

A MACRO-ECONOMETRIC MODEL
OF THE INDIAN ECONOMY ANALYZING
INFLATION DURING 1951-1973

by

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ABSTRACT

This thesis attempts to analyze the behavior of prices -- absolute as well as relative -- and real outputs in the Indian economy over the period 1951-1973. This is done in a general equilibrium framework through specifying a macro-econometric model of the economy. In contrast with most other existing macro-econometric models of the Indian economy, the model presented in this thesis does not focus on the behavioral specification of the individual components of aggregate demand in the economy, but instead emphasises the disaggregation on the supply side. The model specification is based on an eclectic approach, integrating the elements of structural, demand pull, cost push, and monetary theories of inflation.

The model is divided into two broad sectors -- agriculture and nonagriculture. The agricultural sector is further subdivided into the foodgrain and commercial crop sectors, while the nonagricultural sector is subdivided into manufacturing and other (residual) sectors. The major features of the model include (i) an explicit treatment of the simultaneous determination of the marketed surplus and the price of foodgrains, (ii) an endogenous determination of capacity utilization in manufacturing, (iii) endogenous specification of government budgetary operations, and (iv) specification of an explicit linkage between the fiscal and monetary sectors.

The model equations are estimated through Two Stage Least Squares estimation procedure, using annual data for the period 1951-1973. The model performs satisfactorily in analyzing the behavior of outputs and prices in the economy over the period 1952-53 to 1970-71. The impact of the following factors on prices and outputs in the economy within the model framework is explored: (i) fluctuations in agricultural output, (ii) foreign exchange shortages, and (iii) changes in government investment.

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CHAPTER I. INFLATION IN INDIA: THE PROBLEM

The object of the present study is to analyse the behavior of prices in the Indian economy over the period 1951-1973. This is done in a general equilibrium framework through specifying a macro-econometric model of the economy. An understanding of the process of inflation can be useful in identifying the constraints to sustained economic development.

Unlike the many developing economies of Latin America, India has not suffered from very high rates of inflation. Yet, inflation has been a major economic problem since 1961-1962. This was particularly true after 1964-1965, when a succession of agricultural droughts, slowing down of Public Law 480 imports from the U.S.A, increases in government expenditures on account of the Indo-Pakistani war and later the Bangladesh refugee relief--all contributed to the high rates of inflation in the economy. The recent increases in the import prices of oil, fertilisers, etc., further intensified the inflationary pressures in the economy.

This chapter is divided into three sections. Section I presents a discussion of the major trends in prices as well as certain selected macro variables in the economy over the period 1951-1973. Section II presents a very brief review of some of the familiar theories of inflation and discusses the relevance of these theories to the Indian situation. Section

III reviews some of the recent empirical studies that have been done on this subject, and lays groundwork for the analysis of inflation in a general equilibrium context.

Section I: Price trends in the Indian economy

Inflation in the Indian economy over the period 1951-1973 has been moderate by international standards, the general price level increasing at an average annual rate of about 3 per cent. This apparently moderate overall increase for the period as a whole, however, conceals certain very important aspects of inflation in the economy. A ten-year period of price stability ending in 1960-1961 was followed by a much higher rate of price increase in the second half of the period.^{1/} In respect to another important aspect of inflation, the terms of trade between agriculture and other sectors of the economy, again, the experience varied considerably over the period. A decline in the terms of trade up to 1954-1955 was followed by a very sharp increase up to 1965-1966 and a turnaround after that. It was only in 1972-1973 that the terms of trade moved sharply in favor of agriculture once again.

^{1/} All figures in this section relate to fiscal years. Fiscal year t corresponds to the year beginning April t - 1 and ending March t.

In the following subsections we present the movements in the aggregate price level, the terms of trade between agriculture and the rest of the economy, and manufacturing prices, over the period 1951-1973, together with a discussion of some important determinants of the same.

(i) Overall price trends

Table I shows the annual percentage changes in the implicit price deflator for the gross domestic product in the economy as well as for its agricultural and non-agricultural components. In the ten years ending 1960-1961, the overall GDP deflator increased at an annual average rate of 0.4 per cent. Over the same period, the annual average increase in the implicit price deflator for agriculture was 0.8 per cent and that for non-agriculture 0.3 per cent. Even excluding the year 1954-1955 which experienced a marked decline in agricultural prices, for the remaining nine years the annual average increases in the GDP deflators--overall, agricultural, and non-agricultural--were 1.6, 2.9, and 0.5 per cent respectively. In contrast with this relative price stability, the following ten years witnessed an acceleration in price change. The overall GDP deflator increased at an average annual rate of 6.1 per cent, while the corresponding increase in the agricultural and non-agricultural sector deflators was 7.4 and 5.3 per cent, respectively. This trend continued in 1971-1972 and was

accentuated in 1972-1973. A graphical presentation of these price movements is provided in Chart I.

These trends in prices should be viewed in the context of variations in demand aggregates over the same period. Chart II presents movements in two major indicators of demand in the economy, i.e., the ratio of aggregate investment in the economy to the gross domestic product at constant prices, and the ratio of government fiscal deficit to the gross domestic product. Following a major boost coinciding with the beginning of the Second Five-Year Plan, the two indicators showed a strong rising trend up to 1965-1966, and declined after that. The continuing large price increases of 1966-1967 and 1967-1968 were, therefore, in spite of the deceleration of these major demand indicators. After 1965-1966, the share of aggregate investment in the gross domestic product declined consistently up to 1971-1972, rising again in 1972-1973. The share of government deficit also declined, reaching a low of 6.4 per cent in 1969-1970, but increased in the following three years to 8.3 per cent in 1972-1973.

In addition to observing the pattern of variation in certain real demand aggregates over this period, it is useful to gauge the movements in money supply. Chart III depicts changes in the aggregate price level and in money supply side by side. It is interesting to note that while the pattern of

the change in prices follows closely that of the change in money supply, the correspondence is by no means exact. A movement in money supply is not always accompanied by a movement in prices in the same direction. There is more to prices than increases in money supply.

(ii) Terms of trade between agriculture and non-agriculture

In analysing the behavior of prices in the Indian economy, the pattern of movements in the terms of trade between agriculture and the rest of the economy is of particular interest, as it is crucial to the understanding of the process of price formation as well as of real growth in the economy. As Chakravarty puts it, "It is . . . an unfortunate fact that in many underdeveloped economies, one has to distinguish between a food bottleneck and a labor bottleneck....Since food constitutes the principal wage good, it becomes necessary to pay attention to the interchange of produce between the traditional and the modern sectors....On this interpretation, the question of the terms of trade between industry and agriculture assumes a crucial role."^{1/}

Chart IV shows movements in the terms of trade between agriculture and the other sectors in the economy. Following a downward trend between 1950-1951 and 1954-1955, terms of

^{1/} Chakravarty, S. (13).

trade started to move in favor of agriculture. This upward trend was particularly marked after 1962-1963 and continued through 1966-1967, the second successive agricultural drought year. The following four years, 1967-1968 to 1970-1971, saw a decline in the terms of trade of agriculture relative to the other sectors in the economy. This pattern was reversed in 1971-1972, and the improvement in the terms of trade for agriculture was even more marked in 1972-1973.

Table II provides the relative rates of growth of the agricultural and non-agricultural sectors in the total real gross domestic product in the economy. While gross domestic product in sectors other than agriculture grew at an annual average rate of 5.1 per cent during 1961-1971 compared with 4.9 per cent during 1951-1961, growth in the agricultural sector actually decelerated, notwithstanding the Green Revolution. The two successive agricultural droughts of 1965-1966 and 1966-1967 were mainly responsible for the lowering of the annual average growth rate in agriculture from 3.1 per cent in the first period to 2.7 per cent in the second. The gap between the growth rates of agriculture and non-agriculture was, to some extent, covered by the cushioning possibilities available in the first period, i.e., the relatively less scarce foreign exchange, and PL 480 imports of foodgrains. Although the latter continued to increase through 1966-1967,

these were not sufficient to bridge the gap between the relative rates of growth of agriculture and non-agriculture, so that the terms of trade moved sharply in favor of agriculture. Chart V shows the pattern of movements of foodgrain imports and brings out the dramatic decline in these imports after 1966-1967. As was pointed out above, the following years also witnessed a decline in the terms of trade until 1971-1972 when the pattern was reversed once again.

Within agriculture, an important distinction has to be made between the foodgrain sector and the commercial crop sector. Relative price movements of these two sectors, apart from influencing their relative outputs, are also of significance in that the performances of these sectors constitute different constraints on the economy at large. Chart VI depicts the relative price of foodgrains and of commercial crops (oilseeds, fibres, and sugarcane) - each in terms of the price of the manufactured good.

(iii) Trends in manufacturing prices

Manufacturing prices form an important component of non-agricultural prices, and warrant separate attention because of their influence on corporate savings and investment through affecting corporate profits, as well as their susceptibility to the pressures of increasing import prices.

As Chart VII shows, prices of manufactured goods increased

Table I. Annual Per Cent Changes in Implicit Price
Deflators for Gross Domestic Product

Year ^{1/}	Total	Agriculture	Non-agriculture
1952	1.74	0.35	3.25
53	-5.24	-7.52	-2.65
54	0.66	1.97	-0.58
55	-10.53	-18.89	-1.88
56	1.87	4.12	-0.82
57	7.97	16.77	0.45
58	1.72	0.23	2.85
59	3.40	6.49	0.74
60	0.95	1.07	0.74
61	1.69	2.93	0.56
Avg. 1952-61	0.42	0.75	0.27
1962	1.97	2.32	1.67
63	3.59	4.68	2.75
64	8.40	12.83	5.02
65	9.12	12.23	6.35
66	8.39	13.28	6.03
67	13.82	21.33	8.66
68	8.19	7.07	7.25
69	-0.69	-3.36	2.31
70	5.05	3.59	6.15
71	3.52	-0.38	6.47
Avg. 1962-71	6.14	7.36	5.27
1972	4.32	4.89	4.32
73	8.78	14.94	5.32

^{1/} Data relate to changes over fiscal year price averages. Fiscal year 1952 refers to the year beginning April 1951 and ending March 1952, etc.

Table II. Annual Per Cent Changes in Gross Domestic Product
at 1960-61 Prices

Year ^{1/}	Total	Agriculture	Non-agriculture
1952	2.0	1.6	2.4
53	3.3	5.5	0.9
54	6.2	8.1	3.9
55	3.0	0.2	6.3
56	3.4	-0.2	7.5
57	5.5	5.0	6.1
58	-1.3	-5.1	2.6
59	8.2	11.2	5.3
60	2.2	-1.7	6.1
61	6.9	6.1	7.7
Avg. 1952-61	3.9	3.1	4.9
1962	3.8	0.8	6.6
63	2.6	-2.5	7.1
64	5.4	2.6	7.6
65	7.7	9.2	6.6
66	-4.4	-14.3	3.3
67	1.4	-1.8	3.5
68	8.9	17.1	3.9
69	3.5	1.4	5.0
70	5.5	6.4	4.9
71	4.7	7.7	2.6
Avg. 1962-71	3.9	2.7	5.1
1972	1.5	-1.9	3.8
73	-0.4	-7.2	4.1

^{1/} Data relate to changes over fiscal year price averages. Fiscal year 1952 refers to the year beginning April 1951 and ending March 1952.

CHART I IMPLICIT PRICE DEFLATORS FOR GROSS DOMESTIC PRODUCT

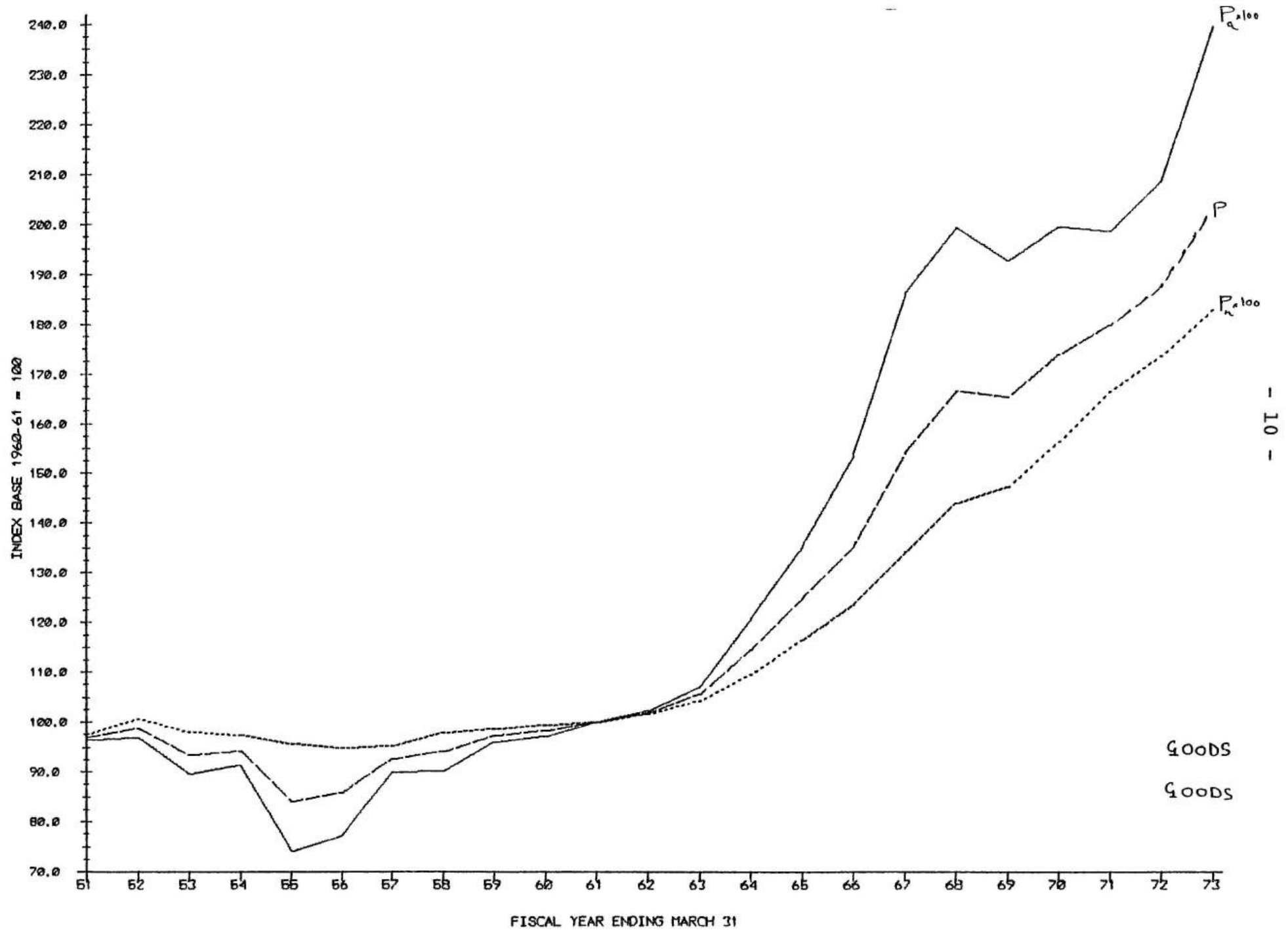


CHART II MAJOR INDICATORS OF DEMAND

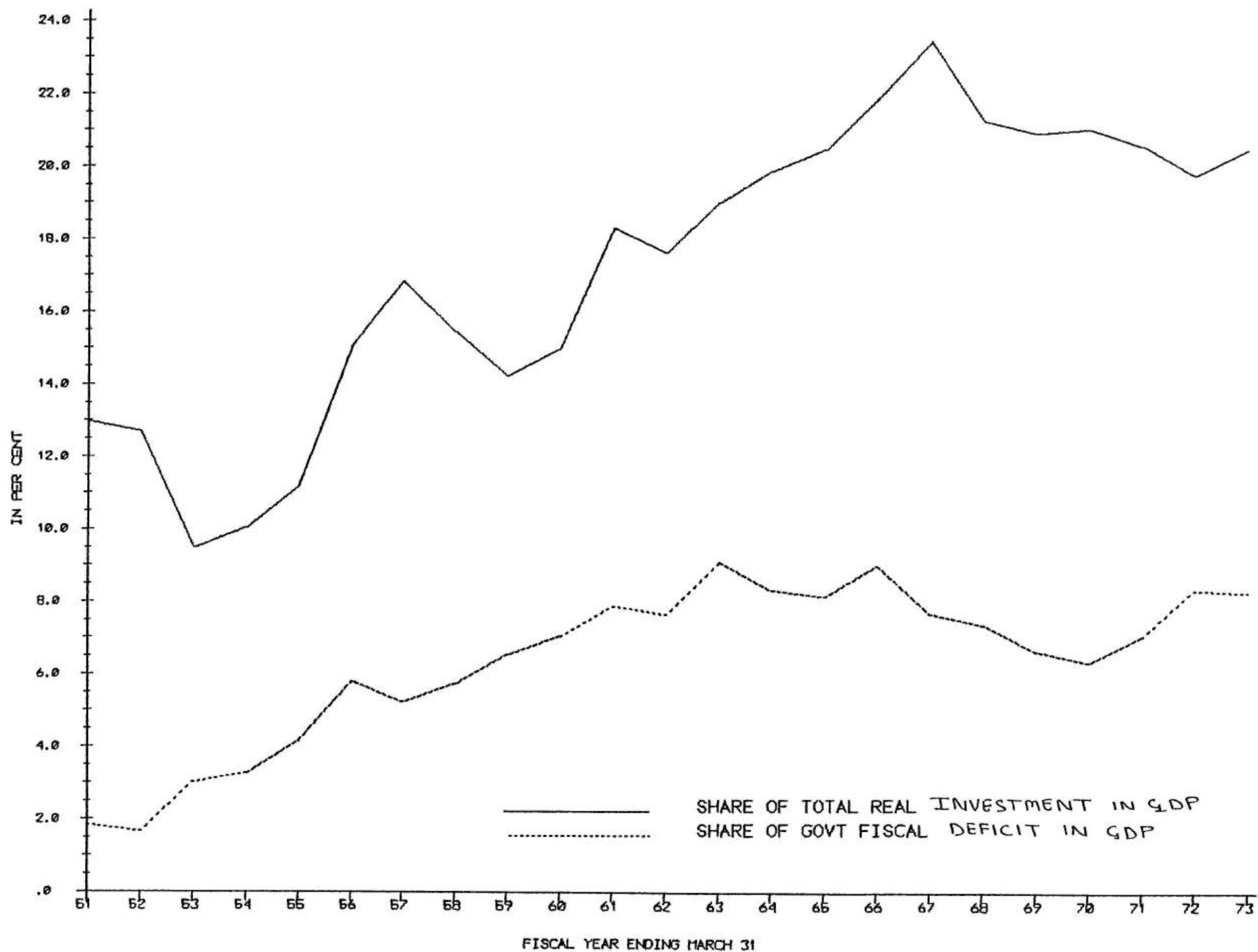


CHART III CHANGES IN AGGREGATE PRICE LEVEL AND IN MONEY SUPPLY

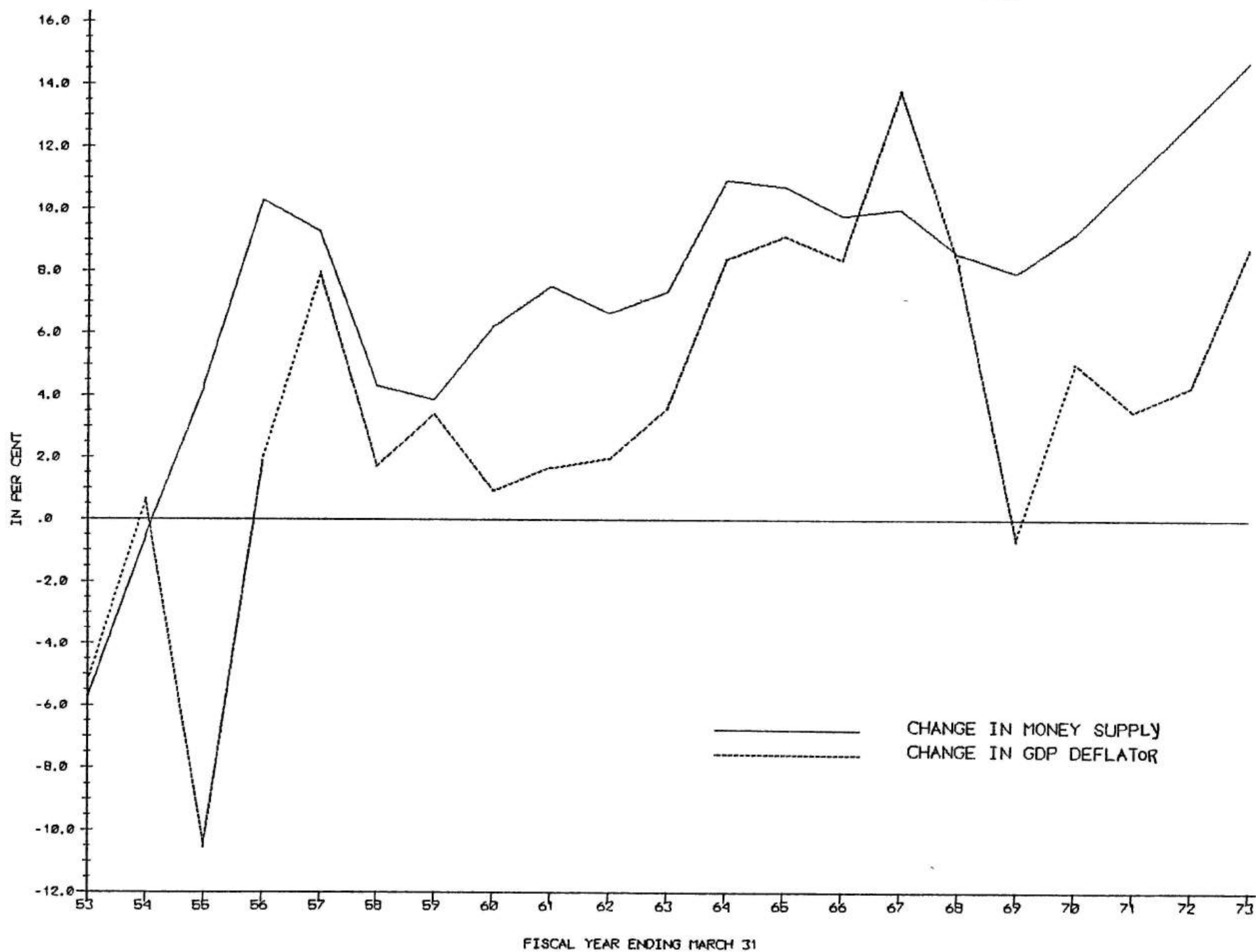


CHART IV TERMS OF TRADE BETWEEN AGRICULTURE & NONAGRICULTURE

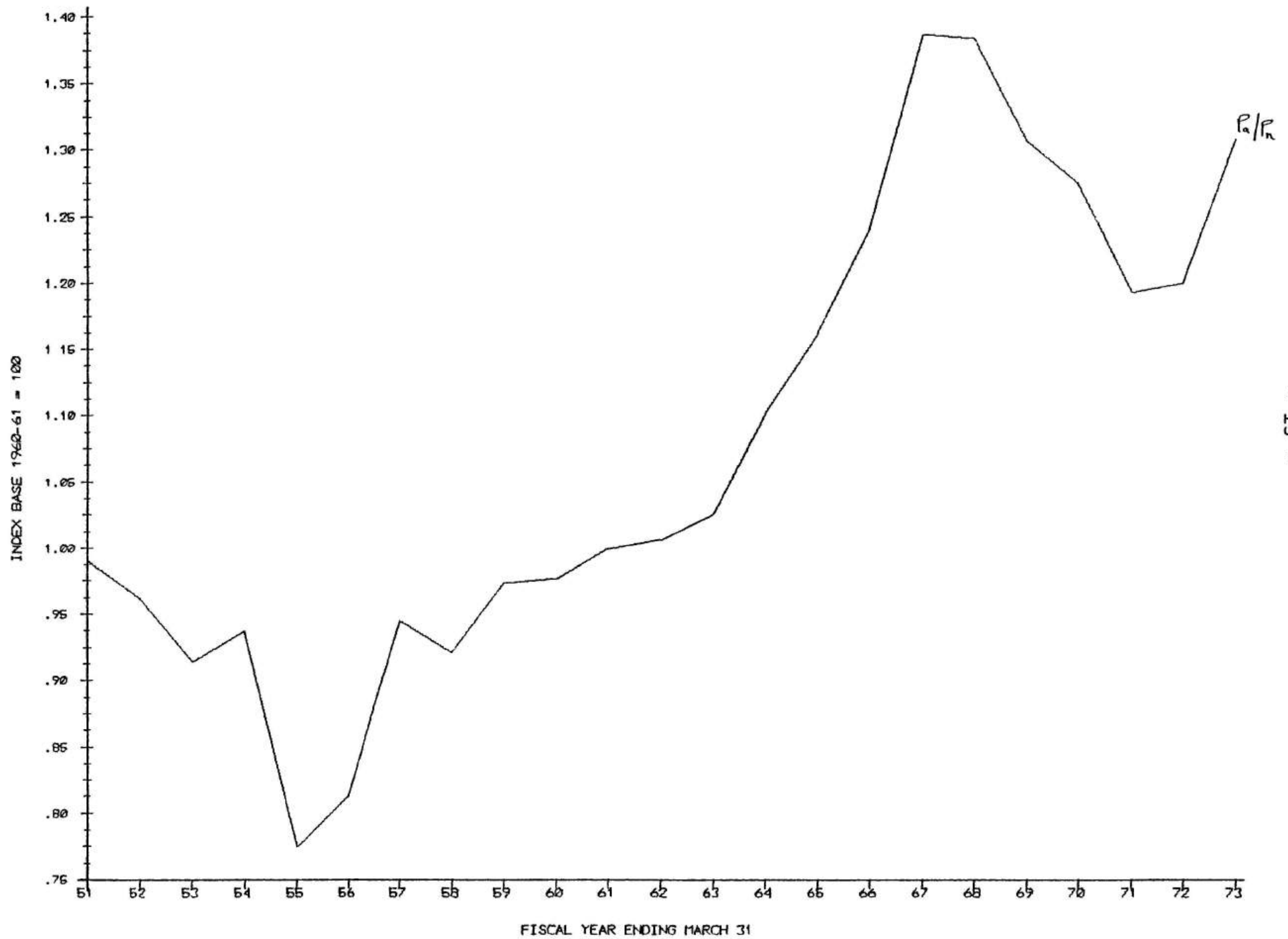


CHART V IMPORTS OF FOODGRAINS (REAL)

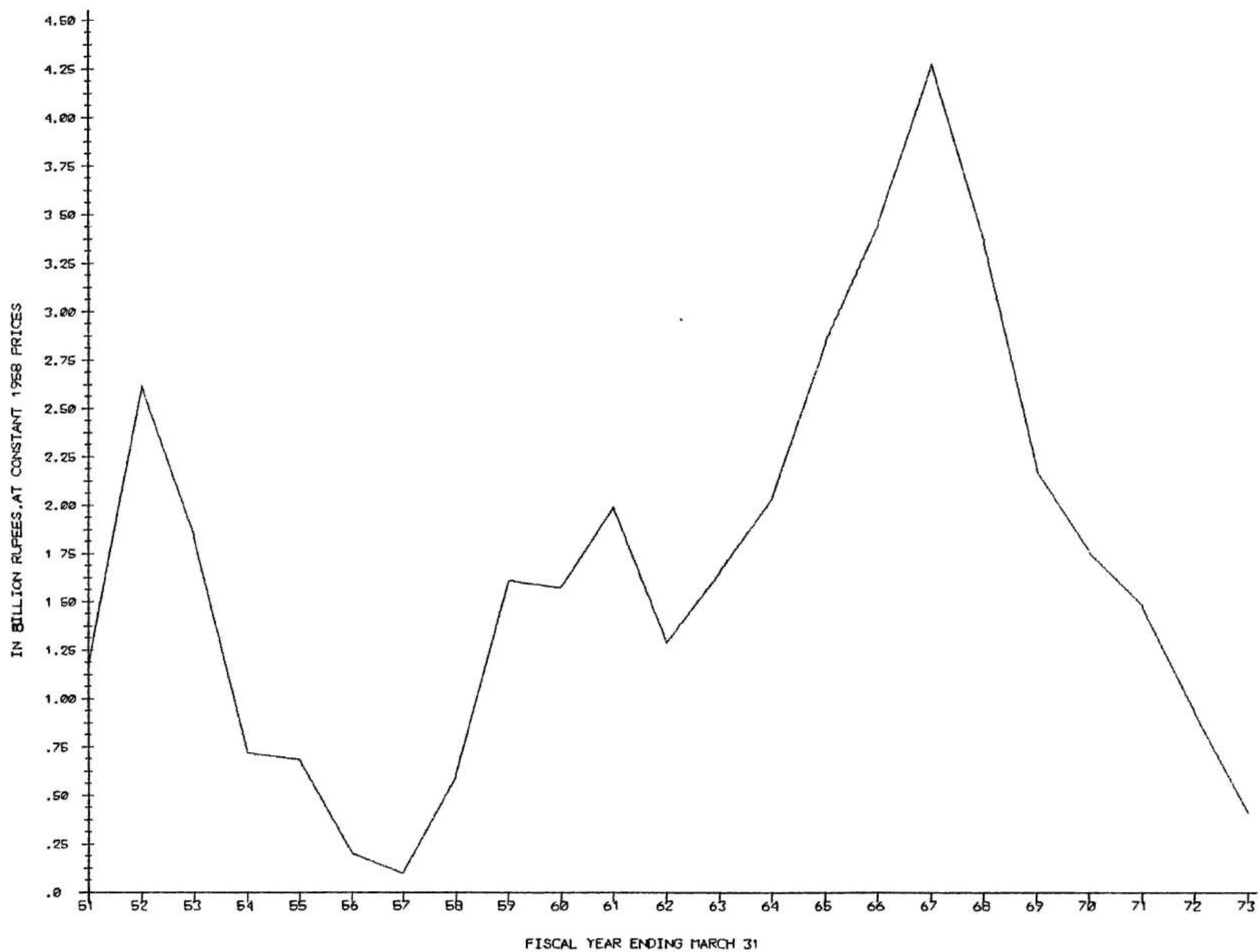


CHART VI RELATIVE PRICES OF FOODGRAINS AND COMMERCIAL CROPS

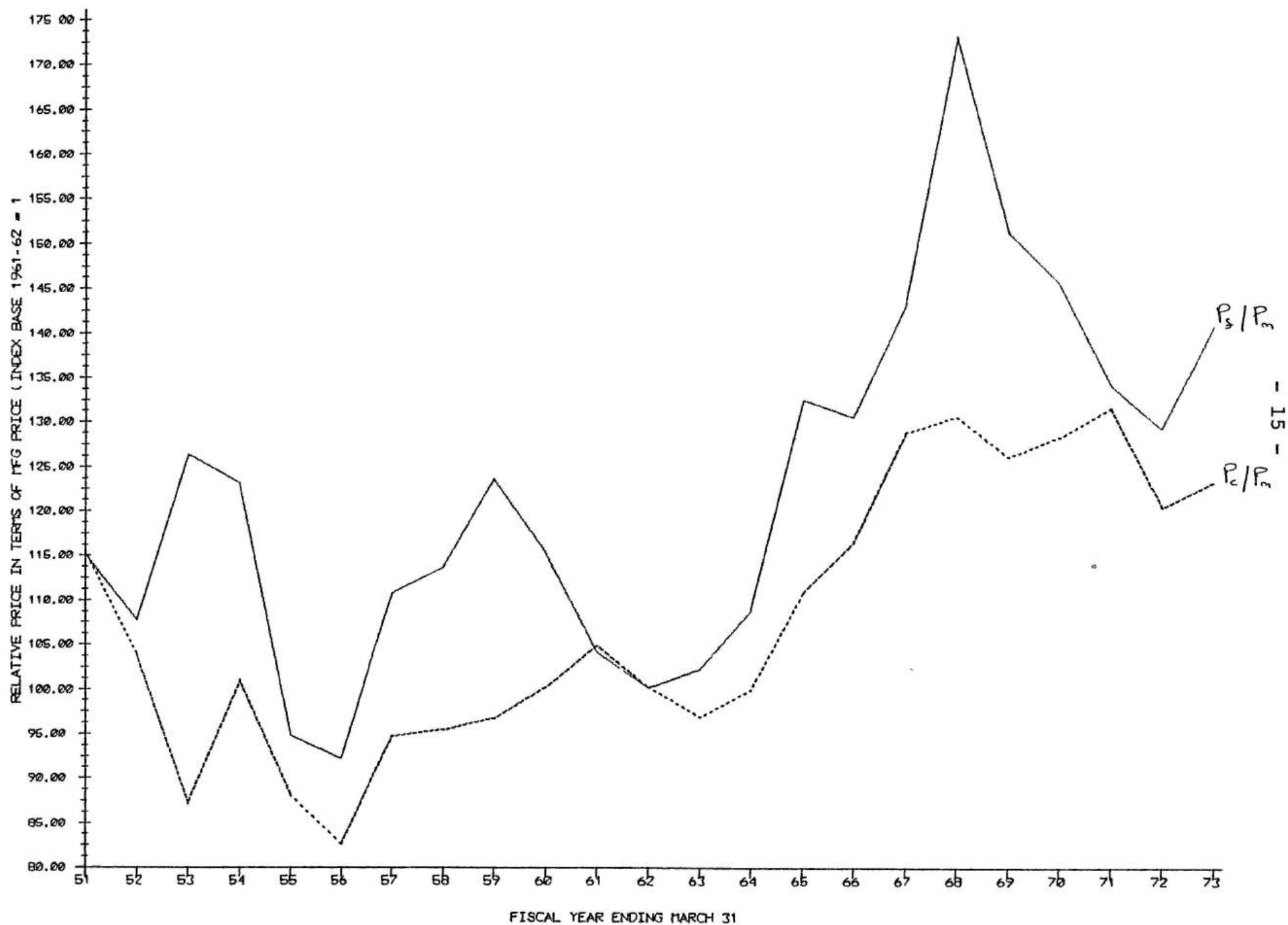


CHART VII PRICE OF MANUFACTURED GOODS. AND SELECTED IMPORT PRICES

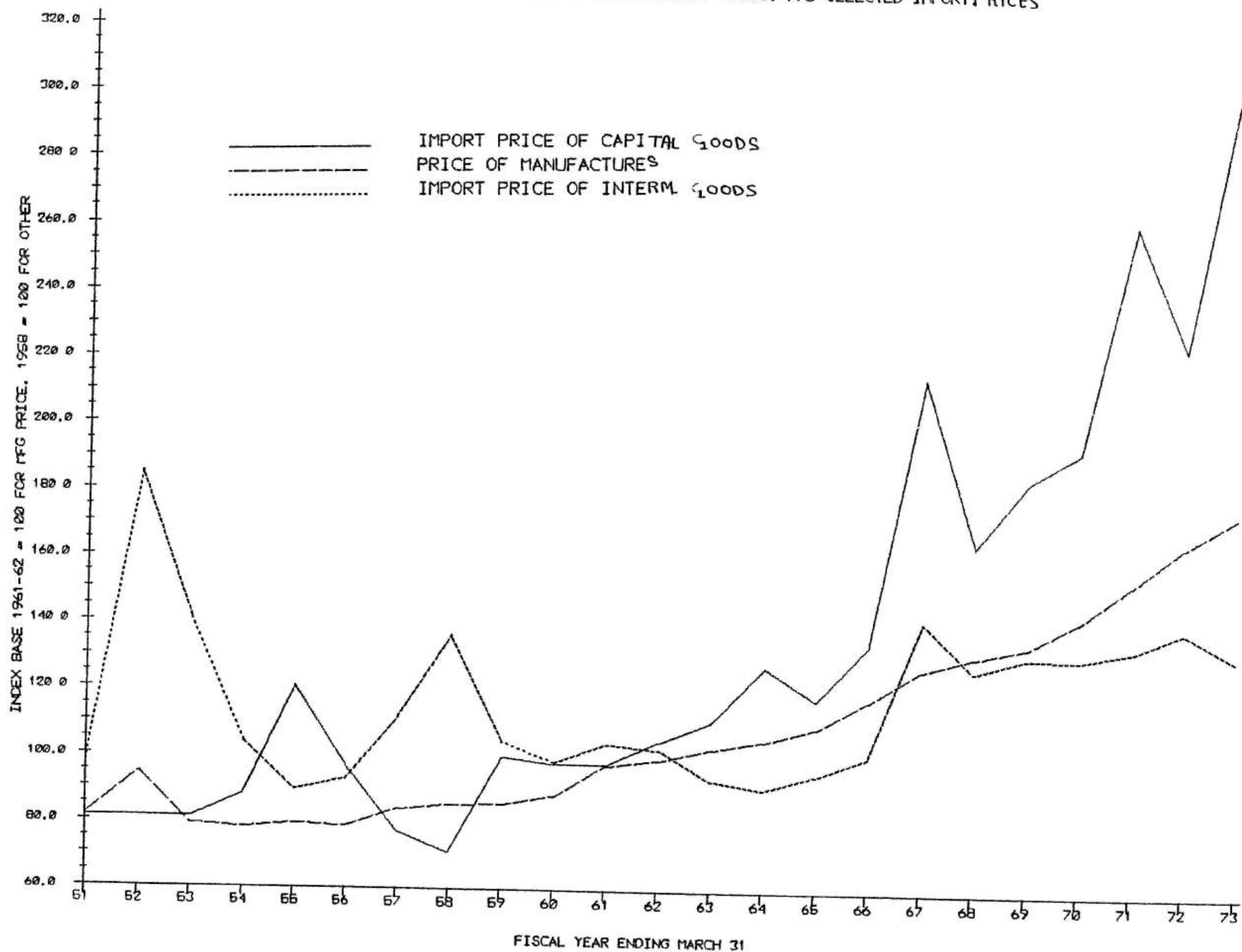
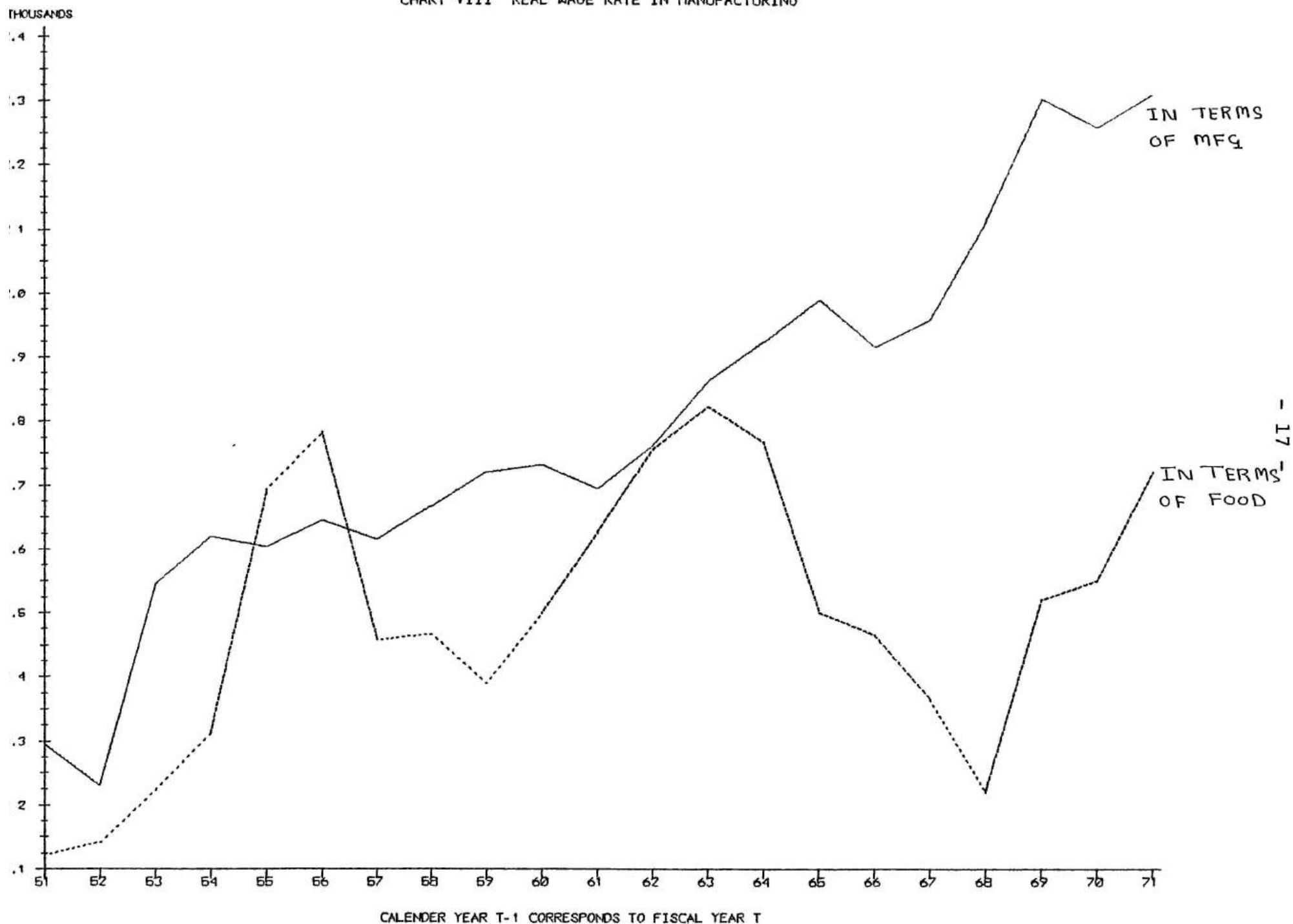


CHART VIII REAL WAGE RATE IN MANUFACTURING



very slowly during the first half of our period of study, but accelerated in the second half. One of the determinants of the price of manufactured goods is the price of imported materials and/or of imported capital goods. Chart VII also shows movements in the prices of these imports. The latter, particularly the price of imported capital goods, accelerated in the second half of our period of study.

Another important factor affecting the price and output of manufactured goods is the real wage rate in manufacturing. Chart VIII depicts movements in the real wage rate showing a strong upward trend. However, it is interesting to note that in terms of foodgrains the real wage rate shows almost no trend.

Section II. Review of Theories of Inflation.

Since alternative theories of inflation have been discussed and reviewed extensively in the literature, only a brief review is presented here.^{1/} In general, one can identify a number of "specific" theories of inflation which emphasize one or other key factor in explaining inflation. These theories can be classified into two categories: (i) those

^{1/} Bronfenbrenner & Holzman (11), Johnson (40).

that are based on aggregative expenditure generating processes across all sectors in the economy, and (ii) those that primarily emphasize imbalances originating in particular sectors. The Keynesian demand-pull theory and the monetarist or the quantity theory belong to the first category, while the cost-push theory, the imported inflation theory, Schultze's demand shift theory, and the structuralist theories form part of the second.^{1/} Perhaps the most important feature of these various theories is that they are not necessarily inconsistent with each other. It is generally agreed that an eclectic theory incorporating many if not all of these possible processes is feasible and indeed may be the desirable approach in analysing inflation in an economy. The issue then becomes an empirical one of determining in particular economies which factors or processes are quantitatively most important and when. In this section we will provide a brief review of the various elements that must somehow be blended into the eclectic or completely general theory of inflation.

