix are defined in a similar way for the remaining equations of the system. The form of the Jacobian matrix, a matrix of order n x n, is therefore,

$$J = \begin{bmatrix} \frac{\partial f_1}{\partial Y_1} & \frac{\partial f_1}{\partial Y_2} & \ldots\ldots & \frac{\partial f_1}{\partial Y_n} \\ \frac{\partial f_2}{\partial Y_1} & \frac{\partial f_2}{\partial Y_2} & \ldots\ldots & \frac{\partial f_2}{\partial Y_n} \\ .. & .. & & .. \\ .. & .. & & .. \\ .. & .. & & .. \\ \frac{\partial f_n}{\partial Y_1} & \frac{\partial f_n}{\partial Y_2} & \ldots\ldots & \frac{\partial f_n}{\partial Y_n} \end{bmatrix}$$

Note that, in general, since the f are non-linear functions, the elements of J are themselves functions of Y.

Like the Gauss-Seidel method, the Newton-Raphson method is also an iterative method requiring starting values. These are denoted by:

$$Y^{o} = (Y_{1t}^{o}\ Y_{2t}^{o} \ldots\ Y_{nt}^{o})$$

When the Jacobian matrix is evaluated at these values of the endogenous variables and the specified values of the predetermined variables, the result is denoted by J. The Newton-Raphson iterations then proceed according to:

$$Y^{i+1} = Y^{i} - (J^{i})^{-1} (f(Y^{i}, \bar{X}) + e)$$

i being set initially at zero and then at 1, 2, ... in successive iterations. The iterative process continues until the values of the endogenous variables in successive iterations converge to a pre-set level of tolerance in the same way as explained in case of the Gauss-Seidel method.

Deterministic Versus Stochastic Simulation

We have briefly described above two important techniques of simulation viz., the Gauss-Seidel Method and the Newton-Raphson Method. It may be noted in this context that in order to solve a model, some assumptions should be made either with respect to error terms or the coefficient estimates, or both, which in turn presuppose assumptions about the distribution of the error terms and/or coefficient estimates. Many models, however, assume normality of these distributions for simplicity.

Against the above backdrop, we may now distinguish between the deterministic and stochastic simulations. If the model is simulated with one set of values of the error terms, the simulation is said to be 'deterministic'. Mostly the expected values of error terms in the models are zero, and hence, for deterministic simulations, the error terms are set to zero. On the other hand, stochastic simulation is one in which many draws of error terms are made in the process of solving the model, thus enabling the model builder to test the model under varying conditions, i.e. under varying assumptions about the error terms.

Thus, in stochastic simulation, instead of setting expected values

of error terms at zero, we add some stochastic elements to each of the equations in the model and then solve the system for various endogenous variables. Hence, the basic problem in stochastic simulation is to obtain stochastic elements to be added in the non-linear system before simulating a model either using Gauss-Seidel method or Newton-Raphson method.

Methods of generating stochastic elements

There are two methods of generating stochastic elemetns viz., (a) M. McCarthy's method and (b) A.L. Nagar's method@

(a) M.McCarthy's Method :

In this method the residuals from the regression equations are used to obtain stochastic error terms to be associated with each of the equations in the model. In stochastic solutions, we substitute random drawings for each of the e_{it}, i.e. for i th endogenous variable and for t th period. The random numbers are normally distributed variates that have the same variance-covariance matrix of the sample residuals. The variance-covariance matrix is an estimate of

$$\Sigma = E[e_{it}\ e_{jt}]$$

This method of drawing the random number is suggested by McCarthy. It consists of forming the matrix

$$U = \begin{bmatrix} e_{11} & e_{12} & \cdots & e_{1n} \\ e_{21} & e_{22} & \cdots & e_{2n} \\ \cdot\cdot & \cdot\cdot & & \cdot\cdot \\ \cdot\cdot & \cdot\cdot & & \cdot\cdot \\ \cdot\cdot & \cdot\cdot & & \cdot\cdot \\ e_{t1} & e_{t2} & \cdots & e_{tn} \end{bmatrix}$$

@ Besides these two methods of stochastic simulation, an advanced technique of stochastic simulation was proposed by Fair taking into account, simultaneously, the stochastic properties of error terms as well as regression coefficients. As per Fair's method, covariance matrix of the error terms can be estimated from the actual residuals of the regression equations and given the estimation technique and the data, one can also estimate the variance-covariance matrix of the regression coefficients. For detailed discussion about Fair's method, refer to Fair (1984, pp. 252-260).

of residuals in each of n equations for a sample period of length t. Thus, each column of U is a t-element vector of residuals from one of the structural equations. The next step is to draw random numbers from a normal distribution with zero mean and unit variance.

$$N = \begin{bmatrix} n_{11} & n_{12} & \cdots & n_{1t} \\ n_{21} & n_{22} & \cdots & n_{2t} \\ \cdot\cdot & \cdot\cdot & \cdots & \cdot\cdot \\ \cdot\cdot & \cdot\cdot & \cdots & \cdot\cdot \\ \cdot\cdot & \cdot\cdot & \cdots & \cdot\cdot \\ n_{s1} & n_{s2} & \cdots & n_{st} \end{bmatrix}$$

Each row of N is a vector of independent unit normal variates of length equal to the sample span t. There are as many rows in N as there are periods of simulation. The matrix product

$V = \frac{1}{\sqrt{t}}$ NU provides an s x n matrix of

disturbances that have the same variance-covariance matrix as the sample estimate of Σ. This is McCarthy's technique.

If the random numbers are independently drawn, the successive elements within column of V will be independent

$$E[V_{ti}\, V_{t-j,i}] = 0 \qquad i \neq j$$

The shock procedure preserves variances and unlagged correlations across equation residuals; it does not preserve serial properties, either within, or across, equation residuals. McCarthy has shown how serial properties can be preserved if we modify his procedure as follows. The rows of N should not be independent in this case. The first row will consist of t-element series of independent unit normal variates. The second row will consist of first t-1 elements of the first row shifted one place to the right, and a new independent drawing will be made for vacant first position. The third row will consist of the first t-1 elements of the second row, shifted one place to the right and an independent drawing and so on. The whole matrix will be

$$N^* = \begin{bmatrix} n_1 & n_2 & n_3 & \cdots & n_t \\ n_{t+1} & n_1 & n_2 & \cdots & n_{t-1} \\ \cdot\cdot & \cdot\cdot & \cdot\cdot & \cdots & \cdot\cdot \\ \cdot\cdot & \cdot\cdot & \cdot\cdot & \cdots & \cdot\cdot \\ \cdot\cdot & \cdot\cdot & \cdot\cdot & \cdots & \cdot\cdot \\ n_{t+s-1} & n_{t+s-2} & n_{t+s-3} & \cdots & n_s \end{bmatrix}$$

In this case

$$V^* = \frac{1}{\sqrt{t}} N^* U$$

will have the expected variances, covariances and lag correlations (within and between disturbance series) equal to corresponding sample values obtained from the residual matrix.

(b) A.L. Nagar's Method

In this method instead of using the actual residual error matrix U, we use the variance covariance matrix of residuals. The procedure adopted for generating the random shocks is as follows :

$$\text{Let } N = \begin{bmatrix} n_{11} & n_{12} & n_{13} & \cdots & n_{1n} \\ n_{21} & n_{22} & n_{23} & \cdots & n_{2n} \\ \cdot\cdot & \cdot\cdot & \cdot\cdot & \cdots & \cdot\cdot \\ \cdot\cdot & \cdot\cdot & \cdot\cdot & \cdots & \cdot\cdot \\ \cdot\cdot & \cdot\cdot & \cdot\cdot & \cdots & \cdot\cdot \\ n_{t1} & n_{t2} & \cdot\cdot & \cdots & n_{tn} \end{bmatrix}$$

be a (t x n) matrix of random numbers distributed with zero mean and unit variance.

An estimate of the variance-covariance matrix of the residuals is

$$\Sigma = \frac{1}{t} (U' U)$$

$$= \begin{bmatrix} \sigma_{11} & \sigma_{12} & \cdot\cdot & \sigma_{1n} \\ \sigma_{21} & \sigma_{22} & \cdot\cdot & \sigma_{2n} \\ \cdot\cdot & \cdot\cdot & & \cdot\cdot \\ \cdot\cdot & \cdot\cdot & & \cdot\cdot \\ \sigma_{n1} & \sigma_{n2} & \cdot\cdot & \sigma_{nn} \end{bmatrix}$$

As per Nagar's method, the random shocks are generated from matrix V where V = NA, A is a (n x n) transformation matrix such that V has the same variance-covariance matrix as Σ.

$$\text{Therefore } \Sigma = \frac{1}{t}(U' U) = \frac{1}{t}(V' V)$$
$$= \frac{1}{t}(A' N' NA)$$

We then solve A in terms of Σ.

Since Σ is a symmetric matrix, we do not have sufficient equations to solve for all elements of A. To overcome this problem, we assume A to be a triangular matrix i.e.

$(a_{ij}) = 0$ for $i<j$. The diagonal elements of A are given by the following formulae

$$a_{ii} = \sqrt{\sigma_{ii} - \sum_{k=i+1}^{n} a_{ki}^2} \quad \text{for } i = 1, 2, \ldots, n-1$$

and $a_{nn} = \sqrt{\sigma_{nn}}$ for $i = n$

The off diagonal elements are given by the following formalae for $i > j$

$$a_{ij} = (\sigma_{ij} - \sum_{k=i+1}^{n} a_{ki} a_{kj}) / a_{ii} \quad i = 1, 2, \ldots, n-1.$$

$$a_{nj} = \sigma_{nj} / a_{nn} \quad j = 1, 2, \ldots \ldots n-1.$$

and $a_{ij} = 0$ for $i<j$ by assumption. Given the elements of A as above, the stochastic elements to be added to each equation are obtained as the elements of the matrix

$$V = NA$$

Stochastic shocks obtained, either by using McCarthy's method or Nagar's method, are added to the non-linear systems of the equations before simulating a model. Solution for the endogenous variables can then be obtained either using Gauss-Seidel method or Newton-Raphson method.

Section - II

Specification and Estimation of the Econometric Model

To know the comparative performance of deterministic and stochastic simulation, a small non-linear macro-econometric model relating to the bank credit, output and prices has been developed here. As the emphasis here is on technique, results of policy simulation experiments have been omitted. To demonstrate as to how a small change in one of the structural equations may alter the collective performance of the entire model, a comparative performance of the deterministic and stochastic simulation was carried out using two different versions of the same model viz. model 1 and model 2. In model 2 all the equations have been specified, while it was not so in respect of Model 1 wherein the specification of one of the equations, i.e. equation 3, was inadequate. Specification of the equations for models 1 and 2 are as given below.

