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RESEARCH REPORT 33 OCTOBER 1982

AGRICULTURAL GROWTH AND INDUSTRIAL PERFORMANCE IN INDIA

C. RANGARAJAN

More than 20 years ago, "The Role of Agriculture in Economic Development" discussed the ways in which agriculture can contribute to transforming a traditional low-income, agricultural economy into a modern high-income industrial one.* Since then, barring practices in a few countries and a small proportion of the literature on economic development, the relation between agricultural and industrial development has received very little treatment. In *Agricultural Growth and Industrial Performance in India,* Research Report 33, C. Rangarajan returns our attention to the interaction between agriculture and industry and defines the major points of influence of agricultural growth on industrial growth.

The study focuses on five major linkage relations between agriculture and industry. First, agriculture requires industrially produced inputs such as fertilizer, tools, and machinery. Second, agriculture supplies the raw materials for agriculture-based industries, which in India constituted 34 percent of total industrial output in 1970. In 1946, which represents an earlier stage of India's development, the industries based on agricultural raw materials constituted 66 percent of total industrial output. Third, agriculture affects industrial output through rural household demands for consumer goods and services. It is notable that the value of the share of industrial consumption goods consumed in rural areas is nearly two-and-a-half times larger than that of the share consumed in urban areas. Fourth, agriculture influences industry through government savings and public investment. If crops are good, the government will collect more taxes and spend less on relief measures. Additional government savings may then be directed to public investment, thus generating demand for basic and capital goods. And finally, fluctuations in the terms of trade between agriculture and industry affect private corporate investment as well as household savings and investment.

The study presents data on the year-to-year growth rates for agriculture and industry for the years 1961-75 and the quinquennial growth rates from 1951 to 1976. Although matching data on agricultural performance to industrial production is difficult, especially if the time period is short, certain movements seem to be related. For example, the decline in the output of the consumer goods industries in 1973 and 1975 reflects the decline in agricultural production in 1972 and 1974. But, because of the many other influences on industry, industrial growth cannot be expected to mirror agricultural growth exactly.

*Bruce F. Johnston and John W. Mellor, "The Role of Agriculture in Economic Development," *American Economic Review* 51 (September 1961).

SALIENT FEATURES OF INDUSTRIAL AND AGRICULTURAL GROWTH

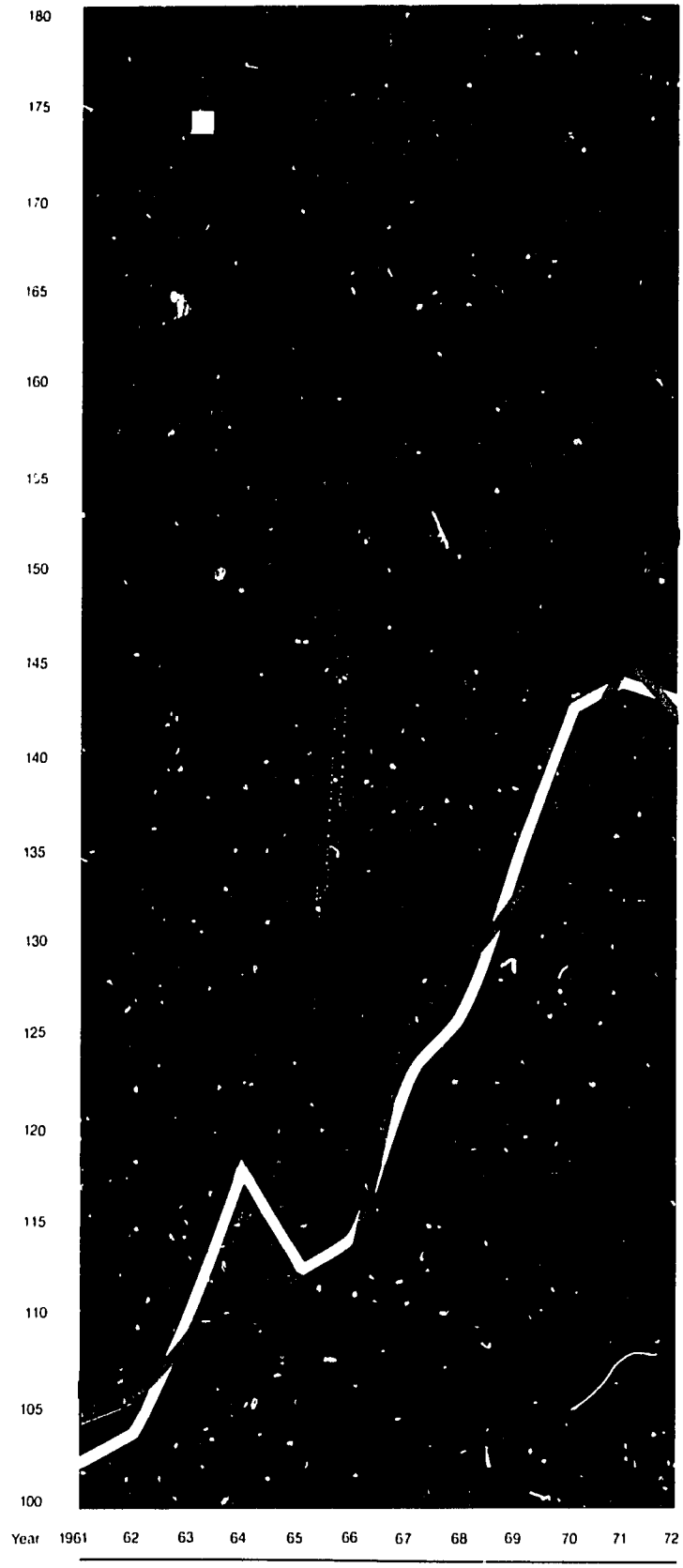
Agriculture's performance affects the industrial consumption goods industries directly, whereas the effects on the basic and capital goods industries occur indirectly through savings and investment linkages, which are affected by the size of agricultural output. For example, when crops are good, rural incomes rise, and farmers buy more goods—tools and machinery as well as household consumer goods such as clothing and sugar. They also save and invest more. The government gains because it collects more indirect taxes, such as those on rail freight, and perhaps saves on public relief expenditures. If the government, in turn, invests these savings in public works, basic and capital goods industries will again benefit from the increased demand for steel and machinery.

The production linkages of agricultural growth at this stage of India's development are naturally rather weak. Only about 13 percent of agricultural output goes to other sectors as inputs. Nevertheless industry is more dependent on agriculture for inputs than agriculture is on industry. This picture could change depending on the relative growth of agricultural technology and of processing industries.

An improvement in the agricultural terms of trade benefits those who sell agricultural commodities—mainly the well-to-do rural landowners. Because this group also buys most of the industrial consumption goods in rural areas, demand for these goods increases. On the other hand, urban families and lower-income rural families who must buy their food will spend more of their income on food if prices rise and less on industrial consumption goods. In testing this hypothesis, Rangarajan finds that an increase in both agricultural output and relative agricultural prices increases rural nonfood spending.