In the Keynesian demand-pull theory, inflation is analysed in terms of an excess demand framework through the use of a savings-investment gap. The role of money is

^{1/} Our survey does not cover the Phillips curve type theories analysing the trade off between inflation and unemployment in industrialized economies.

considered secondary in the inflation process, and the effect of expectations is completely ignored.

The monetarist theory of inflation, on the other hand, takes as its starting point a stable demand function for money with income, wealth, rate of interest, rate of change of prices, and rates of return on alternative financial assets as the major determinants of the demand for money.^{1/} Beginning with an equilibrium in the money market, if money supply is increased, economic units will find themselves holding larger cash balances than they desire, and as they begin to get rid of these balances by buying alternative assets and/or goods, the adjustment process sets in so as to bring about a decline in the rate of interest and an increase in prices.

The 'sectoral imbalance' theories of inflation take as their starting point either autonomous influences on particular sectors or specific constraints--structural or institutional--operating on individual sectors. Thus, the wage-cost-push approach analyses inflation in terms of autonomous pressures on the wage rate and its transmission

^{1/} Friedman (23).

upwards. The imported inflation theory postulates how autonomous increases in prices of imported goods lead to cost-push pressures in the economy. The demand shift theory, on the other hand, emphasises the downward rigidities of prices as an explanation of inflation. This theory, as set out by Shultze, postulates that as demand shifts from one sector to another, and as prices in the sector from which demand has shifted fail to decline to bring about the required relative price change, prices in the sector to which demand has shifted rise. Thus, even in the absence of overall excess demand, inflation results from specific rigidities in the economy. These specific rigidities are emphasised in a general equilibrium framework by the structuralist school. Corbo Lioi (16) presents a good summary of the monetarist and the structuralist views of inflation in his recent study of the Chilean inflation.^{1/}

While emphasising different elements, the theories

^{1/} As Samuelson and Solow (65) point out very clearly, it is extremely difficult if not impossible to devise an empirical test which can determine whether any particular inflation is of cost-push or a demand-pull type.

discussed above are not inherently inconsistent with each other. The question of what the particular causes of any observed inflation are then becomes an empirical one. How do the real--aggregative as well as sectoral--influences combined with the monetary pressures generate and sustain any particular inflationary process?

In the Indian economy where agriculture is the single most important sector (accounting for over 40 per cent of total output generated), any empirical analysis of inflation has to incorporate the role of fluctuations in agricultural output on prices in this sector and the transmission of the same through cost-push mechanisms to prices in the economy in general. This is particularly important since "cushioning" possibilities through foreign trade are limited given the existence of severe balance of payments constraints. Increases in import prices and their impact on the general price level and output can also be analysed in terms of the autonomous cost-push framework.

At the same time, in a mixed economy where the public sector plays a major role in the growth process, the demand pressures generated by the government's expansionary policies present potential sources of demand-pull inflation. Given the importance of the public sector in the economy and the magnitudes of deficit financing from the banking system, any

sharp distinction between fiscal and monetary policy is unrealistic. Monetary expansion almost always reflects an underlying "excess demand" generated in the public sector so that the distinction between demand-pull and monetarist explanations of inflation is blurred.

For these reasons this study attempts to analyse the behavior of prices in India through specifying a model which incorporates elements of the various theories discussed above.

Section III. Empirical work on India.

This section reviews the existing empirical work on Indian inflation. While there are many descriptive studies of inflation in India, quantitative work in this field has been fairly limited. We can broadly classify the latter into two groups: (i) inflationary gap type or quantity theory type analyses at a very aggregative level,^{1/} and (ii) studies of inflation as part of the specification and estimation of an overall macroeconometric model.^{2/}

(i) Aggregative studies.

Raj's study (69) of price behavior in India over the

^{1/} Raj (69), Prasad (59).

^{2/} Desai (19), Pani (58).

period 1949-1966 is a classic example of the first kind. Raj analyses movements in aggregate prices and in food prices using a Keynesian multiplier framework. For the former, he assumes that the marginal propensity to consume is 0.75 and is unaffected by changes in prices from year to year, and that there are only three or four rounds of expenditure taking place in the course of a year. He assumes that changes in aggregate demand are induced only by 'autonomous' changes in expenditure, and that domestic production and imports are the only sources of supply, thereby ignoring movements in stocks. Once the ex-ante demand is generated through the multiplier, and the supply at the previous period's prices is obtained, the adjustment in prices required to bridge the gap is derived and is compared with actual price movements. The two series are found to move fairly closely together. Essentially the same approach is followed in analysing movements in food-grain prices. Demand for foodgrains is estimated on the basis of growth in per capita income and population, assuming a constant income elasticity of demand for foodgrains. In estimating supply, again, movements in stocks are ignored. This is a more serious error in the case

of foodgrains, as stock movements do exercise a major influence on supplies. Given the gap, the extent of the change in price is derived through assuming certain values of the price elasticity of demand for foodgrains.

Raj's study either borrows the estimates of needed parameters (e.g., marginal propensity to consume, price and income elasticities of demand for foodgrains) from other studies or draws upon intuition to devise the same. Also, the highly aggregative approach does not allow for a study of sectoral imbalances and their interactions.

Dar and Mellor (18) in their study of foodgrain prices in India over the period 1949-1964 use a modified inflationary gap approach. They estimate a demand-supply gap variable along Raj's lines. A linear regression equation is then estimated using the gap, its lagged value (this being a proxy for changes in private stocks), and money supply as explanatory variables and the movements in foodgrain prices as the dependent variable.

Divatia and Pani's approach (20) is similar to Dar and Mellor's, as they try to study variations in cereal prices over the period 1951-1952 to 1966-1967 through determining the impact of total supply of cereals, demand for the same by the non-agricultural sector, and availability of monetary resources.

A common limitation of the studies discussed above is that

they try to determine foodgrain prices though equilibrium between total demand and total supply of foodgrains. In fact, about two thirds of foodgrain output is used for self-consumption, and it is the marketed surplus which along with the market demand for foodgrains determines their prices. Marketed surplus depends, among other things, on the price of foodgrains and the price of urban goods in the consumption basket of the producers of foodgrains. The simultaneity in this context is too important to be ignored. Although there have been studies of response of marketed surplus of individual crops or subgroups of foodgrains to prices, this has not been attempted for foodgrains as a whole except by Bhagwati and Srinivasan (9) in the context of determining the impact of the 1966 devaluation on prices in the economy. We shall discuss their specification and results and compare the same with our own specification and results of the marketed surplus and price functions for foodgrains in chapters II and III.

Chakrabarti (12), in his study of the behavior of the relative price of cereals in India over the period 1952-1970, formulates the problem in terms of an equilibrium between market demand and market supply of cereals, but proceeds to obtain a reduced form in which the relative price is a function of current and lagged output, income, and lagged relative price.

(ii) Macroeconometric models.

Apart from these aggregative studies, the only attempts at studying inflation are those implicit in the specifications of various macro-econometric models. Most of these models are explicitly Keynesian in their basic framework, with inadequate specification of the supply constraints in the economy.^{1/} In this category, we include the macro-econometric models of Choudhry (14), Krishnamurti (47), Mammen (52), Marwah (54), Narasimhan (56), and Pandit (57).^{2/} In addition, we shall review the treatment of prices in the models of Agarwala (1), and Pani (57).

We first present a brief review of the Keynesian macro-economic models of India. These models provide behavioral specification of the disaggregated demand components, in real terms in the case of Krishnamurti, Mammen, Marwah, and Pandit, and in nominal terms in the case of Choudhry and Narasimhan. Supply constraints in these models appear either as aggregative production functions or as price functions. In Choudhry's model (14), the aggregate production function gives the real output, and this together with the nominal expenditure equations determines the price level. Narasimhan (56), on the other hand, derives real output by introducing a price equation explicitly.

^{1/} For a review of the macro-econometric models of the Indian economy, see Desai (19).

^{2/} Bhattacharya (10) and Roy (64) explicitly exclude the determination of prices from their models.

The price level in his model is determined by agricultural prices, import prices, and the real wage rate. The price level also affects the expenditure equations through influencing the wage-profit distribution. In Mammen's model (52) the expenditure equations for certain components of aggregate demand, i.e. consumption, investment, and imports, are specified in real terms. These, together with exogenous agricultural output, determine non-agricultural output. Prices are specified as a function of agricultural prices, and as implicit supply equations, these determine the real value of the remaining components of demand, i.e., government expenditures, taxes, exports, etc. In Marwah's model, (54) again, expenditure equations are specified in real terms, while the aggregate price level is determined by the change in the money value of net national product. As in Mammen's model (52), the price level affects the real value of aggregate demand other than consumption and investment. In Krishnamurti's model (47), total real output is determined by real expenditure equations, while agricultural output is determined by an agricultural production function. Once the non-agricultural output is determined in this manner, this determines the level of employment in the non-agricultural sector. The real wage is determined by a trend, and together with employment in the non-agricultural sector, it determines the level of

profits. Pandit (57) specifies expenditure equations which determine the real demand for output. This, together with a production function for the non-agricultural output, determines employment and wages. Prices are then determined by the money market variables, wages, and the price of imports. For the money market equations, Pandit has an appropriately generalized specification of the demand for money function and a specification of the supply of money equation which incorporates the fiscal-monetary link.

A major weakness of these aggregative Keynesian models is that they ignore the role of agriculture in determining output and prices. The approach of combining the Keynesian expenditure equations with a neoclassical aggregate production function is somewhat trivial for the Indian economy, as it means that output is determined solely by demand, and employment is derived by the production function. Even in a labor surplus economy, the availability and price of foodgrains may constitute effective constraints on the employment of labor in the non-agricultural sector. Also, the availability and price of intermediate materials--the domestically produced commercial crops as well as imports of critical inputs--may constitute additional constraints in the determination of output in the non-agricultural sector. These constraints are not reflected in these models. The treatment of prices in

these models also leaves much to be desired. There is no role for relative prices in these models. As regards the effect of agriculture on prices, this is postulated in a cost-push framework, and little effort is made to explain the determination of agricultural prices themselves.

Pani's model (58) tries to incorporate supply constraints, but combines this with a very simple mechanism for determining prices. Agricultural output as well as manufacturing output are determined through specifying production relationships, and emphasizing the linkage from the agricultural to the manufacturing sector through agricultural inputs into manufacturing. Output in the services sector is related to material output (outputs in the agricultural and manufacturing sectors) and government investment in infrastructure. The model also provides behavioral specification of the major components of aggregate demand in real terms, e.g., consumption, fixed investment, exports, and imports, although these demand functions have no effect on either prices or outputs. Prices are determined exclusively through a cost-push mechanism, once the price of foodgrains is determined. The latter is determined in a market clearing framework by the total availability (output plus imports) of foodgrains, income and money supply, the last variable being "reflective of the application of the quantity theory of money". Prices in this

model affect the real demands/supplies in the economy, but the latter have no direct effect on prices other than through the price of foodgrains. A demand function of money is specified, and equilibrium in the money market is achieved by adjustment in the interest rates, and not in prices.

Although Pani's model is an improvement over the Keynesian models discussed above in that it attempts to capture the supply rigidities in the economy, it is inadequate in the following respects: (i) The determination of food-grain prices which is at the core of the price formation process in the model does not incorporate the marketed demand/supply framework (see pg. 26, above). (ii) The mechanism determining other prices in the economy is very simplistic. While the model postulates detailed specifications of the supply functions for the various sectors, there is no interaction between the sectoral relative prices and the sectoral demands/supplies. In fact, the price specifications do not even correspond to the sectoral breakdown in the model. (iii) The role assigned to the interest rate as an adjusting variable bringing about equilibrium in the money market is not realistic in the context of the monetary authorities' control over the interest rates; (iv) the effect of fiscal deficit on money supply is missing.

Agarwala's model (1) also attempts to incorporate the

supply constraints in the economy at a much more aggregative level, and develops a "real" linkage, albeit one way, between the agricultural and the non-agricultural sectors. Availability (output plus net imports) of foodgrains determines employment in the non-agricultural sector which, in turn, along with the capital stock, determines output in this sector. Once the outputs in the two sectors are determined through the production functions as specified, the general price level is obtained through a quantity-theoretic framework. In this model, prices play no role in determining the availability of foodgrains. The role of foodgrain prices as well as other prices in affecting the marketed supplies and therefore the availability of foodgrains is ignored. The specification of the monetary sector of the model leaves much to be desired. Agarwala regards money supply to be a simple function of currency, with no linkages on the fiscal side. Moreover, in a simple quantity theory framework, he specifies money value of income to be a distributed lag (Koyck type) function of money supply. Thus real output is determined through production functions, while money income or price are determined through money supply. Money is needed only as a medium of exchange, and expectations regarding future prices do not affect the demand for money. The price equations as specified in the model determine the sectoral terms of trade. The specifications

allow for the effect of agricultural prices on non-agricultural prices, but not vice versa.

The above review leads us to focus on the following limitations of the existing macroeconometric models of India:

(i) Supply constraints in the economy are mostly not incorporated. If incorporated as in Pani's case, these are not integrated with the rest of the model.

(ii)' The role of agriculture in the process of generation of prices as well as outputs in the economy requires much more careful analysis than is present in the existing models.

(iii) The process of determination of the price of foodgrains--the core level price in the economy--requires an analysis of the marketed surplus function of foodgrains. None of the existing models incorporates this very important behavioral relationship underlying the determination of the foodgrain price. An appropriate specification of this function and a process of simultaneous determination of the marketed surplus and the relative price of foodgrains would lead to a significant improvement in the modeling of the economy.

(iv) To the extent that the utilization of capacity in the manufacturing sector is subject to certain supply constraints originating from the agricultural sector and/or the foreign sector, and demand fluctuations, an explicit building in of these factors would improve the specifications of the manu-

facturing sector.

(v) Government expenditures are regarded as exogenous in the existing macroeconometric models. As government wages and salaries are subject to the pressures of rising cost of living indices, an explicit modeling of this linkage would be an improvement in the specification of the government sector.

(vi) An integration of the fiscal and monetary sector specifications is missing in the existing models. Pandit's model is the only model which postulates a link between the fiscal deficit and money supply. A careful presentation of the various identity constraints can also be useful in the understanding of the various linkages in a model.

The model presented in chapter II attempts to remove these limitations as far as possible, and provides a structural specification in the light of the specific institutional characteristics of the Indian economy.

II. THE BASIC MODEL

This chapter summarises the basic structure of the macro-econometric model, with its sectoral disaggregation and inter-sectoral linkages.^{1/}

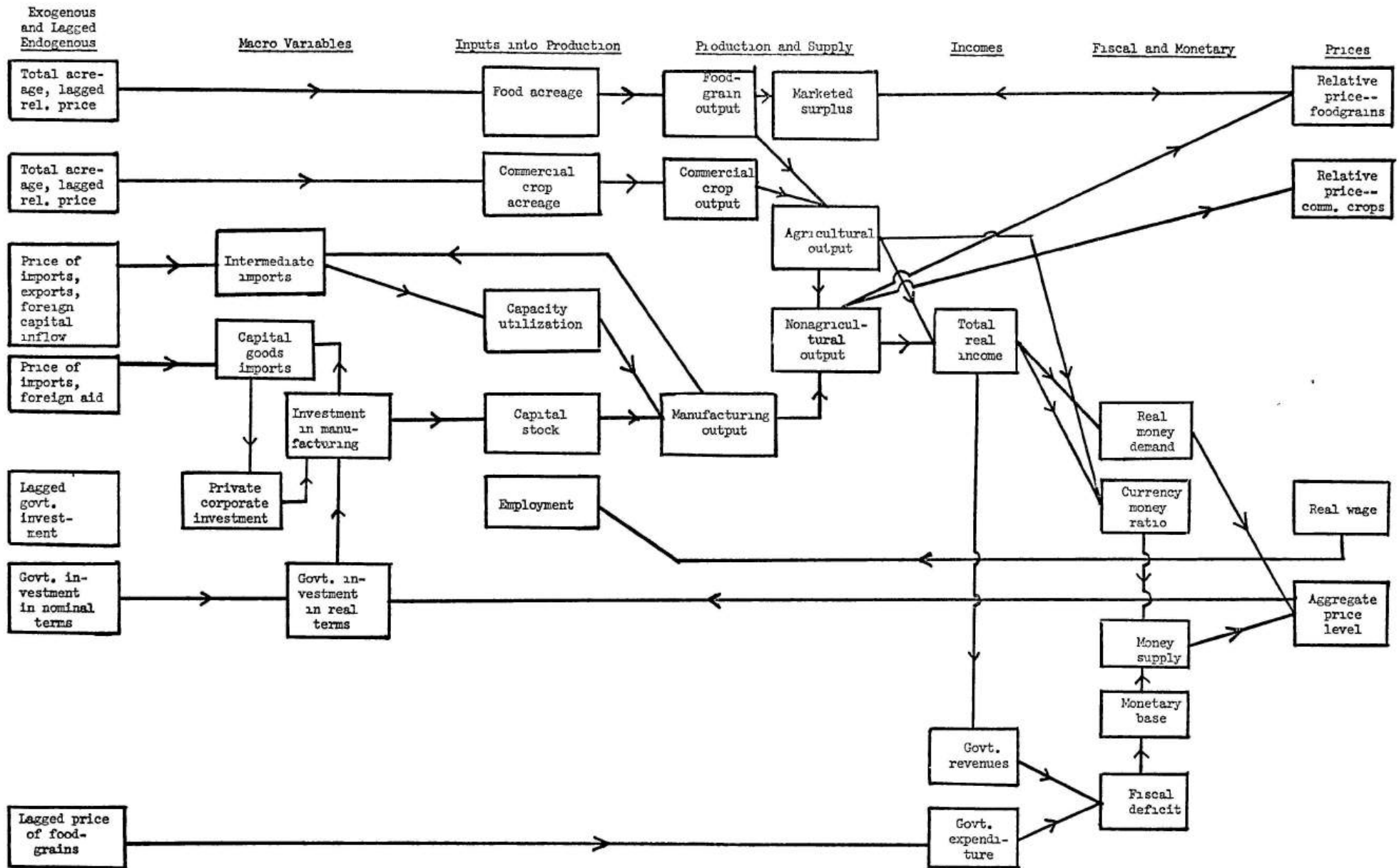
In contrast with most other existing macro models of the Indian economy, the model presented in this chapter does not focus on the behavioral specification of the individual components of aggregate demand in the economy, but instead emphasises the disaggregation on the supply side. In particular, the model allows us to explore the impact of (i) fluctuations in output, marketed supplies, and prices of agricultural commodities, (ii) foreign exchange shortages, and (iii) changes in government investment (which is exogenous in nominal terms but endogenous in real terms) on the economy. A flow diagram showing the interactions in the model is presented on page 36.

The major features of the model are the following:

(i) The model divides the economy into two broad sectors - agriculture and non-agriculture. The agricultural sector is further subdivided into the foodgrain and commercial crop sectors, while the non-agricultural sector is subdivided into

^{1/} A good summary of the limitations of the existing macro-econometric models of developing economies is provided by Behrman J. (6).

FLOW CHART OF THE BASIC MODEL



manufacturing and other (residual) sectors.

(ii) The model specifies a mechanism for the determination of a relative price structure for the two agricultural subsectors defined above as well as a mechanism for the determination of the aggregate price level. The relative price of agricultural and non-agricultural goods is also determined in the model. The relative price functions for all sectors take account of supply (which is explicitly determined in the model) as well as variables reflecting demand.

(iii) The model contains important linkages between the agricultural sector and the rest of the economy. The price of foodgrains affects the level of the money wage in the manufacturing sector. Agriculture also affects the fiscal balance of the economy. Food prices affect government expenditures through their impact on government wages, while agricultural output affects government revenues.

(iv) A distinguishing feature of the model compared to the other existing models is its explicit treatment of the determination of the marketed surplus of foodgrains which is at the core of the process determining foodgrain prices.

(v) The model provides an endogenous determination of capacity utilisation in the manufacturing sector. Capacity utilisation depends upon certain structural supply constraints,

e.g., availability of intermediate materials imports and of agricultural raw materials, as well as fluctuations in demand (particularly in government investment). This specification establishes linkages between the manufacturing sector, on the one hand, and the foreign, agricultural, and fiscal sectors, on the other.

(vi) Exports and foreign capital inflows are exogenous to the model, and so is the import of foodgrains which is a government-determined policy variable. The model specifies import functions for capital goods imports and for intermediate goods imports. Thus, the change in net foreign reserves is obtained endogenously. This constitutes a crucial link between the foreign sector and the monetary sector in the model. To the extent that the imports of capital goods and of intermediate materials are dependent on foreign capital inflows, and these imports influence investment and capacity utilisation in the economy, the model explores the effect of foreign exchange availability on the real activity in the economy.

(vii) Government budgetary operations are endogenised through specifying government revenue and expenditure functions.^{1/} The susceptibility of government wages and salaries to

^{1/} Government revenues and expenditures relate to the respective consolidated aggregates of central government, state governments, and union territories.

increasing food prices constitutes a major link between the agricultural sector and the fiscal sector in the model. The system of government controls--industrial licensing, import controls, price regulations etc., --is too complex to be fully taken account of in a model of this kind.^{1/} However, care is taken to incorporate the government's policy-induced distortions in the specifications of individual equations in the model.

(viii) The aggregate price level is determined at the level which equates demand for money with the nominal supply of money. A behavioral demand function for money as well as an endogenous supply function of money are specified in the model.

(ix) The model permits the real sector to have an explicit effect on the monetary sector in the economy. Money supply responds to pressures in the real sector via their impact on the government fiscal deficit. The government's fiscal deficit operates directly on the expansion in the monetary base via borrowing from the Central Bank. Money supply is also affected by the behavior of the private sector through its choice of a currency-deposits ratio.

Before proceeding to a discussion of the detailed

^{1/} See Bhagwati J., and Desai P. (8)

structure of the model, it may be worth indicating how real and monetary elements have been combined in the specification of the model. Sectoral supplies of and demands for commodities are dependent on relative, not absolute prices. At the same time, the real balance effect is an essential part of the mechanism which equilibrates the money market in the model. Thus, any change in money supply in a given period, *ceteris paribus*, leads to a proportional change in all prices in the same period. The monetary authorities' regulation of interest rates and their influence in turn on investment in the economy is another channel linking the monetary sector with the real sector. This linkage is explored in the model. Also, to the extent that the government's fiscal operations are specified in nominal terms, the determination of the aggregate price level in the money market influences the real value of government revenues and expenditures, and hence of government savings in real terms, thereby affecting the availability of real investment finance.

We now present the detailed specification of the model.

Section I: The Agricultural Sector

Disaggregating the economy into agricultural and non-agricultural sectors is essential to the proper modelling of the Indian economy. Over 40 per cent of Indian gross domestic

product originates in the agricultural sector. At the same time, the economy possesses a relatively modern industrial base whose characteristics are sufficiently different to warrant separate treatment.

The agricultural sector is extremely important both as a supplier of food to the non-agricultural sector, and as a provider of raw materials to the industrial sector, particularly given the acute foreign exchange shortages which have prevailed in India. In such a situation, food shortages (or wage good shortages, more generally) constitute an important constraint on the absorption of labor into the manufacturing sector in spite of the existence of surplus labor in the economy. As Arthur Lewis puts it:^{1/}

"....if the capitalist sector produces no food, its expansion increases the demand for food, raises the price of food in terms of capitalist products and so reduces profits.Hence, if we postulate that the capitalist sector is not producing food, we must either postulate that the subsistence sector is increasing its output, or else conclude that the expansion of the capitalist sector will be brought to an end through adverse terms of trade eating into profits."

Thus, the supply curve of labor to the non-agricultural 'modern' sector may be perfectly elastic at a real wage in terms of foodgrains, but in the face of a decline in agri-

^{1/} Lewis W.A. (51), Pg. 173.

cultural output, this implies an increase in the real wage in terms of the non-agricultural good. This problem is typically ignored in the conventional treatment of surplus labor in two sector single good models. The issue of changing terms of trade between the backward (agricultural) and the modern (non-agricultural) sector is finessed in these models by assuming that the two sectors produce the same good, in which case of course the agricultural sector cannot be a constraint on the modern sector's development. The experience of the Indian economy over the last decade has clearly demonstrated the importance of the distinction between a labor bottleneck and a wage good bottleneck.^{1/}

(i) Agricultural Output

The agricultural sector is subdivided into a foodgrains sector (subscript f) and a commercial crops sector (subscript c).^{2/} Because there is substantial scope for changing cropping patterns, reflecting changing expectations on the relative prices of foodgrains and commercial crops, we specify functions determining the allocation of gross sown area between these

^{1/} For an exposition of this thesis in the Indian context, see Chakravarty S. (13).

^{2/} Commercial crops are defined to include fibres, oilseed, and sugarcane--the major competing crops to foodgrains. Together, foodgrains and commercial crops account for over 90 per cent of total area under all crops. The remainder, A_o (area under other crops) is regarded as exogenous.

sectors. The model then specifies production functions for each sector which include gross sown area in each as an argument.

An acreage function is explicitly specified for foodgrains, while acreage under commercial crops is derived residually through the identity presented below. Gross sown area under foodgrains is specified as a function of the expected relative price of foodgrains and commercial crops, and total gross sown area.^{1/} Various expectational forms for prices are postulated through specific distributed lag assumptions on the relative price variable, and the results are discussed in chapter III.^{2/}

$$A_f = a_1 + b_1 (P_f/P_c)^e + c_1 A \quad (1)$$

$$b_1 > 0, \quad c_1 > 0$$

$$A_c = A - A_f - A_o \quad (2)$$

Production functions in the two subsectors of agriculture are specified on the assumption that labor is not a constraint

^{1/} This specification legitimately ignores the investment decision relating to the long term expansion of area under crops, and concentrates on the short term choice facing the farmer, i.e., the choice of cropping pattern.

^{2/} An index to the symbols used in the model is provided in Appendix I. A prime on a variable denotes that the variable is valued at base year prices.

on production within the agricultural sector.^{1/} Land or gross sown area, irrigation, consumption of fertilisers, and weather are the major factors influencing production in the two subsectors. Capital stocks could not be included in the production functions, as data on these are not available. Again, because of data-related as well as statistical problems, consumption of fertilisers had to be dropped as an explanatory variable in the production functions.^{2/} It is important to note, however, that to the extent that farmers tend to cultivate their land relatively intensively when irrigation is available, the inclusion of gross irrigated area as an explanatory variable captures the effect of the use of fertilisers and other such inputs. Thus,

$$O_f = a_3 + b_3 A_f + c_3 J_f^I + d_3 H_f \quad (3)$$

$$b_3 > 0, \quad c_3 > 0, \quad d_3 > 0$$

$$O_c^I = a_4 + b_4 A_c^I + c_4 J_c^I + d_4 H_c^I$$
$$b_4 > 0, \quad c_4 > 0, \quad d_4 > 0 \quad (4)$$

^{1/} This is certainly less true in the advanced agricultural area of the Punjab.

^{2/} This will be discussed in detail in chapter III.

Output of foodgrains and commercial crops (fibres, oil-seeds, and sugarcane) together account for over 70 per cent of the gross value of output in agriculture. On the assumption that the trends in outputs of these two subsectors of agriculture are representative of the trends in agriculture as a whole, the gross value of output in agriculture is expressed as a function of these two outputs.

$$V'_a = b_5 0^I_f + c_5 0^I_c \quad (5)$$

$$b_5 > 0, \quad c_5 > 0$$

The coefficients b_5 and c_5 cannot be interpreted as base year prices, as the output of foodgrains and commercial crops do not exhaust the total output in agriculture.

The value added in agriculture is then obtained by deducting the cost of inputs in agriculture and adding the charges of the government operation of the irrigation system, treating both the input costs and the irrigation charges as exogenous. This procedure is exactly the same as that followed by the Central Statistical Office in deriving value added in agriculture from the gross value of output in agriculture.

$$Y'_a = V'_a - I'_a + H^g \quad (6)$$

(ii) Marketed Surplus

In order to capture the linkages between agriculture and

the rest of the economy, we need to specify not just production functions in agriculture but also a marketed surplus function for foodgrains. This is particularly important in view of the fact that about two-thirds of total output of foodgrains in the economy is retained for self-consumption. It is the marketed surplus of foodgrains which, along with the net government distribution of foodgrains, constitutes the supply side of the process which determines the price of foodgrains.

Notwithstanding the recognition of the critical importance of marketed surplus of foodgrains for prices as well as growth in the economy, very little empirical work has been done to incorporate this in the existing macro-econometric models.^{1/} This is to a large extent due to the lack of any official time-series data on the marketed surplus of foodgrains. With some effort, we have been able to construct a data series for the marketed surplus of foodgrains, extending and modifying methods originally used by Bardhan and Bardhan in their study of the price responsiveness of the marketed surplus of cereals in the Indian economy, and by Thamarajakshi in her study of the intersectoral terms of trade and marketed surplus

^{1/} In their recent book on Foreign Trade Regimes and Economic Development, Bhagwati and Srinivasan have used marketed surplus of foodgrains in explaining the behavior of food-grain prices in India. They extend the Bardhan-Bardhan time series beyond 1964-65 by assuming that the marketed surplus changed in the same proportion as market arrivals of major cereals. (9).

of agricultural produce. ^{1/} The exact method of construction of this time-series is outlined in Appendix II.

The marketed surplus of foodgrains in the model is specified as a function of the output of foodgrains, current as well as one year lagged, the relative price of foodgrains in terms of the manufactured good, and the income from the commercial crop output expressed in terms of the price of the manufactured good.^{2/}

$$S_f = a_7 + b_7 O_f + c_7 O_f(-1) + d_7 (P_f/P_m) + e_7 (O_c^I P_c/P_m) \quad (7)$$

$$b_7 > 0, \quad c_7 > 0, \quad d_7 \geq 0, \quad e_7 < 0$$

Equation 7 is derived from the following structural equations, i.e., equations 7.1 to 7.3:^{3/}

^{1/} Bardhan and Bardhan (5), and Thamarajakshi (67).

^{2/} Changes in marketed supplies resulting from the cash needs originating from changing demands of intermediate goods, e.g., fertilisers, are ignored in this specification.

^{3/} For a generalised discussion of the behavior of agriculture's marketed surplus, see Bell (7).

$$S_f = O_f - D_f - Z_f \quad (7.1)$$

$$D_f = a + b(P_f/P_m) + c O_f + d(O_C^I P_C/P_m) \quad (7.2)$$

$$b \geq 0, \quad c > 0, \quad d > 0.$$

$$Z_f = e + f(O_f - O_f(-1)) \quad (7.3)$$

$$f > 0.$$

Equation 7.1 defines the marketed surplus identity, such that the marketed surplus of foodgrains is the difference between the output of foodgrains and the self-consumption of foodgrains, less any build-up of producer stocks of foodgrains. Equation 7.2 presents the demand function for foodgrains, making the farmers' self-consumption of foodgrains a function of the output of foodgrains, relative price of foodgrains, and the income originating from the sale of commercial crops. Thus, agricultural income is decomposed into income from commercial crops and that from foodgrains, the latter being further disaggregated into income originating from an increase in output and that from an increase in relative prices. Equation 7.3 specifies the change in producer stocks as a function of the output of foodgrains, current as well as one-year lagged. Substituting 7.2 and 7.3 in 7.1, we obtain:

$$S_f = a + (1 - c - f) O_f + b P_f/P_m + d O_C^I P_C/P_m + f O_f(-1) \quad (7.4)$$

This is the same as equation 7 where the coefficient b_7 is a composite of two structural coefficients, c and f .

This detailed specification enables us to explore the differing responses of marketed surplus to the various components of agricultural income. Thus, an increase in income from the sale of commercial crops leads, a priori, to an increase in the consumption of foodgrains, and therefore to a decline in the marketed surplus. However, the effect of an increase in income from the sale of foodgrains, to the extent that it originates from an increase in the relative price of foodgrains, is indeterminate.

The effect of the relative price of foodgrains on the marketed surplus of the same is indeterminate, a priori, as it depends on whether the substitution effect is stronger than the income effect in the consumption of foodgrains. If the former is smaller than the latter, $d_7 < 0$. Much was made of the perverse price responsiveness of the marketed surplus of foodgrains in the early empirical findings in the field. 'Inelastic cash requirements' on the part of peasants was one of the explanations forwarded for this observed phenomenon.^{1/} In fact, peasants, acting as suppliers as well as consumers of foodgrains, may well reduce their marketed surplus of

^{1/} Ezekiel H. and Mathur P. N. (21)

foodgrains when the price of foodgrains rises, *ceteris paribus*, if the demand for food is income elastic and/or the substitutability between foodgrains and manufactured goods is small.^{1/}

Finally, the income of the peasants from the sale of the commercial crops is included as an explanatory variable in the marketed surplus function. Since an increase in income is expected, *a priori*, to lead to an increase in consumption and therefore to a diminution in the marketed surplus of foodgrains, the size of e_7 is expected to be negative, *a priori*.

Bhagwati and Srinivasan, in their specification of the marketed surplus function of foodgrains, specify the same to be a function of agricultural income and price of foodgrains in terms of cotton manufacturers. We shall compare their estimated results with ours in Chapter III.

(iii) Relative Prices of foodgrains and commercial crops

We have discussed above the behavioral supply functions for the foodgrains and the commercial crop sectors. In addition, we have specified a function for the marketed surplus of foodgrains which is an excess supply function incorporating behavioral demand elements in its specification. The model also specifies a price function of foodgrains, such

^{1/} Krishna R. (44).

that the relative price of foodgrains and the marketed surplus of foodgrains are determined simultaneously. As regards the commercial crops, the model postulates a reduced form specification of the relative price of commercial crops.

Before presenting the specification of the relative price function of foodgrains, we summarise certain aspects of government operations in foodgrains in India, which have an important bearing on price behavior.^{1/}

Government operations in foodgrains mainly consist of (a) large scale public distribution through fair-price shops, and (b) internal procurement and imports of foodgrains to facilitate public distribution. In the field of procurement, government operations have increased in recent years, procurement as a proportion of marketed surplus increasing from as low as 5 per cent in 1963-64 to about 25 per cent in 1969-70. Reliance on imports, however, continues to keep the scale of public distribution relatively high. Public distribution as a proportion of marketed surplus was 38 per cent in 1969-70.

The government sets procurement prices each year, in addition to setting minimum support prices which are announced prior to the sowing season each year. In setting procurement prices, the expected output of foodgrains in the economy as well as the volume and price of imports of foodgrains are the

^{1/} See Krishna R. (45), Dantwala, (17).

major considerations. In essence the system operates so that the farmers sell a certain proportion (varying from state to state) to the government, at prices below those that would rule in an open market. The remaining surplus is sold at open market prices.^{1/} This dual market system is enforced through demarcation of 'surplus' zones and the insulation of markets within these zones from the 'deficit' zones through controls over movements of foodgrains between zones. The amount procured by the government together with the amount imported and the existing government stocks of foodgrains constitute the amounts available for public distribution.

The price at which the government distributes foodgrains through fair price shops is called the issue price. The wholesale price index of foodgrains (which is used for this study) is a weighted combination of the wholesale issue price of the government and the open market wholesale price of foodgrains, except for the fiscal year 1973-1974 when only the official price was used.^{2/} While the open market price is determined by the demand/supply forces in the market, the issue price is determined by the government taking into account

^{1/} The fiscal year 1973-74 was an exception, since the government decided to nationalise the wholesale trade in wheat. This policy was later reversed in April, 1974.

^{2/} We may note here that the use of the wholesale price indices in the demand equations has in it the implicit assumption of constant proportionality of the retail margin.

the procurement price (the price at which domestic procurement is made), the import price (the price at which import of foodgrains are obtained), and the subsidy - a policy decision on the part of the government.

Any specification of the equation determining the relative price of foodgrains has to take account of the government's role, in addition to the demand and supply influences in the market. Two alternative specifications for this equation are given below:

$$P_f/P_m = a_8 + b_8 S_f + c_8 D_f^g + d_8 Y_n' \quad (8.1)$$

$$b_8 < 0, \quad c_8 < 0, \quad d_8 > 0$$

$$P_f/P_m = a_8' + b_8' O_f + b_8' O_f (-1) + c_8' D_f^g + d_8' Y' \quad (8.2)$$

$$b_8' < 0, \quad b_8' < 0, \quad c_8' < 0, \quad d_8' > 0$$

In the above two equations, marketed surplus/output of foodgrains and the government distribution of foodgrains (net of procurement) are the supply variables expected to suppress the price of foodgrains, while non-agricultural income/total income reflects demand pressures.

1/. In the estimations of these equations, we also decomposed the income effect into (a) per capita income effect, and (b) population effect.

The above specifications explicitly incorporate the effect of governmental quantitative intervention in the foodgrain market, but ignore the factors that influence the government's pricing decision in respect of the quantities distributed by it. These factors include the import price of foodgrains, and the desired element of subsidy which the government wishes to confer on consumers. An attempt was made to include the import price of foodgrains in the estimation of this equation, but the statistical quality of the results obtained was poor, probably due to collinearity between this variable and the net government intervention. Various proxies for government subsidy in the pricing of foodgrains were experimented with in the estimation, but with no success.

It is worth comparing our specification of the equation determining the relative price of foodgrains with that of Bhagwati and Srinivasan, since they also follow the market demand/market supply approach in determining the foodgrain price. Thus, nonagricultural income represents the demand variable in their reduced form specification, while agricultural income (through its postulated effect on marketed surplus) is the supply variable. Imports of foodgrains are also included to incorporate their suppressing impact on prices. In our specification, we also include nonagricultural income to reflect the market demand pressures. On the supply side,

we include the marketed surplus of foodgrains as the supply variable. In addition, we include the government intervention variable which is constructed to capture the joint effect of imports and of change in government stocks. Bhagwati and Srinivasan's choice of imports in place of the government intervention variable amounts to assuming that all imports of foodgrains in any given period are distributed in the same period, and there is no change in government stocks.

The model also includes an equation for the relative price of commercial crops in terms of manufactured goods. This specification is a reduced form incorporating the influence of supply as well as demand variables. Thus,

$$\frac{P}{P_m^C} = a_9 + b_9 Y_m^I + c_9 O_C^I + d_9 P_C^m \quad (-1) \quad (9)$$

$$b_9 > 0, c_9 < 0, d_9 > 0.$$

Value added in manufacturing represents the demand variable in this equation, while output of commercial crops represents the supply variable. The import price index of crude materials is included to capture the impact on domestic prices of changes in the supply situation of competing imported supplies.

Section II. The Manufacturing Sector

The manufacturing sector contributes about 15% to the gross domestic product of the economy, but has an importance far exceeding the meager proportion indicated by this figure. This sector accounts for a large and increasing share of total exports in the economy. Its share in total exports has increased from slightly over 40 per cent in 1960-61 to almost 50 per cent in 1972-73.

A production function, a capacity utilisation function, an investment function, and a wage function for the manufacturing sector are specified in the model. No relative price function for manufacturing is specified, as this price is made a simple function of the GDP deflator for non-agriculture which is endogenous in the model. Before discussing the specifications of the individual functions, it is worth noting that the link in the model from agriculture to manufacturing is through the pressures generated by foodgrain prices on the money wage rate, and commercial crop output on the capacity utilisation in manufacturing, while that from manufacturing to agriculture is via demand for commercial crops on the part of the manufacturing sector. The influence of fiscal and monetary variables on the manufacturing sector is exercised through the investment function in manufacturing.

In order to bridge certain data gaps in the manufacturing sector, we have used a linkage procedure--the details of which are discussed in the relevant subsections below. To summarise, this procedure consists of (i) using the time series on gross investment, employment, and value added in large scale manufacturing provided by the Census of Indian Manufacturers (CMI) and the Annual Survey of Industries (ASI) for the estimation of the production function in manufacturing, and (ii) linking the time series on value added and gross investment (which is used to build the capital stock series for the production function) in manufacturing as obtained from the CMI/ASI sources to those provided by the National Accounts. Thus, the value added in manufacturing as shown in the National Accounts, Y'_m , is made a function of the value added in manufacturing as obtained from the CMI/ASI sources. The gross investment from the CMI/ASI sources, on the other hand, is made a function of the investment by the corporate sector (private as well as public) as shown in the National Accounts. The latter is itself endogenously determined in the model.

(i) Production Function

The data used for estimating the production function in manufacturing (taken from the CMI and the ASI) relate to the organised sector only and we have assumed that the production function estimated from this data can be applied to the manu-

facturing sector as a whole. Owing to a changing coverage over time, data for all the three variables are used on per reporting establishment basis.^{1/} The per establishment value added, capital stock, and employment are denoted in small letters by v_m , k_m , and n_m respectively.

In specifying a production function for manufacturing, we have relied upon the Cobb-Douglas Production Function.^{2/} The dependent variable in the production function is value added in manufacturing. This implicitly assumes a zero elasticity of substitution between the inputs of primary factors in the production process (capital and labor) and the excluded intermediate inputs.^{3/} An important feature of the specification is the explicit inclusion of capacity utilisation as a factor influencing production in manufacturing. This is

^{1/} To the extent that the size composition of the sample changes over time, we have to accept this bias in the data.

^{2/} As the Cobb-Douglas production function assumes the elasticity of substitution between the included factors to be unity, we tried to test this independently by estimating the Arrow-Chenery-Minhas-Solow specification of the constant elasticity of substitution production function (assuming constant returns to scale). We also estimated the Kmenta approximation of the CES production function to obtain an estimate of the elasticity of substitution. The results are reported in Chapter III.

^{3/} Griliches Z. and Ringstad V. (38).

extremely important in the Indian situation where the level of capacity utilisation depends critically on the availability of imported and domestically produced intermediate inputs, as we shall see in our empirical results. A Cobb-Douglas production function for manufacturing is specified, with capital stock, capacity utilisation, employment, and technological progress as explanatory variables.

$$\text{Log } v'_m = a_{10} + b_{10} \text{Log } n_m + c_{10} \text{Log } k'_m + d_{10} \text{Log } U + e_{10} T \quad (10.1)$$

$$b_{10} > 0, \quad c_{10} > 0, \quad d_{10} > 0, \quad e_{10} > 0.$$

Also, assuming that the flow of services from capital stock is proportional to utilised capital, we constrain the coefficients of k'_m and U to be the same, and write the above equation as:

$$\text{Log } v'_m = a'_{10} + b'_{10} \text{Log } n_m + c'_{10} \text{Log } k^{u'}_m + e'_{10} T \quad (10.2)$$

$$b'_{10} > 0, \quad c'_{10} > 0, \quad e'_{10} > 0.$$

We tested for the presence of constant returns to scale in the estimated Cobb-Douglas production functions. The results are reported in Chapter III.

The value added in manufacturing as reported in National Accounts is then linked to the value added as shown in the

CMI/ASI sources.^{1/}

$$\text{Log } Y'_m = a_{11} + b_{11} \text{Log } V'_m(-1) + c_{11}T \quad (11)$$

$$b_{11} > 0$$

(ii) Capacity Utilisation

Following a consistent rise between 1950 and 1957, capacity utilisation in manufacturing has fluctuated with a declining trend over the period 1950-1970.^{2/} It is not a coincidence that the latter period also saw the emergence of the foreign exchange bottleneck as an important constraint on Indian development. In order to appreciate fully the trends in output of the manufacturing sector, it is very important to spell out the factors influencing capacity utilisation in manufacturing.