Exhibit-1

Model 1

$$\Delta M_3 = f(\Delta RBCG, \ \Delta BCCS, \ \Delta BCG) \quad \ldots\ldots (1)$$

$$BCCS = f(D, \ (BCG+BR), \ BOR) \quad \ldots\ldots (2)$$

$$\Delta D = f(YR) \quad \ldots\ldots (3)$$

$$YR = f(KR_{-1}, \ WF, \ (BCG+BCCS)/WP) \quad \ldots\ldots (4)$$

$$WP = f(M_3/YR, \ Dummy, \ WP_{-1}), \quad \ldots\ldots (5)$$

Excepting for equation (3), specification of all other equations for both models 1 and 2 are the same. In model 2, equation (3) relating to the deposits is estimated with a different specification as given below.

Model - 2

$$D/WP = f(YR, \ (D/WP)_{-1}) \quad \ldots\ldots (6)$$

All other equations of the model 2 are the same as in case of model 1. The following two identities are used in these two models.

$$M_3 = M_{3-1} + \Delta M_3 \quad \ldots . (7)$$
$$D = D_{-1} + \Delta D \quad \ldots \ldots . (8)$$

Endogenous & Exogenous Variables are :

M_3	=	Broad money supply
D	=	Deposits (demand deposit + time deposit)
BCCS	=	Banks' credit to the commercial sector
YR	=	Net domestic output at factor cost at 1980-81 prices
WP	=	Wholesale price index (Base = 1980-81)
BCG	=	Other Banks' credit to the government (i.e. excluding RBI credit to the government)
RBCG	=	Reserve Bank credit to government
BR	=	Bankers' deposits with the RBI
BOR	=	Reserve Bank's claims on the commercial banks
WF	=	Weather index
KR	=	Net capital stock at 1980-81 prices
Dummy	=	Dummy variable, 1 for 1973-74 and 1974-75 and 0 for the other years

and Δ = Difference.

The structural parameters of both the models are estimated using annual data for the period 1971-72 to 1988-89, compiled from various issues of the National Accounts Statistics and Report on Currency and Finance published by the Government of India and the Reserve Bank of India, respectively. The behavioural equations are estimated using Ordinary Least Squares (OLS). Despite its limitations, the OLS technique is widely used to estimate structural parameters, particularly when the number of variables covered are large and the sample of observations is small. Though the emphasis of this study is on technique, however, to obtain some useful results, several alternative formulations of the equations were chosen on the basis of economic and statistical criteria like the appropriateness of sign according to *a priori* theory, the coefficient of determination adjusted for degrees of freedom ($\bar{R}^2$), the Durbin-Watson statistics (D.W. and h), the t-statistics and the standard error as a proportion to the mean of the estimate. The empirical results are given below.

Money supply Equation ..... (9)

ΔM_3 =	260.19	+ 0.71508	ΔRBCG	+ 0.78748	ΔBCCS	+ 1.24537	ΔBCG
t	0.56	3.68		5.60		4.47	
E		0.22		0.51		0.24	

$\bar{R}^2$ = 0.98 D.W. = 1.76 SEE = 1193.93 Mean (M_3) = 68072 CV (wrt M_3) = 1.75

Bank's Credit to the Commercial Sector ... (10)

BCCS =	- 1466.53	+ 1.29009 D	- 1.32511	(BCG + BR)	+ 1.20250 BOR
t	2.44	22.28	8.46		2.61
E		1.54	-0.54		0.04

$\bar{R}^2$ = 0.99 D.W. = 1.04 SEE = 783.12 Mean = 43691 CV = 1.79

Demand for Deposits ..... (11)

ΔD =	- 20998.10549	+ 0.25304 YR	
t	13.86	19.66	
E		3.59	

$\bar{R}^2$ = 0.96 D.W. = 1.52 SEE = 1361.45 Mean = 8098.61 CV (wrt D) = 2.61

D/WP =	230.24338	+ 0.00362 YR	+ 0.64212 $(D/WP)_{-1}$	.... (12)
t	3.90	4.01	5.62	
E		0.93	0.58	

$\bar{R}^2$ = 0.99 D.W. = 1.72 SEE = 18.64 Mean = 449.15 CV = 4.15

Real Output ..... (13)

YR =	31977.15121	+ 59.27327 (BCCS + BCG)/WP	+ 0.12948 $(KR)_{-1}$	+ 72.72775 WF	
t	3.27	2.47	2.16	2.81	
E		0.25	0.36	0.11	

$\bar{R}^2$ = 0.99 D.W. = 1.56 SEE = 2528.80 Mean = 114990.33 CV = 2.20

Price Equation ..... (14)

$$WP = 0.07794 + 0.35619\,(M_3/YR) + 0.77988\,(WP)_{-1} + 0.06993\ \text{Dummy}$$

t	1.67	2.15	5.57	2.22
E		0.19	0.72	0.008

$\bar{R}^2 = 0.99$ D.W. = 1.57 SEE = 0.0382 Mean = 0.9805 CV = 3.89

Regression equation (9), represents sources of changes in broad money supply. The empirical results yielded statistically good fit. Similarly, empirical results of equation (10) also show expected signs. The relationships indicate that a 1 per cent rise in banks' credit to the government and banks' reserves, would cause a decline of 0.54 per cent in the banks' credit to the commercial sector. As mentioned earlier, for the purpose of testing the hypothesis concerning the sensitivity of the model with and without proper specification of relationships, equation (11) which relates real output to changes in deposits is deliberately specified inadequately. It has, however, been ensured that the equation yields a statistically good fit. In terms of equation (12), the elasticity of real deposits (i.e. nominal deposits deflated by the wholesale price index) with respect to real output works out to be 0.93 in the short-run and 2.58 in the long-run.

In Equation (13), which captures the positive impact of the banks' credit (to both commercial and government sector), the elasticity of output with respect to net capital stock (with a lag of one year) works out to be marginally higher at 0.36 as compared to the estimate of 0.29 obtained by Rangarajan and Arif (1990). The elasticity of real output with respect to banks' credit is estimated at around 0.25. According to Rangarajan and Arif, who considered M_3 instead of BC, the corresponding elasticity of output with respect to M_3 worked out to be 0.23. In line with the theoretical frame-work, the price level estimated through equation (14) responds positively to monetary expansion and inversely to higher output. The lagged price variable serves as a proxy for price expectations besides capturing the lagged effects of output and money supply on the current year's price. A dummy variable takes into account the outliers on account of the unusually high inflation levels observed in 1973-74 and 1974-75. Thus, the equation which is framed in partial adjustments framework by and large explains a high proportion of variation in prices. In sum, the empirical results of almost all the equations conform to the economic principles and therefore are rendered amenable for carrying out the test of collective performance through simulation.

Section - III

Comparative Performance of Deterministic and Stochastic Simulation

In Section I, we have presented literature on two different methods of simulating an econometric model viz., Gauss-Seidel method and Newton-Raphson method. In this section, we shall use only Gauss-Seidel method. Similarly, of the two different approaches of stochastic simulation viz. (a) Stochastic Simulation using M. McCarthy's method for generating random shocks and (b) Stochastic Simulation using Nagar's method for generating random shocks, the empirical coverage of this study is limited to McCarthy's method only. This is done mainly for reasons of convenience.

Regarding the deterministic simulation, the explanation could be brief. Collective performance of the model can be judged on the basis of root mean square percentage error and mean absolute percentage error, etc. and is presented along with the corresponding results for the stochastic simulation in Tables 3 and 4. However, before presenting the final results of the stochastic simulation, it may be essential to analyse some statistical characteristics of the error terms obtained through the OLS and those of random shocks obtained from the use of McCarthy's method.

As described earlier, the basic distinction between the deterministic simulation and stochastic simulation is that in stochastic simulation, the actual errors of the regression equations are replaced by the random shocks generated by using the random numbers and the error terms of the equations. Therefore, one desirable characteristic of the random shocks is that they should follow similar distribution as those of the error terms. Hence, the mean error terms, i.e. E[ei], worked out on the basis of the error terms obtained from the OLS residuals and from the random shocks should not deviate much.

Tables 1 and 2 give the mean error terms and corresponding variance terms estimated on the basis of OLS residuals and the random shocks to be added to the constant terms of the regression equations before attempting stochastic simulation of the models. The empirical results suggest that the distribution of the random shocks do not deviate widely from the corresponding distributions of the OLS residuals.

For a quick comprehension of the results of two methods and two

Table 1 : Mean Error Term of the OLS Residual and Random Shocks

(Simulation period = 16 years)

	Model - 1				
	ΔM_3	BCCS	ΔD	YR	WP
OLS Residuals	22.18	-67.23	-175.69	63.62	0.0037
Random shocks	188.64	135.82	403.40	539.41	-0.0100
	Model - 2				
	ΔM_3	BCCS	D	YR	WP
OLS Residuals	22.18	-67.23	-151.21	63.52	0.0012
Random shocks	188.64	135.82	107.00	539.41	-0.0100

Δ : Difference

Note : The structural parameters are estimated using data for 18 years.

Table 2 : Variance of the Error Terms of the OLS Residuals and Random shocks

	Model - 1				
	ΔM_3	BCCS	ΔD	YR	WP
OLS Residuals	1243125	499874	1592869	5555501	0.0012
Random shocks	1131759	545801	1529638	5016840	0.0010
	Model - 2				
	ΔM_3	BCCS	D	YR	WP
OLS Residuals	1243125	499874	3529460	5555501	0.0012
Random shocks	1131759	545801	2540331	5016840	0.0010

models, the actual values and simulated values using deterministic and stochastic simulation are given in the graphs.

In all 20 graphs, 10 each for model 1 and model 2, are included in the study. Of the 10 graphs for each model, 5 relate to static simulation and 5 to dynamic simulation. To facilitate the comparative analysis of model 1 and model 2, graphs for each variable are presented in continuation. That is, figures 1 to 4 relate to M_3 and the first two figures are for static version of simulation for model 1 and 2, respectively and the subsequent two figures relate to the respective dynamic version of simulation.

The results of simulation exercises carried out using Models 1 and 2 are given in Tables 3 and 4, respectively. A comparative study of the simulation results obtained by using Models 1 and 2 shows some interesting results. While the deterministic simulation of Model 1 under the static scenario yielded comparatively better results, the corresponding results under the dynamic scenario showed wide variations (vide Table 3). However, using Model 2 (which is the same as Model 1 excepting that the specification for equation (3) of Model 1 is more appropriately defined), the results showed marked improvement when both deterministic and stochastic simulations are carried out under both the static and dynamic scenarios.