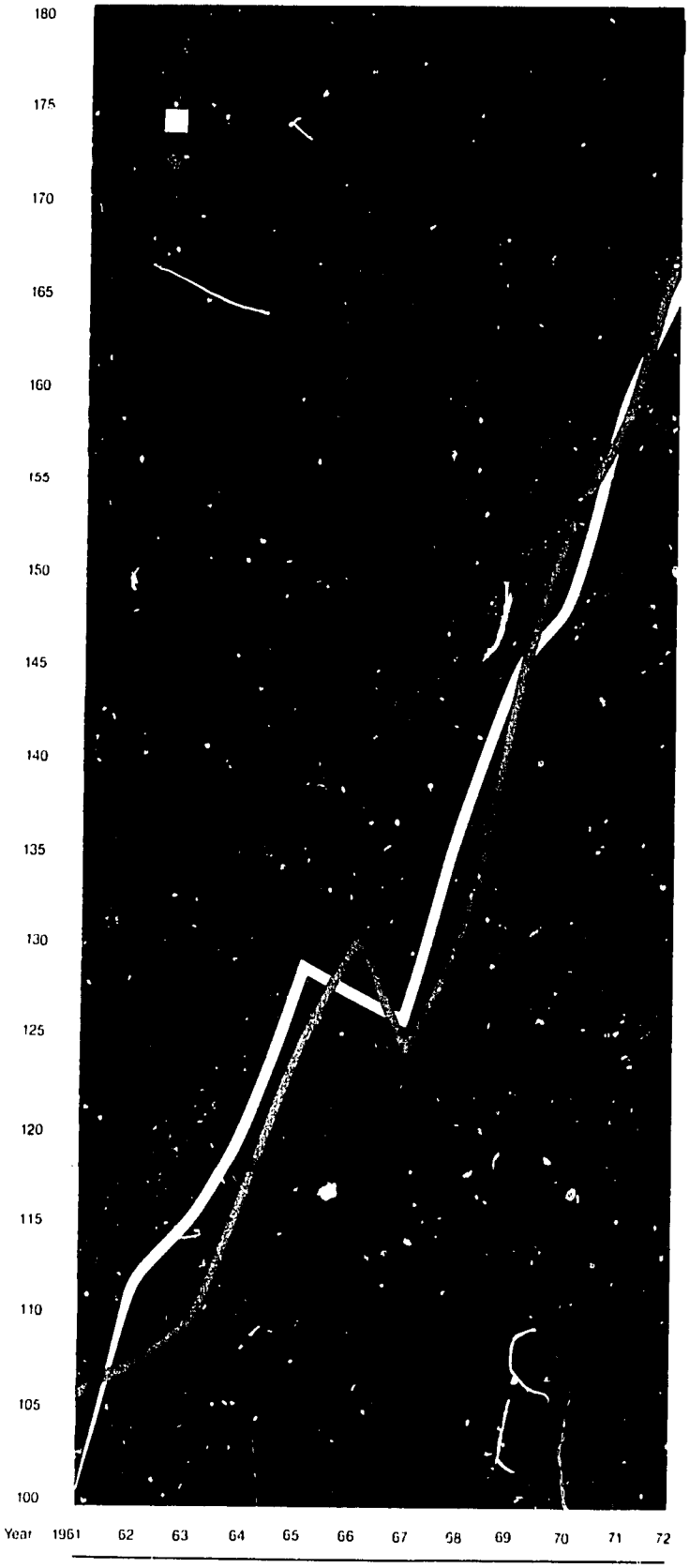
In analyzing influences on savings and investment, the effects on government and household savings and on corporate investment are examined separately. Income is the primary stimulus to increased household savings. Like demand, rural savings are influenced positively by a relative rise in agricultural prices, whereas urban savings are influenced negatively. In 1967/68 rural savings were in aggregate 1.83 times higher than urban savings. The estimated equations indicate that increased agricultural income positively affects both household and government savings. A rise in relative agricultural prices has a negative effect on corporate investment and on government savings; it has a positive effect on household savings.

Figure 1—Index of national income, actual and simulated, 1961-72



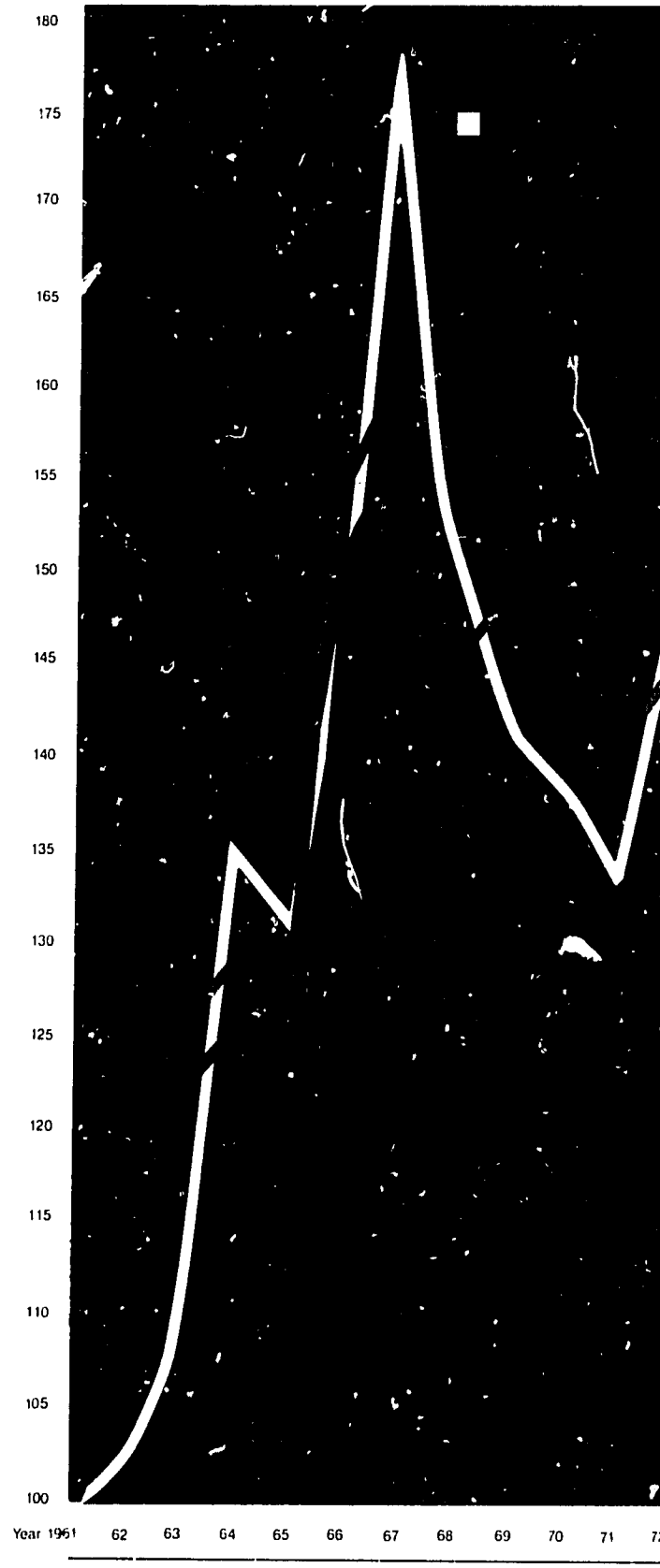
The simulation model developed in this study provides an accurate picture of the actual past movements of national income (Simulation I compared to the actual behavior). Introducing a boost in the agricultural growth rate of 1 percent (Simulation V) shows a very significant effect in growth of national income.

Figure 2—Index of the output of the consumer goods industries, actual and simulated, 1961-72



It can also be seen that accelerated agricultural growth has a sharply favorable effect on growth in consumer goods industries.

Figure 3—Foodgrain terms of trade, actual and simulated, 1961-72



The simulation is less effective in showing changes in relative agricultural prices. Nevertheless, the one percent higher agricultural growth rate (Simulation V) provides markedly lower relative foodgrain prices that not only accelerate overall growth but increase the real incomes of low-income people. Of course that can only occur if cost-decreasing technology is applied.

THE MODEL

In setting up a macroeconomic model to evaluate agriculture's influence, Rangarajan divides the linkages into three groups: production, demand, and savings and investment. The model, which is based on historical data covering 12 years, 1961-72, is constructed with appropriate lags. It does not explicitly include the demand for foodgrains that arises from industrial growth, though part of this effect is captured through the foodgrain terms of trade. The study does not attempt to relate a given rate of growth in agriculture to a rate of growth in industry. Instead, it asks what the effect on industry would be if agriculture grew at a certain rate. It appears that a 1 percent increase in agriculture will generate a 0.5 percent increase in industrial growth. Considering how many other factors influence industry, this is a strong influence. The resultant effect on national income is an increase of 0.7 percent. These are the results when relatively little government policy is specifically designed to enhance the influences of agricultural growth on industrial growth. A number of studies under way at IFPRI are directed toward discovering policies that may have that effect.