Unlike developed economies, constraints on the use of the existing capital stock in developing economies are not dominantly imposed by variations in demand, although these also play a role, but reflect largely the scarcities of intermediate inputs. Thus, production in the manufacturing sector is a function not only of the capital stock, and employment, but

^{1/} While per establishment data is used for the estimation of the production function, value added for the reporting establishments as a whole is used for this linkage.

^{2/} Reserve Bank of India (61). The limitations of this data series are discussed in Chapter III.

also of the utilisation of capacity which is dependent on certain structural supply constraints as well as fluctuations in demand. The former set includes factors such as availability of commercial crops and imported intermediate materials, etc., while the latter is influenced by the share of government investment in the economy. These very complex interactions are modelled in a reduced form specification as follows:

$$\text{Log } U = a_{12} + b_{12} \text{Log } (M'_O/K'_m(-1)) + c_{12} \text{Log } (O^I_c/K'_m(-1)) + d_{12} \text{Log } I^g/Y$$

$$b_{12} > 0, \quad c_{12} > 0, \quad d_{12} > 0 \quad (12)$$

(iii) Capital stock and Investment

A major data problem facing us is the absence of consistent capital stock and investment data series for the manufacturing sector as a whole. We have tried to work within this constraint by using the linkage procedure referred to earlier. Capital stock per establishment in successive periods is obtained as:

$$k'_{m1} = k'_m 0 + I'_m/S - d'_k \quad (13)$$

Thus, the series on net capital stock at constant prices is built by using the net capital stock figures per establishment at the beginning of the period (from CMI), a time-series on gross

investment per establishment (from CMI and ASI), a constant 5 per cent depreciation rate, and a suitable deflator. This capital stock series is used in the estimation of the production function. The time series on gross investment for the reporting establishments as a whole is then linked to gross investment by the corporate sector as provided in the National Accounts.

$$\text{Log } I'_m = a_{14} \text{Log } I^{\text{gn}'}(t) + b_{14} \text{Log } I^{\text{pc}'} \quad (14)$$

$$a_{14} > 0, \quad b_{14} > 0$$

The model then specifies a behaviorally determined gross real investment function for the private corporate sector. This investment is specified as a function of the nominal interest rate, the expected inflation rate, lagged government investment in the economy, and imports of capital goods.

$$\text{Log } I^{\text{pc}'} = a_{15} + b_{15} \text{Log } i_t + c_{15} p_m^e + d_{15} \text{Log } M'_k$$

$$+ e_{15} \text{Log } I^{\text{gg}'}(-1) + f_{15} \text{Log } K'_m(-1) \quad (15)$$

$$b_{15} < 0, \quad c_{15} > 0, \quad d_{15} > 0, \quad e_{15} > 0, \quad f_{15} > 0$$

In addition to the inclusion of lagged capital stock, interest rate, and expected prices^{1/} as explanatory variables in the investment function, government investment and imports of capital goods are included

^{1/} Assuming perfect foresight, expected price in period t was defined as $(P_m - P_m(-1))/P_m(-1)$.

to incorporate the special institutional features of the Indian economy. Government investment other than that in public enterprises is included to test the 'engine of growth' hypothesis which maintains that the provision of infrastructure, etc., by the government has a positive effect on private investment. Also, given the very high (though somewhat declining) dependence on imported capital goods for investment in the economy, imports of capital goods are an additional factor constraining investment in the economy.

As regards the gross investment by public enterprises, this is exogenous in nominal terms, although the price deflator for government investment is endogenised in the model.

(iv) Money Wage Function

The money wage rate in manufacturing as specified in the model is assumed to respond positively, albeit with a lag, to the price of foodgrains. In a situation where food constitutes a major share of the budgets of these income groups, and the latter are organised in trade unions, this positive link seems to be a reasonable assumption. Incorporating, in addition, the influence of labor productivity in manufacturing on the money wage rate, we have

$$\text{Log } W_m = a_{16} + b_{16} \sum_{i=1}^k \beta_i \text{Log } P_f(-1) + c_{16} \sum_{i=1}^l \gamma_i \text{Log } (v'_m/n_m(-i)) \quad (16)$$

$$b_{16} > 0, c_{16} > 0$$

The coefficients b_{16} and c_{16} represent the sum of lagged coefficients on the respective variables. The various lag structures used in the estimation of this equation are discussed in Chapter III.

It is easily seen that once money wages are determined, the model can be solved for employment and output in manufacturing. Capacity utilisation in manufacturing is subject to demand fluctuations and supply constraints. Output in manufacturing is a function of capital stock, capacity utilisation, and employment in this sector. Money wage rate is a distributed lag function of the price of foodgrains and labor productivity. Thus, employment can be derived such that

$$n_m = f \left(\frac{W_m}{P_m}, k'_m, U \right) \quad (17)$$

Section III: The Foreign Sector

In modelling the operations of the foreign sector, a few major features of the Indian economy have to be borne in mind:

- By any 'objective' standards, India would be described as a relatively 'closed' economy with merchandise trade constituting 8 per cent of the gross national product and capital movements under strict control of the government.

- Notwithstanding the small quantitative significance of

trade, the foreign sector has a crucial impact on the process of sustained industrialisation. Imports of capital goods and intermediate materials are crucial for investment as well as for the utilisation of existing capacity in the economy.

- In general the demand for foreign exchange to satisfy the "development" needs of the economy is very high compared to the availability of foreign exchange because of the constraints on export expansion. Agricultural exports, which form about 50 per cent of total exports, are dependent on weather on the supply side, and face uncertain prospects on the demand side owing to the very low elasticity of foreign demand. Non-traditional exports which have a high potential for expansion (due to elastic foreign demand), on the other hand, are themselves to some extent dependent on the availability of intermediate materials imports.

- Imports are regulated through an allocation mechanism by the government.

We have attempted to reflect these features in the specifications for the foreign sector as far as possible.

(i) Import Functions

In view of the institutional characteristics of the Indian economy as discussed above, import functions for the various categories of goods, e.g. food, capital goods, intermediate goods, etc. can not be specified as being dependent

only on the relevant prices and the level of activity, but must incorporate the influence of factors such as foreign aid and import capacity reflected in export earnings.

The model disaggregates imports of goods into the following categories: (a) food, (b) capital goods, and (c) the residual.

Imports of food are considered exogenous. Food imports are obtained on government account and are in effect a government policy variable, responding partly to the desire to keep food prices to consumers low, but governed also by complex politico-economic policy considerations.

Imports of capital goods are specified as a function of gross investment in the economy, price of imported capital goods, and foreign aid (excluding the PL 480 food aid) deflated by the price of imports. Since the scope for substitution between the imported capital goods and the capital goods produced domestically is relatively limited, the domestic price of capital goods is not included in the specification of the import function, as it is not expected to influence the imports of the same. In fact, government policy explicitly acts to exclude imports of capital goods which are domestically produced.^{1/}

^{1/} Our empirical experimentation to this effect confirmed our a priori expectation. Another domestic price, i.e., that of the final goods, which, through its effect on the profit element, may affect the imports of goods, was also found in the empirical estimation to have no effect on the imports of capital goods.

$$\text{Log } M'_k = a_{18} + b_{18} \text{Log } I' + c_{18} \text{Log } P_k^m + d_{18} \text{Log } F'_{anf} \quad (18)$$

$$b_{18} > 0, \quad c_{18} < 0, \quad d_{18} > 0$$

While gross investment in the economy is the activity variable influencing the imports of capital goods positively, foreign aid in real terms is the supply of foreign exchange made available to the economy, an increase in which, ceteris paribus, leads to higher imports of capital goods.

Residual imports consist largely of intermediate materials, and are specified as a function of non-agricultural output, the foreign price, foreign aid, and export earnings, the latter two being deflated by the price index of imports.^{1/}

$$\text{Log } M'_0 = a_{19} + b_{19} \text{Log } Y'_m + c_{19} \text{Log } P_0^m + d_{19} F' + e_{19} \text{Log } X'$$

$$b_{19} > 0, \quad c_{19} < 0, \quad d_{19} > 0, \quad e_{19} > 0. \quad (19)$$

Finally,

$$M' = M'_f + M'_K + M'_0 \quad (20)$$

(ii) Other Foreign Sector

Exports of goods (X) as well as trade in service (S^{net}) are considered exogenous to the model. Also treating foreign

^{1/} As in the case of capital goods, price of domestic intermediate materials is not included as an explanatory variable for the same reasons.

aid or capital inflow (F) as exogenous, the change in international reserves is obtained endogeneously as follows:

$$DFR_{BP} = X - M' \cdot P^m + S^{net} + F \quad (21)$$

Section IV: The Fiscal Sector

In an economy following an explicit strategy of planned development within a 'mixed economy' framework, fiscal policies assume substantial importance. The government sector contributes about 16 per cent to gross domestic product and accounts for more than 40 per cent of the gross capital formation in the Indian economy. The indirect effect of the fiscal sector on the other sectors either through policy intervention or through provision of infrastructure is also taken into account in the model. At the same time, the fiscal sector is subject to pressures originating in the other sectors, particularly the agricultural sector. These features form essential ingredients in the modelling of the fiscal sector.

We will first note the major characteristics of the fiscal sector as specified in the model. Government investment in nominal terms is regarded as exogenous to the model, as this is a policy variable of the government. However, its value in real terms is determined within the model through endogenising

its price. Based on the 'engine of growth' hypothesis, government investment is postulated as having an a priori influence on private investment in the economy. Government wages and salaries are assumed to respond to the pressures generated by an increase in the price of foodgrains. The performance in the foodgrain sector, therefore, constitutes a constraint on government savings, which is additional to the usual constraint exercised through the government revenue functions. The government budget constraint and its link with the monetary sector will be explored in Section V.

(i) Revenues

Disaggregated government tax revenue functions are specified, while non-tax revenue is regarded as being exogenous. Direct tax revenues are disaggregated into (a) agricultural, and (b) non-agricultural, while indirect tax revenues are divided into (a) customs, and (b) other.

In the tax revenue functions specified below, the income variables represent the tax base, while the time variable accounts for changes in the structure of taxation over time.

The agricultural direct tax revenue function is specified as a function of agricultural income and time.

$$T_a^g = a_{22} + b_{22}Y_a + c_{22}T \quad (22)$$

$$b_{22} > 0, c_{22} \geq 0$$

Similarly, non-agricultural direct tax revenue is specified as a function of non-agricultural income and time.

$$T_n^g = a_{23} + b_{23}Y_n + c_{23}T \quad (23)$$

$$b_{23} > 0, c_{23} \geq 0$$

Customs revenue in India is derived largely from the duties on imports (excluding those of food and capital goods). It is therefore specified as a function of the value of intermediate imports and time.

$$\text{Log } T_c^g = a_{24} + b_{24}\text{Log } M_o + c_{24}T \quad (24)$$

$$b_{24} > 0, c_{24} \geq 0$$

Tax revenue from other indirect taxes is specified as a function of gross domestic product in sectors other than agriculture, and time.

$$T_o^g = a_{25} + b_{25}Y_n + c_{25}T \quad (25)$$

$$b_{25} > 0, c_{25} \geq 0$$

(ii) Current Expenditure

The model endogenises a major component of government current expenditure, i.e., government wages and salaries. The latter constituted more than 45 per cent of total current expenditure in the fiscal year 1972-73. The susceptibility of government wages and salaries to inflation in the economy, particularly to the rising price of foodgrains, is a key link in the model between the 'real' sector and the fiscal and monetary sectors.

Government wages and salaries are specified as a function of the lagged price of foodgrains and of nonwage current expenditure of the government.

$$W^g = a_{26} + b_{26} \sum_{i=1}^K \beta_i P_f(-i) + c_{26} E_O^g \quad (26)$$

$$b_{26} > 0$$

(iii) Other Fiscal Sector

Government current expenditures other than wages and salaries, and government investment are regarded as exogenous. The following identity defines the government budget deficit which results from the elements discussed above.

$$DF^g = W^g + E_O^g + I^g - T_a^g - T_n^g - T_c^g - T_0^g - NT^g \quad (27)$$

The government fiscal deficit together with the government financial constraint constitutes the link between the fiscal and the monetary sectors, as will be discussed in the following section.

Section V: The Monetary Sector

The specification of the monetary sector in the model reflects the complex framework within which this sector operates in the economy. The behavior of the private non-banking sector is incorporated in the specification of the demand for money function and the demand for currency function. The currency-money ratio generated by this sector feeds into the money supply function. The numerous levels of intervention by the monetary authorities are suitably incorporated in the specification of the behavioral relationships, balance sheet identities, and equilibrium conditions for the monetary sector. The close link between the fiscal and monetary sectors previously referred to forms an integral part of the process of generation of money supply in the economy.^{1/} Changes in money supply, therefore, are brought about by changes in the monetary base as well as changes in the currency-money ratio, the reserves-deposits ratio, and time deposits-demand deposits ratio.

^{1/} For a discussion of the issues involved in the integration of the fiscal sector with the monetary sector, see Choudhury (15), and Hansen B. (39).

The demand functions for money as well as currency are specified in real terms, while the supply of money is determined in nominal terms. The aggregate price level adjusts to clear the money market.

At the outset, we may note that money in this model is defined as currency plus demand deposits, consistent with the concept of narrow money. The role of time deposits or broad money in the money supply generation process is, however, incorporated in the model.

(i) Demand for Money

A generalised demand function for money is specified in equation 28 where real money balances are made a function of the real gross national product at market prices, short term interest rate, and expected prices. The transactions element in the demand for money is captured by the coefficient of the real gross national product, while the movements in the demand for money in response to short term variations in the opportunity cost of holding money are captured by the coefficient of the short term interest rate. Since a possible alternative to holding private savings in money form is in the form of holding commodity stocks in the absence of a fully developed financial capital market, an expected price variable is included in the demand for money function to take account of these

movements.^{1/} Equation 29 specifies a demand for currency function in real terms along the same lines as equation 28. The ratio of agricultural income to total income is included in the demand function for currency as a proxy for structural change (including increasing monetisation) over time, and as will be seen in chapter III, this variable is highly significant in the estimated function. Equation 30 specifies the ratio of time deposits to demand deposits as a function of the real non-agricultural income, interest rate on time deposits, and interest rate on a close substitute--government bonds.

$$\text{Log } L' = a_{28} + b_{28} \text{Log } Y^{\text{mp}'} + c_{28} \text{Log } i_z + d_{28} P^e \quad (28)$$

$$\begin{aligned} \text{Log } C' = a_{29} + b_{29} \text{Log } Y^{\text{mp}'} + c_{29} \text{Log } i_z + d_{29} \text{Log } (Y'_a/Y') \\ + e_{29} P^e \end{aligned} \quad (29)$$

$$\text{Log } (TD/D) = a_{30} + b_{30} \text{Log } Y'_n + c_{30} \text{Log } i_g + d_{30} \text{Log } i_d \quad (30)$$

$$b_{28} > 0, c_{28} < 0, d_{28} < 0$$

$$b_{29} > 0, c_{29} < 0, d_{29} < 0, e_{29} < 0$$

$$b_{30} > 0, c_{30} < 0, d_{30} > 0$$

Equations 28 to 30 above exhaust the modelling of the behavior of the nonbank private sector within the monetary submodel.

^{1/} Assuming static expectations P^e at period t is defined as $(P(-1) - P(-2))/P(-2)$.

(ii) Supply of Money

The factors determining money supply are endogenised in equations 31 to 36 of the monetary sector, and the identity 37 determines money supply explicitly. Thus, money supply is not entirely under the control of the monetary authorities. The latter, in conjunction with the pressures of the fiscal authorities, determine the monetary base, while the private sector determines the currency-deposits ratio, and the time-deposits-demand-deposits ratio.

Equation 31 as given below represents the budget constraint of the government. Given the government's fiscal deficit as defined in section IV, and the exogenous capital receipts (internal as well as external), the government's financial constraint is reflected in borrowing from the banking system

$$B_{bs}^g = DF^g - K_r^g \quad (31)$$

Equation 32 postulates the crucial link between the fiscal and monetary sectors in the model. Change in monetary base or high powered money is specified to be a function of the lagged foreign assets of the central bank (hereafter referred to as the Reserve Bank of India), the lagged change in money income, and the government fiscal deficit. The

underlying hypothesis is that the monetary authorities try to relate the change in monetary base to an expected change in money income and their lagged foreign assets, while incorporating the government's needs to finance its fiscal deficit through borrowing from the Reserve Bank of India.

$$\begin{aligned} \text{DMB} = a_{32} + b_{32} \text{FR}_{\text{RBI}}(-1) + c_{32} (Y^{\text{mp}}(-1) - Y^{\text{mp}}(-2)) + d_{32} \text{DF}^g \\ b_{32} > 0, \quad c_{32} > 0, \quad d_{32} > 0 \end{aligned} \quad (32)$$

Equation 33 presents the balance sheet identity of the Reserve Bank of India. Once the change in the monetary base is determined by equation 32, the change in net foreign reserves by the foreign sector, and the Reserve Bank lending to commercial banks by the Reserve Bank of India (exogenous), equation 33 determines the Reserve Bank's lending to the government.

$$B_{\text{RBI}}^g = \text{DMB} - \text{DFR}_{\text{RBI}} - B_{\text{RBI}}^b - B_{\text{RBI}}^o \quad (33)$$

The foreign sector feeds into this identity as follows:

$$\text{DFR}_{\text{RBI}} = \text{DFR}_{\text{BP}} - \text{DFR}_0 \quad (34)$$

Equation 35 is an identity which determines the commercial banks' lending to the government, given the total government borrowing and the borrowing from the Reserve Bank of India.

$$B_b^g = E_{bs}^g - B_{RBI}^g \quad (35)$$

Commercial bank lending to the government is determined by the Reserve Bank's policy decision on the division of total lending by the banking system to the government between its own lending to the government and that of the commercial banks. This policy decision is executed by manipulating the commercial banks' liquid assets ratio requirement.^{1/} Since bank reserves as well as interest rates are exogenous in the model, commercial banks' profit maximisation is reflected in their adjustment of their credit to the private sector.

Equation 36 presents the Balance Sheet identity of the commercial banking sector in flow terms. All elements on the right hand side of this identity are determined elsewhere in the monetary sector. Deposits are determined by the demand functions for money. Commercial bank credit to the government is determined by the Reserve Bank of India as discussed above. Given the banks' borrowing from the Reserve Bank of India, and

^{1/} Commercial banks are required to hold a stipulated proportion of their assets in "liquid" form, the liquidity criterion being laid down by the Reserve Bank of India. Government securities are the major component of the liquid assets.

change in reserves, then, equation 36 determines the credit to the private sector by the commercial banks.

$$B_b^p = TD^f - TD^f(-1) + D^f - D^f(-1) - (R - R(-1)) - B_b^g + B_{RBI}^b + B_b^o \quad (36)$$

Finally, the money supply identity is presented below:

$$L = \frac{\frac{C}{D} + 1}{\frac{C}{D} + \frac{R}{D}} (MB - r TD) \quad (37)$$

The aggregate price level is obtained through equation 38 which equates the demand for money with the supply of money.

$$P = L/L' \quad (38)$$

Section VI. Other equations and identities

In the final section of this chapter, we present the equations and identities of the model which have not been discussed above, with a view to facilitating the understanding of the full mechanics of the model.

Equation 39 relates gross domestic product at constant prices in the economy as a whole to real gross domestic product originating in agriculture, and the same in manufacturing. Identity 40 then determines the gross domestic product originating in sectors other than agriculture.

$$Y' = a_{39} + b_{39}Y'_a + c_{39}Y'_m \quad (39)$$

$$b_{39} > 0, \quad c_{39} > 0$$

$$Y'_n = Y' - Y'_a \quad (40)$$

As regards the relative prices of foodgrains and of commercial crops, crop-year (July-June) price averages were used in the agricultural sector equations. However, the linkage between the agricultural sector and the other sectors in the economy involves fiscal year (April-March) price averages. The latter are linked to the crop-year price averages through equations 41 and 42.

$$(P_f/P_m)^f = a_{41} + b_{41}P_f/P_m \quad (41)$$

$$(P_c/P_m)^f = a_{42} + b_{42}P_c/P_m \quad (42)$$

Equation 43 specifies the ratio of GDP deflators of agriculture and non-agriculture as a function of the relative price of foodgrains in terms of the manufactured goods, the relative price of commercial crops in terms of the manufactured goods, and time.

$$P_a/P_n = a_{43} + b_{43}(P_f/P_m)^f + c_{43}(P_c/P_m)^f + d_{43}T \quad (43)$$

Given the absolute level of the GDP deflator as determined in equation 38 and the ratio of agricultural to non-agricultural deflators as determined in equation 43, the identities 44 and 45 determine the absolute levels of the two deflators, i.e., those for agriculture and non-agriculture.

$$P_n = PY' / (P_a Y'_a / P_n + Y'_n) \quad (44)$$

$$P_a = (Y - Y_n) / (Y' - Y'_n) \quad (45)$$

$$Y = PY' \quad (46)$$

$$Y_a = P_a Y'_a \quad (47)$$

$$Y_n = P_n Y'_n \quad (48)$$

$$Y^{mp} = Y + TLS' (P) \quad (49)$$

Identities 46 to 49 are self-explanatory representing the gross domestic product at factor cost, its agricultural component, its non-agricultural component, and gross domestic product at market prices - all in nominal terms.

Equation 50 relates the wholesale price index of the manufactured goods to the GDP deflator for the non-agricultural sector, while identities 51 and 52 determine the wholesale price index of foodgrains and of commercial crops respectively.

$$P_m = a_{50} + b_{50} P_n \quad (50)$$

$$P_f^f = (P_f/P_m)^f P_m / 100 \quad (51)$$

$$P_c^f = (P_c/P_m)^f P_m / 100 \quad (52)$$

Equations 53 and 54 relate the deflators for government investment and private investment respectively to the overall GDP deflator and the import price index of capital goods.

$$\text{Log } P_I^g = a_{53} + b_{53} \text{Log } P + c_{53} \text{Log } P_k^m \quad (53)$$

$$\text{Log } P_I^p = a_{54} + b_{54} \text{Log } P + c_{54} \text{Log } P_k^m \quad (54)$$

As was discussed above, gross investment by the government is considered exogenous in nominal terms, while its price is endogenised in equation 53. Gross investment in the private corporate sector is specified through equation 15. To complete the investment picture, equation 55 specifies the gross investment by the 'household' (private noncorporate) sector

in real terms to be a simple function of lagged real income.

$$\text{Log } (I^{hh'}) = a_{55} + b_{55} \text{Log } (Y'_{-1}) \quad (55)$$

Equations 56 and 57 represent the identities determining the gross investment in the economy in real terms, and that in the private sector in nominal terms.

$$I' = I^{pc'} + I^{hh'} + I^g/P_I^g \quad (56)$$

$$I^p = (I^{pc'} + I^{hh'}) P_I^p \quad (57)$$

Equations 58 and 59 determine the mid-fiscal year levels of demand deposits and time deposits respectively, while equations 60 and 61 determine their end-fiscal year levels.

$$D = (L' - C')P \quad (58)$$

$$TD = D(TD/D) \quad (59)$$

$$DD^f = a_{60} + b_{60} D \quad (60)$$

$$TD^f = a_{61} + b_{61} TD \quad (61)$$

The outstanding monetary base and the foreign assets of the Reserve Bank of India are determined by identities 62 and 63 respectively.

$$MB = MB(-1) + DMB \quad (62)$$

$$FR_{RBI} = FR_{RBI}(-1) + DFR_{RBI} \quad (63)$$

The identities 64 to 67 close the remaining loose ends of the model, and are self-explanatory.

$$P_f/P_c = (P_f/P_m) \cdot 100/(P_c/P_m) \quad (64)$$

$$V_m' = v_m' S \quad (65)$$

$$K_m' = k_m' S \quad (66)$$

$$T^g = T_a^g + T_n^g + T_c^g + T_o^g \quad (67)$$

Finally, we list below the endogenous variables in order of appearance, and the exogenous variables of the model.

Endogenous variables
(in order of appearance)

$A_f, A_c, O_f, O_c^I, V_a', Y_a', S_f, P_f/P_m, P_c/P_m, v_m', Y_m', U, k_m', I_m',$
 $I^{pc'}, W_m, n_m, M_k', M_o', M', DFR_{BP}, T_a^g, T_n^g, T_c^g, T_o^g, W^g, DF^g,$
 $L', C', TD/D, B_{bs}^g, DMB, B_{RBI}^g, DFR_{RBI}, B_b^g, B_b^p, L, P, Y',$
 $Y_n', (P_f/P_m)^f, (P_c/P_m)^f, P_a/P_n, P_n, P_a, Y, Y_a, Y_n, Y^{mp}, P_m, P_f^f,$
 $P_c^f, P_I^g, P_I^p, I^{hh'}, I', I^p, D, TD, DD^f, TD^f, MB, FR_{RBI}, P_f/P_c,$
 V_m', K_m', T^g (67 in number)

Exogenous variables

$A, A_o, B_o^o, B_{RBI}^o, B_{RBI}^b, D_f^g, d_k, DFR_o, E_o^g, F, F_{anf}, F_f, H_c^I, H_f, H_g', i_d,$

$i_g, i_i, i_z, I_a', I^g, I^{gn}, I^{gg}, J_c^I, J_f^I, K_r^g, M_f, NT^g, P^m, P_c^m, P_f^m, P_k^m, P_o^m,$

$R, S, S^{net}, T, TLS, X, Z, Z^f$ (41 in number).

CHAPTER III. ESTIMATES OF THE BASIC MODEL

This chapter presents estimated equations following the specifications described in chapter II. These results are obtained using annual data for the period 1950-51 to 1972-73 and following the Two Stage Least Squares estimation procedure.^{1/} The symbols used in the equations as well as the numbering of the equations are the same as in the earlier chapter. The division of this chapter into individual sections also follows the pattern of the earlier chapter.

The reasons for preferring two stage least squares estimation to ordinary least squares are well known. OLS estimates of parameters for a set of simultaneous equations are both biased and inconsistent. The TSLS procedure, while it does not remove the problem of bias in estimation, at least ensures consistency. The use of TSLS requires the construction of instrumental variables for each endogenous explanatory variable in the equations to be estimated. The exact method of obtaining the instrumental variables in the face of the nonlinearities in the model is discussed in Appendix III.^{2/}

^{1/} In a few equations the estimation had to be limited to shorter periods because of the lack of data availability for the entire period.

^{2/} For a discussion of the issues involved in the use of instrumental variables in the face of specific nonlinearities, see Goldfeld and Quandt.(24)

In the reporting of the results, the t-statistic for each coefficient is presented (within brackets) below the coefficient. The values of $\bar{R}^2$ and the Durbin-Watson statistic are also reported in all cases. Throughout this chapter we use the term significance to indicate that the coefficient is significantly different from zero and is of the sign indicated at the 5 per cent confidence level for a two-tailed test. Where relevant, the elasticity values implied by the various coefficients at the point of sample mean are provided as the basis for comparing the effects of the explanatory variables on the dependent variable. Alternative specifications of an equation are estimated in certain cases, and the rationale for this procedure as well as the results of the estimation are discussed in detail.

Section I: The Agricultural Sector.^{1/}

(i) Agricultural Output

As stated in Chapter II, gross sown area under foodgrains is specified as a function of the expected relative price of foodgrains and commercial crops, and the total gross sown area.^{2/}

^{1/} All equations relating to the Agricultural Sector are estimated using crop-year annual data. Crop year t - t+1 refers to the year beginning with July of t and ending with June of t+1.

^{2/} This specification legitimately ignores the investment decision relating to the long term expansion of area under crops, and concentrates on the short term choice facing the farmer, i.e., the choice of cropping pattern.

We postulate two alternative hypotheses regarding the formation of price expectations: (a) that expectations are static, i.e., that the expected price in period t is equated to the actual price in period $t - 1$, and (b) that the expected price in period t is some weighted combination of lagged actual prices. Since the acreage-output cycle is completed within a crop year, the specification relates to the expected price at the time of sowing for harvest later in the same year.

(a) Assuming static expectations, the expected relative price of foodgrains and commercial crops in period t , $(P_f/P_c)_t^e$, is taken to be equal to the actual relative price in period $t-1$, i.e., $(P_f/P_c)_{t-1}$. The linear estimate of equation 1 using the static expectations hypothesis is presented in Table III, as equation 1.1. The estimate of the elasticity of foodgrain acreage with respect to the expected relative price of foodgrains is .06 which is consistent with the 'low response' pattern of foodgrain acreage generally obtained in other empirical studies.^{1/}

(b) Assuming that the expected relative price of foodgrains and commercial crops $(P_f/P_c)^e$ is a function of

^{1/} In reviewing the estimates of the elasticities of acreage responses of individual crops, Raj Krishna finds that the elasticities for subsistence grain crops fall in the range of 0 - 0.1 in developing countries (46).

TABLE III.

ESTIMATES OF ACREAGE FUNCTIONS (FOODGRAINS)
(1951-52 - 1972-73)

1.1

$$A_f = 2.432 + .694 A + .059 P_f/P_c (-1)$$

(0.7) (39.7) (3.7)

elasticity
at mean .920 .059

$$\bar{R}^2 = .987$$

$$DW = .980$$

1.2

$$A_f = -1.879 + .685 A + .110 \sum_{i=-1}^{-3} P_f/P_c(i)$$

(0.3) (27.5) (3.8)

elasticity
at mean .908

$$\bar{R}^2 = .978$$

$$DW = 1.308$$

lagged actual prices, we estimate an equation using the lagged relative prices for the preceding three years. The estimated results are reported in Table III as equation 1.2.

In terms of overall statistical fit, both estimates of equation 1 provide very similar results. The coefficients of the relative price variable and total acreage in the estimated equations are positive and significant, as expected. The Durbin-Watson test on positive autocorrelation reveals positive autocorrelation in equation 1.1, and is inconclusive in equation 1.2.^{1/}

Once the gross sown area under foodgrains is endogenously determined, equation 2 derives the area under commercial crops, as a residual, given the total gross sown area under all crops.

The results of estimating the output of foodgrains as a function of gross sown area under foodgrains, gross irrigated area under foodgrains, and a rainfall index as specified in equation 3 of chapter II are reported as equation 3.1 in Table IV.^{2/} The estimates of b_3 , c_3 , and d_3 are positive and

^{1/} We also experimented with "the adaptive expectations" hypothesis, using a Koyck lag structure in the estimation of the equation explaining gross sown area under foodgrains. The results were relatively poor, partly because of the statistical problems arising out of the collinearity between the lagged area under foodgrains and total gross sown area under all crops. In addition, it would seem that this hypothesis has limited applicability in a situation where the amplitude of fluctuations of prices around the trend is relatively high.

^{2/} Gross sown area is defined as the sum of net sown area and area sown more than once. Similarly, gross irrigated area is the sum of net irrigated area and area irrigated more than once.

TABLE IV.
ESTIMATES OF OUTPUT FUNCTIONS (FOODGRAINS)
(1950-51 - 1971-72)^{1/}

3.1

$$O_f = -77.863 + .569 A_f + 2.565 H_f + .335 J_f^I$$

(5.4) (2.6) (5.9) (4.0)

elasticity
at mean .819 .755 .412

$$\bar{R}^2 = .947$$

$$DW = 1.786$$

3.2

$$O_f = -90.372 + 1.292 A_f - .433 H_f + .012 F_f + .261 J_f^I$$

(3.5) (3.1) (0.2) (1.4) (2.6)

$$\bar{R}^2 = .938$$

$$DW = 1.800$$

^{1/} Equation 3.2 was estimated for 1952-53 - 1971-72.

significant as expected. The equation explains 95 per cent of the total variation in the output of foodgrains, and the Durbin-Watson test on positive autocorrelation is inconclusive.

When the consumption of fertilisers is added as an explanatory variable to the specification of equation 3 in chapter II, the corresponding estimated equation 3.2 shows a deterioration in the results compared with equation 3.1. Because the consumption of fertilisers is highly correlated with irrigation, both variables increasing over time, the coefficients of both variables F_f and H_f are insignificant, while the $\bar{R}^2$ for equation 3.2 is also marginally diminished compared to equation 3.1 and the Durbin-Watson test on positive autocorrelation remains inconclusive.

We also estimated output functions including consumption of fertilisers but excluding irrigation as an explanatory variable. The results (not reported here) are similar to equation 3.1. Since the data on consumption of fertilisers is less reliable, we decided to choose the specification as presented in chapter II.^{1/}

In view of the above, the coefficient of the gross irrigated area in equation 3.1 has to be interpreted as measuring the impact of the overall variable-input-intensity of cultivation. Our results show a marginal response of output

^{1/} The breakdown of fertiliser consumption between foodgrain and commercial crops is not available. Following common practice, we attributed 75 per cent of the consumption of fertilisers to foodgrains and the remaining to commercial crops.

of 0.6 tons to a unit hectare change in gross cropped area. Given the gross cropped area, the additional impact of the intensive use of irrigation, fertilisers, etc., as captured by the irrigation variable is 2.6 tons of output of food-grains per irrigated hectare.

The results of estimating the output of commercial crops as a function of acreage, irrigation, and a rainfall index, as specified in equation 4 are reported in Table V, as equation 4.1.

The coefficients of b_4 , c_4 , and d_4 are positive and significant, as expected. The equation explains 94 per cent of the total variation in the output of commercial crops. While the hypothesis of positive autocorrelation is rejected, the test on negative autocorrelation is inconclusive.

As in the case of foodgrains, the output function of commercial crops is also estimated including the consumption of fertilisers as an additional explanatory variable. The results reported as equation 4.2 in Table V are similar to those for foodgrains.

It is interesting to note that the additional impact of 'irrigation' on the output index of commercial crops is .5, while the incremental response of the output index to gross cropped area index is .9. The marginal impact of the intensity of cultivation, given the gross cropped area, is smaller in the case of commercial crops compared to that in the case

TABLE IV
ESTIMATES OF OUTPUT FUNCTIONS (COMMERCIAL CROPS)
(1950-51 - 1971-72)^{1/}

4.1

$$O_c^I = -44.031 + .858 A_c^I + .455 H_c^I + .116 J_c^I$$

(3.2) (4.3) (4.8) (1.8)

elasticity
at mean

.853 .479 .118

$\bar{R}^2 = .938$
DW = 2.100

4.2

$$O_c^I = -52.997 + .821 A_c^I + .580 H_c^I - .010 F_c + .128 J_c^I$$

(3.0) (1.9) (1.5) (0.4) (1.8)

$\bar{R}^2 = .922$
DW = 2.141

^{1/} Equation 4.2 was estimated for 1952-53 - 1971-72.

of foodgrains. This result is consistent with the observation that the impact of the Green Revolution has been much larger on foodgrains than on commercial crops.

Equation 5 which relates the gross value added in agriculture on fiscal year basis to the output of foodgrains and of commercial crops for the corresponding crop years yields the following results on estimation:^{1/}

$$V'_a = 16.721 + .555 \text{ } 0_f^I + .135 \text{ } 0_c^I$$

(10.0) (14.3) (3.3) (5)

elasticity at			Period: 1950-51 - 1972-73
mean	.647	.156	
			$\bar{R}^2 = .988$
			DW = 1.121

(ii) Marketed Surplus

The results of estimating the marketed surplus as specified in chapter II are shown as equation 7.3 in Table VI. The advantage of this expanded specification can be seen in comparison with the relatively simple specifications of the marketed surplus function which have been used in the existing literature. For example, specifications along the lines of equation 7.1 in Table VI have been used in the Indian litera-

^{1/} Fiscal year t - t+1 refers to the year beginning with April of t and ending with March of t+1.

TABLE VI
ESTIMATES OF MARKETED SURPLUS FUNCTIONS OF FOODGRAINS
(1951-52 - 1970-71)

7.1

$$S_f = 10931.9 + .396 O_{fn} - 150.014 P_f/P_m$$

(5.2) (13.3) (8.4)

elasticity
at mean 1.370 -.918

$$\bar{R}^2 = .867$$

$$DW = 2.146$$

7.2

$$S_f = 8938.9 + .312 O_{fn} + .099 O_{fn}(-1) - 140.123 P_f/P_m$$

(4.2) (6.7) (2.2) (8.3)

elasticity
at mean 1.079 .330 -.857

$$\bar{R}^2 = .881$$

$$DW = 1.765$$

7.3

$$S_f = -4442.7 + .406 O_{fn} + .259 O_{fn}(-1) - 68.1 P_f/P_m - 119.163 (P_c/P_m)(O_c^I/100)$$

(1.2) (8.2) (4.5) (2.9) (4.1)

elasticity
at mean 1.405 .865 -.417 -.631

$$\bar{R}^2 = .901$$

$$DW = 1.400$$

ture.^{1/} It is clear from the results that the expanded equation 7.3 yields markedly better statistical results. The coefficients on all the variables are significant and the $\bar{R}^2$ for this equation is higher than for any other equation.^{2/}

The following results emerge from these estimations:

(a) The coefficient of the net output variable is between .3 and .4 in the estimated equations, while the elasticity of marketed surplus with respect to net output is greater than 1 in all three cases. A similar result was obtained by Bardhan (4) using cross-section data on 27 villages of the Punjab and U.P. As discussed in chapter II, the coefficient on the net output variable in our equation is a composite of two underlying structural coefficients, c and f (ref. page 48 chapter II). In equation 7.3, the estimated value of f is .259, so that c , the marginal response of the self-consumption of foodgrains on the part of farmers to a unit change in the output of foodgrains, is estimated to be .3.^{3/}

^{1/} Krishna R. (44), Krishna T.N. (48).

^{2/} The output variable used in the estimation of the marketed surplus functions is net of the amount used for feed, seed, and wastage. Following common practice, we have assumed that the latter accounts for 12.5 per cent of the total output of foodgrains.

^{3/} The value of c is obtained from the following: (i) the estimated value of the coefficient of net output, such that $1 - c - f = .406$, and (ii) the estimated value of the coefficient of lagged output, such that $f = .259$.

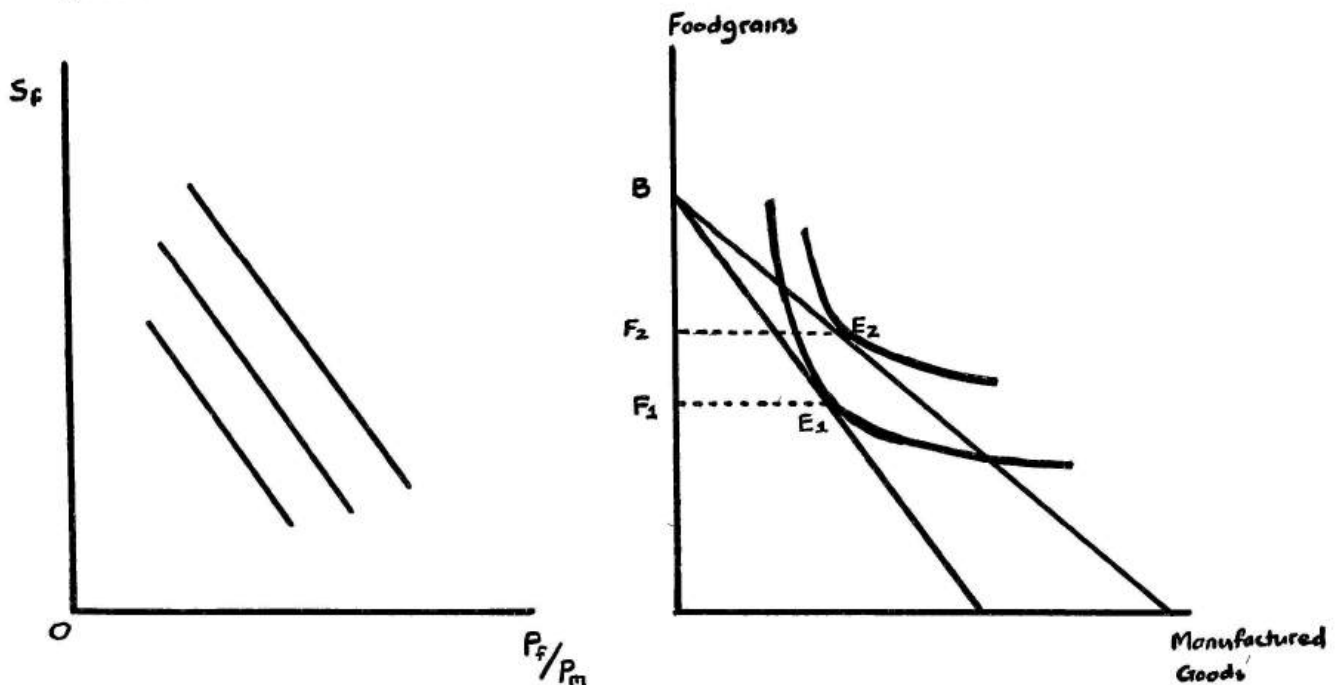
(b) The coefficient of the relative price of foodgrains is negative and significant in all equations. This suggests that the income effect on the consumption of foodgrains is stronger than the substitution effect, which is not surprising for a subsistence economy. This result is also consistent with Bardhan's result using cross-section data.

(c) The dominance of the income effect on the self-consumption of foodgrains is further confirmed by a negative and statistically significant coefficient on the income of farmers from alternative sources, captured here by the sale of commercial crops. The inclusion of this alternative income variable in equation 7.3 leads to an increase in the $\bar{R}^2$ from .88 to .90. All coefficients in this equation have the expected signs and are statistically significant, while the Durbin-Watson test on positive autocorrelation yields inconclusive results.

These results are markedly better than the results obtained by Bhagwati and Srinivasan with their specifications that was discussed in chapter II. Two stage least squares estimation of their equation yields an $\bar{R}^2$ of .29, a statistically significant positive coefficient of agricultural income, and a coefficient of the relative price variable which is not significantly different from zero.^{2/}

^{2/} Bhagwati and Srinivasan (9).

Our findings on the marketed surplus of foodgrains are summarised in Figures 1a and 1b. Fig.1a shows the estimated relationship between the marketed surplus of foodgrains and the relative price of foodgrains to have a negative slope. This linear function shifts outward as output of foodgrains increases. Fig.1b is the familiar indifference curve diagram which spells out the conditions under which this 'perverse' relationship between the two variables will hold. It can be easily seen in Fig.1b that when the relative price of foodgrains increases, a move from the initial equilibrium point E_1 to the new equilibrium point E_2 results in a decline in the marketed surplus of foodgrains from BF_1 to BF_2 , when (i) the demand for foodgrains is income elastic, and (ii) the elasticity of substitution between foodgrains and manufactured goods is small.



Thus, the problem of marketed surplus could be resolved in the long run by increases in output. In the short run, however, an increase in the relative price of foodgrains does not induce a larger marketed surplus of foodgrains.

In chapter II, two alternative sets of specifications are provided for the determination of the relative price of foodgrains. The difference arises from the choice of variable reflecting the supply of foodgrains, the alternative variables being (a) the marketed surplus of foodgrains, and (b) the total output of foodgrains.

The estimated equations 8.11 to 8.13 corresponding to specification (a) above are presented in Table VII. Equation 8.12 among the estimated equations corresponds to specification 8.1 of chapter II.

In equation 8.11, the relative price of foodgrains is negatively related to the marketed surplus of foodgrains, and positively to non-agricultural income, both coefficients being statistically significant. The equation explains 73 per cent of the total variation in the relative price of foodgrains. The Durbin-Watson test on positive autocorrelation yields inconclusive results.

When net government distribution of foodgrains is added as an explanatory variable in equation 8.12, it has a negative coefficient which is statistically significant at the 10 per

TABLE VII.