We may, now examine the plausible reasons for the divergent results obtained by using Models 1 and 2. It may be noted that using Model 1, the mean absolute percentage error and root mean square error in case of stochastic simulation worked out to be much larger than those obtained for deterministic simulation. In the former case, the mean absolute percentage error is so high that one is compelled to check the appropriateness of the specifications of each of the equations of the model and attempt reformulation of the same. Accordingly, it may be seen that when equation (3) in Model 1 is suitably modified in Model 2, the collective performance of the model improved very much under both deterministic and stochastic simulations (vide Table 4).

In case of deterministic simulation, the mean absolute percentage error and root mean square percentage error were found to be well within the acceptable range, except for two variables, *viz.*, BCCS and D in which case the root mean square percentage error were 15.53 per cent and 11.67 per cent, respectively.

For all other variables, the mean square percentage error and root

Table 3 : Results of Deterministic and Stochastic Stimulation

Model - 1

	Deterministic			Stochastic		
	OLS	Static	Dynamic	OLS	Static	Dynamic
1. M_3^*						
MAPE	0.00	3.48	13.65	0.00	5.69	39.25
RMSPE	0.00	4.58	17.05	0.00	7.53	46.05
2. BCCS						
MAPE	1.68	6.16	25.84	2.23	10.17	75.65
RMSPE	2.01	8.01	30.80	3.73	13.68	88.80
3. D*						
MAPE	0.00	3.83	29.45	0.00	5.81	49.18
RMSPE	0.00	4.63	38.94	0.00	8.15	57.98
4. YR						
MAPE	1.64	2.50	3.51	2.28	3.61	15.13
RMSPE	2.26	3.61	5.18	3.08	5.37	17.92
5. WP						
MAPE	3.16	3.07	7.68	4.10	4.05	10.66
RMSPE	3.90	3.81	10.08	5.38	5.18	12.68

Note: MAPE: Mean Absolute Percentage Error
RMSPE: Root Mean Square Percentage Error
* Identity

Table 4 : Results of Deterministic and Stochastic Simulation

Model - 2

	Deterministic			Stochastic		
	OLS	Static	Dynamic	OLS	Static	Dynamic
1. M_3^*						
MAPE	0.00	3.84	5.35	0.00	2.97	2.20
RMSPE	0.00	5.27	8.63	0.00	3.73	2.84
2. BCCS						
MAPE	1.68	5.26	9.34	2.23	4.29	6.90
RMSPE	2.01	8.20	15.53	3.73	6.87	9.53
3. D						
MAPE	3.99	4.13	6.85	4.41	3.73	3.94
RMSPE	5.22	6.63	11.67	5.39	4.98	5.76
4. YR						
MAPE	1.64	2.43	2.23	2.28	3.18	3.70
RMSPE	2.26	3.22	2.59	3.08	4.06	4.76
5. WP						
MAPE	3.16	3.13	5.83	4.09	4.18	8.42
RMSPE	3.90	3.95	6.92	5.33	5.43	10.20

Note : MAPE : Mean Absolute Percentage Error
RMSPE : Root Mean Square Percentage Error
* Identity

mean square percentage error were below 10 per cent. As regards stochastic simulation, surprisingly, the collective performance was found to be equally good. Out of the five endogenous variables, for three variables *viz.*, M_3, BCCS, and D both the mean absolute percentage error and root mean square percentage error were on the lower side as compared to their corresponding values in the deterministic simulation. However, in the case of YR and WP, there appears to be wider variations in the stochastic simulation.

Section - IV

Conclusion

In this paper, an attempt has been made to present methodological and procedural aspects of simulating an econometric model with reference to the deterministic and stochastic simulations. The paper covers two different methods of simulating a model *viz.*, Gauss-Seidel and Newton-Raphson method. Similarly, it also covers two different approaches of stochastic simulations. However, empirical coverage of the study has been limited to the Gauss-Seidel method and M. McCarthy's method. There is considerable scope for trying the other methods. One could also conduct further empirical research in the area of developing appropriate simulation exercises with a view to evaluating their comparative performance through adoption of more sophisticated approaches.

By considering the Gauss-Seidel method and using the M. McCarthy's method for generating random shocks, the paper has analysed the empirical relevanace of the two types of simulations viz. deterministic and stochastic simulations with the help of a small econometric model, wherein alternative versions of proper and improper specifications of one of the structural equations of the model have been assumed. One could infer from this study that even if the specification of one of the equations is not appropriate, the collective performance of the model using stochastic simulation would not improve much, since it is very sensitive to the mis-specification of any of the structural equations.