In the model agricultural output and its components are treated as exogenous variables, whereas the terms of trade are endogenous. Having separated total industrial output into consumption goods and basic and capital goods, Rangarajan determines the output of each.

Five simulations are run: Simulation I is the basic simulation; Simulation II shows the effects of a one-time increase in agricultural output; Simulation III studies the effects of a change in the relative prices of food grain; Simulation IV traces the results of a steady increase in agricultural output during the period; and Simulation V examines the influences of a 1 percentage point increase in the agricultural growth rate. The simulations are all deterministic but Simulation I is also stochastic.

The analysis shows that agricultural growth has a quite significant effect on industrial and overall growth. For example, accelerating the agricultural growth rate on Simulation V from the actual level of 2.35 percent to 3.35 percent raises the industrial growth rate from 4.58 to 5.08 percent and the rate of growth of national income from 3.10 to 3.31 percent (see Figure 1).

The effect of agricultural growth on the consumer goods industries is, of course, more direct and larger than the effect on capital and basic goods. But considering the indirect processes of these relations, through savings and investment in the household, government, and corporate sectors, the effect is by no means slight (see Figure 2).

The net effect of a rise in relative foodgrain prices on industrial output is negligible. This is because the negative effect on the output of consumer goods industries is cancelled by the positive effect on the output of the basic and capital goods industries. This is in sharp contrast to the positive net effect of an increase in agricultural output. Although the model does not include the effect of prices on agricultural production, a net positive effect may arise from that source. Of course, accelerating the growth rate of agricultural production does result in relatively lower food prices despite the stimulation effect on other sectors (see Figure 3).

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AGRICULTURAL GROWTH AND INDUSTRIAL PERFORMANCE IN INDIA

C. Rangarajan

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AGRICULTURAL GROWTH AND INDUSTRIAL PERFORMANCE IN INDIA

C. Rangarajan

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CONTENTS

Foreword

1. Summary 7

2. Introduction 8

3. Salient Features of Industrial and Agricultural Growth 10

4. Links Between Agriculture and Industry 13

5. The Macroeconomic Model 17

6. Conclusion 27

Appendix 1: Definitions of Variables 28

Appendix 2: Simulation Tables 29

Appendix 3: Figures Comparing Actual and Simulated Values 32

Bibliography 38

TABLES

1. Growth rates in the output of different sectors of industry and agriculture, 1951-76 10
2. Annual rates of growth in industrial and agricultural production, 1961-75 11
3. Equation system of the model 17
4. Estimated equations 21
5. Actual and simulated growth rates of selected variables, 1961-72 23
6. Actual and simulated annual growth rates in national income and industrial production, 1962-72 23
7. Deterministic and stochastic simulations, 1961-72 24
8. Simulated trends in national income, 1961-72 25
9. Actual values of six endogenous variables, 1961-72 29
10. Predicted values of six endogenous variables, Simulation I, 1961-72 29
11. Predicted values of six endogenous variables, Simulation II, 1961-72 30
12. Predicted values of six endogenous variables, Simulation III, 1961-72 30
13. Predicted values of six endogenous variables, Simulation IV, 1961-72 31
14. Predicted values of six endogenous variables, Simulation V, 1961-72 31

ILLUSTRATIONS

1. Structure of the model 20
2. Index of national income, actual and simulated, 1961-72 32
3. Index of industrial production, actual and simulated, 1961-72 33
4. Index of the output of the consumer goods industries, actual and simulated, 1961-72 34
5. Index of the output of the basic and capital goods industries, actual and simulated, 1961-72 35
6. Foodgrain terms of trade, actual and simulated, 1961-72 36
7. Terms of trade, actual and simulated, 1961-72 37

FOREWORD

In "The Role of Agriculture in Economic Development," written nearly a quarter of a century ago, Bruce Johnston and I discussed the principal means by which agriculture could assist in transforming a traditional low-income economy to a modern high-income one. In the intervening years the literature and much of the practice of development has been dominated by either emphasis on industrialization, independent of agricultural development, or on agriculture as a provider of basic human needs, independent of commercialization and industrialization. Perhaps the time is ripe to pick up the old threads of a dynamic interaction between agriculture and industry. Those threads lead to a very specific strategy for development of agriculture itself in which technological change plays the key role.

This research report by C. Rangarajan defines major points of influence of agricultural growth on industrial growth. The paper then attempts measurement of the broad relationships involved. In the process, valuable elements of description of these relationships and the measurement of associations provide a convincing argument for the significant effect that agricultural growth can have on industrial growth and a breakdown of the relative weight of the component parts.

In appraising the importance of the relationship Rangarajan sketches, it is notable that the value of the proportion of industrial consumption goods consumed in rural areas is nearly two-and-a-half times larger than the proportion consumed in urban areas. The study shows that these consumption linkages are much more powerful than the links from the use of inputs by agriculture or the provision of raw materials to industry.

This analysis then serves as a prelude to studies providing much more detailed information on the costs of obtaining agricultural growth, so that the costs may be compared with the benefits, more complete and alternative specifications of the relationships between agriculture and industry, and more precise measurement of those relations and their component parts. But, even more importantly, the analysis points out the need for careful studies at the farm, village, and rural regional levels of the precise nature of these interactions and hence the policies that may be applied to further develop and enlarge them. Current IFPRI field work in collaboration with the Tamil Nadu Agricultural University in Coimbatore, India, and with the Bangladesh Institute of Development Studies in Bangladesh will shed light on these matters. This work will not only corroborate the strong positive role of agriculture in development but will lead to policies to enhance that role.

It is notable that Rangarajan finds that a 1 percent addition to the agricultural growth rate stimulates a further 0.5 percentage point increase in the growth rate of industrial output (and hence a 0.7 percent increase in the growth rate of national income). This finding, though based on a different methodology, is roughly the same as the findings of Peter Hazell and his associates in the Muda River Project in Malaysia. It is perhaps fair to say that in neither case were there explicit policies to enhance this multiplier effect of agricultural growth. Thus a research effort to define the details of these relationships in order to find policies for enhancing the multipliers is well founded. At IFPRI we have a substantial effort under way to pinpoint investment and policy needs for increasing these multipliers, for turning agricultural growth into greater employment opportunities for the poor, and for generating a greater market for agricultural output—all summing up to a further increase in overall growth rates with broader participation in the benefits of that growth.

John W. Mellor

Washington, D.C.
October 1982

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1

SUMMARY

This report examines the linkages between agriculture and industry in India and tries to determine how close are the ties between agricultural performance and industrial growth. Agriculture influences industry in many ways. It generates demand for industrial products used in farming, such as fertilizer, tools, and machinery. It provides raw materials needed by agriculture-based industries. It fosters direct rural demand for consumer goods, such as clothing and sugar, and it creates indirect demand for basic and capital goods (such as steel and machinery) through its influence on the savings and investment of the household, corporate, and government sectors. For example, a rise in agricultural production leads to a rise in rural incomes, which leads to increased demand for industrial consumption goods. A rise in rural income also generates more household savings and investment. If crops are good, the government will collect more taxes and revenues from other sources such as railway freight. The government also saves because it spends less on public relief measures than it would in times of crop failure.

Although agricultural and industrial growth appear to be similar in many periods, they do not mirror each other exactly. Nor, considering the many other influences on industrial growth, should that be expected. For example, in 1961-65 when industrial growth in India was most rapid, agricultural performance was erratic. It may be that lags distorted the picture or that the effects of different linkages offset each other.