ESTIMATES OF RELATIVE PRICE FUNCTIONS (FOODGRAINS)
(1951-52 - 1970-71)

8.11

$$P_f/P_m = 112.665 - .652 S_f^I + .819 Y_n'$$

(8.9) (4.2) (7.1)

elasticity
at mean

-.452 .529

$\bar{R}^2 = .734$
DW = 1.567

8.12

$$P_f/P_m = 132.046 - .934 S_f^I + 1.034 Y_n' - .003 D_f^G$$

(8.0) (4.3) (6.3) (1.9)

elasticity
at mean

-.648 .667 -.101

$\bar{R}^2 = .759$
DW = 1.812

8.13

$$P_f/P_m = 100.398 - .758 S_f^I + .515 Y_n' + .001 D_f^G + .421 P_f^m(-1)$$

(4.7) (3.9) (1.7) (0.2) (1.9)

elasticity
at mean

-.526 .332 .016 .354

$\bar{R}^2 = .826$
DW = 2.016

cent level, and the $\bar{R}^2$ increases from .73 to .76, while the test on positive autocorrelation is once again inconclusive.

As discussed in chapter II, specification 8.1 focuses exclusively on the volumes of foodgrains distributed by the government but does not specify the factors influencing the government's pricing decision in respect of these quantities. On the hypothesis that the import price of foodgrains is one such extraneous factor, we included this variable in the estimation of equation 8.13. This, however, amounts to assuming that the government subsidy on foodgrain prices remained constant over time. Although the equation has a higher $\bar{R}^2$ compared to equation 7.12, the coefficient of non-agricultural income is insignificantly different from zero, and the net government distribution variable also has an effect on the relative price which is insignificantly different from zero. The import price of foodgrains itself has a positive and statistically significant coefficient. Our efforts to devise a government subsidy variable were not successful. Our preferred equation is therefore equation 8.12.

In equations 8.11 to 8.13, non-agricultural income is used as an explanatory variable reflecting the demand side of the market. We also estimated these equations, decomposing the income variable into (i) per capita non-agricultural income, and (ii) non-agricultural population, separating the demand

pressures originating from an increase in population from those arising from an increase in per capita income. This leads to an overall deterioration in the results, as the multicollinearity between the per capita income variable and the population variable makes it impossible to ascertain their individual effects. The results are not reported here.

Table VII presents the results of estimated equations 8.21 to 8.23, basically along the lines of equations 8.11 to 8.13, with the difference that output of foodgrains, current as well as one year lagged, replaces marketed surplus of foodgrains as the supply variable, and total real income in the economy replaces non-agricultural income as the demand variable. The lagged output of foodgrains is included in the relative price equation to account for the influence of stock movements on foodgrain prices.

The relatively simple estimated form of specification 8.2, i.e., the equation 8.21, performs almost as well as the relatively simple estimated form of specification 8.1, i.e., the equation 8.11. The coefficients of the output variables are negative and relatively significant, while that of real income is positive and significant.

The government intervention variable has no contribution to make to the explanation of the movements in relative prices as specified in 8.2. Once self-consumption of foodgrains is

TABLE VIII
ESTIMATES OF RELATIVE PRICE FUNCTIONS (FOODGRAINS)
(1951-52 - 1970-71)

8.21

$P_f/P_m = 126.844 - .737 O_{fn}^I - 1.289 O_{fn}^I(-1) + 1.310 Y'$				
(6.5)	(1.8)	(3.9)	(5.6)	
elasticity at mean	-.591	-.999	1.551	
				$\bar{R}^2 = .730$ DW = 1.261

8.22

$P_f/P_m = 162.612 - 1.638 O_{fn}^I - 1.490 O_{fn}^I(-1) + 1.898 Y' - .003 D_f^E$					
(4.1)	(1.7)	(3.3)	(3.2)	(1.2)	
elasticity at mean	-1.314	-1.155	2.246	-.110	
					$\bar{R}^2 = .674$ DW = 1.495

8.23

$P_f/P_m = 118.086 - .842 O_{fn}^I - 1.240 O_{fn}^I(-1) + .978 Y' + .002 P_f^E + .543 P_f^m(-1)$						
(3.7)	(1.2)	(3.9)	(1.8)	(0.6)	(2.3)	
elasticity at mean	-.676	-.961	1.158	.055	.457	
						$\bar{R}^2 = .829$ DW = 1.939

included in the specification of the price equation, government intervention loses its importance. As the reported results of the equation 8.22 in Table VIII show the inclusion of this variable leads to a decline in the $\bar{R}^2$ compared to equation 8.21, while the variable itself has a coefficient which is insignificantly different from zero. The results of including the import price of foodgrains in equation 8.23 are similar to those in equation 8.13 which corresponds to specification 8.1.

As before, the equations 8.21 to 8.23 were reestimated decomposing the income effect into a per capita income effect and a population effect. The results (not reported here) show that the population variable has a positive and statistically significant effect on the relative price of foodgrains, while the per capita income variable has an effect which is not significantly different from zero. However, in view of the high multicollinearity between the per capita income variable and the population variable, we cannot conclude from the estimated results that changes in per capita income have no effect on relative prices.

Our review of the estimated equations of the relative price of foodgrains, i.e., equations 8.11 to 8.23, as reported in Tables VII & VIII leads us to accept the equation 8.12 as our preferred equation. A general conclusion that

emerges from our reported results is that marketed surplus of foodgrains, which we would expect, a priori, to be a relevant determinant of the price of foodgrains, also performs empirically marginally better than output of foodgrains in these relative price equations.

We can make some broad comparisons between the results of equation 8.12 and the Bhagwati-Srinivasan equation for the relative price of foodgrains.^{1/} Their equation, estimated for the period 1952-53 to 1969-70, explains 62% of the variation in the relative price of foodgrains. Agricultural income as their supply variable is statistically less powerful in explaining movements in the relative price of foodgrains than marketed surplus in our equation 8.12.

The estimates of the equation explaining the relative price of commercial crops in terms of manufactured goods as specified in chapter II (equation 9) are presented in Table IX. Price of commercial crops was obtained by taking a weighted average of the prices of fibres, oilseeds, sugarcane, and gur. Gur price was included because the sugarcane price is regulated by the government, and consequently market

^{1/} The Bhagwati-Srinivasan denominator for the relative price of foodgrains is the price of cotton manufactures, and not of all manufactures as in our case.

TABLE IX

ESTIMATES OF RELATIVE PRICE FUNCTIONS
(COMMERCIAL CROPS)
(1950-51 - 1972-73)^{1/}

9.1

$$P_c/P_m = 103.715 - .577 O_c^I + 2.726 Y_m^I$$

(7.6) (2.5) (5.4)

$$\bar{R}^2 = .740$$

$$DW = 1.187$$

9.2

$$P_c/P_m = 76.775 - .284 O_c^I + 2.118 Y_m^I + .088 P_c^m(-1)$$

(5.6) (1.5) (4.7) (1.5)

$$\bar{R}^2 = .858$$

$$DW = 1.581$$

^{1/} Equation 9.2 is estimated for the period 1951-52 - 1972-73.

pressures are reflected in fluctuations in the Gur price.^{1/}

Equation 9.1 estimates the relative price of commercial crops as a function of manufacturing output - the demand variable, and the output of commercial crops - the supply variable. The equation explains 74 per cent of the variation in the relative price, and the Durbin-Watson test on positive autocorrelation is inconclusive.

When the lagged import price of crude materials is added as an explanatory variable and equation 9.2 is estimated, the $\bar{R}^2$ increases from .74 to .86, while the test on positive autocorrelation is still inconclusive. However, the coefficients of output and the price of crude materials are statistically significant only at the 10 per cent level.

Section II: The Manufacturing Sector

(i) Production Function

The basic data set for estimating the production function in the manufacturing sector consists of (i) the time series for 1950-1958 from the Census of Manufacturing Industries (CMI), and (ii) the time series for 1959-1970 from the Annual Survey of Industries (ASI). As explained in chapter II, these two series relate to different sets of reporting establish-

^{1/} The wholesale price indices for the various subgroups used to construct the price index of commercial crops suffer from a systematic bias in that the wholesale price index series record statutory ceiling prices for commodities even in cases where the ceilings have not been operative. In such cases, e.g., in the case of cotton, the index number underestimates the rise in prices in a period of rising prices. See Dantwala (17).

ments.^{1/} Because of the problem presented by the changing coverage over time, we have transformed the time series for value added, capital stock, and employment for the total number of reporting establishments to time series on per establishment basis. These time series are then used to estimate the parameters of the production function.

The specification of the production function follows a standard Cobb-Douglas form. Following the discussion in the previous chapter, we have explicitly incorporated capacity utilisation as a factor influencing output. As explained in the previous chapter, the level of capacity utilisation is endogenously determined in the model. (The estimated results of the capacity utilisation function are reported below.)

Before presenting the production function estimates, we may note the limitations of the time series on capacity utilisation as constructed by the Reserve Bank of India.^{2/} This series is obtained by taking a weighted average of the capacity utilisation series for the various industries, the

^{1/} To account for the differences resulting from the change in the source of data beginning 1959, dummy variables were included to test for both differences in intercept and differences in slope in the two periods. However, these dummy variables had statistically insignificant coefficients in all cases. For this reason, these results are not reported in the text.

^{2/} Reserve Bank of India (61).

weights being their respective shares in value added. Capacity utilisation for each industry is defined as the ratio of actual output to potential output, the latter in turn being defined as the peak level of production attained for an industry at time t or prior to it when t is the time at which the potential is measured. Thus defined, and measured as the peak monthly level of the production index reached by an industry during any year, the potential is assumed not to decline subsequently. The concept of capacity utilisation is therefore based on a rather mechanical definition of potential output. An appropriate definition of potential output would be that level of output which can be sustained rationally in the medium run in a plausible situation with respect to market demand and intermediate input availability. However, in the absence of any better data series for capacity utilisation, we have used the Reserve Bank of India series, extending it backward prior to 1960 by using Krishnamurti's estimates of this index.^{1/}

Table X . summarises the results of our production function estimates. Equation 10.12 reports the results of estimating equation 10.1 as specified in chapter II, including labor, capital stock, capacity utilisation, and time as explanatory variables. In addition, we report an alternative form, i.e., equation 10.11, which excludes time as an

^{1/} Krishnamurti K. (47).

TABLE X.

ESTIMATES OF PRODUCTION FUNCTION IN MANUFACTURING
(1950 - 1970)

10.11

$$\text{Log } v_m' = -4.848 + .482 \text{ Log } n_m + .285 \text{ Log } k_m' + .449 \text{ Log } U$$

(4.7) (2.4) (13.2) (3.5)

$$\bar{R}^2 = .982$$

$$DW = .809$$

10.12

$$\text{Log } v_m' = -5.665 + .513 \text{ Log } n_m + .070 \text{ Log } k_m' + .541 \text{ Log } U + .032 T$$

(7.7) (3.5) (2.2) (6.0) (7.6)

$$\bar{R}^2 = .990$$

$$DW = 1.484$$

10.21

$$\text{Log } v_m' = -4.617 + .568 \text{ Log } n_m + .285 \text{ Log } k_m^u$$

(4.4) (2.7) (12.6)

$$\bar{R}^2 = .982$$

$$DW = .717$$

10.22

$$\text{Log } v_m' = -4.902 + .710 \text{ Log } n_m + .126 \text{ Log } k_m^u + .023 T$$

(5.5) (4.1) (3.4) (5.0)

$$\bar{R}^2 = .986$$

$$DW = .852$$

TABLE X A.

ESTIMATES OF RETURNS TO SCALE IN MANUFACTURING
(1950 - 1970)

10.21'

$$\text{Log } v_m' = -4.617 + .285 \text{ Log } (k_m^u / n_m) + .853 \text{ Log } n_m$$

(4.4) (12.6) (4.7)

$$\bar{R}^2 = .982$$

$$DW = .717$$

10.22'

$$\text{Log } v_m' = -4.902 + .126 \text{ Log } (k_m^u / n_m) + .836 \text{ Log } n_m + .023 T$$

(5.6) (3.5) (5.5) (5.1)

$$\bar{R}^2 = .986$$

$$DW = .852$$

explanatory variable. Equation 10.22 corresponds to equation 10.2 as specified in chapter II, and differs from 10.12 in that the coefficients of capital stock and capacity utilisation are constrained to be the same. Equation 10.21 is an alternative form of the equation 10.2 with the deletion of time as an explanatory variable.

The following features of these results are worth noting:

(a) Capacity utilisation has a positive and statistically significant effect on value added in manufacturing in both the equations in which it is included, i.e., equations 10.11 and 10.12. Interestingly, the coefficient on capacity utilisation (or the elasticity of value added in manufacturing with respect to capacity utilisation) is higher than that with respect to the capital stock. This finding is entirely plausible in the Indian context since in the short run, an increase in capacity utilisation is likely to lead to relatively greater increases in output than an increase in capital stock.

(b) The inclusion of time as an explanatory variable reflecting technological progress of the "manna from heaven" kind leads to marginal improvements in the $\bar{R}^2$, and the coefficient of the time variable is positive and statistically significant. However, the coefficient of capital stock becomes very small. This is inconvenient (although not entirely surprising) since the capital stock series has a strong time

trend itself, and is therefore heavily correlated with the time variable.

(c) The estimated results suggest that the assumption of constant returns to scale in manufacturing is not unreasonable. The sum of the coefficients of labor and capital stock in equations 10.21 and 10.22 are .853 and .836 respectively. Given the standard errors on the coefficients, these are not significantly different from unity. This can be seen by estimating equations 10.21' and 10.22' as reported below, and checking whether or not the coefficient of $\text{Log } n_m$ in these equations is significantly different from unity. The coefficient of $\text{Log } n_m$ in equations 10.21' and 10.22' is exactly equal to the sum of the coefficients of labor and capital in equations 10.21 and 10.22 respectively, and the particular estimating form provides us with a t-statistic for this estimate. The t-statistics on the two coefficients of $\text{Log } n_m$ in equations 10.21' and 10.22' imply that both these coefficients are not significantly different from unity.

Our preferred estimate of the production function is the equation 10.11 excluding technical progress. This equation gives "reasonable" estimates of the elasticity of output with respect to capital and labor.

Our use of the Cobb-Douglas production function has implicit in it the assumption of unit elasticity of substitution

between any pair of factors included in the production function. We tried to test for this assumption by obtaining independent estimates of the elasticity of substitution, using a constant elasticity of substitution (CES) production function in the form of the ACMS estimating equation and in the form of the Kmenta approximation.^{1/} The results we obtained did not leave us with any clear indication on the magnitude of the elasticity of substitution between labor and capital.^{2/}

As explained in chapter II, in our model the estimated value added per establishment provides the basis for determining the value added in the manufacturing sector as a whole by means of a linking function. This function is estimated for the period 1950-51 to 1970-71 by estimating equation 11 of chapter II, using National Accounts data on fiscal year basis and CMI/ASI data on calendar year basis for value added in manufacturing.^{3/}

^{1/} Arrow, Chenery, Minhas, Solow. (2), and Kmenta (43).

^{2/} The ACMS approximation of the CES production function gives an elasticity of substitution estimate which is greater than unity when time is excluded as an explanatory variable, and less than unity when time is included. These results are consistent with the findings of Bannerjee (3) for the period 1946-1958 using the ACMS estimating equation for India. The Kmenta approximation yields an estimate of the elasticity of substitution less than one when utilised capital stock and labor are included but time is excluded, and gives poor results in terms of the sign and significance of the coefficients when time is included.

^{3/} Fiscal year $t - t+1$ refers to the year beginning with April of year t and ending with March of year $t+1$.

$$\text{Log } Y'_m = -.257 + .318 \text{ Log } V'_m (-1) + .030 T \quad (11)$$

(0.4) (4.3) (4.0)

Period: 1950-51 - 1970-71

$$\bar{R}^2 = .993$$

$$DW = 1.252$$

(ii) Capacity Utilisation

As described in chapter II equation 12, capacity utilisation is a function of intermediate materials' imports relative to the capital stock, output of commercial crops relative to the capital stock, and share of government investment in the gross domestic product. This equation estimated in its loglinear form yields equation 12.3 which is reported in Table XI. In view of the statistical collinearities between intermediate materials' imports and output of commercial crops, the equation was reestimated dropping one of these variables at a time, and the results are shown as equations 12.1 and 12.2 in Table XI.^{1/}

The coefficients of the output of commercial crops relative to capital stock, and of the share of government investment in the gross domestic product are positive and

^{1/} In these equations we have used calendar year data for U and K'_m and fiscal year data for the other variables, as the K'_m data are only available in this form.

TABLE XI.

ESTIMATES OF CAPACITY UTILIZATION FUNCTIONS IN MANUFACTURING (1950 - 1970)

12.1

$$\text{Log } U = 5.254 + .052 \text{ Log } (M'_O/K'_m(-1)) + .293 \text{ Log } (I^G/Y \times 1000)$$

(77.6) (5.9)
(13.3)

$$\begin{aligned}\bar{R}^2 &= .894 \\ DW &= 1.549\end{aligned}$$

12.2

$$\text{Log } U = 5.474 + .051 \text{ Log } (O_c^I / K_m'(-1)) + .298 \text{ Log } (I^G / Y \times 1000) \quad (14.6)$$

$$\begin{aligned}\bar{R}^2 &= .908 \\ DW &= 1.346\end{aligned}$$

12.3

$$\text{Log } U = 5.580 + .078 \text{ Log } (O_c^I/K_m^I(-1)) - .030 \text{ Log } (M_o^I/K_m^I(-1)) + .297 \text{ Log } (I^g/Y \times 1000)$$

(34.5) (2.2)
(0.8)
(14.6)

$$\begin{aligned}\bar{R}^2 &= .906 \\ DW &= 1.283\end{aligned}$$

statistically significant in equation 12.3, as expected. The coefficient of the intermediate materials' imports is, however, not significantly different from zero. This is probably because of the multicollinearity between the imports variable and the commercial crop output variable over time. As is evident from the results of equation 12.1 and 12.2, when one of these variables is dropped at a time, the other has a significant positive effect on the utilisation of capacity in manufacturing. The share of government investment in the total gross domestic product, which reflects an important demand factor for this sector (particularly because of its indirect multiplier effects on overall demand in the economy), has a positive and statistically significant coefficient in all the equations. All the three equations explain about 90 per cent of the variation in capacity utilisation, while the Durbin-Watson test is inconclusive in all the three cases. In view of the multicollinearity problem in equation 12.3, our preferred estimates for the capacity utilisation equation are equations 12.1 and 12.2.

(iii) Investment Function

As discussed in chapter II, the specification of investment in our model involves linking real gross investment from CMI/ASI sources with the aggregate level of gross invest-

ment in the private corporate sector and in public enterprises. Since government investment is assumed to be exogenous (a policy variable), this requires us to estimate only one aggregate investment function for the private corporate sector.

The estimated results for the linking function as specified in equation 14 of chapter II are reported below:^{1/}

$$\text{Log } I_m' = .265 \text{ Log } I^{pc'}(1) + .732 \text{ Log } I^{gn'}(1) \quad (14)$$

(3.1) (8.4)

$$\bar{R}^2 = .864$$

$$DW = 1.83$$

Period: 1950-51 - 1970-71

The real gross investment by the private corporate sector specified as a function of an interest rate, an expected price variable, lagged government investment, imports of capital goods, and lagged capital stock is estimated as equation 15.2. The expected price variable is based on the hypothesis of perfect foresight, so that the expected price change is equal to the actual price change in any period. An alternative hypothesis of static expectations (where the expected price change equals the price change one period lagged) was tested,

^{1/} As in the case of equation 12, calendar year data are used for the dependent variable, and fiscal year data for the others.

but was rejected on estimation. Owing to the limited number of observations in the sample, experimentation with other expectations hypotheses involving relatively more lagged prices could not be undertaken. In addition to equation 15.2, we estimated equation 15.1 dropping the imports of capital goods variable in order to emphasize the impact of the foreign exchange bottleneck on investment. The results are reported in Table XII.

In equation 15.1, the coefficients of all variables have the expected signs and are statistically significant. The equation explains 83 per cent of the variation in investment and the Durbin-Watson statistic reveals absence of positive autocorrelation. The inclusion of the imports of capital goods in equation 15.2 leads to an increase in the explanatory power of the equation from .83 to .91. The imports of capital goods have a positive and significant impact on real investment in the private corporate sector. Equation 15.2 is our preferred estimate of the investment equation.

(iv) Money Wage Function

As discussed in chapter II, the money wage rate in manu-

TABLE XII.

ESTIMATES OF INVESTMENT FUNCTIONS
PRIVATE CORPORATE SECTOR
(1951-52 - 1970-71)

15.1

$$\begin{aligned} \text{Log } I^{\text{pc}'} &= 2.989 - 2.205 \text{ Log } i_i + 2.141 \text{ Log } I^{\text{gg}'}(-1) - .431 \text{ Log } K_m'(-1) \\ &\quad (1.6) \quad (4.2) \quad (6.6) \quad (4.0) \\ &\quad + 3.766 P_m^e \\ &\quad (3.6) \end{aligned}$$

$$\begin{aligned} \bar{R}^2 &= .833 \\ \text{DW} &= 2.083 \end{aligned}$$

15.2

$$\begin{aligned} \text{Log } I^{\text{pc}'} &= -2.615 - 2.300 \text{ Log } i_i + 1.561 \text{ Log } I^{\text{gg}'}(-1) - .307 \text{ Log } K_m'(-1) \\ &\quad (1.9) \quad (6.0) \quad (4.6) \quad (3.3) \\ &\quad + 3.613 P_m^e + .470 \text{ Log } M_k' \\ &\quad (4.7) \quad (2.4) \end{aligned}$$

$$\begin{aligned} \bar{R}^2 &= .917 \\ \text{DW} &= 2.550 \end{aligned}$$

facturing is specified as a distributed lag function of the price of foodgrains and of labor productivity in manufacturing (equation 16 of chapter II). This equation is estimated using alternative assumptions with respect to the lag structures. Assuming that the coefficients of both the variables follow a geometrically declining pattern, we estimated equation 16.1, using a Koyck lag structure. Equation 16.2 is estimated on the assumption that the preceding two years' price of foodgrains and labor productivity influence the money wage rate in manufacturing. Finally, equation 16.3 is estimated, assuming that only the one year lagged price of foodgrains and productivity have an impact on the money wage rate. The results are reported in Table XIII.

In equation 16.1, using a Koyck lag structure, the coefficients of the lagged price of foodgrains and of the lagged labor productivity variables are insignificantly different from zero. The coefficient of the lagged dependent variable, however, is positive and statistically significant, suggesting a slow adjustment of the money wage rate to these variables. The equation explains 99 per cent of the variation in the money wage rate. The Durbin-Watson statistic is meaningless in this context, since the equations include the lagged dependent variable as an explanatory variable. Because of the small number of observations, the Durbin test can also not be

TABLE XIII.

ESTIMATES OF MONEY WAGE FUNCTIONS
(1951 - 1970)^{1/}

16.1

$$\begin{aligned} \text{Log } w_m = & -.116 + .073 \text{ Log } (P_f(-1)) + .062 \text{ Log } (v'_m/n_m)(-1) + .939 \text{ Log } w_m(-1) \\ & (0.5) \quad (1.1) \qquad \qquad (0.4) \qquad \qquad (6.4) \end{aligned}$$

$$\begin{aligned} \bar{R}^2 &= .994 \\ DW &= 1.803 \end{aligned}$$

16.2

$$\begin{aligned} \text{Log } w_m = & .759 + .235 \text{ Log } (P_f(-1)) + .239 \text{ Log } (P_f(-2)) + .661 \text{ Log } (v'_m/n_m)(-1) \\ & (3.0) \quad (2.2) \qquad \qquad (2.3) \qquad \qquad (2.2) \\ & + .327 \text{ Log } (v'_m/n_m)(-2) \\ & (1.1) \end{aligned}$$

$$\begin{aligned} \bar{R}^2 &= .981 \\ DW &= 1.059 \end{aligned}$$

16.3

$$\begin{aligned} \text{Log } w_m = & .963 + .459 \text{ Log } (P_f(-1)) + .955 \text{ Log } (v'_m/n_m)(-1) \\ & (4.1) \quad (8.1) \qquad \qquad (11.6) \end{aligned}$$

$$\begin{aligned} \bar{R}^2 &= .979 \\ DW &= 1.490 \end{aligned}$$

^{1/} Equations 16.2 and 16.3 could be estimated only for the periods 1952-1970 and 1953-1970 respectively.

applied to test for positive autocorrelation.

When the lagged influence of food prices and labor productivity is limited to two years, the results of equation 16.2 reveal positive and significant effect of foodgrain prices and of labor productivity lagged one year, while the two year lagged productivity variable has a coefficient which is not significantly different from zero. This may be due to the multicollinearity between the two productivity variables. The equation explains 98 per cent of the variation in the money wage rate, and the Durbin-Watson test on positive autocorrelation yields inconclusive results.

Finally, equation 16.3 presents the results with only one year lagged food prices and labor productivity as the explanatory variables. Both variables have positive and statistically significant effect on the money wage rate, while the equation explains 98 per cent of the variation in the money wage rate, and the Durbin-Watson test on positive autocorrelation yields inconclusive results.

Section III: The Foreign Sector

Of the various items in the foreign sector, only imports are endogenised in the model. Exports and net foreign capital transactions are treated as exogenous.^{1/}

^{1/} All equations in this section are estimated using fiscal year data. Fiscal year $t - t+1$ refers to the year beginning with April of year t and ending with March of year $t+1$.

(i) Import functions

As stated in chapter II, the model specifies behavioral functions determining imports of capital goods and of other non-food goods (largely intermediate materials). Imports of food are exogenously determined, and are regarded as a key policy variable.

Imports of capital goods (machinery and transport equipment) are specified as a function of the level of gross investment in the economy, the price of imported capital goods, and utilized foreign aid (excluding the PL 480 food aid deflated by the import price index as in equation 18 of chapter II). This functional relationship is estimated in loglinear form, and the results are reported in Table XIV. All the variables in equation 18 have statistically significant coefficients with the expected signs, and the equation explains 87 per cent of the total variation in the imports of capital goods. The Durbin-Watson test on positive autocorrelation, however, yields inconclusive results.

We also estimated equation 18 including alternatively the domestic price of capital goods and the domestic price of manufactured goods as additional explanatory variables. The results are not reported here. In all cases, the coefficient of the domestic price variable was insignificantly different from zero, and the $\bar{R}^2$ of the respective equations

TABLE XIV

ESTIMATES OF NON-FOOD IMPORT FUNCTIONS
(1950-53 - 1972-73)

18

$$\text{Log } M'_k = 5.040 - 1.155 \text{ Log } P^m_k + .159 \text{ Log } F'_{anf} + .710 \text{ Log } I'$$

(3.8) (8.7) (2.5) (3.3)

$$\bar{R}^2 = .874$$

$$DW = 1.417$$

19

$$\text{Log } M'_O = -.175 - .597 \text{ Log } P^m_O + 1.077 \text{ Log } X' + .00003 F' + .202 \text{ Log } Y'_m$$

(0.2) (4.8) (4.5) (2.0) (1.5)

$$\bar{R}^2 = .897$$

$$DW = 1.280$$

were marginally lower compared with the results reported in Table XIV. As stated in chapter II, these results are consistent with our a priori expectations.

Imports of goods other than food and capital goods--largely intermediate materials--are specified as a function of value added in manufacturing, the import price index of these goods, foreign capital inflow (deflated by the import price index), and exports (deflated by the import price index). The estimates of this equation (equation 19 of chapter II) are also reported in Table XIV.

Equation 19 explains 90 per cent of the variation in 'other' imports. The coefficient of the price of imports is negative and statistically significant as expected, while that of real exports and of foreign capital inflow are positive and significant, again, as expected. However, the coefficient of value added in manufacturing is positive but significant only at the 10 per cent level. A loglinear form of this equation could not be estimated, as the foreign capital inflow variable takes positive as well as negative values. As in the case of capital goods, estimation of equation 19 was tried including the price index of domestic substitutes as an additional explanatory variable, and the results were similar.

Section IV: The Fiscal Sector

The specification of the fiscal sector as described in chapter II treats both tax revenue and wage expenditures of the government as endogenous. Given nontax revenue, other current expenditure, and government investment--all exogenous to the model, the government fiscal deficit is obtained endogenously.^{1/}

(i) Revenues

Our estimates of the four tax revenue functions 22 to 25 corresponding to agricultural taxes (direct), non-agricultural taxes (direct), customs, and other indirect taxes are reported in Table XV.. The coefficient of the time trend variable is insignificantly different from zero in the non-agricultural direct tax revenue equation and the customs revenue equation, but is positive and statistically significant for the agricultural tax revenue and the other indirect tax revenue equations. The coefficients of the tax base variables have the expected positive and statistically significant signs in all cases except equation 22. In the latter, the coefficient of agricultural income is negative and statistically significant. This result is peculiar indeed.

^{1/} All equations in this section are estimated using fiscal year data.

TABLE XV

ESTIMATES OF TAX REVENUE FUNCTIONS
(1950-51 - 1972-73)

22

$$T_a^g = 674 - 6 Y_a + 72 T$$

(16.4) (5.2) (8.8)

elasticity
at mean -.536 .892

$$\bar{R}^2 = .847$$

$$DW = 1.237$$

23

$$T_n^g = -780 + 49.0 Y_n + 29.4 T$$

(3.2) (8.8) (0.6)

elasticity
at mean 1.084 .081

$$\bar{R}^2 = .973$$

$$DW = .676$$

24

$$T_o^g = -7087.7 + 184.4 Y_n + 119.0 T$$

(36.3) (40.3) (3.0)

elasticity
at mean 1.404 .113

$$\bar{R}^2 = .993$$

$$DW = .380$$

25

$$\text{Log } T_c^g = -3.959 + 1.341 \text{ Log } M_o + .011 T$$

(0.6) (1.7) (0.3)

$$\bar{R}^2 = .700$$

$$DW = .532$$

It is quite likely that this peculiarity is a reflection of the fact that various states have completely eliminated land revenue over the last ten years.^{1/} In the absence of a rate variable in the equations as specified, this drastic change in the rate structure leads to anomalous results.

Table XV also reports the elasticity values implied by the coefficients of the tax base variables at the point of the sample mean. We find this elasticity to be greater than one for all the tax revenue functions except the agricultural tax revenue function.

(ii) Current Expenditure

Government wages and salaries are estimated as a function of lagged price of foodgrains and of the other current expenditure of the government (equation 26 of chapter II), and the results are reported in Table XVI.

Equations 26.1 to 26.3 in Table XVI present the results of estimating the government wages equation under differing assumptions in regard to the lagged impact of foodgrain prices, i.e., one year, two year, and three year lag specifications respectively. Each of the three equations explains 99 per cent of the variation in government wages and salaries, while

^{1/} Agricultural income tax and land revenue are levied by the state governments and not the Union government.

TABLE XVI

ESTIMATES OF GOVERNMENT WAGE FUNCTIONS
(1951-52 - 1972-73)^{1/}

26.1

$$W^G = 64.054 + 51.924 P_f(-1) + .703 E_O^G$$

(0.1) (5.6) (16.3)

elasticity
at mean .432 .564

$$\bar{R}^2 = .992$$

$$DW = 1.370$$

26.2

$$W^G = -207.663 + 42.245 P_f(-1) + 15.175 P_f(-2) + .679 E_O^G$$

(0.3) (3.2) (1.1) (15.0)

elasticity
at mean .345 .119 .549

$$\bar{R}^2 = .992$$

$$DW = 1.392$$

26.3

$$W^G = -749.948 + 67.353 \sum_{-1}^{-3} P_f(i) + .635 E_O^G$$

(0.9) (6.4) (13.8)

$$\bar{R}^2 = .994$$

$$DW = 1.328$$

^{1/} Equations 26.2 and 26.3 could only be estimated for 1952-53 - 1972-73 and 1953-54 - 1972-73 respectively.

the Durbin-Watson test on positive autocorrelation is inconclusive. The coefficients of the two variables are positive and statistically significant, as expected.

Section V: The Monetary Sector

As discussed in Chapter II, the behavioral functions in the monetary sector consist of (a) money demand functions, and (b) a function explaining the change in monetary base. These functions, along with the balance sheet identities and the equilibrium conditions, determine the real demand for money, the nominal supply of money, the aggregate price level, and the other related variables. We discuss the estimates of the behavioral functions below.^{1/}

(i) Demand for Money

The demand for real money balances is specified as a function of real income, the short term interest rate, and expected prices (equation 28 of chapter II). The estimated log-linear results using a static expectations hypothesis are presented as equation 28.1 in Table XVII. An alternative version, dropping expected prices as an explanatory variable is reported as equation 28.2 in Table XVII.^{2/}

^{1/} All equations in this section are estimated using fiscal year data.

^{2/} The expected price $p^e = (P(-1) - P(-2))/P(-2)$.

TABLE XVII

ESTIMATES OF DEMAND FUNCTIONS FOR REAL MONEY BALANCES
(1951-52 - 1971-72)

28.1

$$\text{Log } L' = -.959 - .162 \text{ Log } i_z + .973 \text{ Log } Y^{\text{mp}'} - .188 P^e$$

(1.5) (1.7) (13.7) (1.2)

$$\bar{R}^2 = .958$$

$$DW = 1.664$$

28.2

$$\text{Log } L' = -.905 - .191 \text{ Log } i_z + .974 \text{ Log } Y^{\text{mp}'}$$

(1.5) (2.2) (14.6)

$$\bar{R}^2 = .961$$

$$DW = 1.6$$

In equation 28.1 as estimated, the coefficients of real income and the short term interest rate have positive and negative signs respectively and both coefficients are statistically significant as expected, although the coefficient of the interest rate is significant only at the 10 per cent level. The estimates also show that price expectations have no effect on the demand for real money balances. The equation explains 96 per cent of the variations in the demand for money, and the Durbin-Watson test on positive autocorrelation is inconclusive. When equation 28.2 is estimated, dropping expected prices as an explanatory variable, the $\bar{R}^2$ as well as the coefficients of the other variables are relatively unaffected, while the statistical significance of both the coefficients is improved. This equation is our preferred estimate of equation 28 in the model.

Demand for currency is specified along the lines of the demand for total real money balances function, with an additional variable, i.e., the ratio of agricultural income to total income as a proxy for structural change in the economy (equation 29 of chapter II). The results of estimating this equation are presented as equation 29.1 in Table XVII. We have also presented in this table the results of estimating equation 29 without the expected price variable--equation 29.2.

The structural change variable has negative and statis-

TABLE XVIII
ESTIMATES OF DEMAND FUNCTIONS FOR CURRENCY
(1951-52 - 1971-72)

29.1

$$\text{Log } C' = 2.476 - .502 \text{ Log } i_z + .660 \text{ Log } Y^{\text{mp}'} - 1.029 \text{ Log } (Y_a'/Y') - .539 P^e$$

(1.7) (2.8) (4.2) (3.8) (1.7)

$$\bar{R}^2 = .901$$

$$DW = 1.074$$

29.2

$$\text{Log } C' = 2.160 - .566 \text{ Log } i_z + .708 \text{ Log } Y^{\text{mp}'} - .876 \text{ Log } (Y_a'/Y')$$

(1.8) (3.9) (5.7) (4.2)

$$\bar{R}^2 = .912$$

$$DW = .660$$

tically significant coefficients in both equations, as expected. As the structure of the economy changes over time, i.e., the share of agriculture declines, and there is increasing monetisation, this leads to an increase in the demand for currency. The coefficients of income and short term interest rate have the expected signs and are statistically significant in both the equations. The coefficient of the expected price variable, however, is insignificantly different from zero again. The exclusion of this variable leads to marginal improvement in the results in equation 29.2. This is the preferred estimate for equation 29 in the model.

Equation 30 below presents the estimated results for the equation determining the ratio of time deposits and demand deposits as specified in chapter II. The elasticity of this ratio with respect to real non-agricultural income is estimated to be greater than one. The ratio responds positively to a change in the interest rate on time deposits and negatively to a change in the interest rate on government bonds--a close substitute to time deposits.

$$\begin{aligned} \text{Log (TD / D)} = & - 3.655 + 1.014 \text{ Log } Y'_n - .796 \text{ Log } i_g + .362 \text{ Log } i_d \\ & (12.6) \quad (6.3) \quad (2.3) \quad (3.3) \\ \text{Period 1951-52 - 1972-73} \quad \bar{R}^2 = & .902 \\ & \text{DW} = .44 \quad (30) \end{aligned}$$

The equation explains 90 per cent of the variation in this ratio, although the Durbin-Watson test reveals the existence of positive autocorrelation.

(ii) Supply of Money

The results of estimating the change in monetary base as a function of lagged foreign assets of the Reserve Bank of India, lagged change in money income, and the government fiscal deficit (equation 32 of chapter II) are reported as equation 32.1 in Table XIX. Equation 32.2 reports the results of estimating the equation excluding the lagged change in money income variable.

Equation 32.1 explains 85 per cent of the variations in the change in the monetary base. The coefficient of the government fiscal deficit is positive and highly significant. The coefficient of the lagged change in money income variable, on the other hand, is insignificantly different from zero. A priori, we expected this coefficient to be positive, reflecting 'accommodating' monetary expansion on the part of the Reserve Bank of India. The coefficient of the lagged foreign assets variable is positive but relatively insignificant. The Durbin-Watson statistic rejects the hypothesis of positive autocorrelation. When the change in money income variable is dropped from the equation, and equation 32.2 is estimated, this leads to a marginal improvement in the R^2 . The coefficient

TABLE XIX
ESTIMATES OF MONETARY BASE FUNCTION
(1951-52 - 1972-73)

32.1

$$\text{DMB} = -771.117 + .193 \text{DF}^{\text{G}} + .056 \text{FR}_{\text{RBI}}(-1) - .009 (\text{Y}^{\text{mp}}(-1) - \text{Y}^{\text{mp}}(-2))$$

(2.0) (8.0) (1.1) (0.6)

$$\bar{R}^2 = .851$$

$$\text{DW} = 1.82$$

32.2

$$\text{DMB} = -785.041 + .183 \text{DF}^{\text{G}} + .060 \text{FR}_{\text{RBI}}(-1)$$

(2.1) (11.1) (1.2)

$$\bar{R}^2 = .857$$

$$\text{DW} = 1.69$$

of the fiscal deficit is positive, once again, and is highly significant. The positive coefficient of the lagged foreign assets variable is, however, still relatively insignificant, and the Durbin-Watson test yields inconclusive results.

VI. OTHER EQUATIONS AND IDENTITIES

Finally, we present below the estimates of the remaining equations in the model.

39

$$Y' = -11.005 + 1.401 Y_a' + 2.939 Y_m'$$

(2.7) (15.2) (27.2)

Period 1950-51 - 1972-73

$$\bar{R}^2 = .991$$

$$DW = 2.12$$

41

$$(P_f/P_m)^f = 1.886 + .982 P_f/P_m$$

(0.4) (25.4)

Period 1950-51 - 1972-73

$$\bar{R}^2 = .967$$

$$DW = 1.854$$

42

$$(P_c/P_m)^f = 5.824 + .943 P_c/P_m$$

(1.1) (19.0)

Period 1950-51 - 1972-73

$$\bar{R}^2 = .943$$

$$DW = 2.242$$

43

$$P_a/P_n = .111 + .003 (P_f/P_m)^f + .005 (P_c/P_m)^f + .009 T$$

(1.1) (2.9) (3.1) (3.7)

Period 1950-51 - 1972-73

$$\bar{R}^2 = .916$$

$$DW = .923$$

50

$$P_m = -12.657 + 101.970 P_n$$

(2.6) (25.3)

Period 1950-51 - 1972-73

$$\bar{R}^2 = .967$$

$$DW = .716$$

53

$$\text{Log } P_I^g = -4.599 + .918 \text{ Log } (P) + .062 \text{ Log } (P_k^m)$$

(11.6) (4.9) (0.5)

Period 1950-51 - 1971-72

$$\bar{R}^2 = .918$$

$$DW = .307$$

54

$$P_I^p = .082 + .007 P + .001 P_k^m$$

(2.2) (11.4) (3.4)

Period 1950-51 - 1972-73

$$\bar{R}^2 = .979$$

$$DW = .668$$

55

$$\text{Log } I^{hh'} = -.925 + 2.062 \text{ Log } (Y')(-1)$$

(0.9) (10.1)

Period 1951-52 - 1970-71

$$\bar{R}^2 = .840$$

$$DW = 1.026$$

60

$$DD^f = -521.509 + 1.098 D$$

(4.5) (148.6)

Period 1951-52 - 1972-73

$$\bar{R}^2 = .999$$

$$DW = 1.123$$

61

$$\text{TD}^f = -333.307 + 1.097 \text{ TD}$$

(3.1) (193.2)

Period 1951-52 - 1972-73

$$\bar{R}^2 = .999$$
$$DW = 1.866$$

CHAPTER IV. MODEL SIMULATIONS

The basic macro econometric model underlying this study as well as its estimates were presented in chapters II and III. In this chapter we present the solutions of the model over the sample period 1952-53 to 1970-71. These solutions - static as well as dynamic - serve to indicate the extent to which the model captures the crucial features of economic behavior over the period. In addition, we present the dynamic multipliers relating to changes in certain exogenous variables. These results can also be used to study the properties of the model which are easier handled through simulation techniques than through direct mathematical analysis of the equation system since the model is large and nonlinear.

This chapter is divided into three sections. Section I defines the distinction between a 'static' and a 'dynamic' solution, and briefly describes the particular simulation technique used. Section II presents and examines the static and dynamic solutions of the model over the sample period. Section III discusses the "multiplier effects" of changes in certain selected exogenous variables by comparing the dynamic solution after incorporating these changes with the dynamic solution without these changes.

Section I: Simulation Methods: "Static" vs. "Dynamic"
solutions

Simulation is a computer-intensive method of solving a system of simultaneous equations through iteration, such that it yields the solution values for a set of endogenous variables, given the predetermined variable--exogenous as well as lagged endogenous. For a dynamic model we can distinguish between two types of solutions--static and dynamic. If the lagged endogenous variables are given only for the initial period, and the solution for subsequent periods uses the generated lagged endogenous variables for the other periods, simulation yields a solution time path which is 'dynamic' in that it uses the model to link the various time periods in a forward recursive manner. Alternatively, the simulation procedure could use the actual lagged values of the relevant endogenous variables. In this case, the solution time path is 'static' in that it represents a sequence of single period solutions without any inter-period linkages through the endogenous values generated by the model.

Both static and dynamic solutions are useful in analysing the properties of a model. The static solution can be examined to see how well a model replicates the behavior of an economy over the sample period. By using actual rather than the model-generated lagged endogenous variables, the static solution prevents the inevitable errors (discrepancies between actual

and model generated values) from cumulating over time. It is important to note that such errors are likely to arise even if there is no misspecification in the model, because of the existence of a stochastic element in the determination of each endogenous variable. Each model equation only predicts the deterministic component of each variable, and the model solution for each year is therefore bound to differ from the actual values of these variables which are generated in the light of stochastic disturbances each year. Since it is the actual values that are relevant in subsequent solutions, there is little point in using model-generated values for lagged endogenous variables if the object is to replicate observed behavior.