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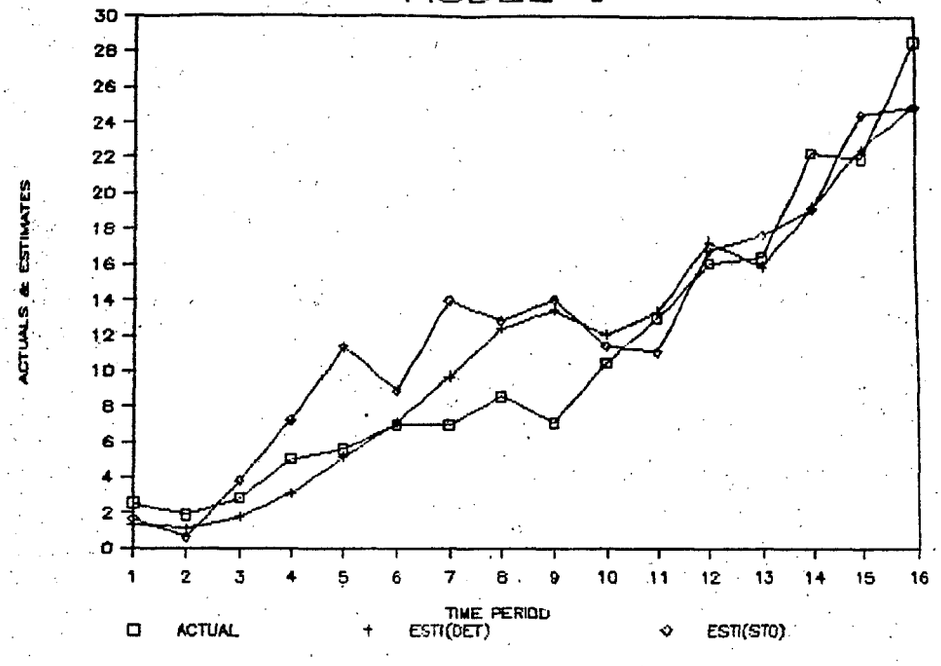
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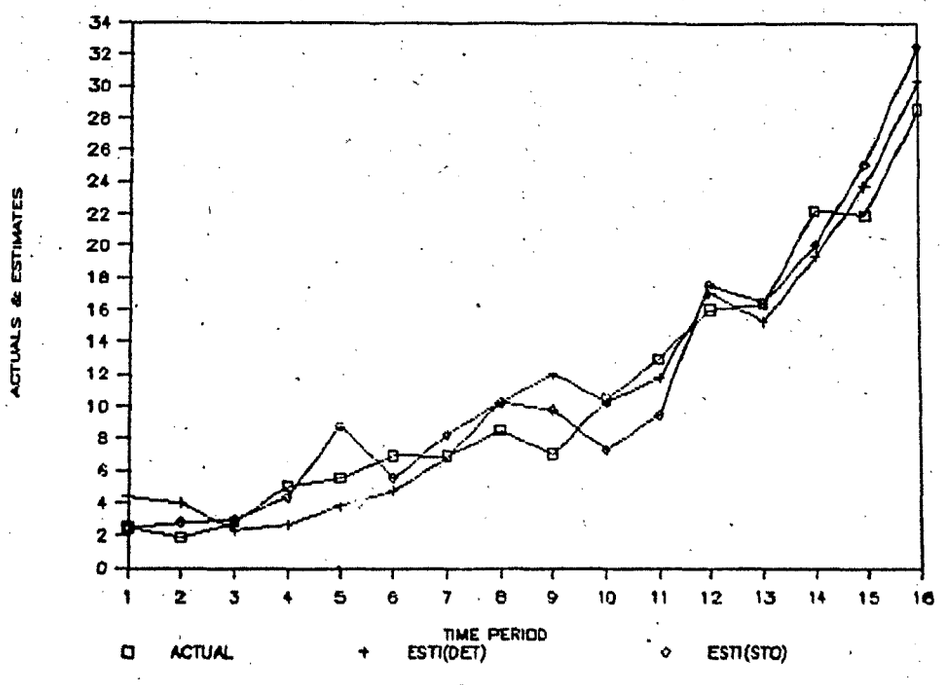
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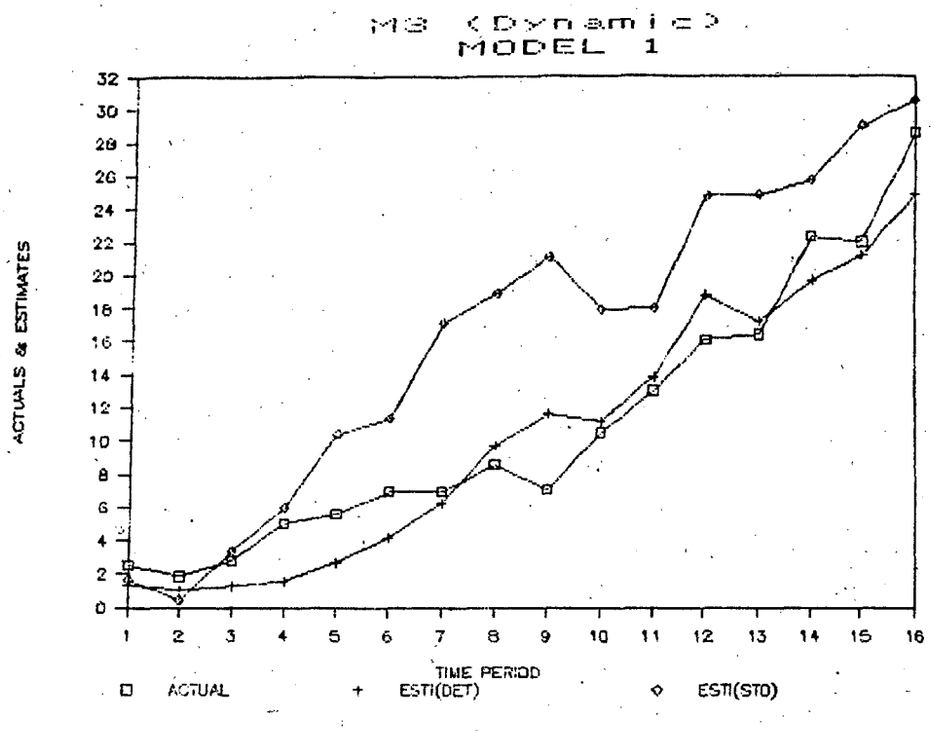
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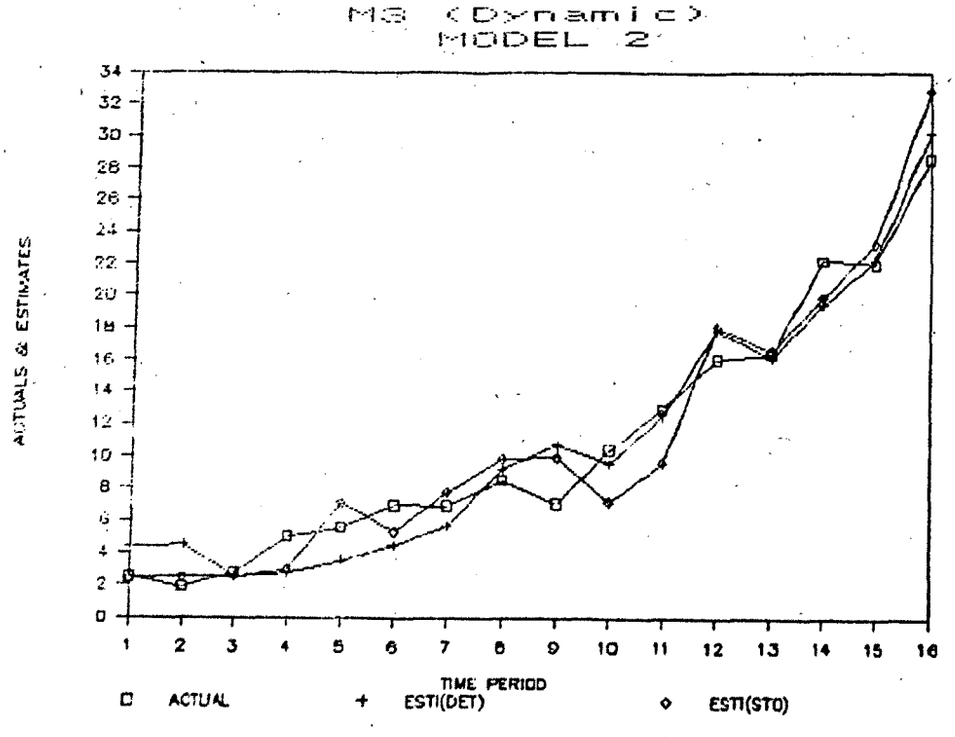
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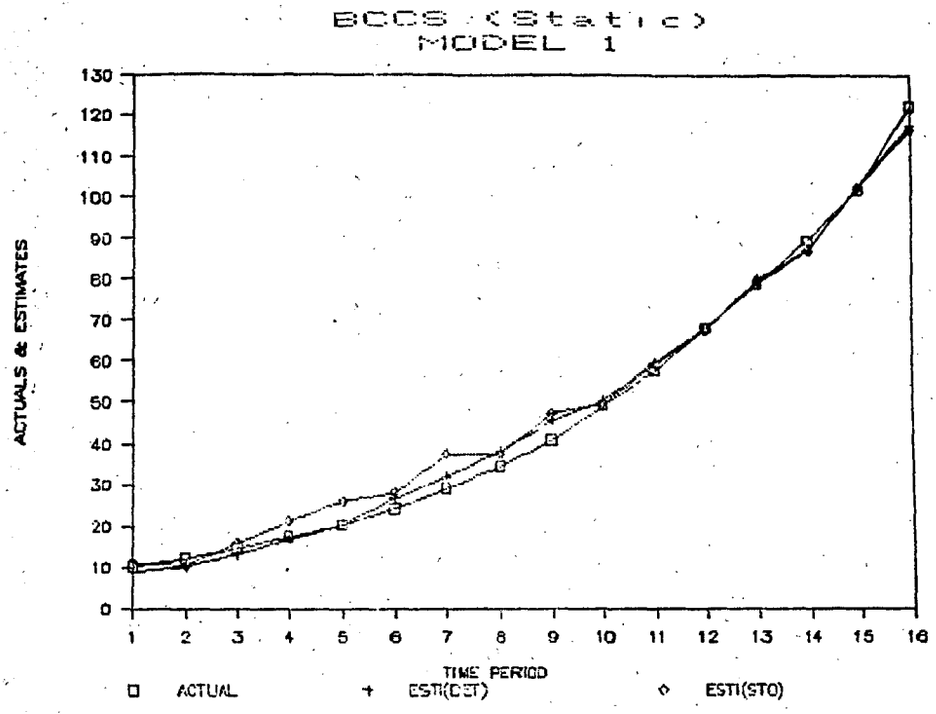
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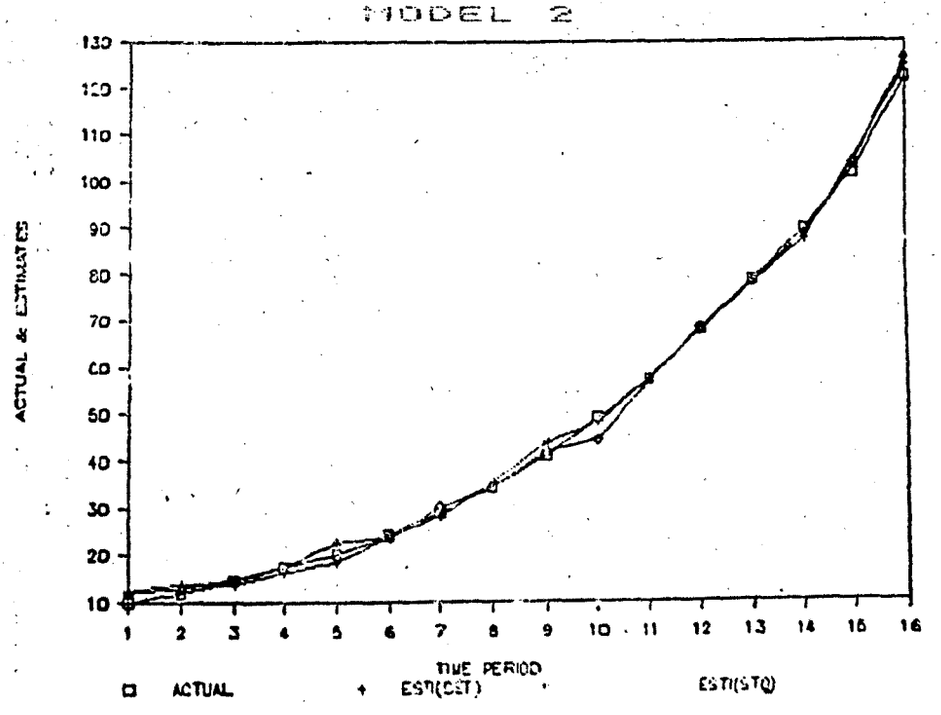
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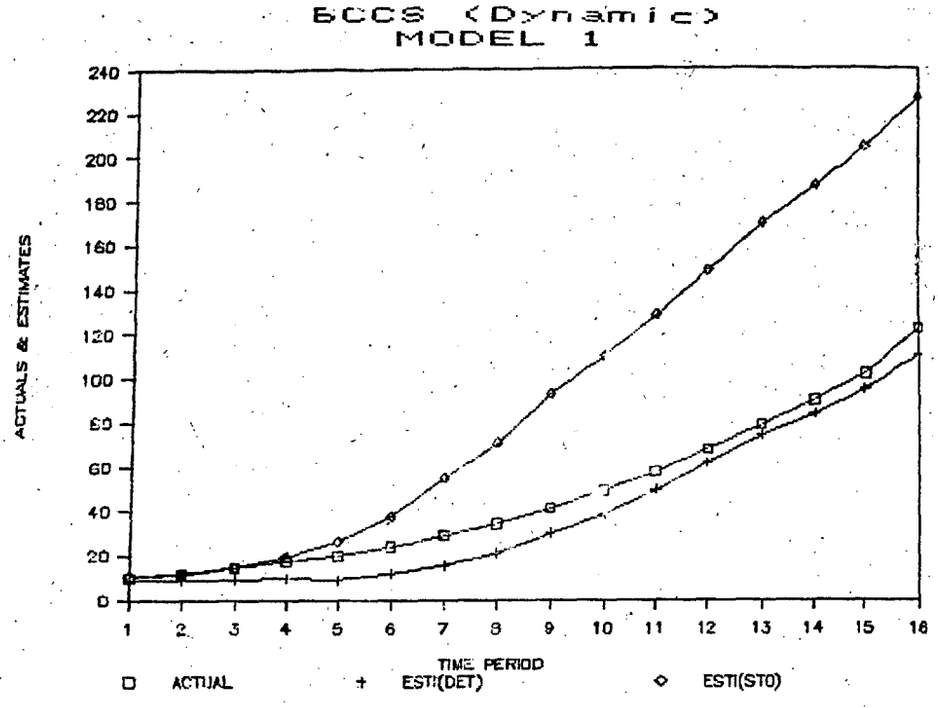