Agriculture influences industry through three types of linkages—production, demand, and savings and investment. A macroeconomic model incorporating all these relationships is constructed to study the effects of agriculture on the economy. The model does not explicitly incorporate the demand for foodgrains that arises as a result of industrial growth. However, it captures part of the effect through the foodgrain terms of trade. The model asks what the effect on industry would be if agriculture grew at a certain rate.

Historical data covering 12 years (1961-72) are used to estimate the quantitative relationships. Appropriate lag structures are also introduced. The model separates total industrial output into two categories: consumption goods and basic and capital goods. Agricultural output is treated as an exogenous variable, whereas the terms of trade between agriculture and industry are treated as endogenous.

To test the model, simulated values derived from the model are compared with the actual values. The model captures fluctuations in industrial production but there are wide differences in the values for year-to-year growth of basic and capital goods.

Simulation I, the basic simulation, is deterministic, but the model is also simulated stochastically. Simulation II shows the effects of a one-time increase in agricultural output. Simulation III takes one of the variables, foodgrain terms of trade, and traces the effect of a change in it. Simulation IV attempts to determine what would have happened if agricultural output had increased steadily during the period. Finally, Simulation V studies the influences of a 1 percent increase in the agricultural growth rate. The results of Simulations II and V indicate that a 1 percent growth in agricultural output increases industrial production by about 0.5 percent and thus national income by a little more than 0.7 percent.

2

INTRODUCTION

In an economy such as India's, where approximately half of the gross domestic product originates in agriculture and allied activities, it is generally assumed that the influence of agriculture on industry is strong. Before this assertion can be validated, however, the channels through which agricultural performance influences industrial growth must be clearly delineated. Only the examination of each of these links will show to what extent the performance of agriculture explains the behavior of industry.

There are at least five separate channels of influence. First, because agriculture requires industrial inputs, such as fertilizer, growth in agriculture generates demand for such industrial products. Perhaps as the technology of agricultural production changes, this link will become stronger.

Second, agriculture supplies the inputs needed by agriculture-based industries. This segment of the industrial structure accounted for 66 percent of total industrial output in 1946, 47 percent in 1960, and 34 percent in 1970. Obviously, the availability of agricultural raw materials must have a significant influence on these industries.[1]

Third, agriculture influences the output of industrial consumption goods through demand. Industrial consumption goods include clothing, footwear, sugar, edible oils, and furniture. It is not often recognized that rural consumption of industrial consumption goods is nearly two-and-a-half times that of urban consumption. However, it is necessary to distinguish between the output effect and the effect of the terms of trade between agricultural and industrial products on demand.

Given the income elasticities of demand for industrial consumption goods of the rural population, the effect of an increase in rural income resulting from a rise in agricultural production can be estimated. The changing pattern in the distribution of rural income and the elasticities of demand of the different classes will have to be taken into account to understand the effects in the long run. The effects of the terms of trade need to be analyzed from both the rural and urban perspectives. An increase in the terms of trade in favor of agriculture (particularly food prices) will adversely affect the demand for nonfood items in urban areas. The cross elasticity of demand is negative, especially among lower-income groups in urban areas where food consumption is a sizable part of the total budget.

In rural areas the effects of the terms of trade are not necessarily either solely positive or solely negative. The effects for lower-income groups will be the same in rural areas as in urban areas because the bulk of the rural population in this income group also buys food. For rural upper-income groups, the negative effect on demand arising from the increase in the terms of trade in favor of food can be offset by the increase in the income resulting from the improvement in agricultural prices. Thus the overall effect of the change in the terms of trade will be a combination of the effects for all population groups. The effect of an increase in food prices on the demand for nonfood items by different expenditure groups in rural areas can be broken into two parts. First, there is the negative cross elasticity of demand. Second, there is the positive income effect, which will depend on the increase in total expenditure from a rise in prices and on the expenditure elasticity of demand for nonfood items of that expenditure group. Thus the effect of a 1 percent rise in food prices will be $Eif + \alpha n_i$, where Eif is the cross elasticity of demand for good i (nonfood), α is the percentage increase in total expenditure due to a 1 percent increase in food prices, and n_i is the expenditure elasticity for i (nonfood) of that group. The value of α will be zero for low-income groups that do not sell any food; its value is likely to increase

[1] These two direct links between agricultural production and industrial production will be weakened if the industrial inputs required by agriculture are imported or if the agricultural inputs used in industry are exported, instead of being processed domestically.

moving from lower- to higher-income groups. Strictly speaking, if the effects of foodgrain prices alone are considered, the value of α will depend on the share of foodgrain output in the total output of each group. Also, because the income relevant in this context is monetary income, it will depend on the marketed surplus of each group. Thus, for higher-income groups in rural areas, the combined effect of the two parts can be positive.[2]

The fourth channel of influence is via government savings and public investment. A rise in agricultural production can result in increased government savings by increasing the amount of indirect taxes collected and by improving freight earnings for the railways. In addition, when crops are good, the government spends less on programs such as drought relief. An increase in government savings may, in turn, be reflected in higher public investment, which may generate the demand for the output of basic and capital goods industries. The combined weight of the basic and capital goods industries in total industrial production is 53 percent. One explanation for the decline in the growth rate of the industrial sector since 1965 is the fall in public investment; therefore, the link between public investment and agricultural performance, however indirect it may be, should be explored.

Fifth, fluctuations in agricultural production may affect private corporate investment decisions through the impact of the terms of trade on profitability. A low and stable price for wage goods (particularly food) may lead to increased profitability for industrial goods, which may be conducive to increased private corporate investment. On the other hand, an increase in the terms of trade in favor of agriculture may promote rural household savings and investment.

Whereas some of the channels emphasize the link between agriculture and industry on the supply side, others stress the link on the demand side. In subsequent chapters, each of these links is examined separately to see how strong each influence has been in India during the past 20 years. A model is constructed, which incorporates all these relationships, so that one can study the overall impact of agriculture's performance on the economy. First, however, a look at industrial growth and agricultural performance during the period 1955-75 will highlight some of the trends.

[2] For a discussion of this type of effect and some empirical estimates see: R. Radhakrishna, "Demand Functions and Their Development Implications in a Dual Economy, India," *The Developing Economies* 16 (June 1978): 199-210.

3

SALIENT FEATURES OF INDUSTRIAL AND AGRICULTURAL GROWTH

There are two distinct periods in the history of industry in India during the 20 years beginning in 1955. In the first decade industrial production increased at an average annual rate of 7.1 percent, but in the second decade, 1965-75, the growth rate fell sharply to 3.9 percent. Undoubtedly, the industrial structure of India is far more diversified now than it was in 1950. But the sluggishness of industrial production persisted for more than a decade and by 1975 had spread to all branches of industry.

Table 1 provides data on the rate of growth of industrial and agricultural production since 1951. Data on the growth rates of different sectors, such as basic goods, capital goods, and consumer goods, are also provided. Table 2 shows year-to-year rates of growth in the components of industrial and agricultural production from 1961 to 1975. The highest industrial growth rate was achieved during the period 1961-65. On average, industrial production grew by 9.0 percent per year. The sharpest increase was in the capital goods industries, which grew at an annual rate of 19.7 percent. This is partly accounted for by the low base those industries started from. During this period

Table 1 — Growth rates in the output of different sectors of industry and agriculture, 1951-76

Sector	1951-55	1956-60	1961-65	1966-70	1971-76
			(percent)		
Industry					
General index	6.68	5.70	9.0	3.7	3.6
Use-based classification					
Basic goods industries	30.90[a]	4.71[a]	10.5	6.2	5.3
Capital goods industries	...	...	19.7	1.4	5.4
Intermediate goods industries	5.79	9.83	7.19	3.99	1.84
Consumer goods industries	3.43	2.88	5.0	4.0	1.6
Input-based classification					
Agriculture-based industries	...	...	3.9	1.6	1.3
Metal-based industries	...	...	16.49	3.89	4.78
Chemical-based industries	...	...	8.25	9.[illegible]1	2.90
Sectoral indicators					
Transport	...	...	12.87	1.60	4.09
Electrical and allied activities	...	...	13.68	12.23	5.08
Agriculture					
All crops	4.3	4.3	1.0	6.8	2.7
Foodgrains	5.3	3.9	2.0	8.9	2.0
Nonfoodgrains	2.6	5.1	0.9	3.5	2.4

Sources: The figures for industry from 1951 to 1961 are from V. V. N. Somyajulu, "Structural Changes and Growth in Indian Industries 1946-1970," *Asian Economic Review* 16 (December 1974): 131-184; the figures for industry after 1961 are from Reserve Bank of India, *Report on Currency and Finance*, various volumes (Bombay: Reserve Bank of India, various years). All figures for agriculture are from India, Ministry of Agriculture and Irrigation, Directorate of Economics and Statistics, *Estimates of Area and Production of Principal Crops in India*, various issues (Delhi: Controller of Publications, various years).