The dynamic solution, on the other hand, yields a solution time path which explicitly incorporates the interperiod linkages through the lagged endogenous variables generated by the model. It is particularly useful for the study of dynamic multipliers which require the perturbation of a dynamic solution to examine the pattern of the impact over time of a change in one variable on other selected variables of the system. In a nonlinear model, the dynamic multipliers provide some test (albeit nonrigorous) of the local stability of the model. It is worth noting that in a nonlinear model, the magnitude and time pattern of a dynamic multiplier is not

independent of the initial configuration of the exogenous variables in the period in which the shock is introduced. Also, the initial level of the exogenous variable at which the change in that variable is introduced makes a difference to the multipliers.

The particular simulation method used for this study is the Gauss-Seidel iterative solution method as incorporated in SESAME (System for Efficient Solution and Analysis of Models in Econometrics) available at the Brookings Social Science Computation Centre. The solution involves the substitution of actual values for exogenous variables and appropriate values for endogenous variables. The Gauss-Seidel method proceeds as follows: Beginning with the actual initial values of the endogenous variables where necessary, the method solves each equation for the endogenous variable appearing as the dependent variable in that equation. This is done in the order in which the equations are presented in the model. When an endogenous variable that has already been solved appears as an explanatory variable in a subsequent equation, the solution value for the former is used in the later equation. In each iteration, all the equations are solved producing iteration values for the endogenous variables. The iteration values from iteration i are then used to solve the equation and produce a new set of iteration values for iteration $i + 1$. The iterative

process continues until the change in each variable from iteration i to iteration $i + 1$ is less than that specified by a convergence criterion. When all equations have been solved for one period of the simulation, the process begins again for the next period.

Section II. Simulation Results: 1952-53 To 1970-71

In this section, we analyse the static as well as the dynamic solution of the model within the sample period 1952-53 to 1970-71. Since our interest in the model is largely to explore the movement of prices as well as real outputs in the various sectors of the economy, and the linkages that are important in this context, we have selected 30 out of 67 endogenous variables in the model which relate to these aspects of the economy in order to determine how well the model replicates the actual behavior of the economy over

-
- 1/ For each variable, the convergence criterion is defined as $.1^f . (.1)$, where f is the number of places to the right of the decimal point for the data series relating to the variable.
 - 2/ The results of our experimentation with various specifications for the individual equations of the model were reported in chapter III. Our final choice for each equation to be included in the model as well as the reasons for this choice were also discussed in chapter III. Appendix IV presents the model as a whole, including the set of preferred estimates of the behavioral equations and the identities. The ordering of the equations in the presentation of Appendix IV corresponds to the one which was used for model simulations through iterations, and is different from the one followed in chapters II and III.

this period. This set of 30 includes all the important endogenous variables, the remaining ones being (i) the linkage variables,^{1/} (ii) the intermediate variables determining output, e.g., acreage, capital stock, etc., and (iii) the credit allocation variables resulting from the various balance sheet identities of the monetary sector.

In examining the simulation results, it is useful to focus on two distinct aspects of the model solution. First, there is the goodness of fit criterion, and second, there is the question of whether the model captures turning points.

(i) Goodness of Fit

The broad picture of the "goodness of fit" of the model can be obtained by analysing the average percentage error (percentage deviation of the actual from the solution value) over the sample period for the selected endogenous variables for both the static and the dynamic solutions.

Table XX presents the mean absolute percentage error as well as the root mean square percentage error for the selected variables. While the former measure assigns equal weights to all errors, the latter measure assigns a proportionally higher weight to a large error than to a small

^{1/} These variables relate the crop year, fiscal year, and calendar year concepts through 'statistical association' type relationships.

error.^{1/}

Table XX shows that in capturing the actual movements in prices, absolute as well as relative, and in real outputs, the model solutions for the sample period perform very well, the percentage errors of both kinds being less than 10 per cent in all cases. In view of our earlier comments (page 143, para. 2.), we shall discuss the results of the static solution in detail, and make comparative remarks on the results of the dynamic solution. The performance of the static solution is relatively better than that of the dynamic solution. Almost 60 per cent of the price and output variables have mean absolute percentage error between 0 and 5 per cent, while 50 per cent of them have root mean square percentage error between 0 and 5 per cent. The relative price of foodgrains and the marketed surplus function of foodgrains are two variables in this area where the errors are somewhat higher compared to the errors for the other price and output variables. The relative price of foodgrains has a mean absolute percentage error of 9.5 per cent and a root mean square percentage error of 10.7 per cent. The corresponding errors for the

^{1/} Note that the root mean square percentage error must always be greater than or equal to the mean absolute percentage error for the endogenous variables.

marketed surplus of foodgrains are 9.2 per cent and 12.5 per cent respectively. In the dynamic solution, the errors for these variables are a little higher. The relatively less good fit for the marketed surplus of foodgrains and the relative price of foodgrains is not surprising in view of the data problems and the specification reservations that we encountered and referred to in chapters II and III for these two equations.

In contrast with the good performance of the model for the real variables, the performance of the model for the government deficit and the change in monetary base variables is weak. (See Table XX). Since government deficit is the difference between government expenditures and government revenues, both of which are endogenous, the errors in two different directions apparently compound the error on the deficit variable. The change in monetary base variable being a function of the government deficit variable partially reflects the same error.

Investment functions of the private corporate sector and the unorganised private sector (the household sector) also display relatively high errors in the sample period solutions, although the errors are lower in the dynamic solution than in the static solution in both cases. These results are not really surprising given the enormous

difficulty in specifying a theoretically defensible and empirically robust investment function.

Tables XXIa and XXIb present the information of Table XX in the form of Frequency Distributions to facilitate a summary feel for the 'fit' of the model to the actual experience of the Indian economy over the sample period. In Table XXIa (relating to the static solution), the variables with mean absolute percentage error less than or equal to 10 per cent constitute 90 per cent of the total number of variables, while those with root mean square percentage error of less than or equal to 10 per cent constitute 80 per cent of the total. In Table XXIb (relating to the dynamic solution), the corresponding figures are 77 per cent and 70 per cent respectively.

(ii) Turning Points

The analysis of average error for each endogenous variable can be supplemented by a graphical presentation of the actual values of the variable against its solution values (both static and dynamic) over the sample period. This permits us to focus on the performance of the model during turning points. Of the 30 endogenous variables in Table I, we present charts for a selected subgroup--the relative price and output variables, and some others for

Table XX.
Errors in Endogenous Variables

Variable	Static Solution		Dynamic Solution	
	Mean Absolute Percentage Error	Root Mean Square Percentage Error	Mean Absolute Percentage Error	Root Mean Square Percentage Error
1. Y'	1.5	2.1	2.8	3.1
2. Y'_a	2.6	3.8	2.6	3.8
3. S_f	9.2	12.5	10.5	16.7
4. $P_f/P_m \frac{1}{m}$	9.5	10.7	10.0	11.8
5. $P_c/P_m \frac{1}{m}$	4.3	5.3	5.7	6.3
6. P_a/P_n	4.7	6.1	6.4	7.6
7. Y'_m	3.0	3.4	8.3	9.2
8. I^{pc}	23.7	27.5	19.6	24.1
9. I^{hh}	16.0	19.1	13.7	16.7
10. U	2.0	2.7	2.3	2.9
11. w_m	3.8	5.0	34.9	39.6
12. M'_k	9.3	12.4	10.7	12.9
13. M'_o	7.8	9.8	8.2	9.8
14. DF^g	17.5	27.3	14.9	24.0
15. DMB	51.3	90.6	45.1	84.2
16. L	2.5	3.3	3.5	5.4
17. P	3.8	4.4	4.5	6.1
18. P_f	8.2	9.6	8.9	12.1
19. P_c	6.9	9.1	8.1	11.7
20. P_m	4.7	6.1	7.6	10.2

Table XX, continued
Errors in Endogenous Variables

Variable	Static Solution		Dynamic Solution	
	Mean Absolute Percentage Error	Root Mean Square Percentage Error	Mean Absolute Percentage Error	Root Mean Square Percentage Error
21. P_a	5.8	6.7	5.7	8.2
22. P_n	3.2	3.8	6.0	6.8
23. P_I^P	3.0	3.7	3.8	5.8
24. P_I^g	3.7	4.5	5.7	7.1
25. MB	2.3	3.1	4.1	4.9
26. L^i	3.1	4.0	3.6	4.7
27. I^i	7.1	9.1	8.8	10.7
28. T_g	5.8	8.2	4.8	6.6
29. O_f^I	3.5	4.4	3.6	4.4
30. O_c^I	3.7	4.8	3.9	5.0

1/ Fiscal year average.

Table XXI a.

Frequency Distribution of Errors
Static Solution

<u>Error Range/Frequency</u> <u>(%)</u>	<u>Mean Absolute</u> <u>Percentage Error</u>	<u>Root Mean Square</u> <u>Percentage Error</u>
0 - 5	17	14
5.1 - 10	9	9
10.1 - 15	0	3
15.1 - 20	2	1
20.1 and above	2	3

Table XXI b.

Frequency Distribution of Errors
Dynamic Solution

<u>Error Range/Frequency</u> <u>(%)</u>	<u>Mean Absolute</u> <u>Percentage Error</u>	<u>Root Mean Square</u> <u>Percentage Error</u>
0 - 5	11	8
5.1 - 10	12	12
10.1 - 15	4	5
15.1 - 20	1	1
20.1 and above	2	4

which cyclical pattern is observed. These charts, i.e., charts IX to XXVIII, largely speak for themselves. We shall make brief comments on points of special interest with respect to these charts.

The pattern of movement of real agricultural income over the sample period has been dominantly cyclical. The static solution values trace this pattern almost exactly as shown in chart X. The dynamic solution also performed well, with two exceptions: (i) The model fails to capture the trough in agricultural income of 1966-67, and (ii) it highly overestimates real agricultural income in 1955-1956 and 1956-1957.

Marketed surplus of foodgrains also has a marked cyclical pattern over the sample period. While capturing the major swings in the marketed surplus, the model solutions display a fluctuating pattern compared to relatively steady increases or declines in the actual marketed surplus of foodgrains (chart XI).

The relative price of foodgrains and manufactured goods is another variable which moved cyclically around a rising trend over the sample period. The static solution captures both the major peaks over this period, while the dynamic solution misses the one in 1967-1968 (chart XII). The solutions' ability to predict troughs is relatively

weak, the static solution performing slightly better in this respect. However, the main failure of the model here lies in its inability to predict the decline in this relative price in 1970-1971. This failure is also reflected in chart VI which depicts the terms of trade between agriculture and non-agriculture and its solution values for the sample period.

The performance of the model in respect of tracing movements in the relative price of commercial crops and manufactured goods is somewhat weak (chart XIII). The model solutions display a relatively steady path, not reflecting the actual cyclical movements, albeit smaller than the swings in the marketed surplus and the relative price of foodgrains, in this price.

The behavior of investment in private corporate sector has also been highly volatile over the sample period. Chart XIV shows the actual and solution values of this variable. Although the troughs are captured in all but one cases, the peaks are by and large missed by the solution values. It is worth noting that the dynamic solution performs relatively better than the static solution.

Capacity utilisation in manufacturing and its solution values are shown in chart XVIII. The static solution traces the actual movements in capacity utilisation very closely, predicting all peaks and troughs except a very early trough

in 1953-54. The dynamic solution, on the other hand, begins to diverge in 1956-57 and deteriorates in its ability to trace the movements in capacity utilisation in manufacturing after that.

In the case of money wage rate (chart XIX), the static solution by and large traces the pattern of movements of this variable, but the dynamic solution systematically overpredicts it. An obverse of this pattern can be seen in the dynamic solution path for value added in manufacturing (chart XV) where this solution consistently underpredicts the actual value added, while the static solution follows the actual path almost exactly.

Imports of capital goods have undergone large increases and declines over the sample period. The model solutions capture these large swings with marked precision (chart XX). Movements in imports of intermediate goods around an increasing trend, however, are not as well traced by the model solutions (chart XXI). While all the troughs are predicted correctly, all peaks but one are missed by the model.

Chart XXII depicts the government fiscal deficit and its solution values for the sample period. It is interesting to note that any flattening of the government fiscal deficit variable is approximated by dips in the solution path. This probably reflects the lack of symmetry in the response of the endogenous components of government deficit to upward and