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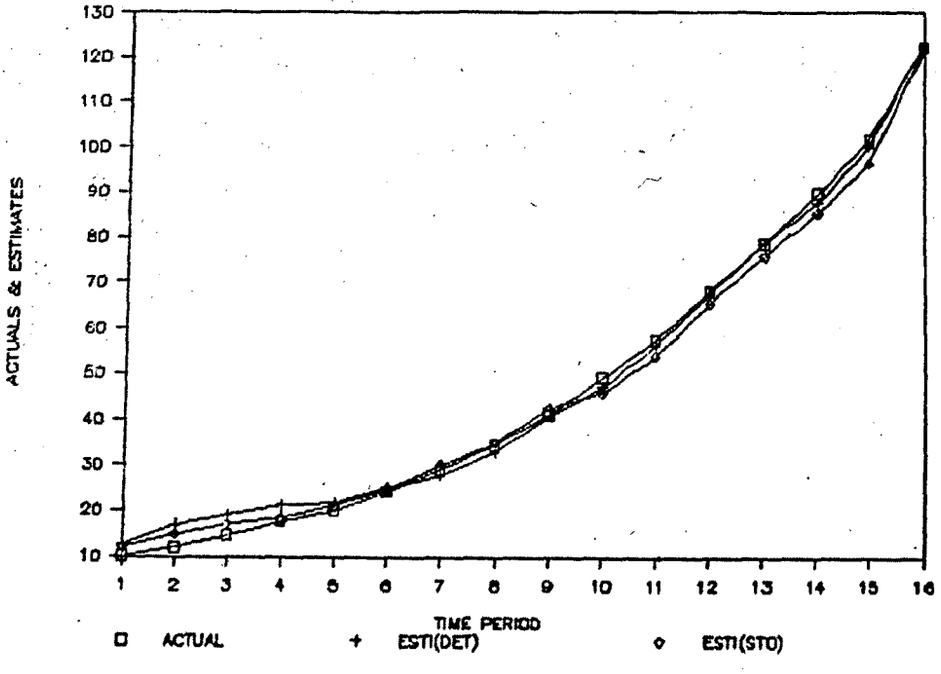
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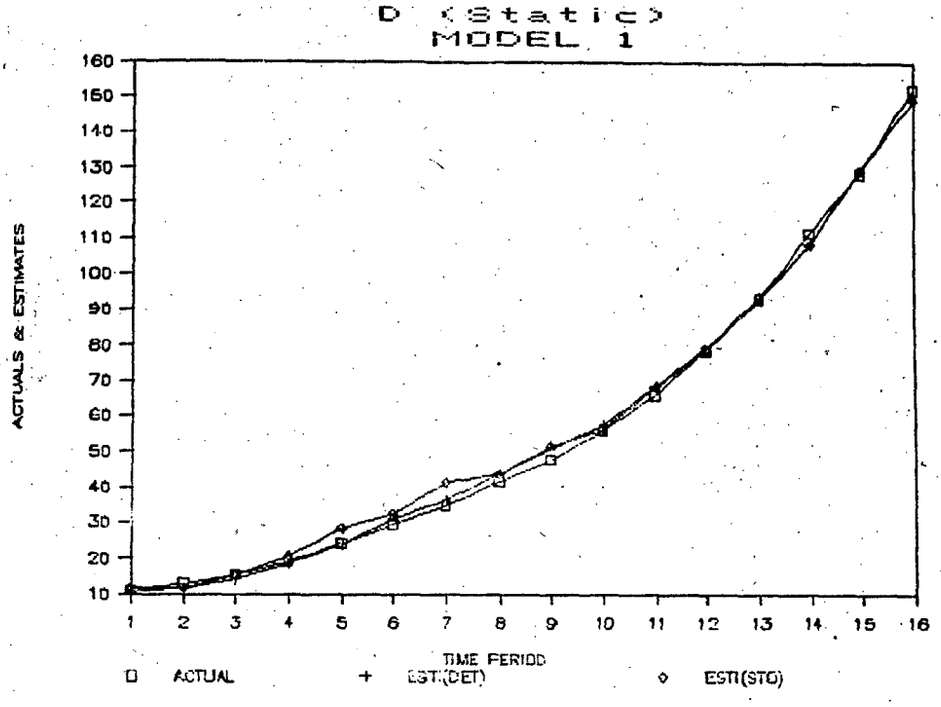
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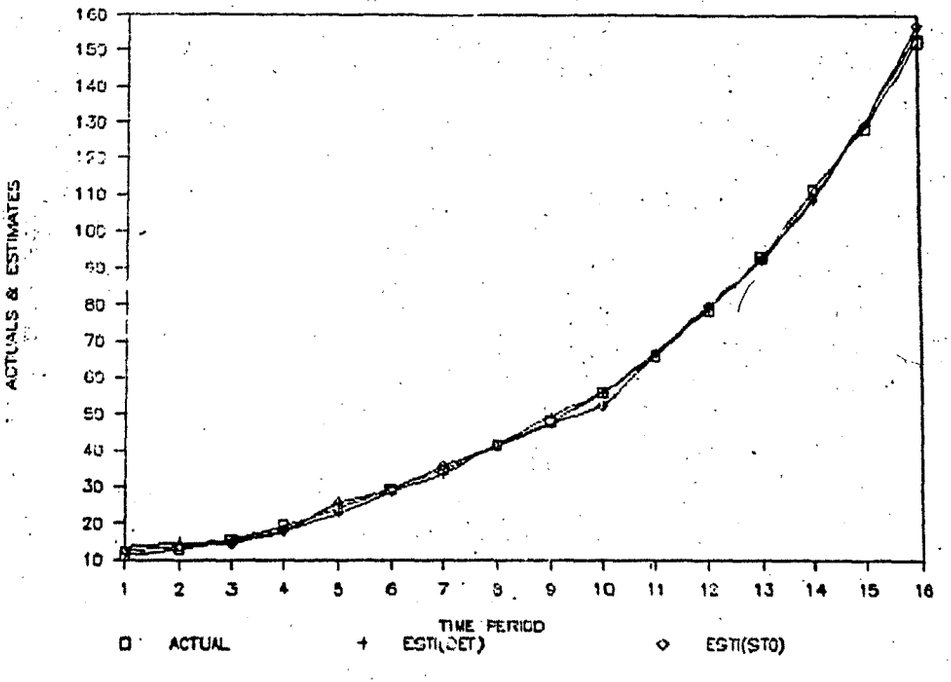
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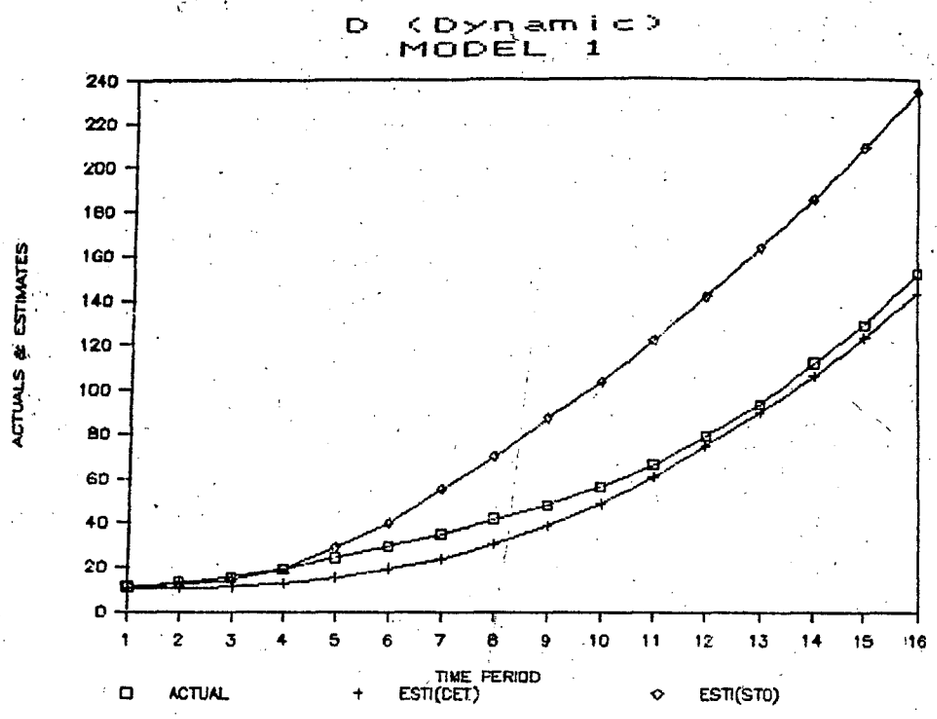
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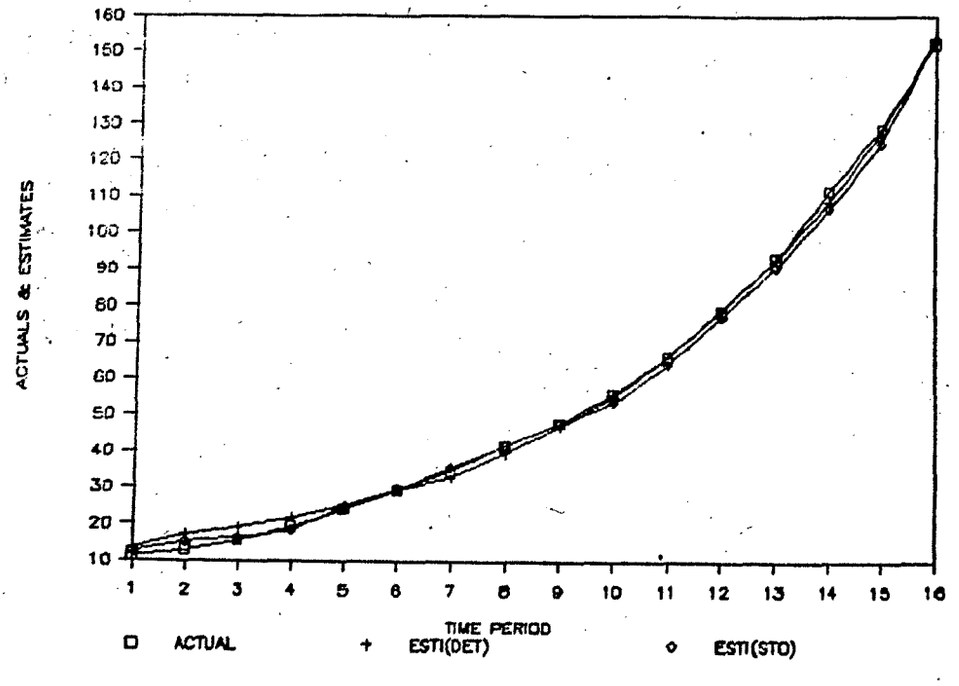
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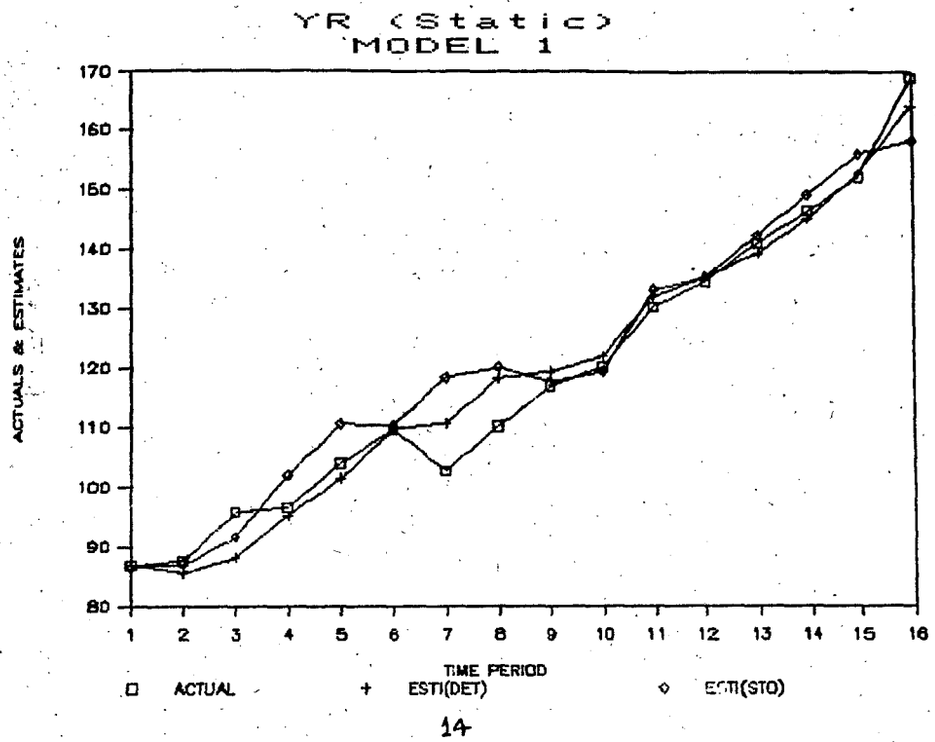
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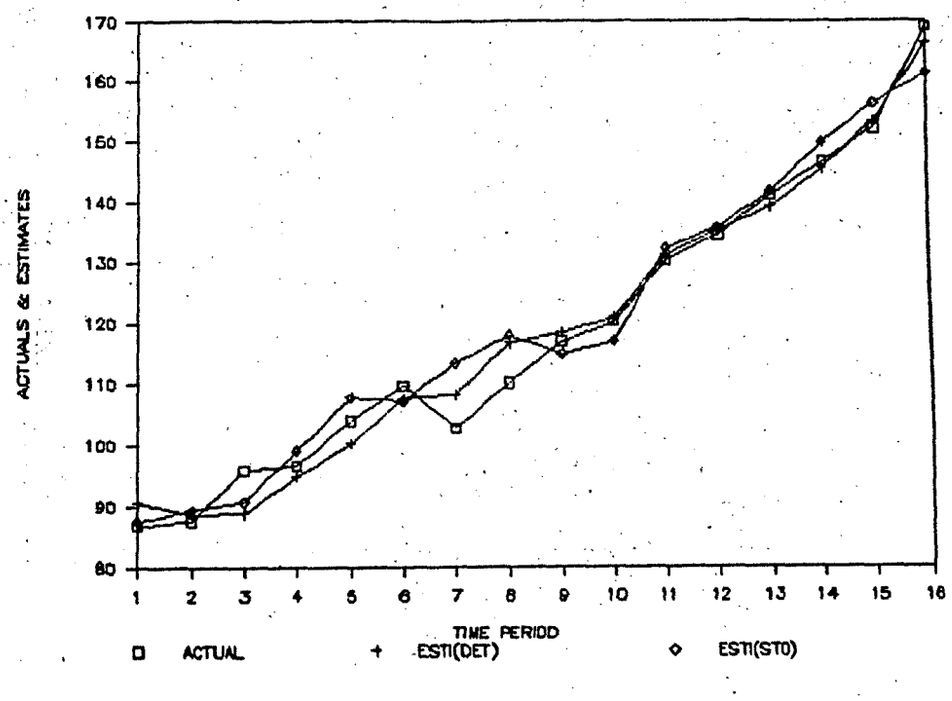