[a] These figures are for the investment goods industries, which are the basic and capital goods industries.

the rate of growth of the consumer goods industries was 5.0 percent, which was the highest growth rate achieved by this segment of industrial output in any five-year period.

The period 1966-70 witnessed a dramatic decline in production. The growth rate fell to 3.7 percent. Although all segments of industrial production suffered during this period, the worst hit were the capital goods industries, which declined an average of 1.4 percent a year. The growth rate of the consumer goods industries declined only slightly. The growth rate of the agriculture-based industries decreased from 3.9 percent in the previous period to 1.6 percent during this period.

During 1971-75, the growth rate of industry was 3.6 percent, which was almost the same as in the previous period. However, the rates of growth of the different segments were strikingly different. The consumer goods industries suffered most during this period. Their growth rate fell to 1.6 percent. The capital goods industries improved their performance, and there was little change in the growth rate of agriculture-based industries. Thus, whereas the decline in industrial output during 1966-70 was primarily due to the setback in capital goods industries, during 1970-75 it was due to the decline in consumer goods industries.

Table 2 shows that, except during 1960-65 when rates of growth were uniformly high, the year-to-year changes have been quite uneven. During 1966-70, the highest rate of growth for industry as a whole was 7.5 percent and the lowest was -0.4 percent. During 1971-75 the highest and lowest growth rates achieved were 5.7 percent and 1.6 percent respectively. Nor did the different

Table 2—Annual rates of growth in industrial and agricultural production, 1961-75

Year	All Industries	Basic Goods	Capital Goods	Consumer Goods	Agriculture-Based Industries	All Crops	Food	Nonfood
				(percent)				
1961	9.2	12.7	18.0	6.6	5.2	0.0	0.8	0.2
1962	9.7	13.3	29.6	1.3	2.8	0.15	3.1	1.8
1963	8.3	14.2	11.1	2.2	2.6	2.4	0.6	2.6
1964	8.6	3.8	17.7	7.4	6.6	10.6	10.8	11.7
1965	9.2	8.6	22.0	7.5	2.4	16.7	19.0	11.4
1961-65 average	9.0	10.5	19.7	5.0	3.9	1.0	2.0	0.9
1966	0.4	5.2	13.9	2.9	0.9	0.0	2.6	3.2
1967	0.4	2.1	2.3	4.3	4.4	21.5	28.0	11.5
1968	6.8	10.2	3.4	4.9	3.5	1.5	1.0	2.1
1969	7.5	8.9	1.7	10.1	5.5	6.7	6.7	6.4
1970	5.1	4.6	4.9	6.4	4.5	7.2	8.9	5.1
1966-70 average	3.7	6.2	1.4	4.0	1.6	6.8	8.9	3.5
1971	4.2	4.6	5.5	3.2	0.5	0.0	1.3	2.0
1972	5.7	8.0	0.9	4.7	5.6	8.0	8.2	7.8
1973	1.6	3.1	15.8	0.5	0.1	9.9	7.8	14.4
1974	2.0	3.9	4.3	2.2	1.0	3.2	5.4	1.1
1975	4.7	13.3	9.5	1.5	1.6	15.2	22.0	2.5
1971-75 average	3.6	5.3	5.4	1.6	1.3	2.7	2.9	2.4

Sources: Calculations from data in India, *Economic Survey*, various issues (Delhi: Controller of Publications, various years); Reserve Bank of India, *Report on Currency and Finance*, various volumes (Bombay: Reserve Bank of India, various years); R. N. Lal, *Capital Formation and Its Financing in India* (Columbia, Mo.: South Asia Books, 1977); Vidya Pitre, "A Study of Trends in India's Imports: 1960-61 to 1974-75," *Economic and Political Weekly*, May 9, 1981, pp. 851-862; and Isher J. Ahluwalia, *Behavior of Prices and Output in India* (Madras: The Macmillan Company of India, 1979).

Notes: The growth rates of industrial production and their components up to 1970 were computed from the series with index 1960 equals 100 and thereafter from the index 1970 equals 100. The growth rates of agricultural output and their components were computed from the series with the triennium ending 1961-62 as a base.

segments of industry grow at the same pace in all years. For example, during 1971-75 the highest growth rates in the basic, capital, and consumer goods industries were reached in 1975, 1973, and 1972, respectively. The disparate behavior of output in different segments of industry points to the need for examining the factors affecting industry in each of the periods.

Against this background of industrial performance, it may be worthwhile to see whether developments in agriculture paralleled those in industry. Computing the growth rate for agriculture, where output changes have been quite sharp from year to year, is a hazardous exercise, particularly if the time period chosen is as short as five years. The inclusion or exclusion of a single year can alter the growth rate substantially. Based on longer time series, however, the general view now held is that there has been no significant decline in the rate of growth of agricultural output in recent years. A decline, if there is one, is perceptible only in non-foodgrains.

From the data on agricultural performance and industrial production, it is possible to see that certain movements are similar. Industrial production rose at an average annual rate of 6.2 percent between 1950 and 1960. This period was also marked by the rapid growth of agricultural output, particularly of foodgrains. Between 1950/51 and 1955/56, foodgrain production rose at an average annual rate of 5.3 percent. During the next five years the rate of growth was 3.9 percent per year. Although industrial production proceeded at an even pace, more or less, foodgrain output fell in four out of five years.

The drought years of 1965 and 1966 had a dramatic effect on industrial production. Industrial output, which had been growing steadily at about 9 percent per year in the previous five years, stopped growing in 1966 and 1967 (Table 2). The revival of industrial growth seen in the next three years was again associated with better performance in agriculture. More recently, the fall in the output of the consumer goods industries in 1973 and 1975 was associated with a fall in agricultural output in 1972 and 1974. But during the period 1961-65, when industrial growth was rapid, agricultural growth was erratic. Agricultural output rose only in 1963/64 and 1964/65. Whereas the foodgrain terms of trade rose during this period, their increase was moderated by annual imports of foodgrains of about 5 million metric tons.

Thus, although there appears to be a rough parallel between industrial growth and agricultural performance, one should not, even in theory, expect industrial production to be a simple reflection of agricultural performance. Industrial growth is fueled by many factors that are not directly influenced by agriculture.[3] On the other hand, raw data may hide some of the influences of agriculture on industrial performance because of the lags involved. Also, if there are several links between agriculture and industry, it is quite possible that whereas some may lead to an increase in industrial production, others may decrease it. It has already been pointed out that the effects of agricultural output on the demand for industrial consumption goods and on the terms of trade for different groups of people are different. In some situations governmental policy may partly offset the effects. A sharp rise in agricultural prices resulting from a decline in agricultural output may be offset by imports. It is therefore necessary to study the influences separately and then to combine them to find the total effect for a given period.