CHART IX REAL INCOME

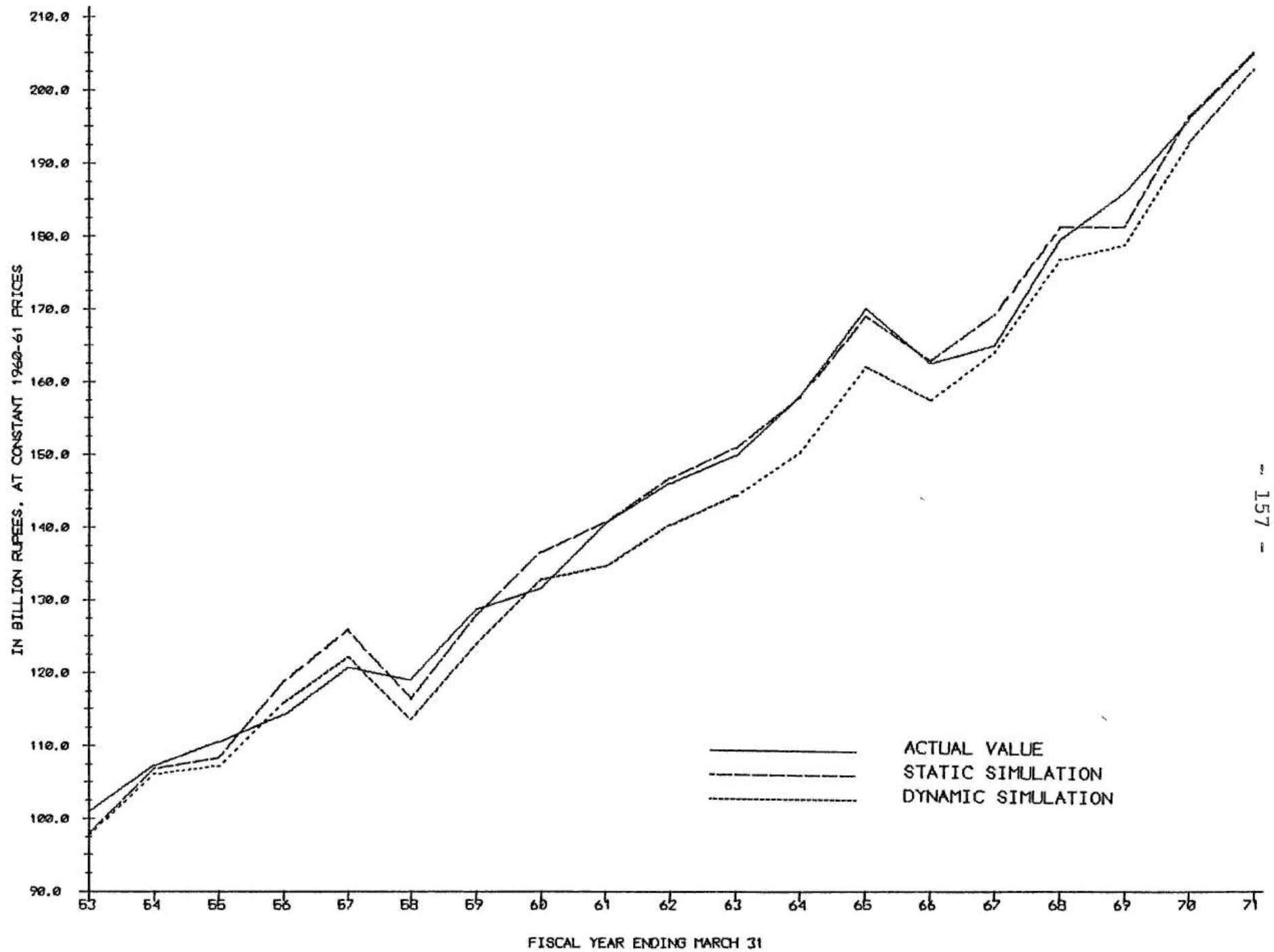


CHART X REAL AGRICULTURAL INCOME

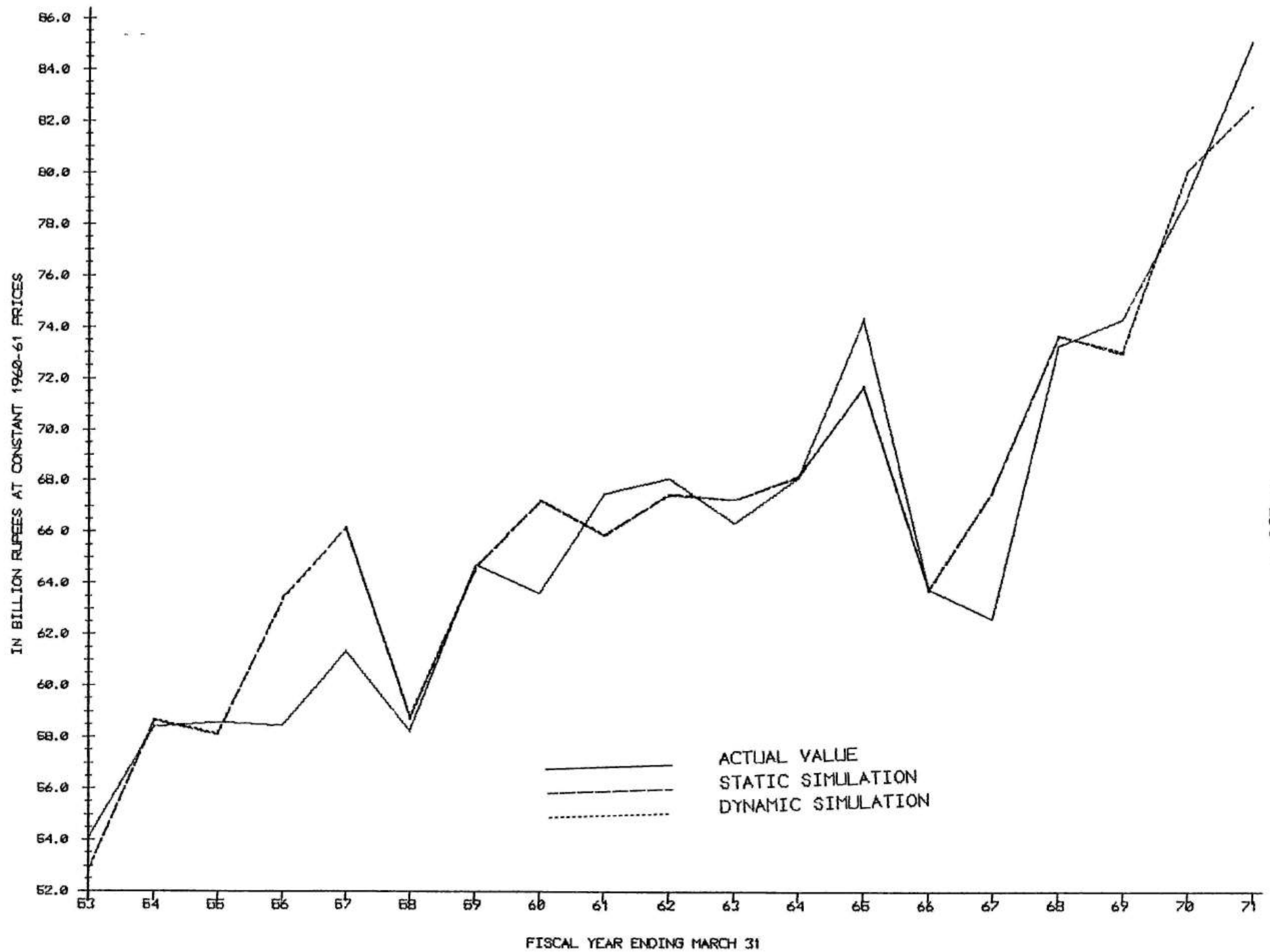


CHART XI MARKETED SURPLUS OF FOODGRAINS

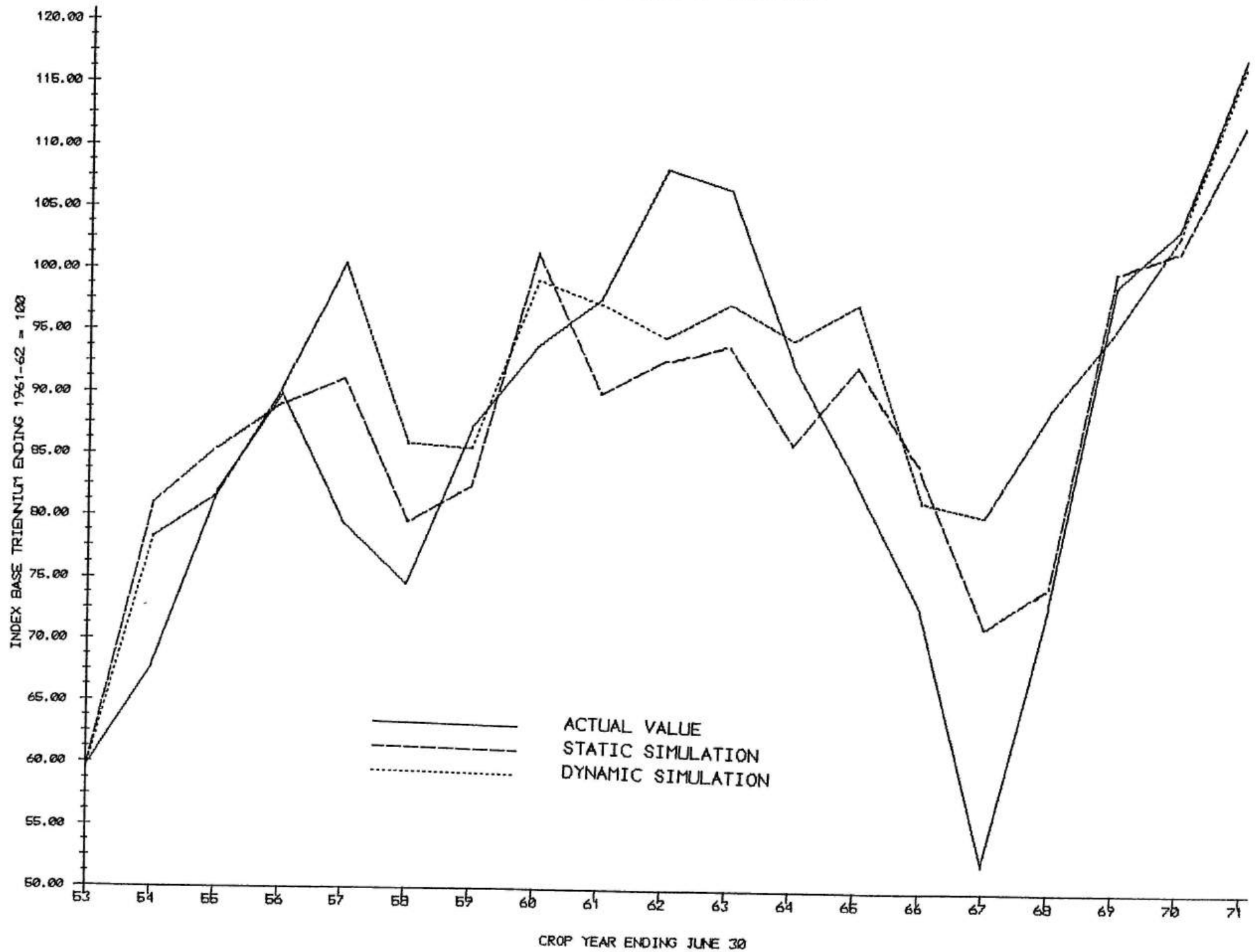


CHART XII RELATIVE PRICE OF FOODGRAINS & MFG GOODS

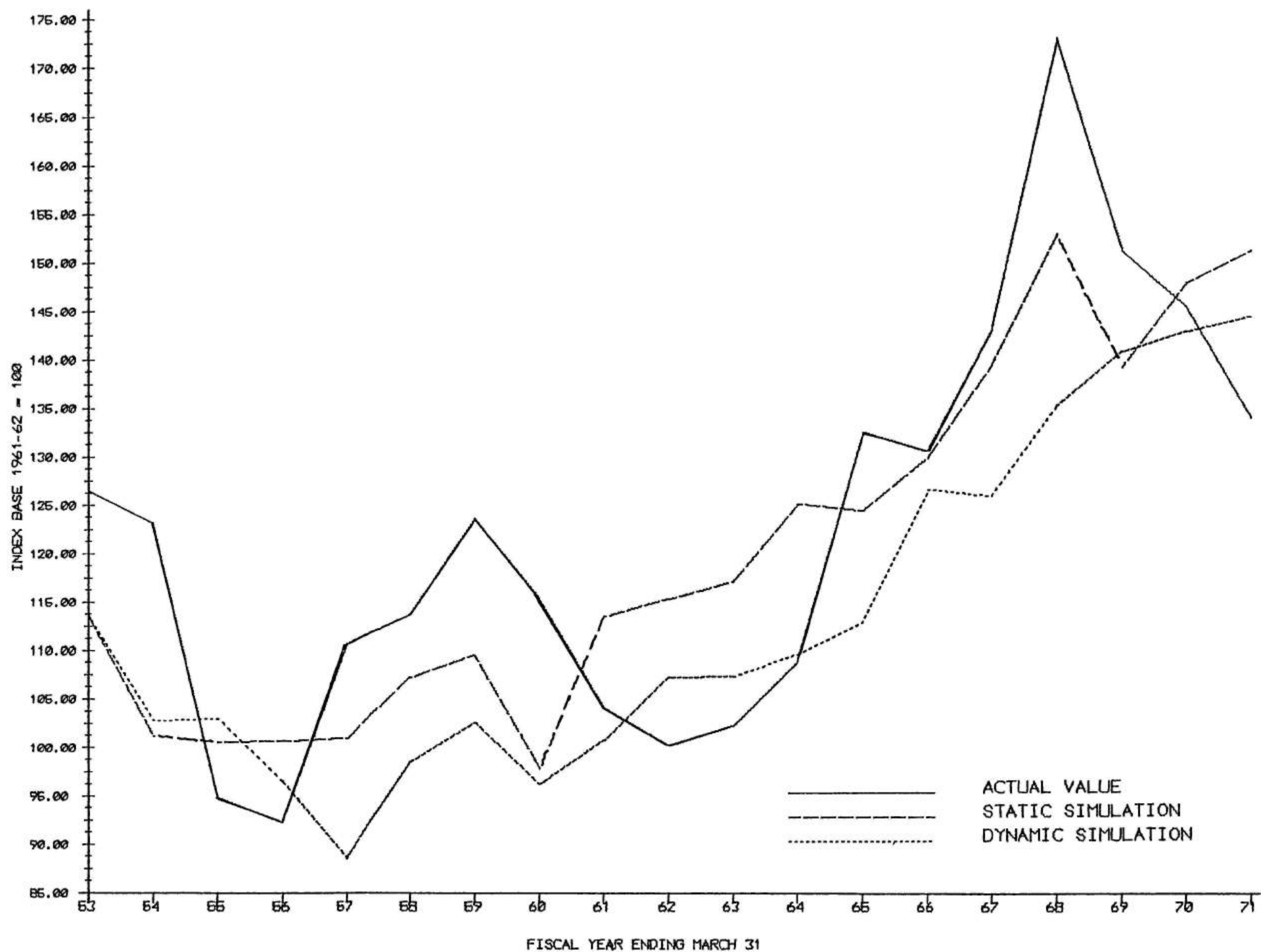


CHART XIII RELATIVE PRICE OF COMMERCIAL CROPS & MFG GOODS

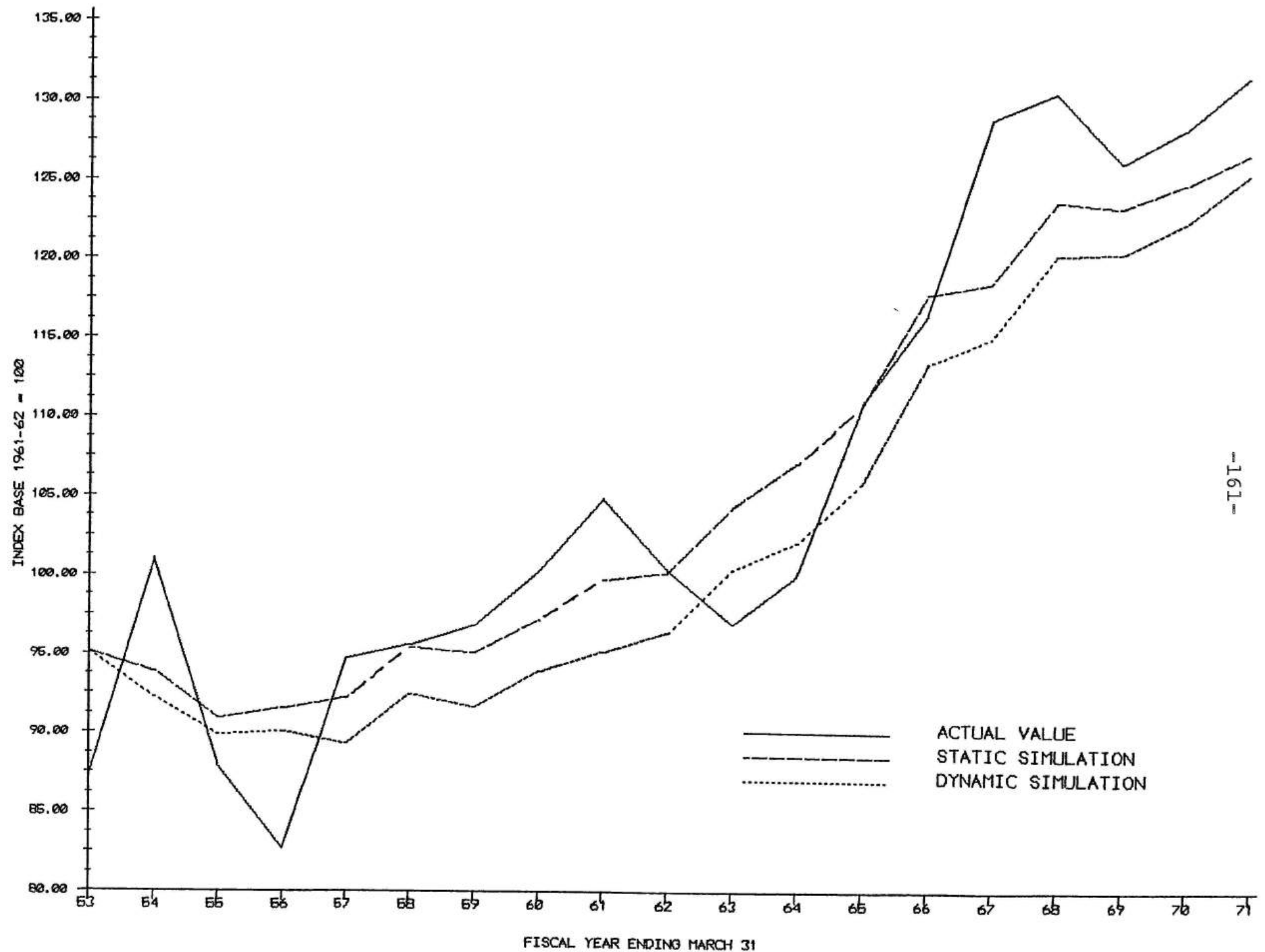


CHART XIV TERMS OF TRADE BETWEEN AGRICULTURE & NON-AGRICULTURE

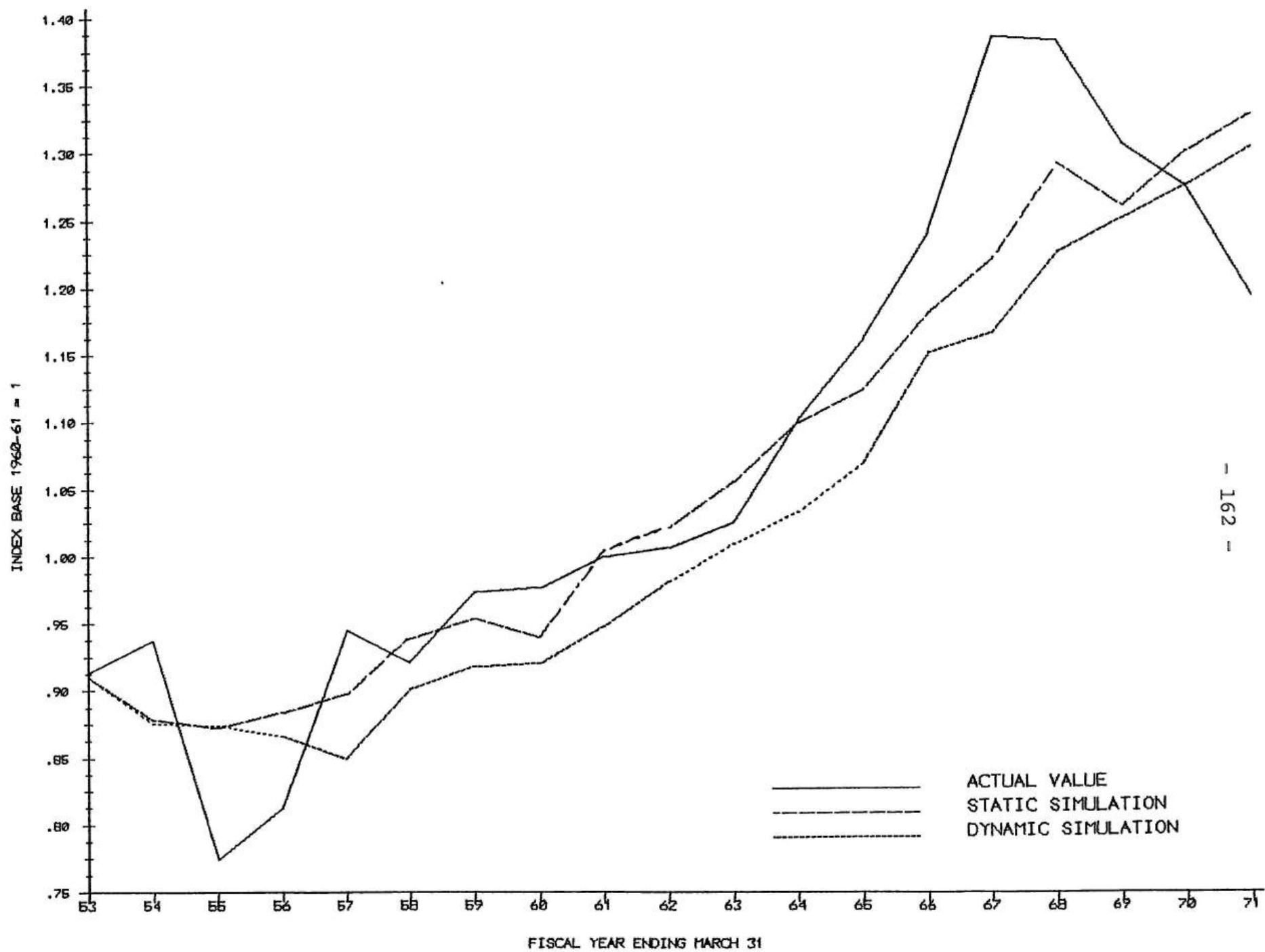


CHART XV REAL VALUE ADDED IN MANUFACTURING

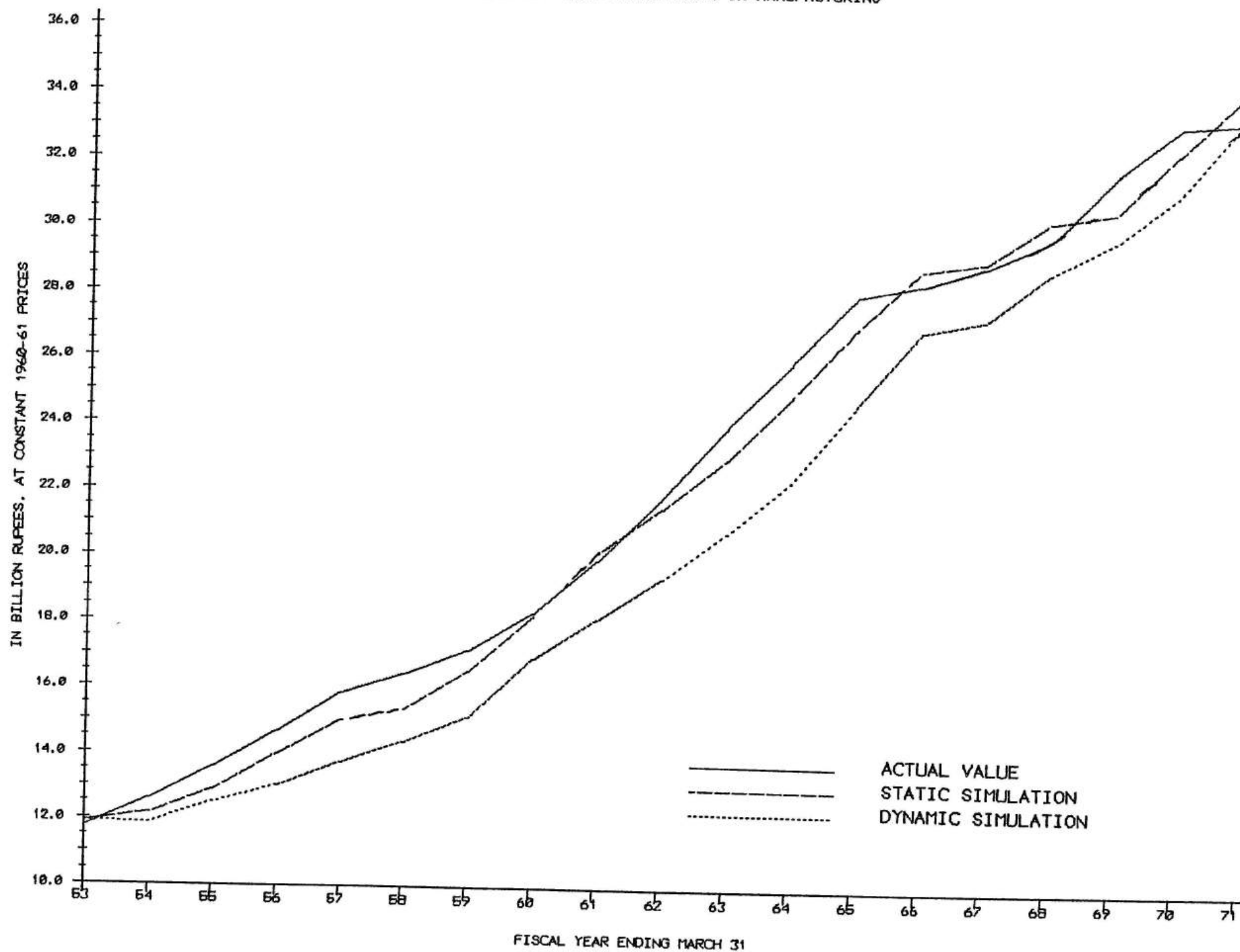


CHART XVI REAL INVESTMENT BY PRIVATE CORPORATE SECTOR

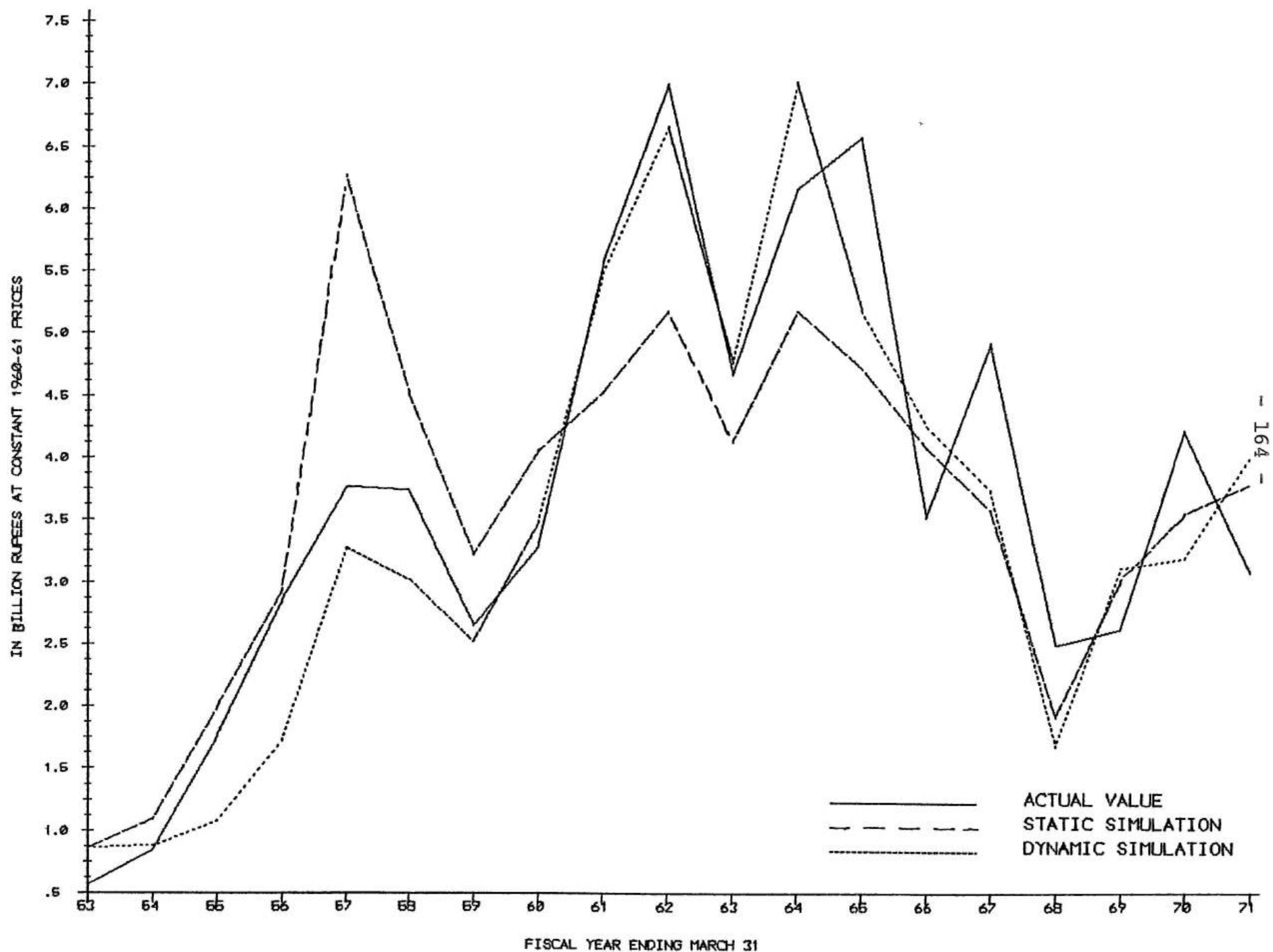


CHART XVII REAL INVESTMENT BY PRIVATE NONCORPORATE SECTOR

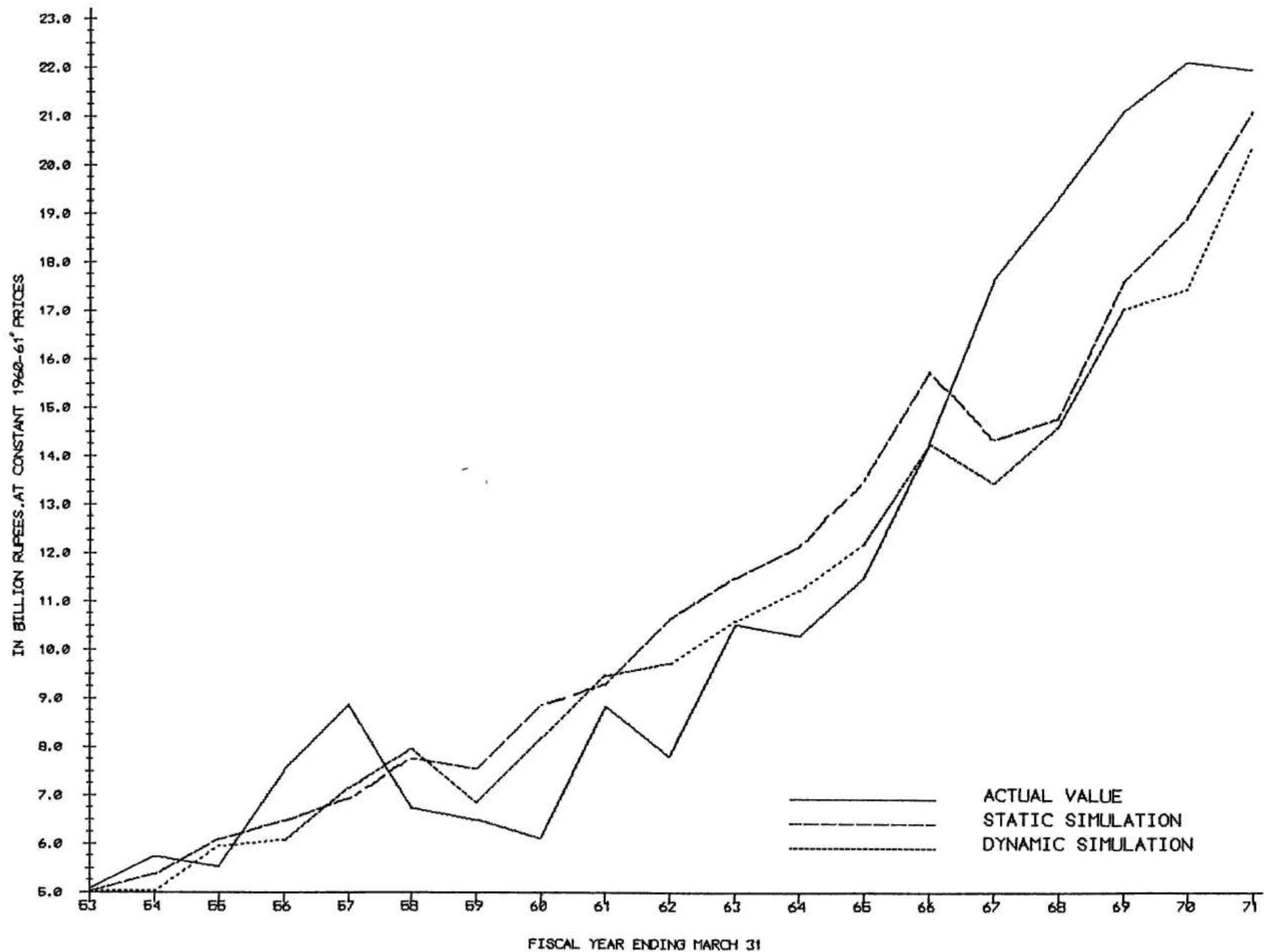


CHART XVIII CAPACITY UTILISATION IN MANUFACTURING

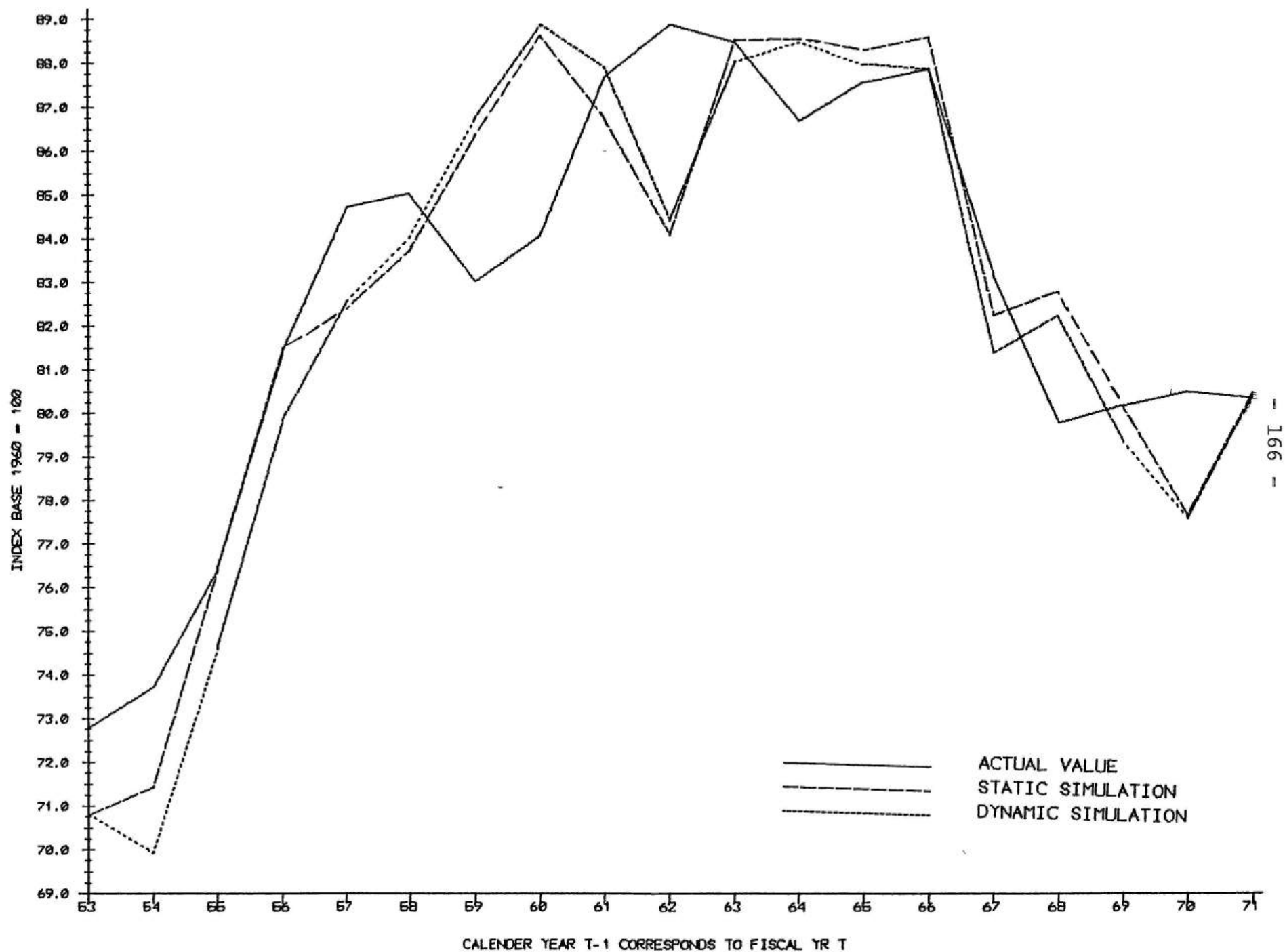


CHART XIX MONEY WAGE RATE

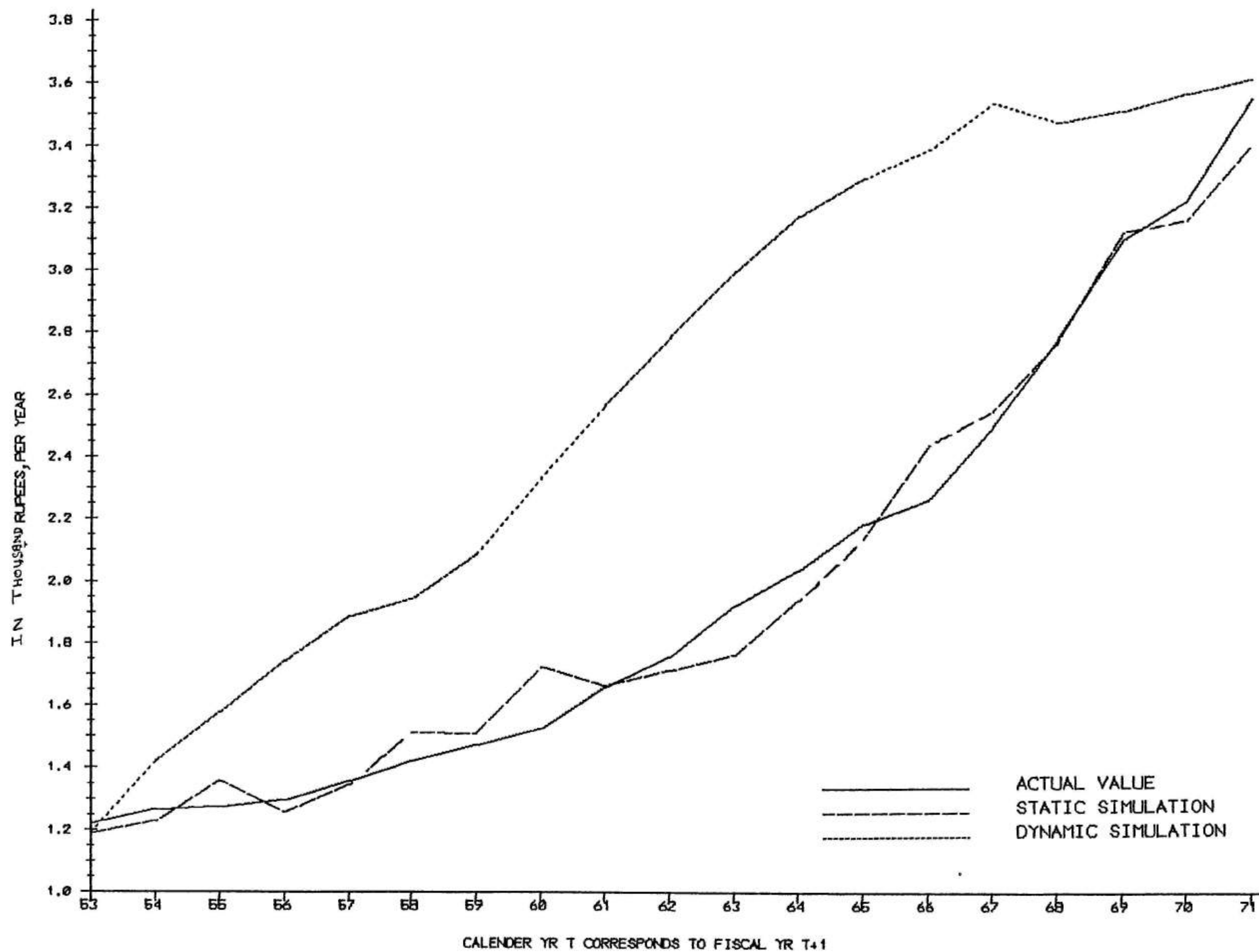


CHART XX REAL IMPORTS OF CAPITAL GOODS

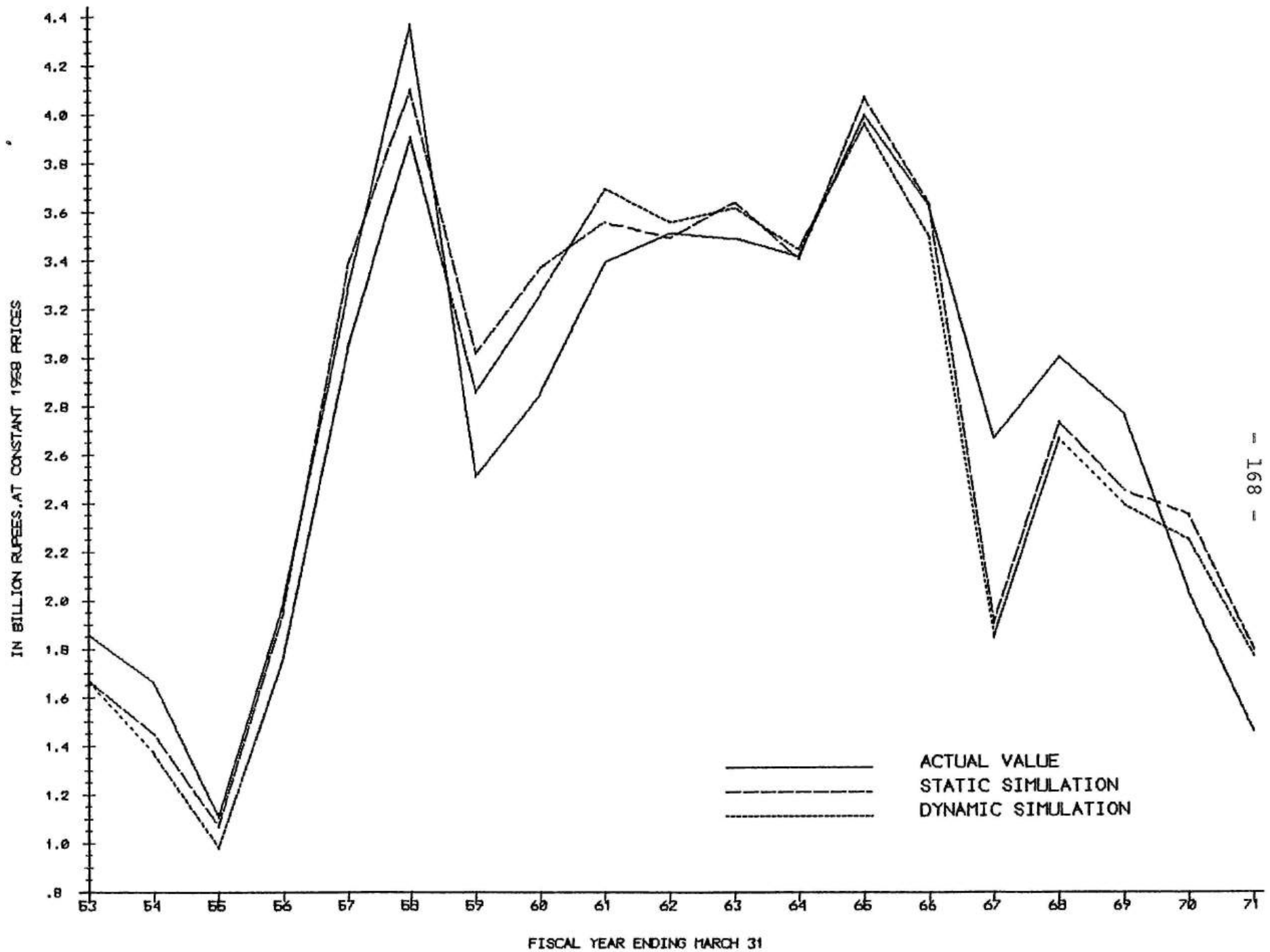


CHART XXI REAL IMPORTS OF INTERMEDIATE GOODS

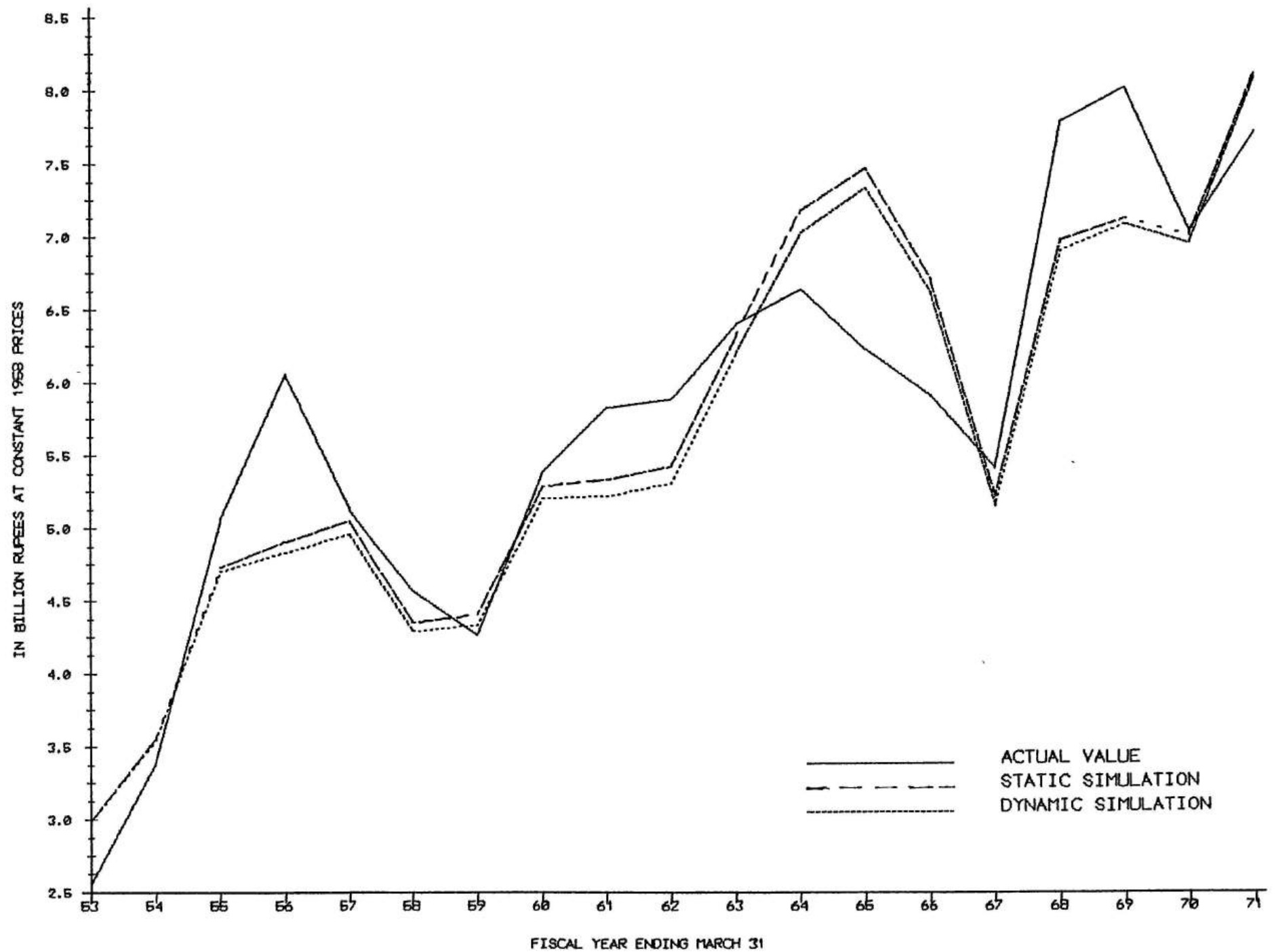


CHART XXII GOVERNMENT FISCAL DEFICIT

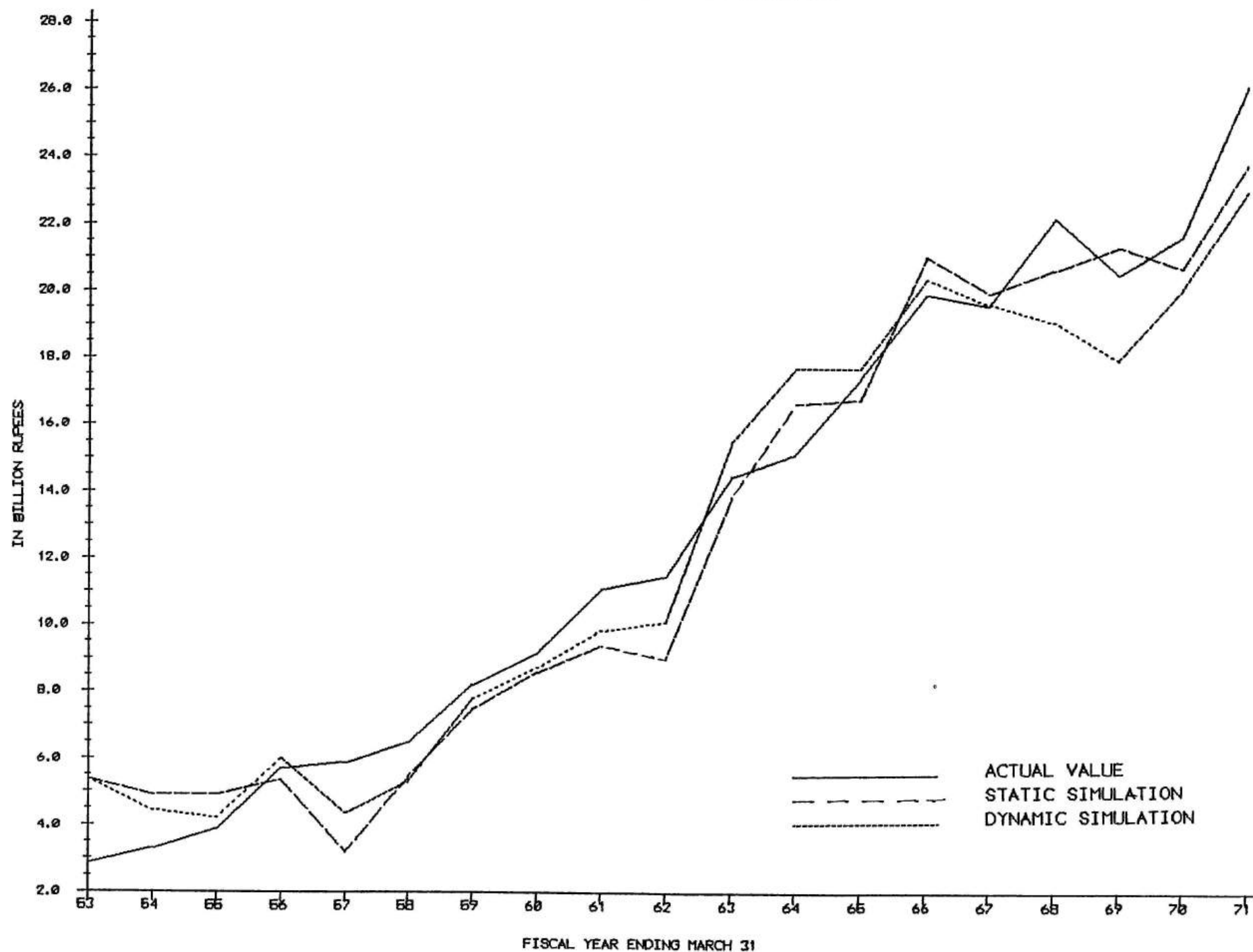


CHART XXIII CHANGE IN MONETARY BASE

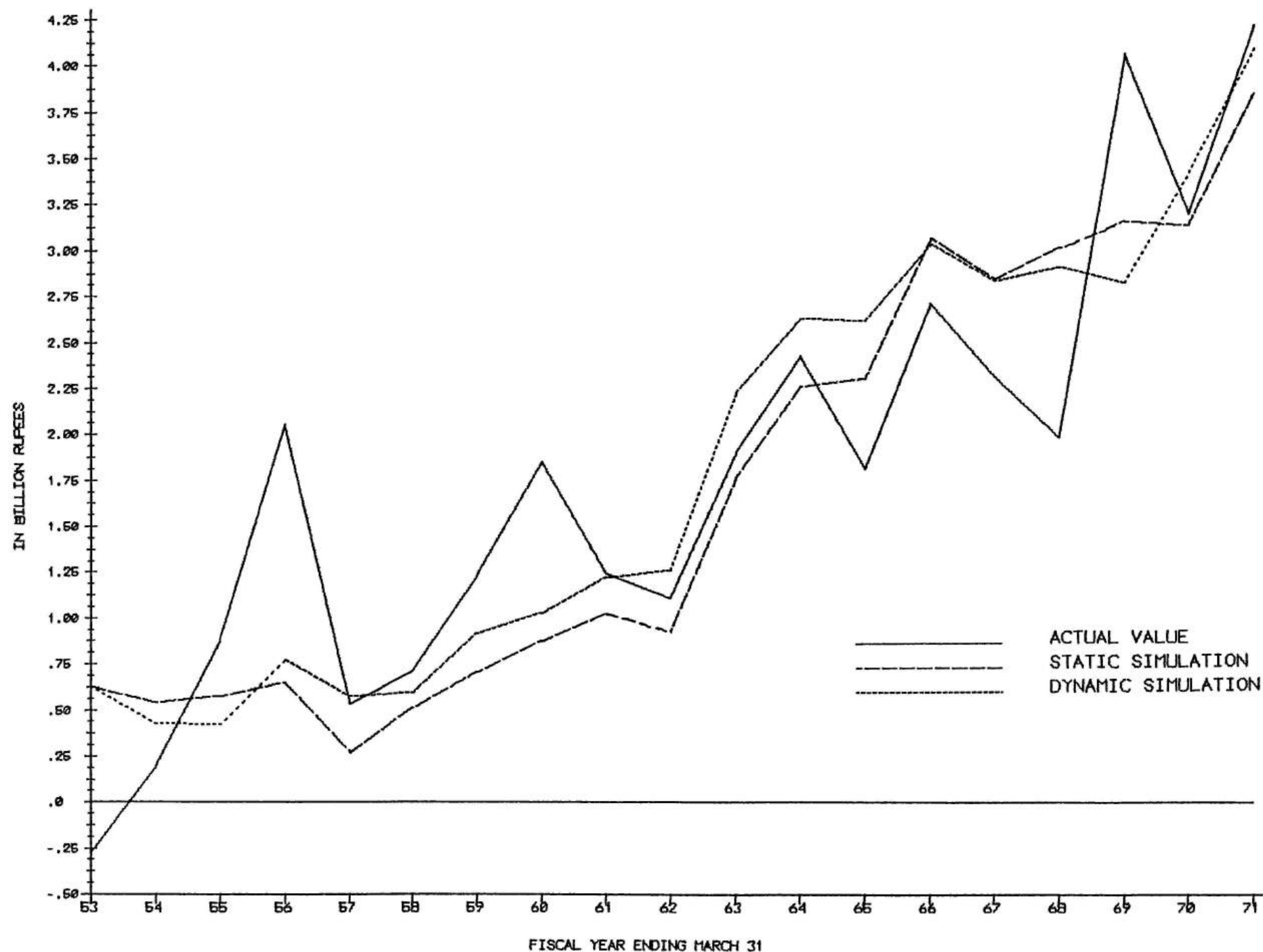


CHART XXIV MONEY SUPPLY

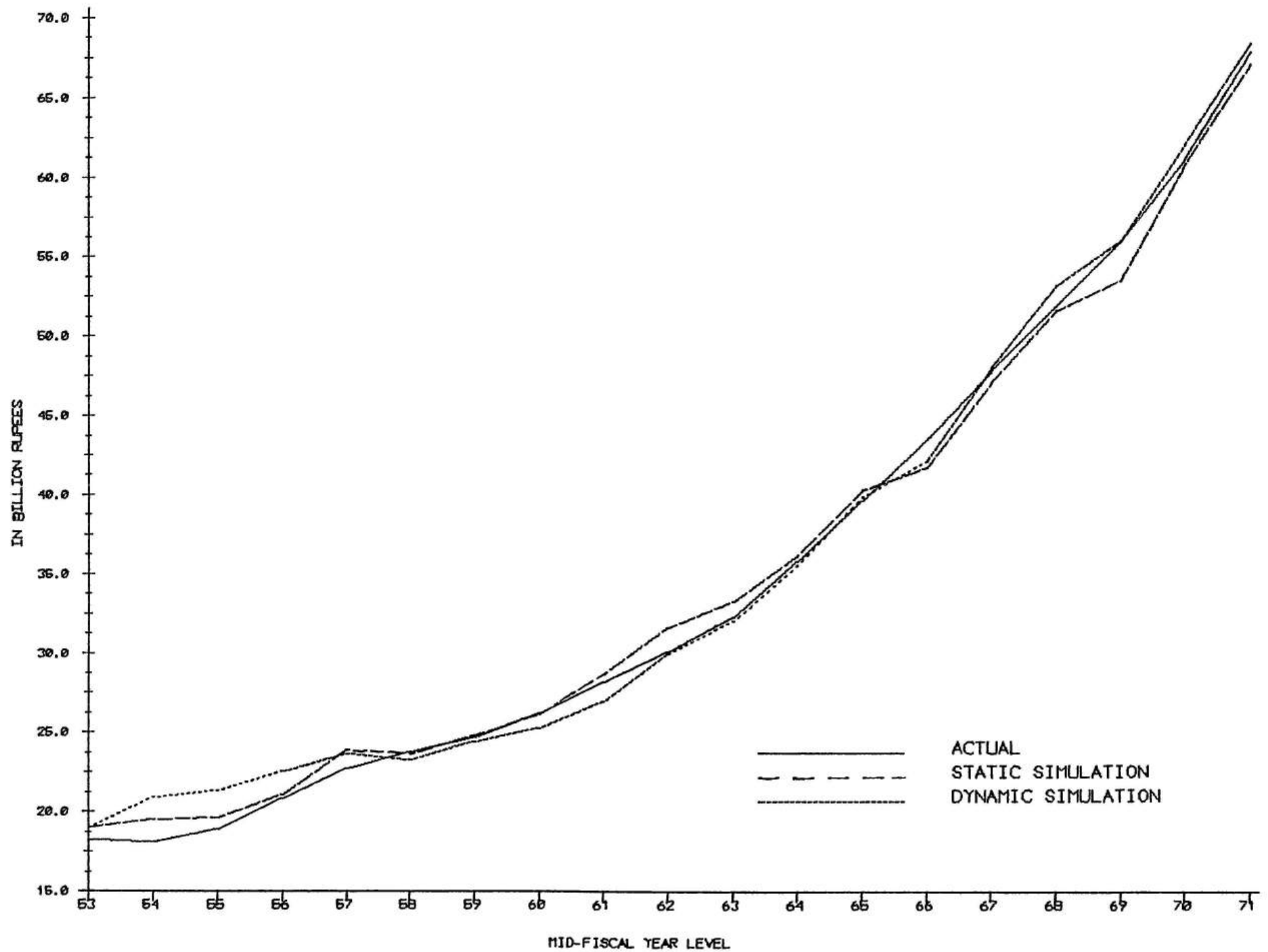


CHART XXV IMPLICIT PRICE DEFLATOR FOR GDP

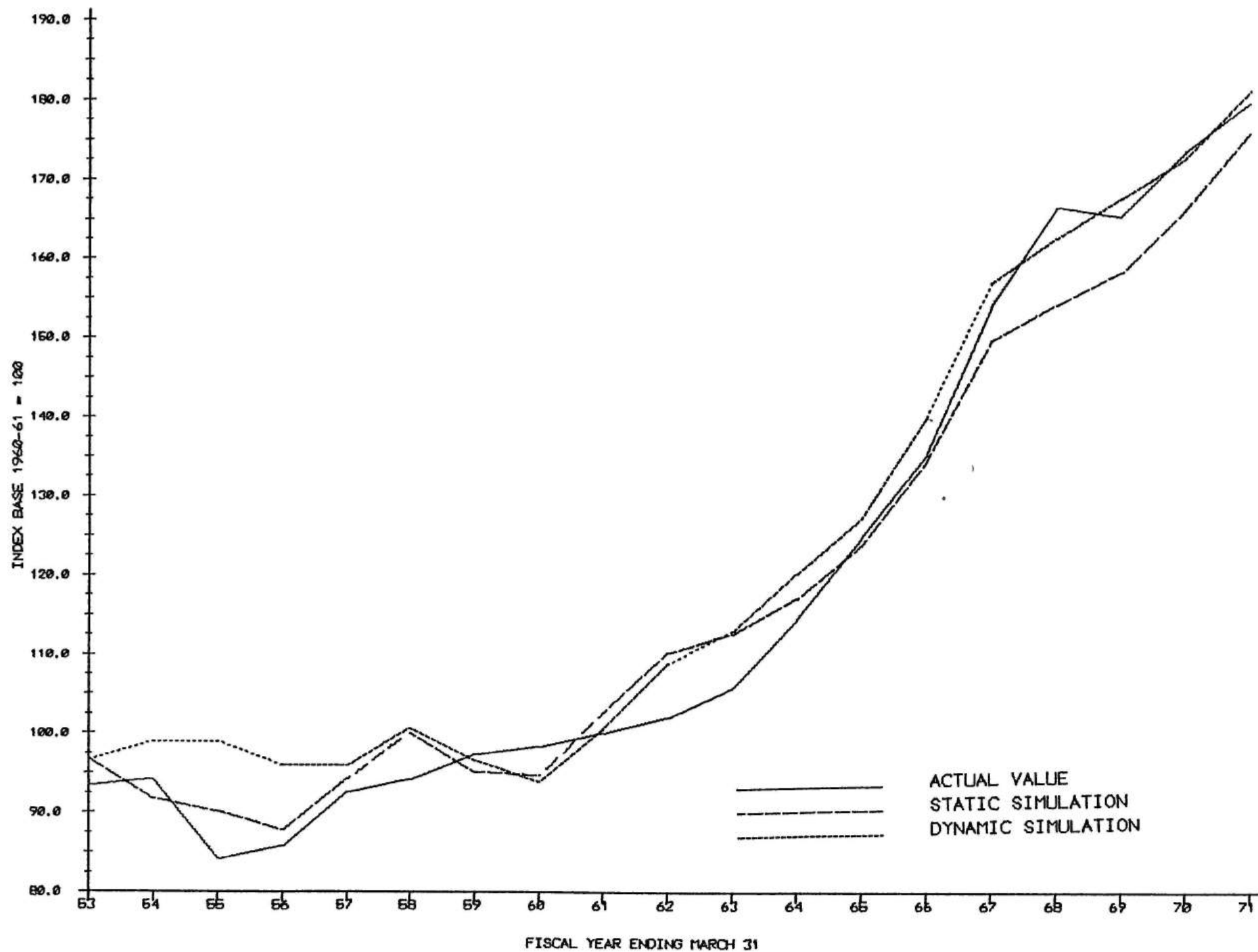


CHART XXVI ABSOLUTE PRICE OF FOODGRAINS

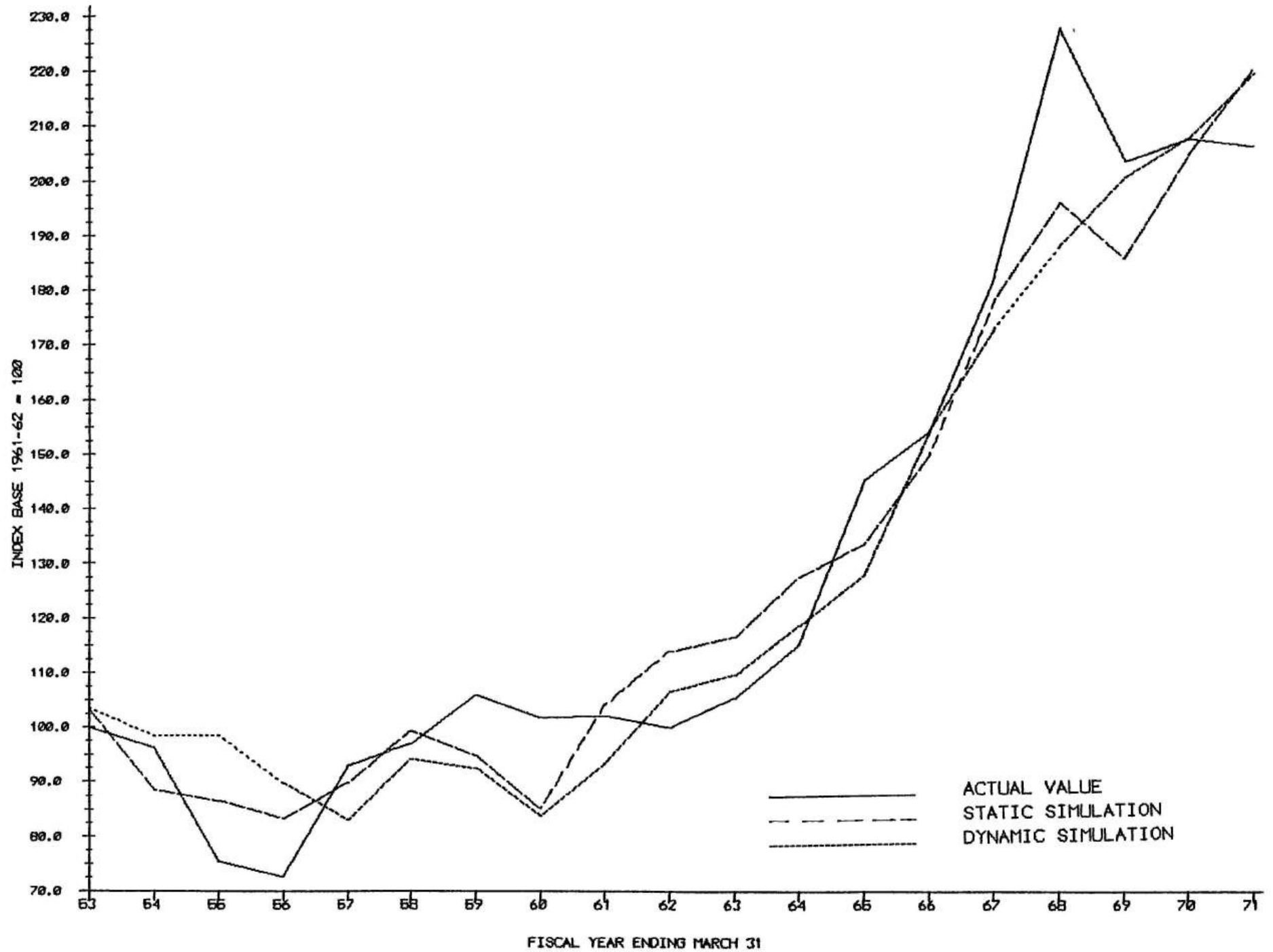


CHART XXVII ABSOLUTE PRICE OF COMMERCIAL CROPS

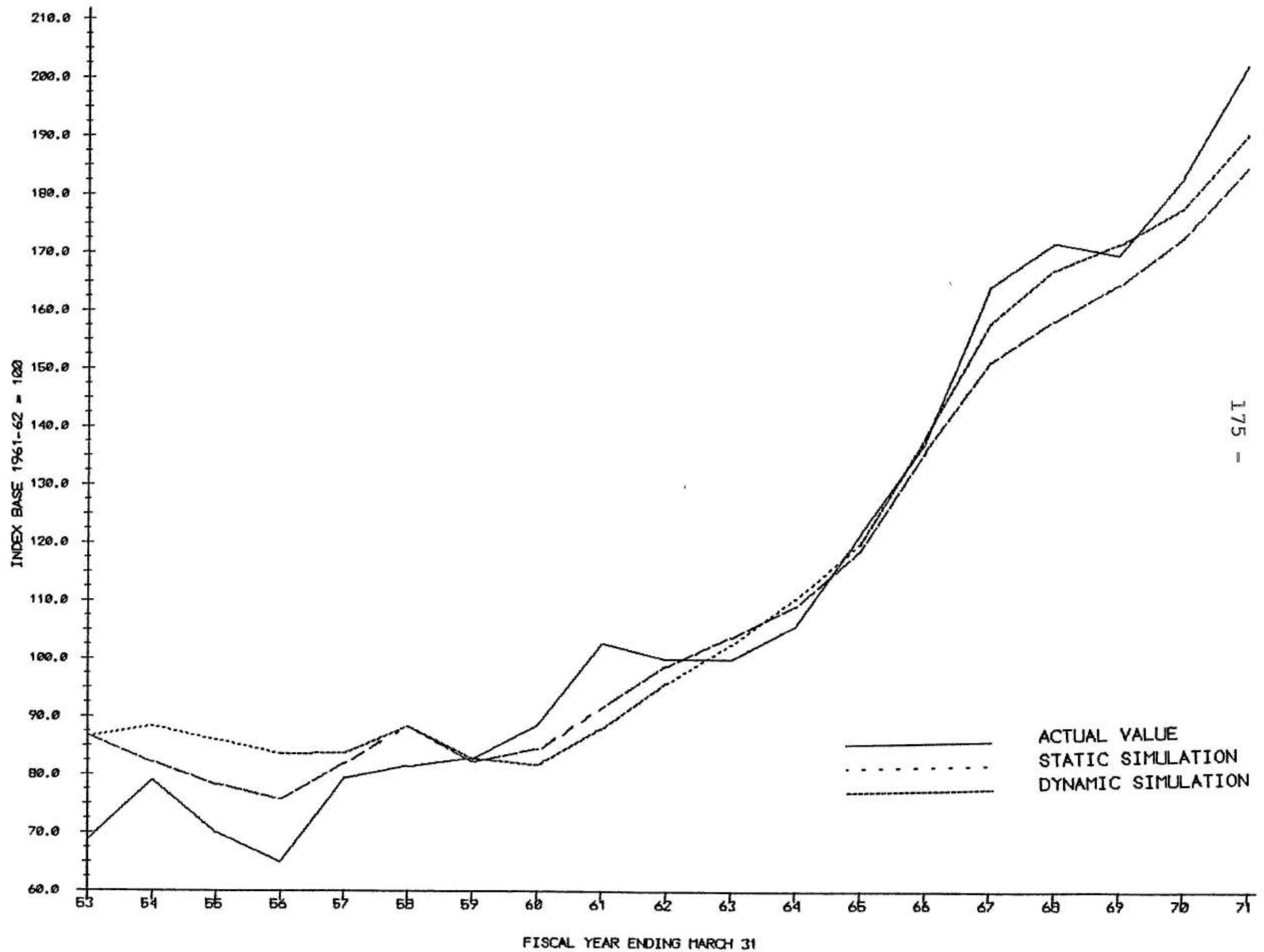
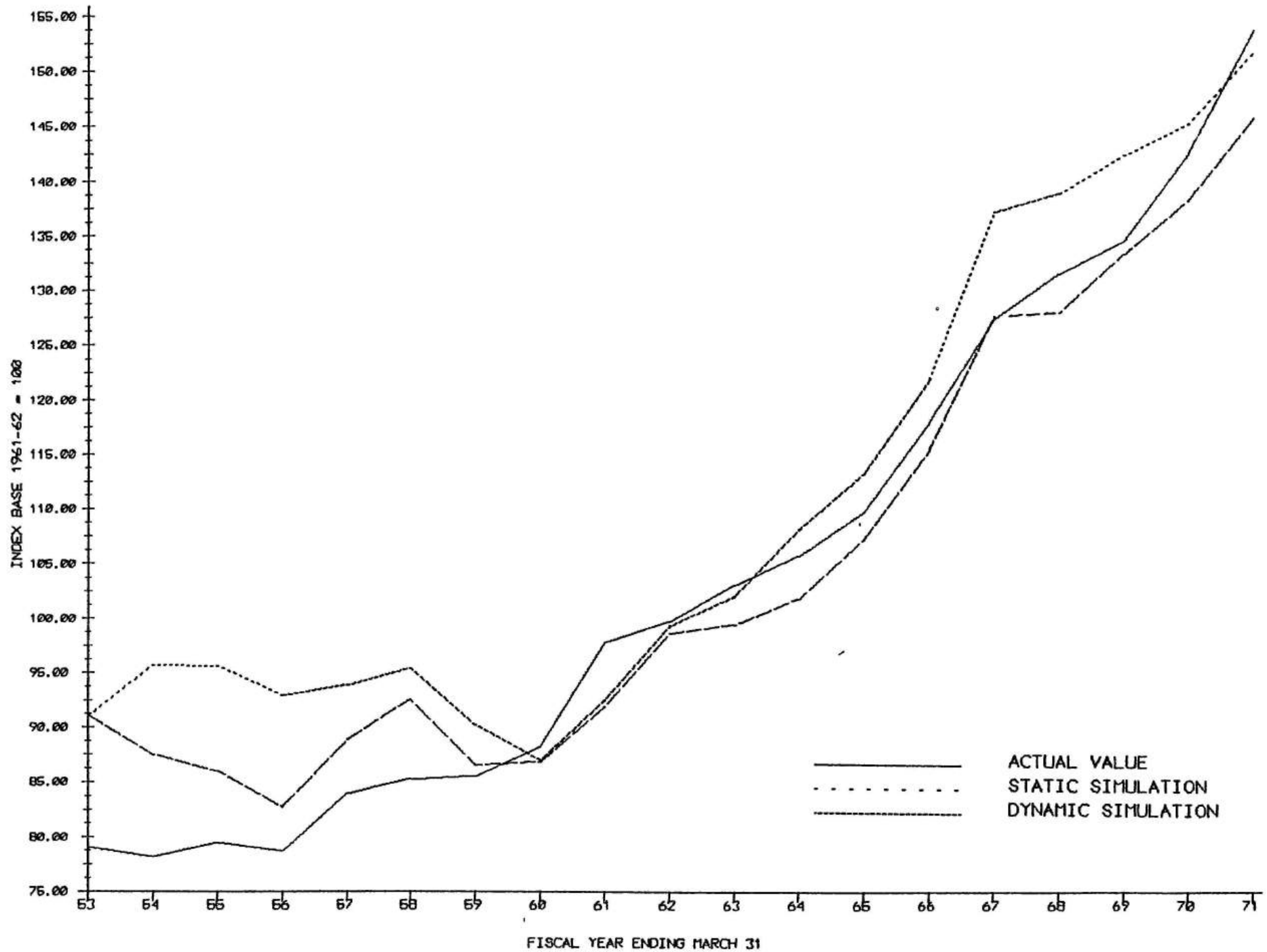


CHART XXVIII ABSOLUTE PRICE OF MANUFACTURED GOODS



downward changes in the exogenous variables.