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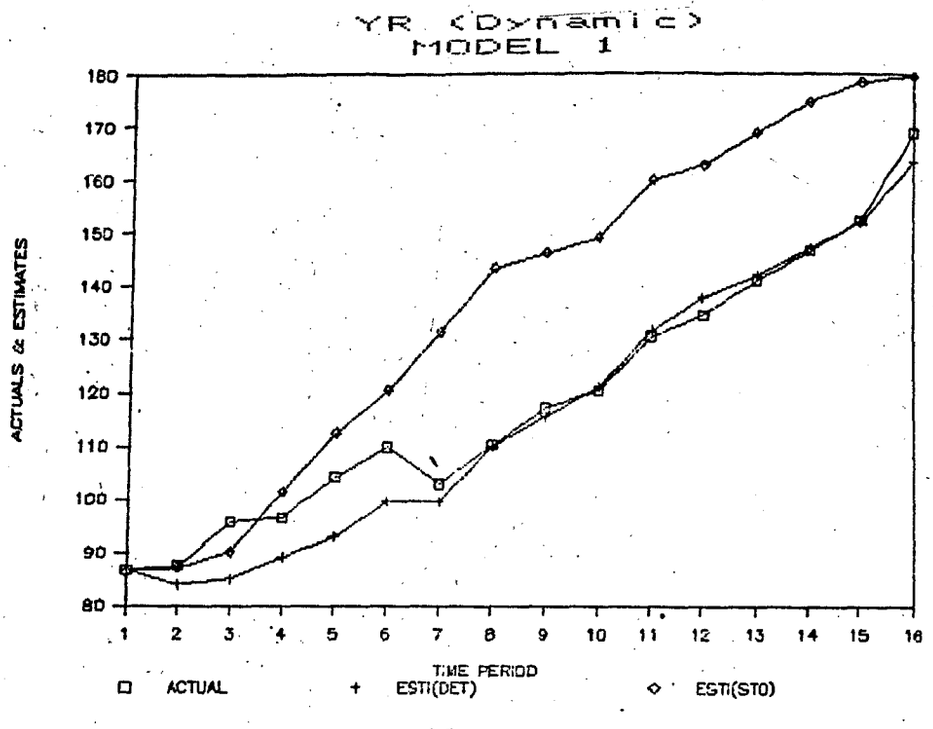
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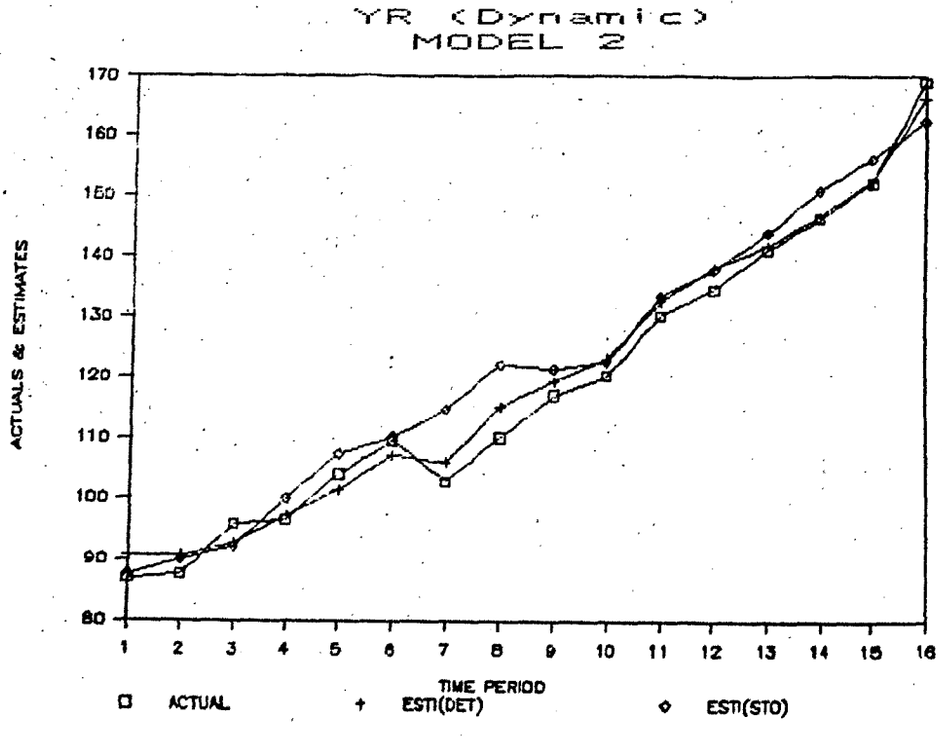
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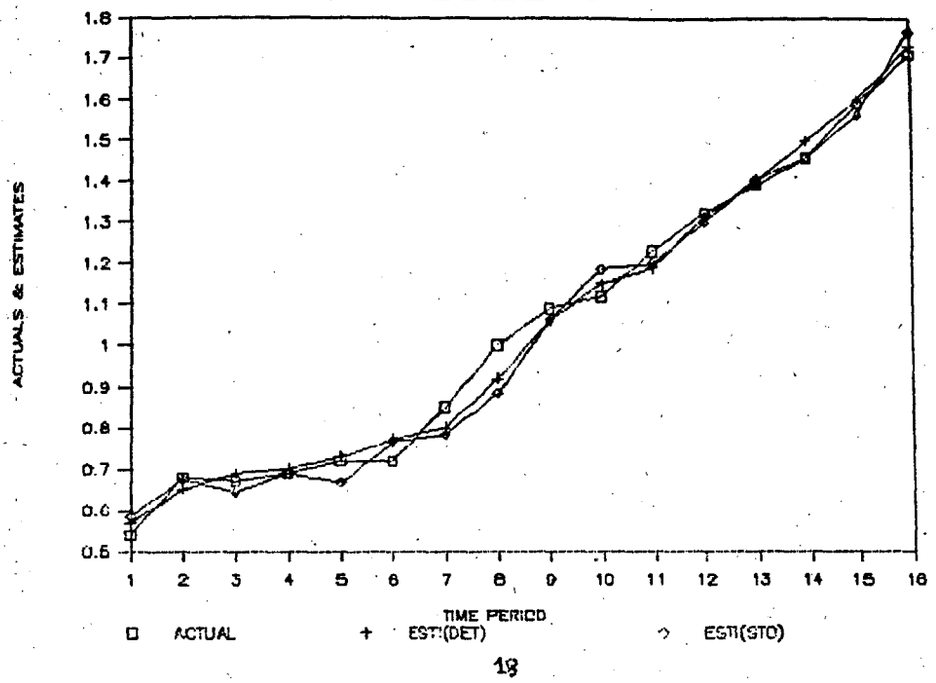
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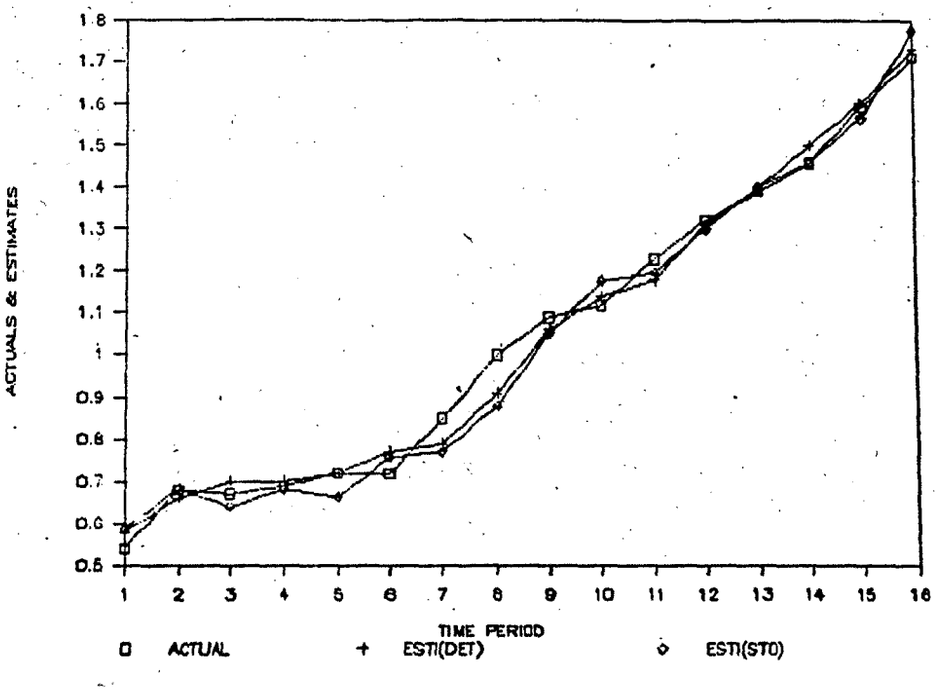
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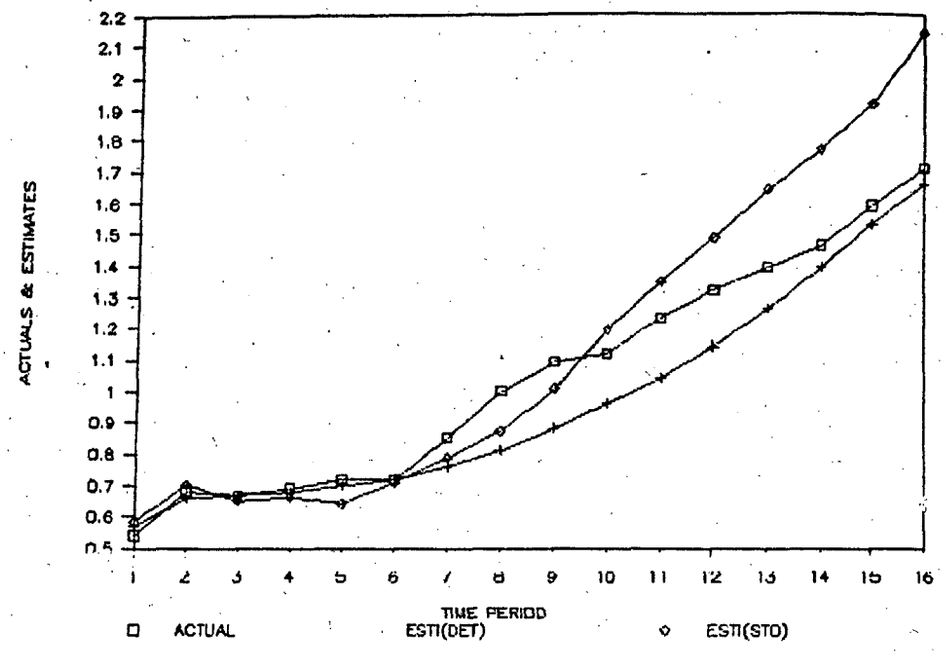
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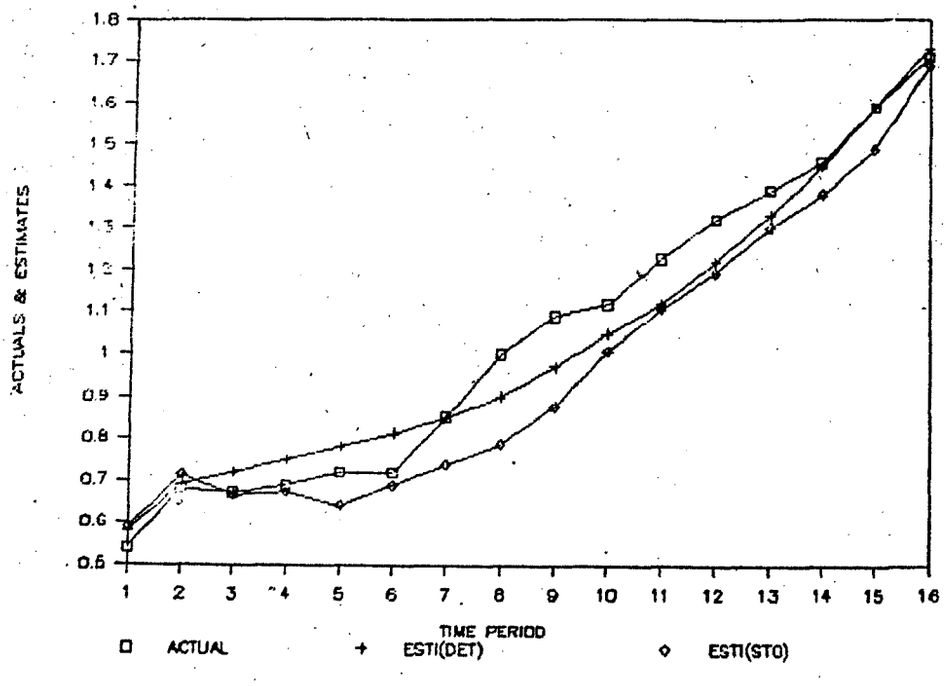
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BOOK REVIEWS