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[3] The deceleration in industrial growth since 1966 has been the subject of many studies. For example, see: P. Patnaik, "Disproportionality Crisis and Cyclical Growth," *Economic and Political Weekly*: Annual Number, February 1972, pp 329-336; K. N. Raj, "Growth and Stagnation in India's Industrial Development," *Economic and Political Weekly*: Annual Number, February 1976, pp. 223-236; T. N. Srinivasan and N. S. S. Narayan, "Economic Performance since the Third Plan and its Implications for Policy," *Economic and Political Weekly*: Annual Number, February 1977, pp 225-240; A. Vaidyanathan, "Constraints on Growth and Policy Options," *Economic and Political Weekly*: September 17, 1977, pp 1643-1650; D. Nayyar, "Industrial Development in India: Some Reflections on Growth and Stagnation," *Economic and Political Weekly*: Special Number, August 1978, pp. 1265-1278; S. Chakravarty, "On the Question of Home Market and Prospects for Indian Growth," *Economic and Political Weekly*: Annual Number, August 1979, pp 1229-1242; C. Rangarajan, "Strategic Issues in Industrial Development," *The Economic Scene*, January 1980, pp. 7-14.

4

LINKS BETWEEN AGRICULTURE AND INDUSTRY

The channels of influence discussed earlier can be grouped into three types of linkages—production linkages, demand linkages, and savings and investment linkages. The purpose of this chapter is to examine separately the nature and significance of each of these linkages in order to construct a macro model.[4]

Production Linkages

Agriculture and industry are linked to each other through the input-output relationship. The output of agriculture provides inputs for many industries, such as sugar, cotton textiles, jute textiles, and tobacco. The proportion of the value of agricultural inputs to the total value of output in these industries varies from 20 percent in matches to 95 percent in *gur* and *khandsari*, which are both forms of brown sugar. Agriculture also absorbs the outputs of other sectors as inputs required in the production process. The major industrial outputs coming under this category are fertilizers and electricity. With an input-output table, it is possible to compute a number of measures that illustrate this type of linkage.[5]

At India's present stage of development, it is only natural that the production linkages are not strong. (The Asian Development Bank's *Second Asian Agricultural Survey* also found that the intersectoral linkages were weak in several other Asian countries.[6]) According to a table of intersectoral transactions for 1968/69,[7] the total value of the output of agriculture and allied activities (including animal husbandry, forestry, and fishing) was Rs 19,702 crores.[8] The total value of inputs used in agriculture was Rs 4,840 crores. Of this, Rs 3,571 crores was the value of inputs coming from agriculture and allied activities. Thus only inputs worth Rs 1,269 crores came from the industrial and service sectors. This was only 6.4 percent of the value of total agricultural output. The flow of the output of agriculture and allied activities to other sectors constituted only a small share of the total value of their output. Output worth Rs 2,489 crores went to nonagricultural sectors as inputs. This was approximately 13 percent of the total output of agriculture and allied activities.

Dividing the economy into three sectors, agriculture, manufacturing, and services, and taking into account direct and indirect requirements, one can see that an increase of Re 1.00 in the final demand for agricultural goods results in an increase in the output of manufactured goods of Re 0.09 and of services of Re 0.02, whereas an increase of Re 1.00 in the final demand for manufactured goods results in an increase in the output of agricultural goods of Re 0.26.[9] In fact, a

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[4] For a pioneering study of the links between agriculture and industry, see A. Rudra, *Relative Rates of Growth—Agriculture and Industry* (Bombay: University of Bombay, 1967).

[5] Several ratios for understanding the agriculture-industry linkages are suggested in Asian Development Bank, *Rural Asia: Challenge and Opportunity* (New York: Praeger Publishers, 1978), pp. 102-126 and pp. 362-383.

[6] Ibid.

[7] Figures are taken from Reserve Bank of India, "Inter-Industry Transactions in the Indian Economy," *Reserve Bank of India Bulletin*, November 1978, pp. 892-935.

[8] In 1972, U.S. $1.00 was equal to Re 0.13. A crore equals 10 million.

[9] The A matrix of input coefficients that was obtained was as follows:

0.1812	0.1242	0.0199
0.0415	0.3887	0.1678
0.0112	0.0968	0.0949

The $(I - A)^{-1}$ matrix was:

1.2357	0.2630	0.0760
0.0907	1.7046	0.3181
0.0250	0.1857	1.1399

rupee increase in manufactured goods has a greater effect on agricultural output than on services. These data also show that the dependence of industry on agriculture is greater than that of agriculture on industry.

The dependence of agriculture on industry for inputs hinges on the technology used in agriculture. Similarly, the dependence of industry on agriculture for inputs hinges on the growth of processing industries, which in turn depends on the amount of income and perhaps export demand. In the short run there is no mechanism for strengthening these linkages, but in the long run structural changes in the production pattern of the economy are important.

Demand Linkages

The factors influencing the demand for industrial consumption goods, both rural and urban in origin, need to be understood clearly. As mentioned earlier, rural demand will be influenced by output changes in agriculture and by the terms of trade. If the terms of trade improve in favor of agriculture, those who buy agricultural commodities will be adversely affected, but those who sell agricultural commodities will benefit. It is well known that the bulk of industrial consumption goods in rural areas is bought by upper-income groups.[10] Because they often are also the sellers of agricultural commodities, an improvement in the terms of trade in favor of agriculture may increase the demand for industrial consumption goods.[11] To test this hypothesis, an equation is estimated relating nonfood expenditures (in constant prices) of the rural sector to the index of agricultural output (AQI) and the terms of trade (TT), which is defined as the ratio of the price of agricultural commodities to the price of manufactured finished products.[12] The independent variables are each lagged by one period. The data used to estimate the equation covers the period 1960/61-1970/71.[13]

The estimated equation for rural nonfood expenditures is:

$$\text{Rural nonfood expenditures} = 757.287 + \underset{(7.7)}{42.026}\ AQI_{t-1} + \underset{(7.08)}{22.526}\ TT_{t-1};$$

$$R^2 = 0.95.$$

The equation shows that the effects of both agricultural output and the terms of trade are positive. The numbers in parentheses are t-values. Both coefficients are statistically significant. The positive coefficient for the terms of trade is not only the result of the "pure" price effect, but also of the effect on monetary income brought about by a rise in agricultural prices relative to prices of manufactured goods.[14] The AQI

[10] National Sample Survey statistics show that the top 10 percent of the rural population accounts for 38 percent of the rural consumption of industrial goods. It has remained more or less at this level for several rounds. For details see S. Roy, "Demand for Industrial Consumer Goods in India — A Study of Linkages" (Ph.D. thesis, Indian Institute of Management).

[11] Many studies have shown that the bulk of the marketable surplus is concentrated in the hands of large landholders. See Dharm Narain, *Distribution of the Marketed Surplus of Agricultural Produce by Size-Level of Holdings in India 1950-51* (Bombay: Asia Publishing House, 1961). A recent micro study on Maharashtra shows that, for wheat, land holdings of more than 10 acres accounted for 60 percent of the total marketed surplus. Taking all foodgrains into account, these holdings accounted for 80 percent of the marketed surplus. See M. V. Nadkarni, "Marketable Surplus and Market Dependence: A Millet Region of Maharashtra," *Economic and Political Weekly*, March 29, 1980, pp. A14-A16.

[12] Rural nonfood expenditures were computed by applying the ratio of rural nonfood expenditures to total nonfood expenditures as revealed by the national income statistics on total nonfood consumption expenditures. Food expenditures included those on cereals, milk and milk products, edible oils, meat, eggs, fish, sugar, salt, and other foods. Expenditures on these items as well as rent and taxes were deducted from total consumption expenditures to obtain nonfood consumption expenditures.

[13] Two years for which NSS data were not available were omitted.