Chart XXIII depicting the change in monetary base variable and its solution values shows relatively better performance of the model in the second half of the sample period than in the first. However, while the troughs are being captured well in the earlier period, in the later period the solutions fail to capture the intensity of the downward movements in the change in monetary base.

Charts XXIV to XXVIII relate to money supply and certain absolute prices, and do not call for any special remarks.

Section III. Analysis of Multiplier Effects

In this section we analyse the impact of specified changes in certain exogenous variables on the endogenous variables of the system. Since the model is nonlinear, the level of the exogenous variable at which a change is introduced is important, as the "multiplier effect" on an endogenous variable depends on the initial value of the exogenous variable, and its relation to the initial values of the other exogenous variables. Our choice of the points at which specified changes are introduced is governed by our interest in specific counterfactual simulations.

The following changes are introduced in the model, one

CHART XXIX OUTPUT OF FOODGRAINS

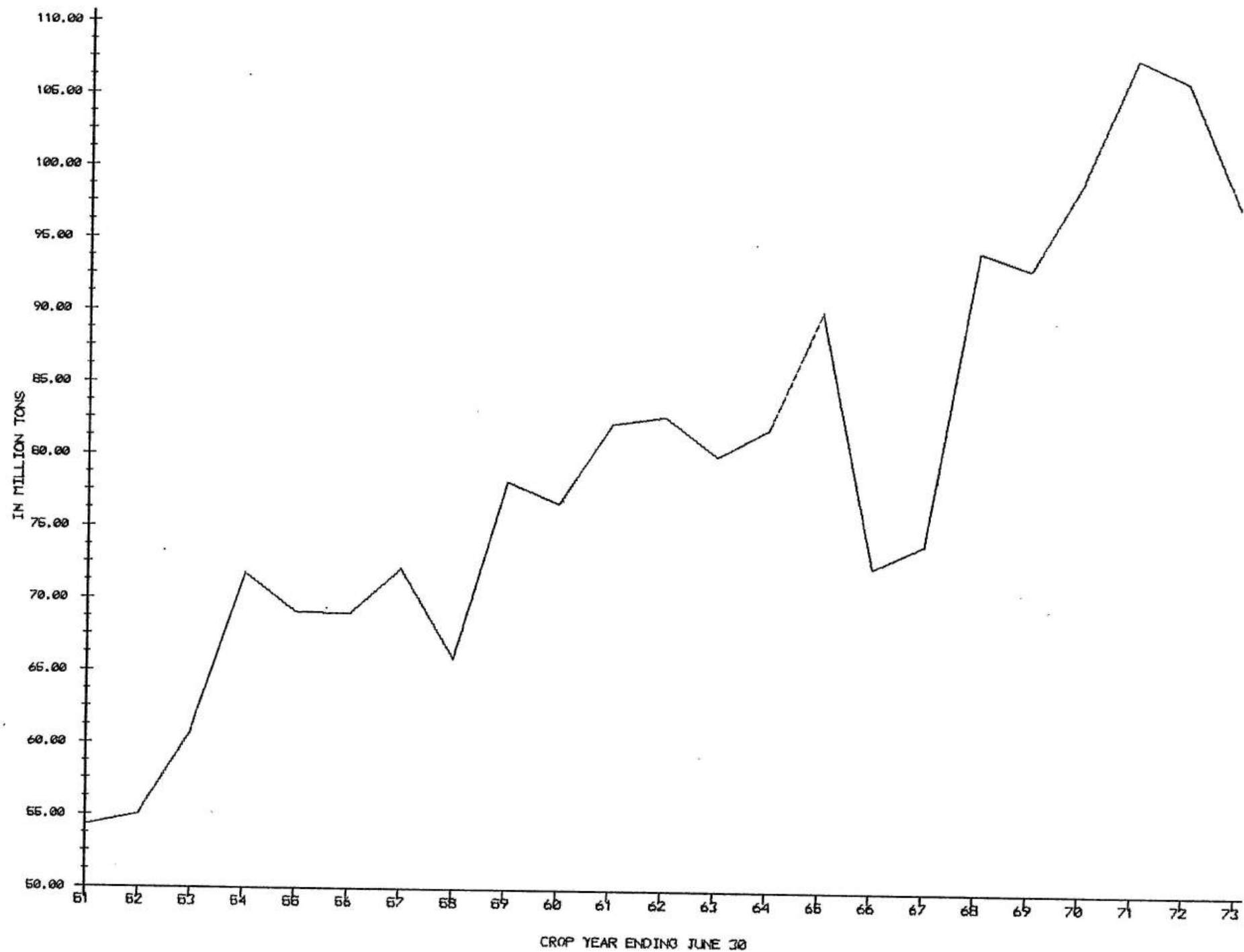
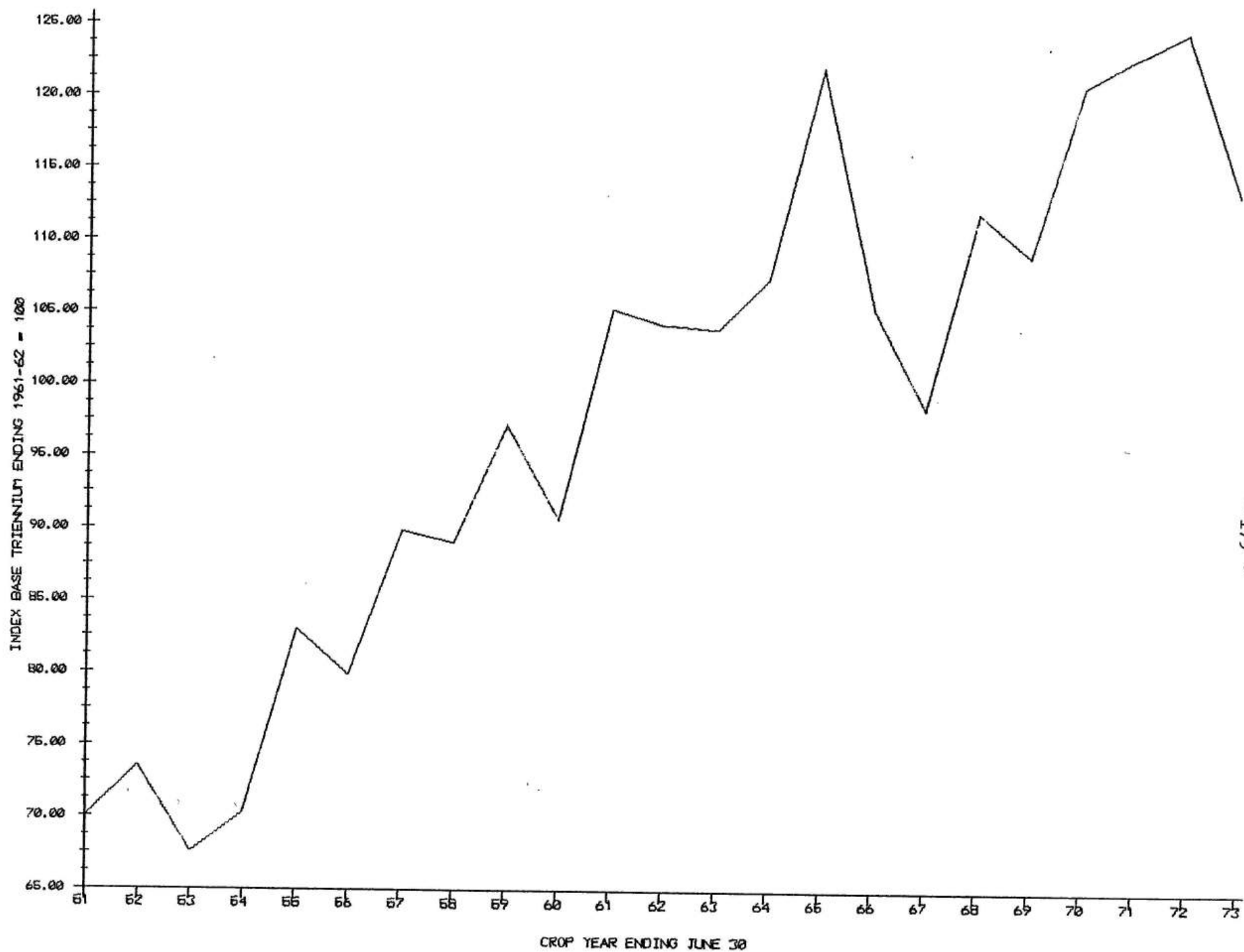


CHART XXX OUTPUT INDEX OF COMMERCIAL CROPS



at a time, and their multiplier effects are studied by comparing the dynamic solution incorporating the change with the dynamic solution without the change. (a) The agricultural outputs of foodgrains and commercial crops are specified at certain non-drought levels in 1965-66 and 1966-67. (b) Government investment is assumed to increase (instead of the actual decline) in 1966-67. (c) Imports of foodgrains are assumed to be nil during the period 1961-62 to 1967-68. (d) In addition to assuming that imports of foodgrains are nil during the period 1961-62 to 1967-68, government current expenditures are assumed to be lower over the same period.

(a) No agricultural drought in 1965-66 and 1966-67

The intensity of the two successive agricultural droughts of 1965-66 and 1966-67 can be seen in charts XXIX and XXX. Coming on the heels of a peak agricultural output year, these droughts represented major declines in the outputs of foodgrains and commercial crops. While the output of foodgrains declined by 20 per cent in 1965-66 and increased only marginally by 2 per cent in 1966-67, the output of commercial crops declined by 14 per cent and 7 per cent in the two years respectively. In order to examine the impact of these droughts, we consider a counterfactual simulation in which the agricultural drought does not occur. This is obtained by assuming

that the outputs in the two drought years were equal to the actual outputs of foodgrains and commercial crops in the year 1963-64 which is a "normal" year preceding the peak agricultural output year of 1964-65.

We obtained dynamic simulations for the model for the period 1963-64 to 1970-71, with and without the agricultural droughts of 1965-66 and 1966-67. In both simulations, we assumed the output of foodgrains and commercial crops to be exogenous. The basic simulation used the actual values of these two variables for the entire period, while the multiplier simulation substituted the values for 1965-66 and 1966-67 as follows:

	O_f		O_c^I	
	Actual	Assumed	Actual	Assumed
1965-66	72.5	82	105.6	107
1966-67	74.1	82	98.4	107

To the extent that we need to regard outputs of foodgrains and commercial crops as exogenous for our purpose here, we are not allowing for the impact of lagged prices on these outputs as in our general version of the model.

The multiplier effects of 'no drought' solution on the endogenous variables of interest are obtained by calculating percentage differences between the values of the endogenous

variables in the multiplier solution and in the basic solution. These effects are summarised in Table XXII.

The first general point to note about the results reported in Table XXII is that the multiplier effect dampens with time. This behavior can be interpreted as indicative of local stability of the model in the particular region. A second interesting point that emerges from these results is that in some cases the endogenous variable in question overshoots in one direction, and then turns around to settle down to its new value.

The direction and magnitude of the multipliers brings to surface some of the linkages built into the model, and these are examined below.

We first discuss the multiplier effects of 'no drought' on agricultural income and prices. Real agricultural income (Y'_a) is affected only for the two years when the change in output occurs, there being no lagged effects on this variable. Marketed surplus of foodgrains (S_f) increases by 24 per cent in 1965-66 in response to the 'no drought' assumption under which foodgrain output is higher by 14 per cent and commercial crop output by 1 per cent. In the year 1966-67, the multiplier effect on the marketed surplus is higher, i.e., 36 per cent, representing the joint effect of 'no drought' in the two years. The positive multiplier effect on the

Table XXII

Multiplier Effects of No Drought in 1965-66 and 1966-67

(In per cent)

Endogenous Variable	1965-66	1966-67	1967-68	1968-69	1969-70	1970-71
Y_a'	10.8	10.8	--	--	--	--
S_f	23.8	35.6	10.2	-1.7	-1.2	-0.7
P_f/P_m	-9.9	-11.0	-4.0	2.6	1.6	1.0
P_a/P_n	-3.3	-4.0	-0.8	0.8	0.8	0.8
P_f	-10.3	-13.9	-8.7	-2.0	-2.0	-1.7
W_m	--	-5.2	-9.8	-9.6	-6.2	-3.8
Y_m'	-0.1	1.2	2.3	2.1	1.3	0.8
Y'	5.9	6.5	1.1	1.0	0.6	0.4
DF^g	-5.5	-8.9	-3.6	0.5	3.0	2.2
DMB	-7.2	-11.9	-5.1	-0.4	2.3	1.3
L	5.2	3.9	-2.5	-2.5	-2.1	-1.7
P	--	-1.8	-3.5	-3.4	-2.6	-2.0

marketed surplus continues in 1967-68, but the following three years witness a decline in marketed surplus, reflecting the overshooting phenomenon referred to earlier. The multiplier effects of 'no drought' on the relative price of foodgrains (P_f/P_m) are spread over time in a pattern similar to that of the marketed surplus of foodgrains, while the direction of the effect is the opposite. The terms of trade between agriculture and non-agriculture (P_a/P_n) also suffer a relative decline in the 'no drought' solution in the first three years, but then increase at a very small rate in the next three years. The multiplier effect of 'no drought' on the absolute price of foodgrains (P_f) is to depress the price continuously through 1971, while the effect decreases from 10 and 14 per cent in the first two years respectively to less than 2 per cent in the last year.

In the manufacturing sector, the multiplier effect of 'no drought' is felt on wages, employment, and output with a one year lag. By depressing the price of foodgrains, the 'no drought' solution leads to a decline in the money wage rate (W_m). The corresponding decline in the real wage rate and increase in employment lead to an increase in the output of the manufacturing sector (Y'_m). Once again, the effects are dampened through time.

The joint effect of the multiplier increase in agri-

cultural income in the first two years and manufacturing output in the following years is to increase real income in the economy in all the years, while the increase dampens through time. The importance of the agricultural sector for the economy as a whole can be seen from the total impact on real income in the economy. The direct impact of a 10.8 per cent increase in agricultural income in 1965-66 and 1966-67 on total real income is 5.9 per cent in 1965-66 and 6.5 per cent in 1966-67, but real income is higher by an average of over 1 per cent in the next two years, and of .5 per cent in the two years after that, reflecting the linkage with the non-agricultural sector.

The multiplier effect of 'no drought' on the government fiscal deficit (DF^g) is to depress this deficit, as tax revenue is relatively higher and government wages and salaries relatively lower. In the first year, i.e., 1965-66, the deficit is 5.5 per cent less. This is solely the result of the multiplier effect on government tax revenues. In the following two years, the lagged effect on government wages and salaries is also present and accounts for part of the multiplier effect on government deficit. The overshooting phenomenon is present here too, but the effects are dampened through time. The multiplier effect on the change in monetary base variable (DMB) follows a pattern similar to that of the

government deficit variable, the latter being the major determinant of the former.

Unlike the effects on government fiscal deficit and the change in monetary base, the multiplier effect of 'no drought' on money supply is to raise it in the first two years. This is the result of a decline in the currency-deposits ratio in the multiplier solution as agricultural income increases. The decline in the currency-deposits ratio offsets the effect on the money supply of the decline in the change in the monetary base. After two years, the latter effect catches up, and money supply is depressed, while the effect dampens through time.

Notwithstanding the multiplier increase in the money supply in the first two years, the aggregate price level is consistently depressed in the 'no drought' solution beginning with the second year. The increase in money demand offsets the increase in money supply in the first year and is relatively stronger in the second year to lead to a decline in the aggregate price level.

(b) Government investment higher in 1966-67

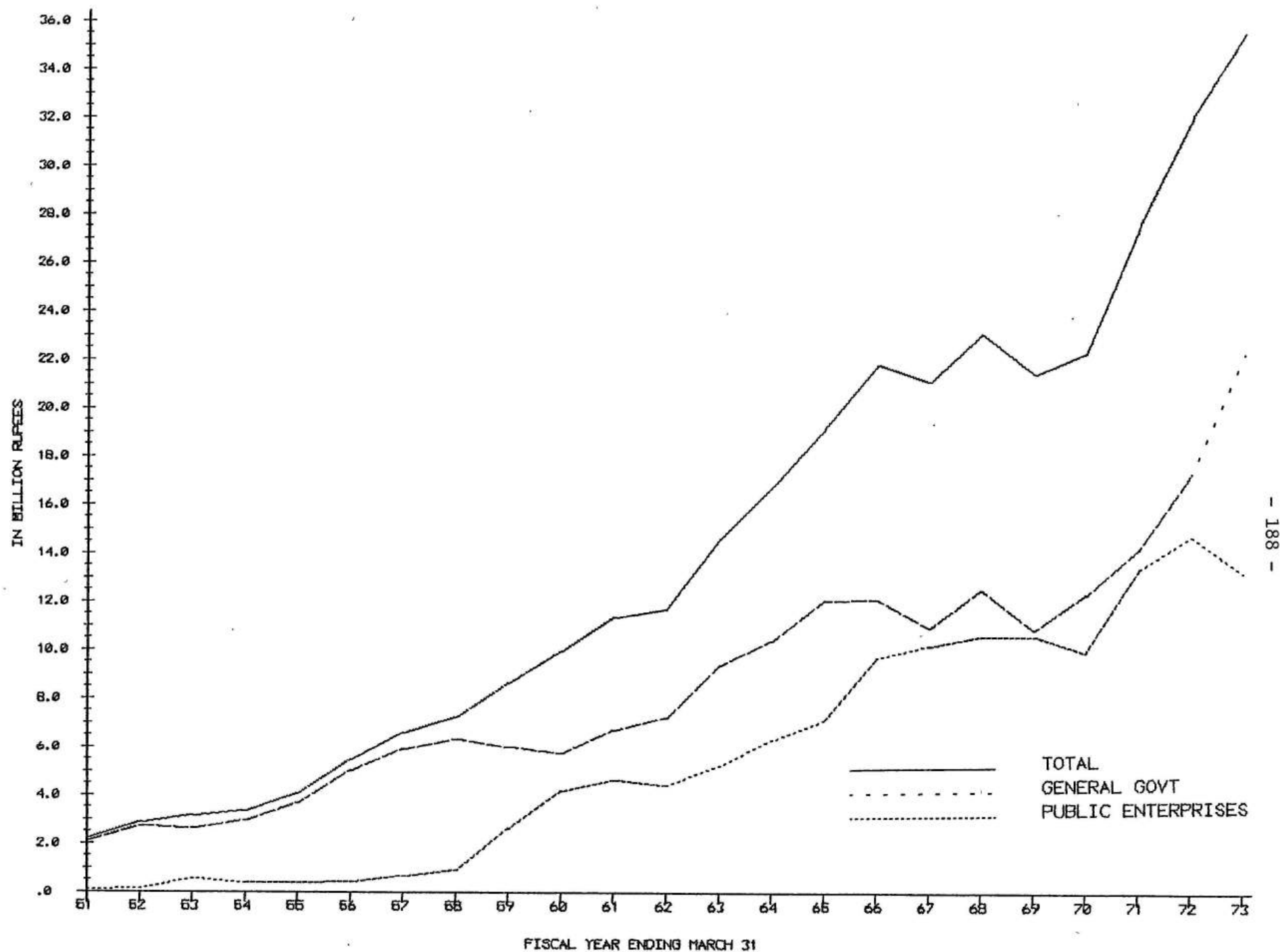
Beginning with the Second Five Year Plan in 1955-56, the Government of India chose to follow a course of accelerated government involvement in the economy within a general mixed

economy framework. This meant, among other things, an acceleration in government investment over time. This process of accelerated government investment was interrupted in the mid-sixties following the very poor agricultural output of 1965-66. Government investment in nominal terms actually declined in 1966-67 (Chart XXXI). We have attempted to use the model to trace the impact on the economy of a counter-factual situation in which government investment does not decline but only slows down.

Dynamic simulations for the model for the period 1965-66 to 1970-71 were obtained with and without the dip in government investment. The basic simulation used the actual values of government investment and its components reflecting the dip, while the alternative simulations substituted the values as given below. The latter used a value for government investment obtained by interpolating between the 1965-66 and 1967-68 values. This value is assumed to be distributed between general government and public enterprises (non-departmental enterprises) in the proportion 55:45--the average proportion observed around this period.

	1966-67	
	Actual	Assumed
I^g	21140	22473
I^{gg}	(10960)	(12360)
I^n	(10180)	(10113)

CHART XXXI GOVERNMENT INVESTMENT



As regards the financing of the increase in government investment, two alternative assumptions were made: (i) that the increase in government investment is financed by a higher fiscal deficit, or (ii) that it is financed by raising tax revenues.

The multiplier effects of higher government investment financed by a higher fiscal deficit on the endogenous variables of interest were obtained by calculating percentage differences between the values of the endogenous variables in the multiplier solution and in the basic solution. These results are summarised in Table XXIII.

As in the 'no drought' case, the multiplier effects dampen with time. Also, the overshooting phenomenon referred to earlier is observed in the response of investment in the private corporate sector (I^{PC}) and capacity utilisation in manufacturing (U).

An increase in government investment of 6.5 per cent in 1966-67 leads to a multiplier effect on real investment in the private corporate sector (I^{PC}) of the order of 26 per cent in 1967-68. The following three years, however, show a downward movement in this investment, reflecting initial overresponse to a change in nominal government investment. The effects peter out with time.

The multiplier effect of government investment on

Table XXIII.

Multiplier Effects of Higher Government Investment
in 1966-67
(In per cent)

Endogenous Variable	1966-67	1967-68	1968-69	1969-70	1970-71
I^{pc}	0.5	25.7	-1.6	-1.2	-0.9
U	1.7	-0.2	-0.2	-0.1	-0.1
Y_m^g	0.4	0.1	0.1	0.1	0.1
Y^g	0.2	0.1	0.1	0.1	0.1
DF^g	6.4	-0.9	-0.6	-0.5	-0.3
DMB	8.4	-1.3	-1.1	-0.8	-0.6
L	0.2	0.6	0.4	0.3	0.3
P	--	0.5	0.4	0.3	0.2

capacity utilisation in manufacturing (U) is 1.7 per cent in 1966-67, followed by small and declining downward adjustments in the following years.

Value added in manufacturing (Y'_m) increases by .4 per cent in 1966-67, and by .1 per cent in the following years. The response of total real income in the economy is smaller, i.e. 0.2 per cent in the initial year, and is 0.1 per cent in the following years.

The effect on government fiscal deficit (DF^g) is indeed positive in the initial year, and dampens out after that. The pattern of the multiplier effect on the change in monetary base variable is similar.

Notwithstanding the increase in government deficit and the monetary base, the effect on the money supply (L) in the initial year is close to nil. A relative decline in the ratio of agricultural income to total income leads to an increase in the currency-deposits ratio. This has an effect on the money supply in a direction opposite to that of the monetary base. The two effects almost cancel out in the first year. The following years show very small and dampening positive effects on money supply as well as the aggregate price level.

It is interesting to note the differences between the multiplier effects of an increase in deficit-financed government investment and that in tax-financed government

Table XXIIIa.

Multiplier Effects of Higher Government Investment in 1966-67
Financed by Higher Tax Revenue

(In per cent)

<u>Endogenous Variable</u>	<u>1966-67</u>	<u>1967-68</u>	<u>1968-69</u>	<u>1969-70</u>	<u>1970-71</u>
I^{pc}	-0.9	25.4	-0.3	-0.2	-0.2
U	1.8	---	---	---	---
Y_m	0.4	---	---	---	---
Y	0.2	---	---	---	---
DF^g	0.1	---	---	---	---
DMB	0.1	-0.2	-0.3	-0.2	-0.1
L	-0.1	---	---	---	---
P	-0.3	---	---	---	---

government investment. The latter are reported in Table XXIIIa. Comparing the results of Tables XXIII and XXIIIa, the following major features emerge:

(i) Increase in government investment whether financed by raising tax revenue or by deficit financing leads to increases in manufacturing output and total output of the order of .4 per cent and .2 per cent respectively in the first year. The continuation of a positive albeit smaller effect in the following years, however, holds only in the case of deficit-financed spending. With tax financed increase in government investment, there is no effect on output after the first year.

(ii) Increase in government investment when financed by running a deficit in 1966-67 leads to some increase in prices over the period. When financed by raising tax revenues, the increase in government investment has a mild negative effect in the first year, and no effect thereafter.

(c) No imports of foodgrains during 1961-62 - 1967-68

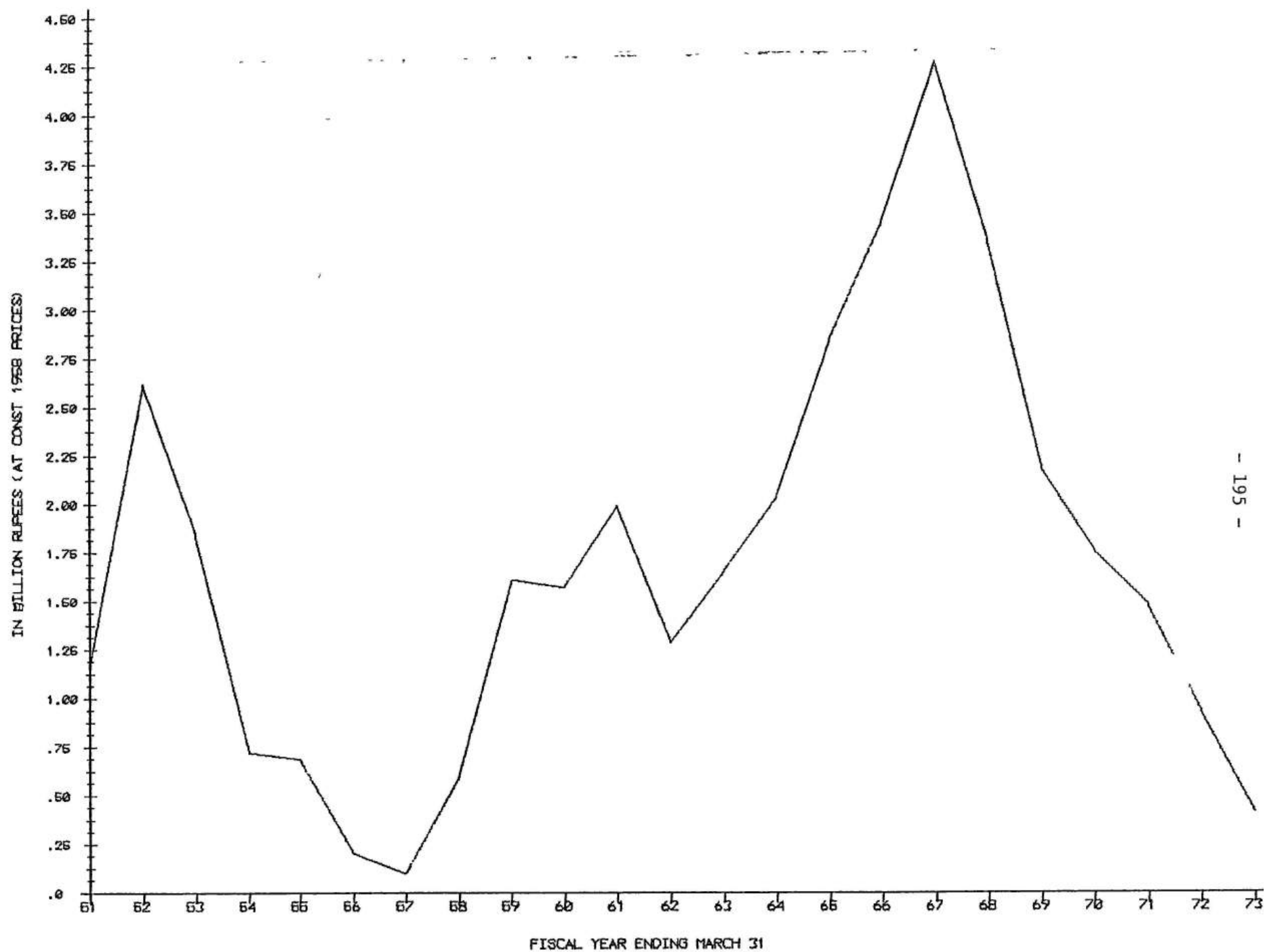
Imports of foodgrains played a very significant role in the Indian economic experience of the last two decades. Beginning with the Second Five Year Plan in 1955-56, the heavy industrialisation strategy of the government which implied some neglect of agriculture, was supported by major reliance on foodgrains imports to supply the marketable

surplus needed for industrialisation. These imports were to a large extent financed under the terms of the Public Law 480 program of the United States government. Under this program, foodgrains were imported by the Indian government from the U.S.A., and payment for these imports was made in rupees rather than in foreign exchange. These foodgrains were then sold on the domestic market through the government distribution system. The rupees acquired by the U.S. government were largely used to provide development loans to India, and partly to finance the expenditure of the U.S. embassy and other U.S. agencies in India. Thus, the injection of foodgrains into the economy was matched by a corresponding amount of rupee expenditure mainly on development. The balance was characterised as being neither inflationary nor deflationary in the view of an official committee to enquire into this question.^{1/} In fact, it is difficult to determine if the development expenditure financed by PL 480 loans should be treated as "additional" or whether it can be assumed that the same level of development expenditure would have been undertaken any way financed through higher fiscal deficits if necessary.

The impact of foodgrains imports on domestic supplies and prices of foodgrains in the economy has to be understood in

^{1/} Government of India (37).

CHART XXXII IMPORTS OF FOODGRAINS (AT CONST 1958 PRICES)



the broader context of government operations in foodgrains in India. As discussed in chapter II, page , imports of foodgrains, together with domestic procurement of foodgrains and change in government stocks of foodgrains, constitute the supply of foodgrains through the government distribution system. The quantitative impact of government operations in the foodgrains market is incorporated in the model by including net distribution (or imports plus depletions of government stocks) as an explanatory variable in the equation for the relative price of foodgrains. This formulation permits study of an alternative development scenario by setting the net distribution variable equal to the depletion of government stocks.^{1/} On the balance of payments account, imports of foodgrains are set equal to zero, and so are the capital inflows on account of PL 480 imports. To the extent that there are foodgrain imports not financed by PL 480 aid, setting these imports equal to zero has a positive impact on foreign reserves, other items in the balance of payments remaining the same.

The basic dynamic simulation uses the net distribution variable defined as imports of foodgrains plus depletions of government stocks during the period. The multiplier simu-

^{1/} This assumes that changes in government stocks are independent of imports of foodgrains.

lation substitutes the depletion in government stocks variable for the net distribution variable, and makes the above mentioned appropriate balance of payments adjustments. Values for the two variables are provided below:

	Net Distribution (basic simulation)	Depletion of Government Stocks (multiplier simulation)
1961-62	3.661	0.260
1962-63	4.157	0.189
1963-64	5.832	0.633
1964-65	6.642	0.090
1965-66	8.062	-0.600
1966-67	9.390	0.062
1967-68	6.060	-0.888

The multiplier effects of no imports of foodgrains on the endogenous variables of interest were obtained by calculating percentage differences between the values of the endogenous variables in the multiplier solution and in the basic solution. These results are summarised in Table XXIV.

It is important to note that in this multiplier analysis of 'no imports of foodgrains over the period', we are neither analysing the impact of a one period change, nor of a steady flow change, in a specific variable on other variables of interest over a number of periods. Instead, we are tracing the impact of no imports of foodgrains relative to the actual imports of foodgrains (as shown in chart XXXII) on other

Table XXIV.

Multiplier Effects of No Imports of Foodgrains
During 1961-62 - 1967-68

(In per cent)

Endogenous Variable	1961-62	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68
O^f	--	0.6	0.5	0.6	0.9	1.0	0.9
O_c^I	--	-2.8	-2.3	-2.9	-3.7	-4.6	-4.2
Y'_a	--	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
S_f	-4.3	-1.6	-2.2	-2.2	-3.6	-2.2	2.9
P_f/P_m	12.2	10.7	13.7	16.2	19.4	19.8	9.9
P_c/P_m	-0.2	--	-0.7	-1.1	-1.5	-1.8	-2.1
P_a/P_n	3.8	3.3	3.9	4.4	5.4	5.2	2.1
P_f	10.6	11.1	15.6	19.7	25.1	27.9	20.9
w_m	--	6.1	10.7	16.0	21.7	27.9	33.2
P_m	-1.4	0.4	1.7	3.1	4.8	6.8	10.1
Y'_m	-0.5	-1.8	-2.8	-3.9	-4.9	-6.0	-6.5
Y'	-0.2	-0.8	-1.3	-1.8	-2.6	-3.1	-3.2
DF^g	3.7	6.0	5.2	6.8	7.0	9.5	7.5
DMB	6.7	9.2	8.2	10.5	12.2	18.4	21.4
L	0.3	1.1	2.2	3.2	4.5	6.0	7.4
P	0.5	1.9	3.4	4.9	7.0	9.0	10.6

variables of interest in the model. The results of this simulation therefore cannot be used to derive implications about the stability of the model. However, they allow us to determine the impact of the imports of foodgrains, quantitatively very important over this period, on prices and outputs in the economy within the framework of our model. Since this subject has been much discussed in the Indian literature, they provide a basis for evaluating government policy in the context of an explicit model of the various interrelationships.

The multiplier effect of 'no imports of foodgrains' on relative prices and outputs within the agricultural sector can be summarised as follows: the relative price of foodgrains is higher, while that of commercial crops is lower; correspondingly, output of foodgrains is higher and that of commercial crops is lower. The joint effect of the increase in the relative price of foodgrains in terms of manufactured goods, and the decline in the relative price of commercial crops in terms of manufactured goods is to turn the terms of trade between agriculture and non-agriculture in favor of agriculture. The net effect of the increase in the output of foodgrains and the decline in the output of commercial crops in the model is to lower real agricultural income marginally.

The impact of 'no imports of foodgrains' on the absolute price of foodgrains is even higher than the impact on the relative price of foodgrains, because of the overall inflation generated in the simulation (see below).

The effect on the marketed surplus of foodgrains represents the composite effect of the increase in the relative price of foodgrains, increase in the output of foodgrains, and decline in the income originating from commercial crops. While the first effect leads to a decline in the marketed surplus of foodgrains, the latter two lead to an increase in the same. Up to 1966-67, the first effect outweighs the other two, so that marketed surplus of foodgrains is lower in the absence of foodgrain imports. In the year 1967-68, however, the situation is reversed such that no importation of foodgrains leads to an increase in the marketed surplus of foodgrains.

The effect of 'no imports of foodgrains' on the manufacturing sector is felt through the money wage linkage with the price of foodgrains. The multiplier effect on the money wage rate is very high indeed. Notwithstanding the increase in the price of the manufactured goods, the multiplier solution yields higher real wage rates, lower employment levels, and lower levels of manufacturing output. Thus, unlike the marginal effect of the absence of food imports on real output

in agriculture, the effect on manufacturing output is negative and substantial. The joint effect of the marginal decline in agricultural output, and the decline in manufacturing output in the multiplier solution is to depress real income in the economy on average by 1.9 per cent over the seven-year period.

The effect on government fiscal deficit of 'no imports of foodgrains' is positive, reflecting the increases in expenditure owing to higher prices of foodgrains. The higher level of the change in monetary base in the multiplier solution over the period reflects the joint effect of the increase in government fiscal deficit and the increase in foreign reserves of the Reserve Bank of India on account of no imports of foodgrains other than those on PL 480 account.

The increase in money supply in the 'no imports of foodgrains' solution is much smaller than the increase in the change in monetary base. This is because of the opposite effect exerted on money supply by the increase in the currency-deposits ratio in response to a decline in the share of agricultural income in the economy. The multiplier effect on the aggregate price level is larger than that on money supply, as the decline in real income experienced in the multiplier solution leads to a decline in the real demand for money.

To summarise, in the absence of imports of foodgrains during the period 1961-62 - 1967-68, real agricultural income

is lower on average by less than .1 per cent per annum, while real total income is lower on average by almost 2 per cent per annum. Terms of trade move in favor of agriculture, being higher on average by 4 per cent. The effect on the marketed surplus of foodgrains is not consistently in the same direction. The marketed surplus is on average lower by 2.7 per cent in the first 6 years, but higher by almost 3 per cent in 1967-68. Money supply and the aggregate price level are higher on average by 3.5 per cent per annum and 5.3 per cent per annum, respectively, over the entire period, while the absolute price of foodgrains is higher on average by 19 per cent per annum.

(d) No imports of foodgrains and lower government expenditures during 1961-62 - 1967-68

The analysis of economic developments in the absence of imports of foodgrains has been conducted so far using the ceteris paribus assumption. In fact, as mentioned earlier, the PL 480 imports of foodgrains were accompanied by development loans made to the government of India by the government of the United States. The pattern of disbursements resulting from the loan agreements did not bear any direct relationship to the flow of imports during the period. Also, it is not possible to determine whether these development

Table XXV.

Multiplier Effects of No Imports of Foodgrains and
Smaller Government Expenditures during 1961-62 - 1967-68

(In per cent)

Endogenous Variable	1961-62	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68
O_f	--	0.6	0.5	0.6	0.8	0.9	0.8
O_c^I	--	-2.8	-2.2	-2.8	-3.4	-4.2	-3.8
Y'_a	--	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
S_f	-4.3	-1.3	-1.7	-0.6	-0.5	1.3	7.0
P_f/P_m	12.0	10.3	12.9	13.6	15.3	15.0	4.4
P_c/P_m	-2.7	-2.2	-1.0	-2.2	-3.4	-4.0	-4.6
P_a/P_n	3.7	3.1	3.5	3.1	3.3	2.8	-0.7
P_f	9.9	8.9	11.6	6.7	5.6	8.7	2.3
W_m	--	6.4	11.6	18.1	28.0	40.9	52.0
P_m	-1.9	-1.3	-1.2	-6.0	-8.4	-5.5	-2.0
Y'_m	-0.6	-2.2	-3.5	-6.1	-8.6	-10.4	-11.4
Y'	-0.3	-1.0	-1.6	-2.9	-4.5	-5.2	-5.6
DF^g	-11.7	-6.0	-9.6	-99.6	3.5	-2.7	-4.6
DMB	-20.8	-7.2	-11.2	-130.4	7.6	1.8	5.5
L	-0.3	-0.6	-0.9	-6.4	-9.7	-8.0	-6.7
P	--	0.3	0.6	-3.9	-6.0	-3.4	-1.7

loans led to additional expenditures being undertaken, or whether the planned level of expenditures could have been undertaken in any case, and if so, how these would have been financed. Notwithstanding these problems, we generate a simple counterfactual simulation in which (i) there are no imports of foodgrains during 1961-62 - 1967-68, and (ii) government current expenditures in each year are lower by the amount of the PL 480 foodgrain imports in that year.^{1/} This simulation provides a broad indication of the role of PL 480 imports in permitting a higher level of government expenditure, given the other financial resources available to the government.

Table XXV summarises the multiplier effects of no imports of foodgrains and smaller government expenditures on the endogenous variables of interest. Once again, the multiplier effects are obtained by calculating percentage differences between the values of the endogenous variables in the multiplier solution and in the basic solution.

It is useful to focus upon the differences between the multiplier effects in Tables XXIV and XXV, as this approach enables us to determine the separate impact of imports of

^{1/} This has in it implicit the assumption that government planned investment is carried through in the absence of development loans, and the brunt of the resource constraint falls on current expenditure.

foodgrains and accompanying increases in government expenditures on real output growth and price inflation in the economy.

The following major features emerge from a comparison of the results of Tables XXIV and XXV.

(i) In both simulations, there is a negligible effect on agricultural output. This result should be viewed in the context of the debate in the Indian literature on the impact of foodgrain imports on agricultural production.^{1/} It has been argued that PL 480 imports of foodgrains had an adverse effect on agricultural output by reducing incentives for production. Our results show that the main effect of foodgrain imports is to shift output from foodgrains to commercial crops, with a slight positive effect on agricultural output as a whole.^{2/} These results lend support to the argument advanced by Dantawala, that "The major component of PL 480 imports was wheat and it is reasonable to assume that these imports affected the prices of wheat or at best also of other substitutable cereals from the consumer point of view, but could not have had much impact on the prices of commercial crops. The expected consequence of this relative shift in prices in favor of commercial crops would be a shift in agricultural inputs for their production. Assuming that this is

^{1/} Schultze (65), Khatkhate (42), Mason (55).

^{2/} For a partial equilibrium analysis of the impact of PL 480 imports on prices and domestic supply of foodgrains (cereal), see Mann (53).

exactly what happened, would such a development be necessarily injurious to Indian agriculture for the Indian economy as a whole?"^{1/}

(ii) The negative effect on manufacturing output is heightened in the 'no foodgrains imports, smaller government expenditure' simulation, reflecting the joint impact of the larger increase in the real wage rate and of the negative effect on capacity utilisation. A simultaneous reduction in government current expenditure and absence of foodgrain imports leads to an average decline of 6.1 per cent per annum in manufacturing output over the seven-year period, compared to that of 3.8 per cent when government expenditure is not lowered. The corresponding declines for total real income in the two simulations are 3 per cent and 2 per cent respectively.

(iii) Because of the relatively large declines in real non-agricultural income in the 'no foodgrains imports, smaller government expenditure' simulation, the demand influences in the foodgrains market are weaker, and the increase in the relative price of foodgrains is less. Corresponding to the relatively smaller increases in the relative price of foodgrains, the decline in the marketed surplus of foodgrains up to 1965-66 is relatively less in Table XXV compared to Table XXIV. Again, the multiplier effect on the

^{1/} - Dantawala (17).

marketed surplus turns positive towards the end of the period as in Table XXIV.