"The History of Econometric Ideas" by Mary S. Morgan (Cambridge University Press, 1990), Price £25 pp. 296.

WHILE presenting an authentic historical record of the evolution of econometrics from the late nineteenth century to the middle of the twentieth century, the book records firstly the achievements, the failures and the difference in the views of the first generation econometricians in their attempts to measure and test the laws of economics and secondly the evolution of basic issues ranging from econometric analyses of the business cycles and their causality to issues of identification, multicollinearity, simultaneity in economic relationships and the use of probability in econometrics.

The book traces how each idea and concept grew, and how the views of the researchers differed which led to considerable debates and genesis of new ideas. The book is divided into three parts : (Part I (chapters 1 to 4) and Part II (chapters 5 and 6) deal with applied areas of economic enquiry, namely, business cycles and demand analysis, respectively. Formal modelling, which combines applied econometric work with theoretical developments, is dealt with in Part III (chapters 7 and 8).

Chapter 1 deals with attempts at employing statistical data to arrive at consistent theories of business cycle, in which the causes of business cycles were non-economic and exogenous. The focus is on Sunspot theory of William Stanley Jevons and the Venus theory of Ludwell Moore. Statistical methods like harmonic analysis, correlation, multiple regression with three variables, and time series decomposition techniques (to find the rhythm and the constitutent parts of the business cycles) were the most widely discussed topics. The chapter also gives reasons for the decline in importance of the theory of Jevons and Moore, mainly due to the difficult problem of interpretation of the results of periodogram analysis used by Moore, disbelief in the periodicity of the cycles and the use of technically less developed methodology.

Following the above developments, the author in chapter 2 delves at length on the alternative applied approach to business cycles developed by Clement Juglar, Wesley Clair Mitchell and Warren M. Persons. Notable advances related to the decomposition of the time series data (into its trend, cyclical, seasonal and irregular components), the development of the indices of business cycles, called the Harvard A-B-C curves (which failed to answer questions of causality) and the proliferation of business research institutes throughout Europe in 1920.

Further advances in the application of econometrics through incorporation of random factors are dealt with in chapter 3. The works of George Udney Yule, Eugen Slutsky and Ragnar Frisch (in which they share the view that random factors may generate business cycles) need be mentioned. Yule's model of pendulum being pelted with peas, and Frisch's model of wooden rocking horse being hit with a club and Slutsky's random cause hypothesis mark the major developments in this context.

Macro-econometric modelling which constituted an important landmark in the advancement of econometric methodology and the developments thereof are extensively dealt in chapter 4. Tinbergen is credited as the first person to construct and estimate the macro-dynamic model of the business cycle. Apart from capturing causal, definitional and technical or institutional relationships, a model, according to Tibergen, should also investigate policy problems. There is a trade-off between realism and simplicity of models and their schematisation do have certain amount of arbitrariness. The choice of the most suitable model is the 'art' of econometric research. He chose equations and variables by iterating hypotheses and statistical verification and by using the economic sense and closeness of fit as the two criteria of choice. In the next stage, he ensured that the time path of the model provided an adequate explanation of the business cycle.

Prof. Tinbergen's work was subject to criticism, particularly by Prof. J.M. Keynes. Noting that some of the criticisms of Tinbergen's work by Keynes were unjustified, the author presented a revealing account of the various issues of debate amongst Keynes, Tibergen, Frisch, Friedman, Haavelmo and others in this chapter.

In Part II (Chapter 5 and 6), the author turns her attention to the most important areas of applied work in econometrics. Though the inverse relationship between price and quantity demanded is a long-established one, the fuzziness of the classical economics about the supply

and demand schedules found expression particularly in the field of demand. Econometric estimation of the demand curve led to the 'problems of correspondence of the matching of measured relationships to theoretical models'. The running theme in these chapters has been the problem of reconciling the requirements of theory with the data. Developments in this direction include many types of adjustments in data to make the models conform with theory. Problems relating to measurement of demand function, explanation of the supply-demand shifts and related aspects of demand functions, no doubt, confounded econometricians and eluded solution. It was with the pioneering works of Pigou, Allen and Bowley and Ezekiel that made deep dent in to unravelling the interaction between theoretical models of demand and their measured counterparts which later stimulated considerable developments in econometric modelling.

Another major problem that needed solution was the ability to empirically identify the relationship as a demand curve as distinguished from a supply curve. Attempts to solve the identification problem in a two-sided relationship frame-work was made by Philip Wright in 1928 followed by Pigou and Leontief. The latter had advocated a simultaneous estimation of both equations. However, it was Tibergen in 1930s who gave the solution of two-equation models. Finally, the pioneering contributions of Koopmans in 1940s led to the formulation of rank and order conditions for identification of linear models involving several equations.