[14] The pure price effect of an increase in food prices on the demand for nonfood items has been found to be negative. See Radhakrishna, "Demand Functions and Their Implications," pp. 199-210; John W. Mellor, "Food Price Policy and Income Distribution in Low-Income Countries," *Economic Development and Cultural Change* 27 (October 1978): 1-26.

One way of separating the pure price effect from the kind of income effect referred to here is to introduce the index multiplied by terms of trade — not the index of agricultural output — as an independent variable to indicate the buying power of agriculture. If, along with this variable, the price of foodgrains is introduced, the two effects can be separated.

is substituted for by the index of marketed surplus (MKS) as an independent variable.[15] The revised equation is:

Rural nonfood expenditures =

$$432.584 + \underset{(4.04)}{36.564}\ MKS_{t-1} + \underset{(2.47)}{15.806}\ TT_{t-1};$$

$\bar{R}^2 = 0.87.$

Both independent variables are significant in this equation also.

In estimating the demand for urban nonfood expenditures, income originating in the nonagricultural sector (Y_{NA}) and the foodgrain terms of trade (FGTT), which are defined as the ratio of the price of food to the price of manufactured finished products, are included as independent variables. Thus,

Urban nonfood expenditures =

$$1{,}114.43 + \underset{(3.18)}{0.234}\ Y_{NAt-1} - \underset{(1.24)}{5.275}\ FGTT_{t-1};$$

$\bar{R}^2 = 0.58.$

As is to be expected, the coefficient of income is positive and the coefficient of foodgrain terms of trade is negative, though the latter variable is not statistically significant.

The major item included in nonfood expenditures is cloth consumption. The equation for rural demand for cloth is:

Rural cloth consumption =

$$491.516 + \underset{(1.78)}{3.473}\ AQI_{t-1} + \underset{(7.2)}{8.190}\ TT_{t-1};$$

$\bar{R}^2 = 0.90.$

The equation for urban demand for cloth is:

Urban cloth consumption =

$$68.084 + \underset{(5.42)}{0.037}\ Y_{NAt-1} - \underset{(0.84)}{0.341}\ FGTT_{t-1};$$

$\bar{R}^2 = 0.86.$

Income or the proxy for income in both equations has a positive coefficient, whereas the terms of trade have a positive coefficient only for rural consumption. The foodgrain terms of trade have a negative (though not statistically significant) coefficient for urban consumption.

Savings and Investment Linkages

Agricultural performance may affect the economy by influencing savings and investment. The effects on government and on households should be analyzed separately. The savings of government will be influenced by agricultural output, industrial output, and the terms of trade. Rises and falls in output have immediate effects on government revenues and eventually affect government expenditures. For instance, a severe decline in agricultural output may force the government to undertake relief measures, thereby increasing government expenditures. The terms of trade, particularly for foodgrains, also affect government expenditures through their effect on allowances payable to government employees.[16] As a rule, one expects agricultural and industrial output to influence government savings positively and the foodgrain terms of trade to influence them negatively. Both influences may work with a lag.

The household sector includes individuals and all noncorporate forms of business. Household savings are largely influenced by income. The effect of the terms of trade on household savings is analogous to their effect on the demand for industrial consumption goods. Rural savings are influenced positively whereas urban savings are influenced negatively. A survey conducted by the National Council of Applied Economic Research (NCAER) shows that in 1967/68 net rural and urban savings were Rs 1,296 crores and Rs 708 crores respectively.[17] Thus rural savings were 1.83 times higher than urban savings. If this is the pattern of

[15] Data on the index of marketed surplus were taken from R. Thamarajakshi's article "Role of Price Incentives in Stimulating Agricultural Production in a Developing Economy," in *Food Enough or Starvation for Millions*, ed. Douglas Ensminger (Columbia, Mo.: University of Missouri, 1976), pp. 325-479.

[16] Government savings as a percentage of tax revenue fell from 18 percent in 1965/66 to 12 percent in 1966/67 and to 9 percent in 1967/68.

[17] National Council of Applied Economic Research, *All India Household Survey of Income, Savings, and Consumer Expenditure* (New Delhi: NCAER, 1972), p. 81.

household savings, the total effect of the terms of trade on household savings and, therefore, investment can be positive.

The effect on the corporate sector can be traced directly to investment. Output, both agricultural and nonagricultural, will influence corporate investment positively through the effect on the demand for industrial goods. An increase in agricultural prices relative to industrial prices will have a negative influence. There are two reasons for this. First, a relative increase in nonfoodgrain prices adversely affects the profitability of agriculture-based industries by increasing the costs of production. Second, a relative increase in foodgrain prices may push up the wage costs, reducing profitability.

During the period 1961-65 the average of the index of the net barter terms of trade between agriculture and industry was 104.6. During the period 1966-70 the average of the index was 123.48. For 1,259 medium and large public limited companies surveyed by the Reserve Bank of India during 1961-65, the average profits were 10.3 percent of total capital employed. During 1966-70 this percentage, for 1,420 medium and large public limited companies, fell to 9.4. Industries not dependent on agricultural inputs are adversely affected only by an increase in foodgrain prices. Agriculture-based industries are affected not only by the prices of foodgrains but also by the prices of nonfoodgrain agricultural products. Profits as a percentage of the total capital employed fell more conspicuously in agriculture-based industries than in others.[18]

The estimated equations relating to household and government savings and corporate investment are presented below. Savings are measured in constant prices. Current price figures are deflated by the implicit investment cost index of the Central Statistical Organization. The data used cover the period 1952/53-1972/73. For the household sector, two independent variables are used—the index of national income in constant prices (NYI) and terms of trade (TT). The same independent variables are used to explain corporate investment. For government savings, in addition to national income, the foodgrain terms of trade are used as an independent variable.[19]

Therefore,

Household savings =

$$-2{,}910.25 + \underset{(7.2)}{27.07}\ NYI_{t-1} + \underset{(2.2)}{17.32}\ TT_{t-1};$$

$\bar{R}^2 = 0.93$;

Government savings =

$$122.667 + \underset{(10.91)}{10.3}\ NYI_{t-1} - \underset{(2.81)}{4.25}\ FGTT_{t-1};$$

$\bar{R}^2 = 0.88$;

and

Corporate investment =

$$-451.66 + \underset{(6.68)}{8.86}\ NYI_{t-1} - \underset{(3.51)}{9.78}\ TT_{t-1};$$

$\bar{R}^2 = 0.74$.

Income has a positive effect on the savings of both households and government. The terms of trade have a negative effect on investment in the corporate sector and on government savings, whereas they have a positive influence on household savings.

[18] For an analysis of this problem, see Ashok Mitra, *Terms of Trade and Class Relations: An Essay in Political Economy* (London: Frank Cass, 1977), pp. 147-158. Also see John W. Mellor, *The New Economics of Growth: A Strategy for India and the Developing World* (Ithaca, N.Y.: Cornell University Press, 1976), pp. 138-141.

[19] The total terms-of-trade variable and the foodgrain terms-of-trade variable used in these equations are taken from Thamarajakshi, "Role of Price Incentives." She defines the total terms of trade as the net barter terms of trade of all products traded between agriculture and nonagriculture. The foodgrain terms of trade are defined as the ratio of the price of foodgrains to the price of nonagricultural products purchased by agriculture.

5

THE MACROECONOMIC MODEL

In constructing a model to study the effects of agricultural performance on industrial growth, the three types of linkages mentioned above are kept in mind. Because the primary aim of the study is to determine the influence of agriculture on industry, agricultural output and its components, foodgrains and nonfoodgrains, are treated as exogenous variables.[20]

In this model national income is determined by agricultural and industrial output. Because agricultural output is treated as exogenous, the most important variable to be determined within the system is industrial output. The features of this model that distinguish it from others are the decomposition of total industrial output into consumption goods and basic and capital goods and the separate determination of the output of each segment. The output of consumption goods is directly determined by certain income factors, and the terms of trade between agriculture and industry are also determined endogenously. The output of basic and capital goods is derived from the influence of agricultural output and the terms of trade on investment by different sectors of the economy.