(iv) The contraction in government expenditure in the 'no foodgrains imports, smaller government expenditure' simulation leads, by and large, to a negative effect on the government fiscal deficit in Table XXV, offsetting the positive influence exerted by the absence of the imports of foodgrains. The effect on the change in monetary base, however, is contractionary only for the first four years, and after that it is mildly inflationary, albeit substantially less so, than in Table XXIV.

(v) Notwithstanding the increase in the change in monetary base in the later part of the period in Table XXV, the effect on money supply is consistently negative, reflecting the dominant effect of the movements in the currency-deposits ratio resulting from the decline in the share of agricultural output. The effect on the aggregate price level is also by and large negative. Thus, average declines of 4.7 per cent per annum and 2 per cent per annum in the money supply and the aggregate price level respectively in Table XXV are in sharp contrast with the average increases of 3.5 per cent per annum and 5.3 per cent per annum in the two variables respectively in Table XXIV.

On the basis of the above results, then, imports of foodgrains have a deflationary impact on the economy. When accompanied by higher government expenditures, however, the deflationary impact is converted into a mildly inflationary impact on the economy.

CHAPTER V. CONCLUSIONS

In the previous chapters we have attempted to analyse the factors determining price behavior in the Indian economy over the period 1951-1973. The approach adopted was to specify a macroeconometric model of the economy to study the effect of various factors on relative and absolute prices as well as on real outputs in the economy. In this chapter we take an overview of the results obtained and present our major conclusions. Before proceeding to summarise the conclusions of our study, it is useful to reflect on some of the fundamental characteristics and limitations of this methodology.

A macroeconometric model of an economy presents a set of behavioral and technological relationships in the economy, together with the relevant identity constraints, within a consistent framework. In the process of defining a model, the model builder faces numerous choices, e.g., the level of disaggregation, the intersectoral linkages, the specification of individual relationships, etc. To the extent that these choices are resolved essentially by judgment, the model builder's "biases" are reflected in the specification of the model itself. These "biases" are tested in the process of estimating the individual equations of the model. Nevertheless,

it remains true that these tests are not very strong in the sense that they cannot distinguish between the validity of alternative specifications. In this sense, the results of any model are conditional upon the view of the functioning of the economy taken by the model builder.

A broad evaluation of the model developed in this study can be summarised as follows. The model performs satisfactorily in analysing the behavior of outputs and prices - sectoral as well as aggregate - in the economy over the period 1952-53 to 1970-71. As discussed earlier, the model specification was based on an eclectic approach, integrating the elements of structural, demand pull, cost push, and monetary theories of inflation. The individual relationships specified in the model were found to be statistically significant both in terms of the overall explanatory power of the equation and in terms of the significance and direction of the partial effects of the explanatory variables in these equations. The performance of the model as a whole was also satisfactory in terms of replicating the actual performance of the economy over the period of study, judged in terms of the size of the error of each variable and the success of the model in capturing turning points over the period.

In addition to the overall statistical evaluation, it is also important to examine the results obtained in terms of

what these tell us about the factors underlying inflation in the Indian economy. Our major conclusions in this respect are summarised below.

(i) The role of agriculture

The model specification adopted was based on the view that agriculture has a very important role to play in the determination of prices and outputs in the economy. The basic interactions involved have been extensively discussed in chapter II, and can be summarised as follows. The agricultural sector provides the marketable surplus of foodgrains, thus determining the relative price of food, the money wage rate, (through a cost push type mechanism), and employment and output in the manufacturing sector. The latter, together with agricultural output itself, affects output in the rest of the economy. Thus, the agricultural sector's performance is an important determinant of the relative price structure in the economy and the level of real output in the economy. By affecting the government fiscal deficit and through it the monetary base, and the currency-deposits ratio, the agricultural sector also affects money supply and the aggregate price level in the economy.

The importance of these linkages is borne out by our empirical investigation. In particular, we analyse the impact

of the two successive agricultural droughts in 1965-66 and 1966-67 on prices and outputs in the economy. This is accomplished by obtaining the 'no droughts in 1965-66 and 1966-67' simulation discussed in chapter IV. The results of this simulation were summarised in Table XXII of that chapter. This simulation shows that increases in agricultural income of 11 per cent in 1965-66 and 1966-67 lead to increases in manufacturing output of 1.2 per cent and 2.3 per cent in 1966-67 and 1967-68 respectively. However, the effect on manufacturing output does not rest with these one year lagged effects. In the three years following 1967-68, manufacturing output increases on average by 1.4 per cent per annum. The effect on the total real income is of the order of 6.2 per cent per annum in the first two years, 1 per cent per annum in the next two years, and .5 per cent in the last two years. The effect on the aggregate price level is an average decline of 2.7 per cent per annum over the five years from 1966-67 to 1970-71. In the two years of simulated increase in agricultural income, the terms of trade between agriculture and other sectors of the economy move in favor of the latter by an average of 3.7 per cent per annum.

To view these results differently, the two successive agricultural droughts of 1965-66 and 1966-67 led to a decline

in agricultural income, a multiplier decline in the output of the nonagricultural sector, an increase in the relative price of foodgrains, an increase in the money wage rate, and an increase in the aggregate price level.

(ii) Imports of foodgrains as a "cushion"

Domestic imbalances between the outputs of the agricultural and the non-agricultural sectors may not necessarily lead to inflation in the economy, if there is sufficient cushion available through foreign trade possibilities. The model specifications allow for the role of the latter within the institutional constraints of the economy. This was discussed in detail in chapters II and IV. Thus, imports of foodgrains, by their suppressing impact on the price of foodgrains, can mitigate the cost push effect of agricultural shortfalls on prices and outputs in the non-agricultural sector, and reduce the pressure on fiscal deficit and on money supply, thereby exerting a downward pressure on the aggregate price level.

Imports of foodgrains in the Indian economy were quantitatively very important during 1961-62 to 1967-68. A counterfactual simulation with no imports of foodgrains during 1961-62 to 1967-68 provides a good basis for analysing the cushioning impact of these imports on the economy. The multiplier

effects of this simulation were reported in Table XXIV, chapter IV. These suggest that imports of foodgrains during this period led to an average decline in the relative price of foodgrains of the order of 14.5 per cent per annum, and that in the absolute price of foodgrains of the order of 18.7 per cent per annum. The effect through the wage rate on output in the manufacturing sector was to increase this output by an average of 3.8 per cent per annum over this period. The positive impact on agricultural output was minimal, as it was limited to bringing about a shift from foodgrains to commercial crops. Total output in the economy was higher by an average of 1.8 per cent per annum during 1961-62 to 1967-68 on account of the imports of foodgrains. Through their negative impact on fiscal deficit and on foreign reserves when not financed by PL 480 aid, foodgrains imports led to declines in money supply and the aggregate price level of 3.5 per cent per annum and 5.3 per cent per annum respectively.

Imports of foodgrains, thus, had a significant impact on bridging the domestic imbalances between the outputs of the agricultural and the non-agricultural sectors.

(iii) The role of fiscal and monetary factors

The view of inflation presented in our model placed heavy emphasis on the role of fiscal and monetary factors which affect the behavior of real as well as monetary variables in the economy.

Government expenditure, by generating demand in the economy, has direct impact on the level of capacity utilisation in the manufacturing sector and hence on output. Furthermore, increase in government investment has a twofold impact on the capital stock in the economy. An increase in government investment in public enterprises leads to an increase in the capital stock in the public corporate sector, directly raising output in the manufacturing sector in subsequent years. In addition, government investment in infrastructure has a lagged positive effect on private corporate investment and thus affects capital stock and output in manufacturing.

The impact of fiscal operations on prices in the economy is felt through the government fiscal deficit and the government budget constraint. The latter serves as the critical link between the fiscal and the monetary sectors in the economy. To the extent that investment leads to deficit financing, the higher fiscal deficit has a positive impact on the monetary base, and through it, on money supply and the aggregate price level. The same is true of an increase in government current expenditure whether arising from pressures originating in the foodgrain sector or from special factors.

The role of these linkages in explaining inflation is explored in chapter IV. This is done in two ways. First, a

simulation of the model for the period 1966-67 to 1970-71, with government investment higher by 6.3 per cent in 1966-67, is obtained and analysed. Second, the model is simulated for the period 1961-62 to 1967-68 with lower current expenditure of government over the entire period. The results provide evidence for the view (see Chapter IV) that in a nonlinear model it is not possible to generalize about the quantitative impact of a change in an exogenous variable, since this impact depends on the amount of change as well as the particular configuration of exogenous variables at the point at which the change is introduced. For example, we find that while lowering of government current expenditure in the second simulation had considerable impact on prices and outputs, raising government investment in the first simulation had only marginal impact on the same.

The results of the simulation with higher government investment financed by running a higher fiscal deficit in 1966-67 were reported in Table XXIII of Chapter IV. These suggest that an increase in government investment of 6.3 per cent in 1966-67 leads to an increase in manufacturing output of .4 per cent in the same year, and .1 per cent per annum in the following four years. The corresponding increases in the total real output in the economy are .2 per cent in 1966-67 and .1 per cent per annum in the following four years. The

small increases in output during the latter period are accompanied by an average increase in the aggregate price level of the order of .4 per cent.

The effects of government expenditures on prices and outputs in the economy are also obtained in an alternative context by comparing the multiplier effects of the two 'no imports of foodgrains' simulations, with and without lower current expenditure of the government, as reported in Tables XXIV and XXV of chapter IV. These results suggest that if the government current expenditure had been lower by the amount of the PL 480 aid,^{1/} an average price increase of 5.3 per cent per annum in the absence of imports of foodgrains would be converted into an average price decline of 2 per cent per annum during 1961-62 to 1967-68, while the decline in total real income of 2 per cent per annum would become instead of the order of 3 per cent per annum. These effects are large, compared with the effects of the simulation reported above.

Our results point to a mixed conclusion on the importance of the fiscal-monetary linkage in the economy. This linkage is found to be consistently strong in the sense that the government fiscal deficit has a dominant impact on the monetary

^{1/} This is based on the assumption that government investment would have been maintained in the absence of the PL 480 aid, and the brunt of the adjustment would have fallen on government current expenditure.

base in the economy. Money supply, however, is a function of the monetary base as well as the public's preference in respect of the currency-deposits ratio and in some cases we find that movements in the latter offset the increase in monetary base.

An important implication of the model structure we have adopted is that it is not possible to ascertain the impact of 'pure monetary increase', since money supply as well as the monetary base are endogenous. At the same time, the simulations with respect to changes in government expenditure cannot be regarded as 'pure fiscal changes' devoid of their monetary impact. Nonetheless, identification of the demand factors originating in the fiscal-monetary complex, and differentiating these from the structural factors originating from the dominance of agriculture in the economy is a useful first step in analysing the process of inflation in the economy.

APPENDIX I

Index to Symbols used in the Model

1. A Gross sown area under all crops, in million hectares - C, Source I.
2. A_C Gross sown area under commercial crops (fibres, oilseeds, and sugarcane), in million hectares - C, Source I.
3. A_C^I Index of gross sown area under commercial crops, base triennium ending 1961-62 = 100 - C, Source I. (See Appendix II).
4. A_f Gross sown area under foodgrains, in million hectares - C, Source I.
5. A_o Gross sown area under crops other than foodgrains and commercial crops, in million hectares - C, Source I.
6. B_{RBI}^b Borrowing of commercial banks from the Reserve Bank of India, in million rupees - F, Source IX.
7. B_b^g Government borrowing from commercial banks in million rupees - F, Source IX.
8. B_{bs}^g Government borrowing from banking system, in million rupees - F, Source IX.
9. B_{RBI}^g Government borrowing from the Reserve Bank of India, in million rupees - F, Source IX.
10. B_b^o Net change in other assets of commercial banks - F, Source IX.
11. B_{RBI}^o Net change in other assets of the Reserve Bank of India - F, Source IX.
12. B_b^p Borrowing of private sector from commercial banks, in million rupees - F, Source IX.

13. C Currency with public, mid-fiscal year level, in million rupees - F, Source IX.
14. d_k Depreciation of capital stock in manufacturing per reporting establishment, in million rupees - A, Source IV.
15. D Demand deposits excluding interbank deposits, mid-fiscal year levels, in million rupees - Source IX.
16. D_f Farmers' demand for foodgrains, in thousand tons.
17. DD^f Demand deposits excluding interbank deposits, end of fiscal year levels, in million rupees - Source IX.
18. D_f^g Net government distribution of foodgrains, i.e, procurement minus distribution of foodgrains, in million tons - C, Source III.
19. DF^g Government fiscal deficit, in million rupees - F, Source XIII.
20. DFR_{BP} Change in official foreign reserves, balance of payments data, in million rupees - F, Source IX.
21. DFR_o Change in official foreign reserves other than those with the Reserve Bank of India, in million rupees - F, Source IX.
22. DFR_{RBI} Change in foreign reserves of the Reserve Bank of India, in million rupees - F, Source IX.
23. DMB Change in monetary base, in million rupees - F, Source IX.
24. E_o^g Current expenditure other than wages and salaries of government, in million rupees - F, Source XIII.
25. F Foreign capital inflows, in million rupees - F, Source IX.

26. F_{anf} Utilised foreign aid excluding PL 480 Aid, in million rupees - F, Source XIV.
27. F_C Consumption of fertilisers in commercial crops, in metric tons - C, Source XIV.
28. F_f Consumption of fertilisers in foodgrains, in metric tons - C, Source XIV.
29. FR_{RBI} Foreign reserves of the Reserve Bank of India, in million rupees, end fiscal year levels, Source IX.
30. H_f Gross irrigated area under foodgrains, in million hectares - C, Source II.
31. H^g Government expenditure on irrigation, in billion rupees - F, Source VII.
32. H_C^I Index of gross irrigated area under commercial crops, base triennium ending 1961-62 = 100 - C, Source II (See Appendix II).
33. i_d Interest rate on three-month deposits, in per cent - F, Source IX.
34. i_g Interest on government bonds in per cent - F, Source IX.
35. i_i Interest rate on industrial securities, in per cent - F, Source IX.
36. i_z Interest rate on bazaar bill rate, in per cent - F, Source IX.
37. I Total investment in the economy, in million rupees - F, Sources V and VIII.
38. I_a Value of inputs into agriculture, in billion rupees - F, Source VII.
39. I_m Gross Investment in manufacturing sector, CMI/ASI data, in million rupees - A, Source IV.
40. I^g Total gross investment by government, in million rupees - F, Sources V and VIII.

41. I^{gg} Gross Government investment in administrative departments and departmental enterprises, in million rupees - F, Source V and VIII.
42. I^{gn} Gross Government investment in public enterprises or nondepartmental undertakings, in million rupees - F, Sources V and VIII.
43. I^{hh} Gross Investment by private noncorporate sector, in million rupees - F, Source V and VIII.
44. I^{pc} Gross Investment by private corporate sector, in million rupees - F, Source VIII.
45. I^p Gross Investment by private (corporate and noncorporate) sector, in million rupees - F, Sources V and VIII.
46. J_c^I Rainfall Index for commercial crops, base = 100 C, Source XVIII.
47. J_f^I Rainfall Index for foodgrains, base = 100 C, Source XVII.
48. k_m Net Capital stock in manufacturing, per establishment, in million rupees - A, Source IV.
49. k_m^u Utilised capital stock in manufacturing per establishment, in million rupees - A, Sources IV and X.
50. K_m Net capital stock in manufacturing, in million rupees - A, Source IV.
51. K_r^g Capital receipts of government, in million rupees - F, Sources IX and XIII.
52. K_m^u Utilised capital stock in manufacturing, in million rupees - A, Sources IV and X.
53. L Currency plus demand deposits, i.e., narrow money, mid-fiscal year levels, in million rupees - Source IX.
54. M Total merchandise imports, in million rupees - F, Source IX.

55. M Imports of foodgrains, in million rupees - F, Source IX.
56. M_k Imports of capital goods, in million rupees - F, Source IX.
57. M_o Imports of goods other than food and capital goods, in million rupees - F, Source IX.
58. MB Monetary base in the economy, end fiscal year levels, in million rupees - Source IX.
59. n_m Employment in manufacturing, per establishment in numbers - A, Source IV.
60. NT^g Nontax revenue of government, in million rupees - F, Source XIII.
61. O_f Output of foodgrains, in million tons - C,
 $O_f = (O_f^I) \cdot (.806)$
62. O_{fn} Net output of foodgrains, in thousand tons, defined as $.875(O_f \cdot 1000)$.
63. O_c^I Output index of commercial crops, base triennium ending 1961-62 = 100 C, Source I (See Appendix II).
64. O_f^I Output index of foodgrains, base triennium ending 1961-62 = 100 C, Source I.
65. O_{fn}^I Net output index of foodgrains, base triennium ending 1961-62 = 100 C, derived from O_{fn} .
66. P Implicit price deflator for gross domestic product. Index base 1960-61 = 100 - F, Sources V and VI.
67. P_a Implicit price deflator for gross domestic product in agriculture. Index base 1960-61 = 100 F, Sources V and VI.
68. P_c Wholesale price index of commercial crops, fiscal year average, base 1961-62 = 100 F, Source XVI. (See Appendix II).

69. P_f Wholesale price index of foodgrains, fiscal year average. Index base 1961-62 = 100 F, Source XVI.
70. P_m Wholesale price index of manufactured goods, fiscal year average, Index base 1961-62 = 100 - F, Source XVI.
71. P_n Implicit price deflator for gross domestic product of sectors other than agriculture. Index base 1960-61 = 100 - F, Sources V and VI.
72. P_I^g Implicit price deflator for government investment, Index base 1960-61 = 100 - F, Sources V and VIII.
73. P_I^p Implicit price deflator for private investment, Index base 1960-61 = 100 - F, Sources V and VIII.
74. P^m Unit value index of total imports, Index base 1958 = 100 - F, Source XII.
75. P_C^m Unit value index for commercial crop imports. Index base 1958 = 100 - F, Source XII.
76. P_f^m Unit value index for foodgrain imports, Index base 1958 = 100 - F, Source XII.
77. P_k^m Unit value index for capital good imports, index base 1958 = 100 - F, Source XII.
78. P_O^m Unit value index for imports of goods other than food and capital goods. Index base 1958 = 100 - F, Sources XII.
79. P_a/P_n Ratio of implicit price deflator of agriculture to non-agriculture.
80. P_C/P_m Relative price of commercial crops and manufactured goods, crop year average, Index base 1961-62 = 100.
81. P_f/P_C Relative price of foodgrains and commercial crops, crop year average, Index base 1961-62 = 100.

82. P_f/P_m Relative price of foodgrains and manufactured goods, crop year average, Index base 1961-62 = 100.
83. $(P_c/P_m)^f$ Relative price of commercial crops and manufactured goods, fiscal year average, Index base 1961-62 = 100.
84. $(P_f/P_m)^f$ Relative price of foodgrains and manufactured goods, fiscal year average, Index base 1961-62 = 100.
85. r Required ratio of reserves to time deposits - Source XI.
86. R Bank reserves, mid-fiscal year levels, in million rupees - Source IX.
87. S Number of reporting establishments in CMI/ASI surveys - A, Source IV.
88. S_f Marketed surplus of foodgrains, in thousand tons - C, See Appendix II.
89. S_f^I Index of marketed surplus of foodgrains, base triennium ending 1961-62 = 100.
90. S^{net} Balance on services account, in million rupees - F, Source IX.
91. T Time, 1950-51 = 1, 1951-52 = 2, etc.
92. TLS Indirect tax less subsidies, in billion rupees - F, Sources V and VI.
93. T_a^g Tax revenue from agricultural direct taxes, in million rupees - F, Source XIII.
94. T_c^g Tax revenue from customs, in million rupees - F, Source XIII.
95. T_n^g Tax revenue from nonagricultural direct taxes, in million rupees - F, Source XIII.
96. T_o^g Tax revenue from indirect taxes other than customs, in million rupees - F, Source XIII.

97.	TD	Time deposits excluding PL 480 deposits, mid-fiscal year levels, in million rupees - Source IX.
98.	TD ^f	Time deposits excluding PL 480 deposits, end of fiscal year levels, in million rupees - Source IX.
99.	TD/D	Ratio of mid-fiscal year time deposits to mid-fiscal year demand deposits - Source IX.
100.	U	Capacity utilisation in manufacturing, Index base 1960 = 100 - A, Source X.
101.	V _m	Value added in manufacturing per reporting establishment, in million rupees - F, Source IV.
102.	V _a	Value added in agriculture, in billion rupees - F, Source VII.
103.	V _m	Value added in manufacturing, CMI/ASI data, in million rupees - A, Source IV.
104.	W _m	Wage rate in manufacturing, in rupees - A, Source IV.
105.	W ^g	Government wages and salaries, in million rupees - F, Sources V, VI, and XV.
106.	X	Merchandise exports, in million rupees - F, Source IX.
107.	Y	Gross domestic product at factor cost, in billion rupees - F, Sources V and VI.
108.	Y _a	Gross domestic product in agriculture, in billion rupees - F, Sources V and VI.
109.	Y _m	Gross domestic product in manufacturing, in billion rupees - F, Sources V and VI.
110.	Y _n	Gross domestic product in sectors other than agriculture, in billion rupees - F, Sources V and VI.
111.	Y ^{mp}	Gross domestic product at market prices, in billion rupees - F, Sources V and VI.

112. Z_f Change in foodgrain stocks, in thousand tons.
- F - Relating to fiscal year, April-March.
- C - Relating to crop year, July-June.
- A - Relating to calendar year, January-December.

The list of sources is given below:

<u>No.</u>	<u>Source</u>
I.	"Estimates of Area and Production of Principal Crops in India 1973 - 74", Directorate of Economics and Statistics, Ministry of Agriculture and Irrigation, Government of India.
II.	Data supplied by Directorate of Economics and Statistics, Ministry of Agriculture and Irrigation, Government of India.
III.	"Bulletin on Food Statistics, 1974", Directorate of Economics and Statistics, Ministry of Agriculture and Irrigation, Government of India.
IV.	"Census of India: Manufactures" 1950 to 1958, and "Annual Survey of Industries" 1959 to 1970, Central Statistical Organization, Calcutta.
V.	"National Accounts Statistics 1960-61 - 1972-73", January 1975, Central Statistical Organisation, Department of Statistics, Ministry of Planning, Government of India.
VI.	"Estimates of National Income 1948-49 to 1961-62, January 1963", Central Statistical Office, Department of Statistics, Cabinet Secretariat, Government of India.
VII.	"National Accounts Statistics 1960-61 - 1972-73 Dis-aggregated Tables, March 1975", Central Statistical Organisation, Department of Statistics, Ministry of Planning, Government of India.
VIII.	Lal R.N., "Capital Formation in India", Ph.D. dissertation, University of Delhi, 1974.

- IX. "Report on Currency and Finance", various issues, "Supplement to Banking and Monetary Statistics of India" Parts 1 and 2, "India's Balance of Payments 1948-49 to 1961-62", 1963, Reserve Bank of India.
- X. "Reserve Bank of India Bulletin", issues of April 1970, March 1972, and October 1973.
- XI. "Functions and Working", Reserve Bank of India.
- XII. Department of Commercial Intelligence and Statistics, Ministry of Foreign Trade, Government of India.
- XIII. "Indian Economic Statistics, Part II, Public Finance", various issues, Department of Economic Affairs, Ministry of Finance, Government of India.
- XIV. "Economic Survey", various issues, Ministry of Finance, Government of India.
- XV. Kumar B. & Kumar J., "Growth of Public Sector - 1950-51 To 1965-66" presented at Sixth Indian Conference on Research in National Income, 1968.
- XVI. "Index Numbers of Wholesale Prices in India New Series Base 1961-62 = 100", Annual Numbers April 1962 - March 1970, and Jan 1968 - Dec 1972, Office of the Economic Adviser, Ministry of Industrial Development, Internal Trade and Company Affairs - earlier and later data supplied by the Office of the Economic Adviser.
- XVII. Roy S. and Sanderson F., "The Green Revolution in India - An Appraisal", Brookings Institution, Dec. 1975.
- XVIII. Ray S.K. in "Towards an Econometric Model of the Indian Economy" by Choudhary, N.K., Desai M., Gupta D.B., Krishnamurty K., Krishna K.L., Nagar A.L. (mimeo).

APPENDIX II

Data Notes

The data series used in the model as well as their sources were summarized in Appendix I. In this Appendix, we present some notes on the construction of the following series: (i) the index of area under commercial crops, A_C^I ; (ii) the index of output of commercial crops, O_C^I ; (iii) the price index of commercial crops, P_C ; (iv) the marketed surplus of foodgrains, S_f .

(i) Index of area under commercial crops

Commercial crops are defined to include fibres, oilseeds, and sugarcane. The individual indices for area under these groups are provided in "Estimates of Area and Production of Principal Crops in India 1973-74". The weights used to combine these individual indices are derived, using Table A as given below.

Table A

	<u>Area Under Commercial Crops</u> (in 'ooo hectares)			<u>Average of Three Years</u>
	<u>1959-60</u>	<u>1960-61</u>	<u>1961-62</u>	
Oilseeds ^{1/}	14669	14487	15495	14884
Fibres	8473	8695	9524	8897
Sugarcane (gur)	2137	2415	2455	2336

Source: Estimates of Area and Production 1973-74.

^{1/} Including five major oilseeds and coconut seed, and excluding cotton seed.

On the basis of the last column of Table A, the normalized wieghts of oilseeds, fibres, and sugarcane in the commercial crop index are .57, .34, and .09 respectively.

(ii) Output index of commercial crops

Output index of commercial crops is constructed by combining the three individual indices for oilseeds, fibres, and sugarcane, using the weights as given in Appendix E of "Estimates of Area and Production of Principal Crops in India 1973-74", i.e., 11.44, 5.04, and 7.79, for oilseeds, fibres, and sugarcane (gur) respectively in the total output index. When normalized, the weights for the commercial crop index are .471, .208, and .321 for the three groups respectively.

(iii) The price index of commercial crops

The wholesale price index of commercial crops is based on combining the respective indices of fibres, oilseeds, and sugar (sugarcane and gur), using the weights provided in Enclosure III of "A Note on the Index Numbers of Wholesale Prices in India (New Series)", 1969 (36).

(iv) Marketed surplus of foodgrains

In the construction of a series on marketed surplus of foodgrains, we use the following steps:

(a) We first obtain the estimates of total nonagricultural population as presented in Table B below.

Table B
Population Figures
(mid-crop-year)
(in millions)

	<u>1951-52</u>	<u>1961-62</u>	<u>1971-72</u>
Total	366.4	447.6	558.6
Rural	307.7	367.1	447.4
Rural Nonagricultural	56.9	76.3	79.2
Urban	58.6	80.5	111.2
Urban Nonagricultural	50.4	72.4	98.9
Total Nonagricultural	107.3	148.7	178.1

In Table B above, total population and its urban-rural distribution are obtained from census reports. The mid-crop-year figures are obtained by taking averages of the figures as of July 1 for two successive years. The 1951 urban-rural distribution figures are obtained from IBRD Staff Reports, where the urban figure is adjusted downwards from 17.3% to 16% in order to ensure consistency over time. In 1951, 86% of urban population and 18.5% of rural population was non-agricultural. In 1961, 89.96% of urban workers and 20.78% of rural workers were nonagricultural. In 1971, 88.9% of urban workers and 17.7% of rural workers were nonagricultural. Using these percentages, total nonagricultural population is

obtained for the three crop-years in Table B. For the intermediate years, total nonagricultural population figures (not shown here) are obtained by using the compound growth rate formula.

(b) We obtain the time series on the per capita expenditure on foodgrains by the urban sector from the various Rounds of National Sample Surveys on Consumer Expenditure. This series was constructed on crop-year basis by combining the results of various Rounds. These figures are presented below.

<u>Year</u>	<u>Per capita Rupee expenditure on foodgrains per year by the urban sector ^{1/}</u>
1951-52	75.24
1952-53	76.41
1953-54	73.97
1954-55	64.97
1955-56	68.25
1956-57	77.75
1957-58	76.89
1958-59	94.17
1959-60	93.68
1960-61	94.17
1961-62	98.18
1962-63	102.08
1963-64	103.42
1964-65	121.67
1965-66	121.91
1966-67	121.91
1967-68	161.09

^{1/} Figures for 1962-63, 1963-64, 1966-67, and 1969-70 are estimates based on incomplete information.

1968-69	160.96
1969-70	164.00
1970-71	167.41

(c) Using the information obtained in (a) and (b), we derive total expenditure on foodgrains by the nonagricultural population.

(d) A time series of price of foodgrains per ton is obtained by multiplying the wholesale price index of foodgrains with the price per ton of foodgrains in the base year. The latter is obtained by taking a weighted average of the wholesale prices of rice per ton and of wheat per ton, as provided in "Projections of Demand and Supply of Agricultural Commodities" by National Council of Applied Economic Research, September 1970. The weights used are the normalized weights of .325 and .675 for wheat and rice respectively, based on the weights of the two commodities in the wholesale price index of all commodities.^{1/} Thus, in 1961-62,

$$\begin{aligned}\text{price per} \\ \text{ton of foodgrains} &= .325(419.1) + .675(539.6) \\ &= 500.44\end{aligned}$$

(e) The data series on total expenditure on foodgrains and the price per ton of foodgrains are used to derive the quantity consumed of foodgrains by the nonagricultural population.

^{1/} Government of India (36).

(f) Finally, net distribution (i.e., distribution minus procurement) of foodgrains by the government is subtracted from the quantity consumed to obtain the marketed surplus of foodgrains.

The final series on the marketed surplus of foodgrains is presented below:

Marketed Surplus of Foodgrains
(in million tons)

1951-52	12.2
1952-53	14.1
1953-54	16.0
1954-55	19.3
1955-56	21.2
1956-57	18.7
1957-58	17.6
1958-59	20.6
1959-60	22.1
1960-61	23.0
1961-62	25.5
1962-63	25.1
1963-64	21.8
1964-65	19.6
1965-66	17.2
1966-67	12.3
1967-68	17.3
1968-69	23.4
1969-70	24.5
1970-71	27.7

We may note one final point about the series on the marketed surplus of foodgrains. In the process of constructing

this series, we ignored the marketed surplus of the agricultural sector. To the extent that agricultural laborers sell in the market in the immediate post-harvest period and buy back later, this marketed surplus is ignored. However, since the demand variable used in the price of foodgrains function is the nonagricultural income, ignoring the income of agricultural laborers, the treatment is consistent on the demand and the supply side.

APPENDIX III

Instrumental Variables

As mentioned in Chapter III, estimates of the individual equations of the model were obtained, using Two Stage Least Squares estimation procedure. In the first stage of the latter, instrumental variables were obtained for those endogenous variables of the model which appear as explanatory variables in other equations of the model. This was achieved by regressing each such endogenous variable on a set of exogenous variables, and taking the fitted value of the endogenous variable as the instrumental variable. These instrumental variables were then used in place of the endogenous explanatory variables in the estimation of the equations of the model. The estimates obtained by using Two Stage Least Squares are consistent.

Before presenting the instrumental variables, it is useful to focus on two properties of the model as presented in Chapters II and III, and summarized in Appendix IV. (i) The agricultural sub-block determining acreage, outputs of foodgrains and commercial crops, and agricultural income at constant prices, is recursive, and (ii) the model is nonlinear in that there are endogenous variables that appear in the model in two or more linearly independent forms.

The recursive nature of the agricultural sub-block enables us to treat the variables in this block as exogenous for our purpose of obtaining the instrumental variables.

As regards the nonlinearities in the model, these are of two kinds: (a) An endogenous variable Y_i appears in the model as Y_i and as $\text{Log}Y_i$, and (b) Endogenous variables Y_i and Y_j appear in the model as Y_i , Y_j , and $Y_i Y_j$. In the face of these nonlinearities, Two Stages Least Squares can still be used to yield consistent estimates of the coefficients, if certain rules are followed.^{1/} Thus, an instrumental variable for $\text{Log}Y_i$ is obtained by regressing this variable on a set of exogenous variables, so that its fitted value is independent of the error term. Again, an instrumental variable for $Y_i Y_j$ is obtained by regressing this multiplicative variable on polynomials in the exogenous variables -- all of the same degree.

Since the model is by and large linear within each block, the nonlinearities are limited to the specified interblock linkages in the model, and are handled as discussed above.

We present below the list of variables for which instrumental variables were obtained, with the included exogenous variables and the $\bar{R}^2$'s of the equations.

$$1. \quad P_f/P_m = F_1(O_{fn}^I, O_{fn}^I(-1), D_f^g, P_f^m(-1), Pop_n), \bar{R}^2 = .82$$

$$2. \quad P_c/P_m = F_2(O_c^I, O_c^I(-1), I^g), \bar{R}^2 = .87$$

$$3. \quad S_f^I = F_3(O_{fn}^I, O_{fn}^I(-1), D_f^g, Pop_n), \bar{R}^2 = .91$$

$$4. \quad Y' = F_4(O_{fn}^I, O_c^I, I^g, F'), \bar{R}^2 = .99$$

^{1/} Goldfeld and Quandt (24), and Kelejian (41).

5. $Y'_m = F_5(F', X', I^g), \bar{R}^2 = .98$
6. $\text{Log } n_m = F_6(\text{Log } O_{fn}^I, \text{Log } I^g(1), \text{Log } n_m(-1)), \bar{R}^2 = .75$
7. $\text{Log } k'_m = F_7(\text{Log } d'_k, \text{Log } i_i, \text{Log } F'), \bar{R}^2 = .99$
8. $\text{Log } U = F_8(\text{Log } X', \text{Log } P_O^m, \text{Log } I^g, \text{Log } (\text{Pop})), \bar{R}^2 = .87$
9. $\text{Log } V'_m = F_9(\text{Log } I^g, \text{Log } S), \bar{R}^2 = .95$
10. $\text{Log } M'_O = F_{10}(\text{Log } P_O^m, \text{Log } F', \text{Log } X', \text{Log } I^g), \bar{R}^2 = .88$
11. $\text{Log } P_I^g = F_{11}(\text{Log } P_k^m, \text{Log } (\text{Pop}), \text{Log } (O_{fn}^I), \text{Log } (P_f^m(-1))), \bar{R}^2 = .98$
12. $\text{Log } I^{PC'} = F_{12}(\text{Log } (i_i), \text{Log } (P_k^m), \text{Log } F', \text{Log } I^g, \text{Log } I^{gg'}(-1)),$
 $\bar{R}^2 = .74$
13. $\text{Log } M'_k = F_{13}(\text{Log } i_i, \text{Log } F', \text{Log } P_k^m, \text{Log } I^g), \bar{R}^2 = .90$
14. $\text{Log } Y^{mP'} = F_{14}(O_{fn}^I, O_C^I, I^g, F', \text{TLS}), \bar{R}^2 = .98$
15. $\text{Log } Y' = F_{15}(\text{Log } O_{fn}^I, \text{Log } I^g, \text{Log } F'), \bar{R}^2 = .98$
16. $\text{Log } Y'_n = F_{16}(\text{Log } I^g, \text{Log } F'), \bar{R}^2 = .97$
17. $\text{Log } I' = F_{17}(\text{Log } I^g, \text{Log } i_i, \text{Log } P_k^m), \bar{R}^2 = .95$
18. $\text{Log } Y'_m = F_{18}(\text{Log } I^g, \text{Log } F', \text{Log } X'), \bar{R}^2 = .98$
19. $Y_a = F_{19}(O_{fn}^I, (O_{fn}^I)^2, I^g, (I^g)^2), \bar{R}^2 = .95$
20. $Y_n = F_{20}(I^g, (I^g)^2, F', (F')^2), \bar{R}^2 = .955$

$$21. \quad DF^g = F_{21}(E_g^O, I^g, (I^g)^2), \bar{R}^2 = .99$$

$$22. \quad \text{Log } P = F_{22}(\text{Log}(J_f^I), \text{Log}(H_c^I), \text{Log}(\text{Pop}_n), \text{Log}(P_f^m), \text{Log}(I^g)), \bar{R}^2 = .90$$

23. $\text{Pop} = \text{Total population}$

24. $\text{Pop}_n = \text{Nonagricultural population}$

Appendix IV

Equations of the Model

1. $A_f = 2.432 + .694 A + .059 P_f/P_c (-1)$
2. $A_c^I = (A - A_f - A_o)/.26117$
3. $O_f = - 77.863 + .569 A_f + 2.565 H_f + .335 J_f^I$
4. $O_c^I = - 44.031 + .858 A_c^I + .455 H_c^I + .116 J_c^I$
5. $V_a' = 16.721 + .689 O_f + .1350_c^I$
6. $Y_a' = V_a' - I_a' - H^g'$
7. $Y' = - 11.005 + 1.401 Y_a' + 2.939 Y_m'$
8. $Y_n' = Y' - Y_a'$
9. $S_f = - 4442.7 + .406 O_{fn} + .259 O_{fn} (-1) - 68.1 \frac{P_f}{P_m} - 119.163 (P_c/P_m) (O_c^I/100)$
10. $P_f/P_m = 132.046 - .934 S_f^I + 1.034 Y_n' - .003 D_f^g$
11. $(P_f/P_m)^f = 1.886 + .982 P_f/P_m$
12. $P_c/P_m = 76.775 - .284 O_c^I + 2.118 Y_m' + .088 P_c^m (-1)$

$$13. \quad (P_c/P_m)^f = 5.824 + .943 P_c/P_m$$

$$14. \quad P_f/P_c = (P_f/P_m) \times 100/(P_c/P_m)$$

$$15. \quad \text{Log } v'_m = -4.848 + .482 \text{ Log } n_m + .285 \text{ Log } k'_m + .449 \text{ Log } U$$

$$16. \quad V'_m = v'_m \times S$$

$$17. \quad \text{Log } Y'_m = -.257 + .318 \text{ Log } V'_m + .030 T$$

$$18. \quad \text{Log } U = 5.254 + .052 \text{ Log } (M'_o/K'_m(-1)) + .293 \text{ Log } (I^g/Y \times 1000)$$

$$19. \quad k'_m = k'_m(-1) + I'_m/S - d'_k$$

$$20. \quad K'_m = k'_m \times S$$

$$21. \quad \text{Log } I'_m = .265 \text{ Log } I^{pc'} + .732 \text{ Log } I^{gn'}$$

$$22. \quad \text{Log } I^{pc'} = -2.615 - 2.300 \text{ Log } i_i + 1.561 \text{ Log } I^{gg'}(-1)$$

(1.9)
(6.0)
(4.6)

$$-.307 \text{ Log } K'_m(-1) + 3.613 P^c_m + .470 \text{ Log } M'_k$$

(3.3)
(4.7)
(2.4)

$$\bar{R}^2 = .917$$

$$DW = 2.550$$

$$23. \text{ Log } n_m = 1.93 (\text{Log } (.005) - 4.848 - \text{Log } \left(\frac{w_m}{p_m} \right) \times 100 + .285 \text{ Log } k'_m + .449 \text{ Log } U)$$

$$24. \text{ Log } w_m = .963 + .459 \text{ Log } (P_f(-1)) + .955 \text{ Log } (v'_m/n_m)(-1)$$

$$25. \text{ Log } M'_k = 5.040 - 1.155 \text{ Log } P^m_k + .159 \text{ Log } F'_{anf} + .710 \text{ Log } I'$$

$$26. \text{ Log } M'_o = - .175 - .597 \text{ Log } P^m_o + 1.077 \text{ Log } X' + .00003 F' + .202 \text{ Log } Y'_m$$

$$27. M' = M'_f + M'_k + M'_o$$

$$28. \text{ DFR}_{\text{RBI}} = X - (M'_f \cdot P^m_f/100) - (M'_k \times P^m_k/100) - (M'_o \times P^m_o/100) + S^{\text{net}} + F + \text{DFR}_o$$

$$29. \text{ FR}_{\text{RBI}} = \text{FR}_{\text{RBI}}(-1) + \text{DFR}_{\text{RBI}}$$

$$30. T^g_n = - 780 + 49.0 Y_n + 29.4 T$$

$$31. T^g_o = - 7087.7 + 184.4 Y_n + 119.0 T$$

$$32. \text{ Log } T^g_c = - 3.959 + 1.341 \text{ Log } M_o + .011 T$$

$$33. T^g = T^g_a + T^g_n + T^g_o + T^g_c$$

$$34. W^g = 64.054 + 51.924 P_f(-1) + .703 E^g_o$$

$$35. \text{ DF}^g = W^g + E^g_o + I^g - T^g - \text{NT}^g$$

$$36. \quad B_{bs}^g = DF^g - K_r^g$$

$$37. \quad DMB = - 785.041 + .183 DF^g + .060 FR_{RBI}(-1)$$

$$38. \quad MB = MB(-1) + DMB$$

$$39. \quad B_{RBI}^g = DMB - B_{RBI}^b - DFR_{RBI} - B_{RBI}^o$$

$$40. \quad B_b^g = B_{bs}^g - B_{RBI}^g$$

$$41. \quad \text{Log } C' = 2.160 - .566 \text{ Log } i_z + .708 \text{ Log } Y^{mp'} - .876 \text{ Log } (Y_a'/Y')$$

$$42. \quad \text{Log } L' = - .905 - .191 \text{ Log } i_z + .974 \text{ Log } Y^{mp'}$$

$$43. \quad \text{Log } (TD/D) = - 3.655 + 1.014 \text{ Log } Y_n' - .796 \text{ Log } i_g + .362 \text{ Log } i_d$$

$$44. \quad D = (L' - C') P/100$$

$$45. \quad TD = (TD/D) D$$

$$46. \quad L = L' (.5(MB + MB(-1)) - r \cdot TD) / (C' + R \cdot 100/P)$$

$$47. \quad P = L \cdot 100 / L'$$

$$48. \quad DD^f = - 521.509 + 1.098 D$$

$$49. \quad TD^f = - 333.307 + 1.097 TD$$

$$50. \quad B_b^p = TD^f - TD^f(-1) + D^f - D^f(-1) - (R - R(-1)) - B_b^g + B_{RBI}^b + B_b^o$$

$$51. \quad Y = Y' \cdot P/100$$

$$52. \quad P_a/P_n = .111 + .003(P_f/P_m)^f + .005(P_c/P_m)^f + .009 T$$

$$53. \quad P_m = -12.657 + 101.970 P_n$$

$$54. \quad P_m^a = 2.235 + .969 P_m$$

$$55. \quad P_f^f = (P_f/P_m)^f \cdot P_m/100$$

$$56. \quad P_c^f = (P_c/P_m)^f \cdot P_m/100$$

$$57. \quad Y^{mp'} = Y' + TLS'$$

$$58. \quad P_n = (P \cdot Y'/100) / (P_a \cdot Y_a'/P_n + Y_n')$$

$$59. \quad P_a = (Y - Y_n) / (Y' - Y_n')$$

$$60. \quad Y_a = Y_a' \cdot P_a$$

$$61. \quad Y_n = Y_n' \cdot P_n$$

$$62. \quad Y^{mp} = Y + TLS$$

$$63. \quad \text{Log } P_I^g = - 4.599 + .918 \text{ Log}(P) + .062 \text{ Log } (P_k^m)$$

$$64. \quad P_I^p = .082 + .007 P + .001 P_k^m$$

$$65. \quad \text{Log } I^{hh'} = - .925 + 2.062 \text{ Log } (Y')(-1)$$

$$66. \quad I' = I^{pc'} + I^{hh'} + I^{g'}$$

$$67. \quad I^p = (I^{pc'} + I^{hh'})/P_I^p$$

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