Part III (covering chapters 7 and 8), deals with how the economic relationships were formalised into econometric models and thus this part forms a prelude to the more rigorous econometric analysis that emerged in recent years. Broadly, it covers the problems of omitted variables, errors in variables and the debate about which variables are to be used as dependent and which as independent and the role and causes of errors in the single equation models. The chapter also presents the developments at a technically advanced level of econometrics in the area of two equation models and briefly describes E.J. Working's graphical and data adjustment methods, P.G. Wright's use of instrumental variables estimator and Tinbergen's use of reduced form of equations to build models of interdependent relationships. The confluence analysis of Frisch, the causal chain models of Tinbergen and the probability approach to econometrics and developments regarding measurement of errors and the use of instrument variables covering the contribution of Koopmans, Wald and Reiersol also merit mention in this regard.

The publication of the paper 'The Probability Approach in Econometrics' by Trygve Haavelmo in 1944, however marked a turning point in the history of econometrics. Koopman's thesis on measurement errors and Tinbergen's modelling of planning horizons eventually paved the way for formulation of probabilistic models. Influenced by Jerzy Neyman and Abraham Wald, Haavelmo argued in favour of general applicability of probabilistic approach in econometrics. Chapter 8 deals fairly extensively with this approach (of Haavelmo which constituted the comparison of economic theory with data, and the correct choice of models and theories) and the interesting and useful debate which followed Haavelmo's paper as also the consensus which emerged on wider applicability of 'probability approach' to econometrics by the end of 1940's.

To sum up, the book is an excellent attempt at sketching the history of econometrics from its genesis. It is a depiction of how the maintstream econometrics stemmed from the attempts of early econometricians grappling with the problems of applied work by endeavouring to match theories with available data. The history of econometric ideas, thoughts, debates, pitfalls and achievemnts and views of various personalities have been very well documented by the author. The presentation in the book is simple and the treatment is elegant (without being too much mathematical) and hence will be intelligible to non-technical readers. However, one would have wished it to be more mathematical and statistical especially in a book of this kind. Nevertheless, to econometric historians, the book will serve as a useful reference. For students of economics as well as econometrics, the book serves as a guide to check on the empirical and methodological evidence available in earlier works on important aspects of econometric enquiry.

Finally, in the face of declining importance of business cycles in the present day context, it is surprising to note that almost half of the book (which is a very large proportion) is devoted to a discussion of the business cycles. Instead, the utility of the book could have been enhanced by giving an account of the more recent problems and issues of macro econometric modelling and the growing tendency on the part of the present day econometricians in preferring to work with smaller macro-econometric models which are more amenable for policy manipulations than the large macro-econometric models in the fifties to seventies.

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Economic Policy Coordination : Requiem or Prologue?

- Wendy Dobson, Institute for International Economics - April, 1991; pages 161 + xii, $11.95.

THE expression 'policy coordination' is so often seen in the literature on international economic relations that it is erroneously considered by many as a *'mantra'* acting as panacea for all global economic problems. It is in fact not. At best, it is a way of expanding the choices available to national policy makers, by giving each Government some influence over other governments' policy instruments. But even this is not practicable since it impinges on national sovereignity in respect of decision making for countries' own interests.

First put into action in 1985 in a somewhat formal manner, it has traversed a long way. In order to know how effective it was, one needs to take stock of the events that took place under policy coordination, and closely inquire into the areas where coordination should be strengthened. The book under review helps us in this task. It contains six chapters. While the introductory Chapter I deals with the meaning of policy coordination, Chapter II discusses the historical development in policy coordination. The analytical framework of coordination process is provided in Chapter IV, after recounting the institutions and players participating in the process in Chapter III. Chapters V and VI are the important contributions of the author. While Chapter V elaborates the impact of coordination on macroeconomic policy variables, Chapter VI suggests recommendations to strengthen the G-7 framework. The author contends that it is not the time to call for a requiem for policy coordination; rather, it is only a prologue, especially in the light of great economic potential available with G-7.

The first three chapters, as one could guess, are descriptive. In Chapter 4, the author shows that the analytical framework lends itself to broad diagnosis of imbalances and exchange rate misalignment and their correction. But without more accurate forecasts and a better understanding of linkages between goals and instruments, it is doubtful whether the G-7 surveillance produces efficient diagnosis by or agreement among the participants to policy coordination on a wide range as a response to a major shock. The record of the period 1985-89 bears this

out. The United States was pressed for policy changes by the other participants who were skeptical of the US administration's ability to deliver on its own, promised changes and therefore they did not always maintain strong counterpressure for remedial US policy action.

Among the policy variables chosen as a medium for coordination, exchange rate alignment was more favoured than tax policies or structural policies. Probably this could be due to the fact that the participants regarded exchange rate policy to be amenable to direct influence. And the participants chose to operate upon this as a mechanism in an informal ad hoc way. The informal approach seem to suit the personalities involved in the process, even though the process itself had become vulnerable when they left their respective positions. The goal of exchange rate stability together with unannounced reference ranges was most emphasised. It is this that enabled to create the impression of a consensus that however exaggerated the group's ability to deliver.

If coordination is to be successful, Governments should agree on institutional improvements in the framework for G-7 coordination. Also, the level of commitment to the ongoing coordination should be high enough, not only during times of crisis but also during normal periods. Given the levels of complexity of the process, has the process been adequately served by emphasizing mainly on exchange rate alignments? Has it not impeded consideration of more relevant issues?

The chapter on the impact of policy coordination has two portions. The first one is an objective assessment of the extent to which economic goals set in the coordination process were actually achieved whereas the second attempts to distinguish the role played by coordination itself, in achieving those goals from the effects of other factors already at work. In this context, three main economic goals in the coordination process, were identified as : (a) reduction of current account imbalances to sustainable levels; (b) change of the pattern of output and domestic demand both in the surplus and deficit countries; (c) alignment of the US $ against DM and Yen so as to stabilise its nominal value within ranges against these currencies. There were two other implicit goals viz., promotion of structural reforms and achievement of sustainable non-inflationary growth. The outcome however, is one of partial success in meeting the three main goals mentioned above.

There is evidence that policy coordination had a direct impact on national policies either through exertion of peer pressure or as a result

of a commitment to what participants saw as mutually beneficial policy changes. In this context, the Louvre Accord stands out as a shining example. Another development which can be attributed to policy coordination process was an increased awareness among treasury ministers of the need for greater discipline in the conduct of macroeconomic policy. The third success was a generalized tightening of monetary policy in the period 1988-89. But, as the author has argued, disentangling the impact of coordination on macroeconomic policy from other influences is difficult, and not easily possible. However, the impact of coordination process on fiscal policy which could be worked out, in the 1980s has been mixed. Nonetheless, the point that needs to be noted is although all the requisite fiscal policy changes were already in place for reasons of good domestic policy, coordination broadened their scope and accelerated their timing.

Peer pressure - a mechanism through which coordination process is expected to work - cannot be exercised beyond measure. This is apparent from the fact that notwithstanding the success in realigning and then stabilising the dollar for a short period of time (1986-88), it continued to fluctuate in fairly wide ranges. Another policy area in which the coordination process had less impact than intended was in incorporating microeconomic policy reform into the multilateral surveillance process.

Does the performance of G-5 and G-7 during 1985-89 suggest that it is time for a requiem for economic policy coordination or have we heard only the prologue? If we accept the latter, what changes are needed to make coordination more effective? On the basis of developments which took place in the industrial countries, the author emphatically argues that coordination played a crucial role. In fact, policy coordination which was seen till 1989 is regarded by the author as only a prologue. But since the latter half of 1989, policy coordination has lost much of its bite. These can be seen from several indications, (a) mutual surveillance discussions seem to have lost a sense of urgency that intially characterised them; (b) slow implementation of policy commitments shifted the dialogue to repetitive discussions of remedial action; (c) the urgency of correcting the external imbalances had faded by the end of the decade since the problem did not seem to unsettle the economic momentum in the G-7 countries, with the result a sense of complacency has crept in; (d) the almost complete turnover of treasury ministers that occured between late 1988 and early 1989 seems to have contributed to lack of firm commitment to the idea itself. This problem seems to have been somewhat magnified by the absence of continuity,

as reflected in the fact that there has been no permanent secretariat.

Success of policy coordination, as the experience shows, depends upon a number of factors. The author cites five of them as necessary: informality and frankness, a strong and clearly defined mandate, a strong leadership and clear demarcation of lines of accountability, an agreed-upon analytical framework with guidelines for remedial action and a strong secretariat and technical support. These five criteria suggest certain specific actions that should be taken, both to preserve what is valuable in the existing coordination structure and to develop it into a stronger and more effective one. It is here that the last chapter of the book has much to say. The author has suggested five proposals *viz.*, (a) involve central bankers more closely; (b) integrate exchange rate and macroeconomic considerations in surveillance process as well as in decision making; (c) create an institutional memory and support by building a better-defined professional base; (d) strengthen the method for implementing remedial policies; and (e) rationalise the process by reducing the number of participants. Implementation of these proposals is undoubtedly a time consuming process. More importantly, some of them are not practicable, since the sovereignty of decision taking would come in the way, and since there is no way by which the number of participants could be reduced at this stage. In fact, a number of small European developed economies have clamoured to be a part of the exclusive G-7 club in the mid-eighties, simply because they did not want to be left out of the process that may be impacted by the actions of G-7 taken in the name of policy coordination.

An important impression one gets on going through the volume is that policy coordination is with activity and country-group specific. But what should the international community do if the process has an impact not only on the countries concerned but also on others? Should not the international community have effective mechanisms to address adverse effects, if any, and to savour those effects which are favourable? Cannot the aims of policy coordination be achieved under the existing multilateral surveillance processes that are for instance available at the UN? In case the IMF annual consultations on G-7 countries are seriously considered, will the results be different from the ones obtained under the name of policy coordination?

To be very realistic, there is no way by which the G-7 could be stopped from mutual discussions. But one could think of a few safeguards to ensure that the G-7 deliberations promote international economic adjustment. It is here that some involvement of other parties

whose interests could be protected, is necessary. The Managing Director of the IMF could be invited to such discussions so that such interests are safeguarded. One could also broaden this forum to include the chairman of the G-24 group to attend the G-7 discussions. Once this idea is accepted, one could work out the levels of participation of the two representatives at the G-7.

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