The Equation System

The equations used in the model are presented in Table 3. Equation (1) states that the index of national income is determined

Table 3—Equation system of the model

Equation Number	Equation
1	$NYI_t = a_0 + a_1 AQI_t + a_2 IQI_t + U_{1t}$
2	$ICI_t = b_0 + b_1 IQI_{t-1} + b_2 AQI_{t-1} + b_3 FGTT_{t-1} + U_{2t}$
3	$FGTT_t = c_0 + c_1 IQI_{t-1} + c_2 NAFG_t + c_3 ICI_t + U_{3t}$
4	$NFGTT_t = d_0 + d_1 ICI_t + d_2 NFI_{t-1} + d_3 DMRMI_t + U_{4t}$
5	$TT_t = e_1 FGTT_t + e_2 NFGTT_t$
6	$GCFHH_t = g_0 + g_1 NYI_{t-1} + g_2 TT_{t-1} + U_{6t}$
7	$GCFPC_t = h_0 + h_1 NYI_{t-1} + h_2 TT_{t-1} + U_{7t}$
8	$DSAVPU_t = k_0 + k_1 NYI_{t-1} + k_2 FGTT_{t-1} + U_{8t}$
9	$GCFPU_t = l_0 + l_1 DSAVPU_t + l_2 DKIF_t + l_3 T + U_{9t}$
10	$GCF_t = GCFPC_t + GCFHH_t + GCFPU_t$
11	$IBKI_t = m_0 + m_1 GCF_t + m_2 MKI_t + U_{11t}$
12	$IQI_t = n_0 + n_1 ICI_t + n_2 IBKI_t + U_{12t}$

Note: The variables are defined in Appendix 1.

[20] It is possible to make agricultural output an endogenous variable by making it a function of past investment and the terms of trade between agriculture and industry, which are determined within the system, and certain other exogenous variables, such as weather. For one such attempt see Isher J. Ahluwalia, *Behavior of Prices and Output in India* (Madras: The Macmillan Company of India, 1979). However, because this paper stresses the effects of agriculture on industry, agricultural output is treated as an exogenous variable in the model.

by the indexes of agricultural output and industrial output. This is treated as a stochastic equation, and not as an identity, because the third component in national income—income originating from the service sector—is determined by the output of the other two sectors.[21]

Equations (2), (3), and (4) determine, respectively, the output of industrial consumption goods, the ratio of food prices to the prices of manufactured consumption goods, and the ratio of nonfood prices to the prices of manufactured consumption goods. These three equations have been derived using certain assumptions about the behavior of these markets. According to equation (2), output of industrial consumption goods in the current period is determined by demand, which is dependent on agricultural output, industrial output, and the ratio of food prices to those of manufactured consumption goods, all of the previous year.[22] Equation (3) is derived from the relationship between prices of manufactured consumption goods and the output of consumption goods, on the one hand, and between food price and the availability of food and demand for food, on the other. As the supply curve of industrial consumption goods slopes upward, the price of industrial consumption goods will rise as output determined by demand increases. In the foodgrain market, supply is fixed exogenously. The price of foodgrains is therefore determined by demand factors and supply. Demand factors influence the price of foodgrains positively and supply negatively.[23]

Thus the ratio of food prices to the price of manufactured consumption goods is dependent on three variables: the industrial output of the previous year, the net availability of foodgrains in the current year, and the output of consumption goods in the current year. The industrial output of the previous year affects the ratio positively because it pushes up the price of food through increased demand for food. The net availability of foodgrains (which includes the domestic output of the previous year and imports of the current year) has a negative effect, as the price of food falls with increased availability. The output of consumption goods has a positive influence on the price of manufactured consumption goods and therefore a negative effect on the ratio of foodgrain price to the price of

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[21] Consider the following identity:

$$NYI = a_1 AQI + a_2 IQI + a_3 SI,$$

where NYI, AQI, and IQI have the same meaning as before and SI is the index of income originating from the service sector. Suppose that

$$SI = b_0 + b_1 AQI + b_2 IQI + U.$$

Then, if the latter is substituted for the former,

$$NYI = a_3 b_0 + (a_1 + a_3 b_1) AQI + (a_2 + a_3 b_2) IQI + a_3 U.$$

[22] Chapter 3 differentiates between rural and urban nonfood consumption expenditures, showing why the ratio of agricultural prices to the prices of manufactured goods has different effects in rural and urban areas. Logically, that dichotomy should have been used in the macro model also. Unfortunately there are not enough data available to build a separate series showing consumption of industrial consumption goods in rural and urban areas. Therefore, only one equation is used. The inclusion of the foodgrain terms of trade of the previous year in equation (2) also needs some explanation. What this equation implies is that demand of industrial consumption goods in the current year is determined by the effective income of the previous year. This income is decomposed into two parts—output and relative price.

[23] The market for foodgrains may be specified:

$$F^d = a - bp_f + c\,IQI \text{ (demand for food)},$$

$$F^s = s_f \text{ (supply of foodgrains)}, \text{ and}$$

$$F^d = F^s \text{ (equilibrium condition)},$$

where F is the quantity of foodgrains, p_f is the price of foodgrains, and IQI is the index of industrial production. In the demand equation the appropriate income variable is taken as the index of industrial production. It follows from this that

$$p_f = a/b - 1/b\,F + c/b\,IQI.$$

manufactured consumption goods.

Similarly, in equation (4) the ratio of the price of nonfoodgrains to the price of manufactured consumption goods is negatively influenced by the availability of nonfoodgrain output and the importation of raw materials. The output of industrial consumption goods will affect both the numerator, which is the price of nonfoodgrain output, and the denominator, which is the price of manufactured consumption goods. The sign of the coefficient of this particular variable depends on the relative effect of the output of manufactured consumption goods on the price of nonfood agricultural output and the price of manufactured goods. Equation (2), together with equation (3), implies that the price of industrial consumption goods in the current period is adjusted to the amount of output determined by demand. However, in the next period the current-period price influences demand for industrial consumption goods. Thus, it becomes clear that the output of manufactured consumption goods over time is not determined by demand factors alone.

Equation (5) is simply an identity that treats the terms of trade between agriculture and industry as a weighted average of the ratio of food prices to the price of manufactured consumption goods and the ratio of nonfood price to the price of manufactured consumption goods. The weights depend on the output of foodgrains and nonfoodgrains, which in the model are treated as exogenous. In fact, equation (5) could have been avoided altogether and the two terms of trade variables could have been introduced separately where appropriate. But, in estimating some of the equations, the introduction of two separate variables raises problems of multicollinearity.

Equation (6) relates the gross fixed capital formation of the household sector to the national income and terms of trade between agriculture and industry, both of the previous period. Note that the gross fixed capital formation of the household sector also includes investment on farms. Therefore, as argued in Chapter 3, the terms-of-trade variable is expected to have a positive influence. Equation (7) makes gross capital formation of the private corporate sector dependent on national income and the terms of trade of the previous year. The terms-of-trade variable is expected to exercise a negative influence on profitability and therefore on investment by the corporate sector.

Equation (8) determines the savings of the public sector. The national income of the previous period and the foodgrain terms of trade of the previous period are used as explanatory variables. The former variable is expected to have a positive effect and the latter a negative effect, as has already been explained. Equation (9) relates the gross capital formation of the public sector to the savings of the public sector, capital inflows from abroad, and a time trend, which is added to express the planners' intention to continue increasing public investment.

Equation (10) is an identity, stating that total gross capital formation is equivalent to the sum of the gross capital formation by the household, corporate, and government sectors. In equation (11), output of basic and capital goods is related to gross capital formation and to imports of capital goods. The former has a positive influence and the latter a negative influence.

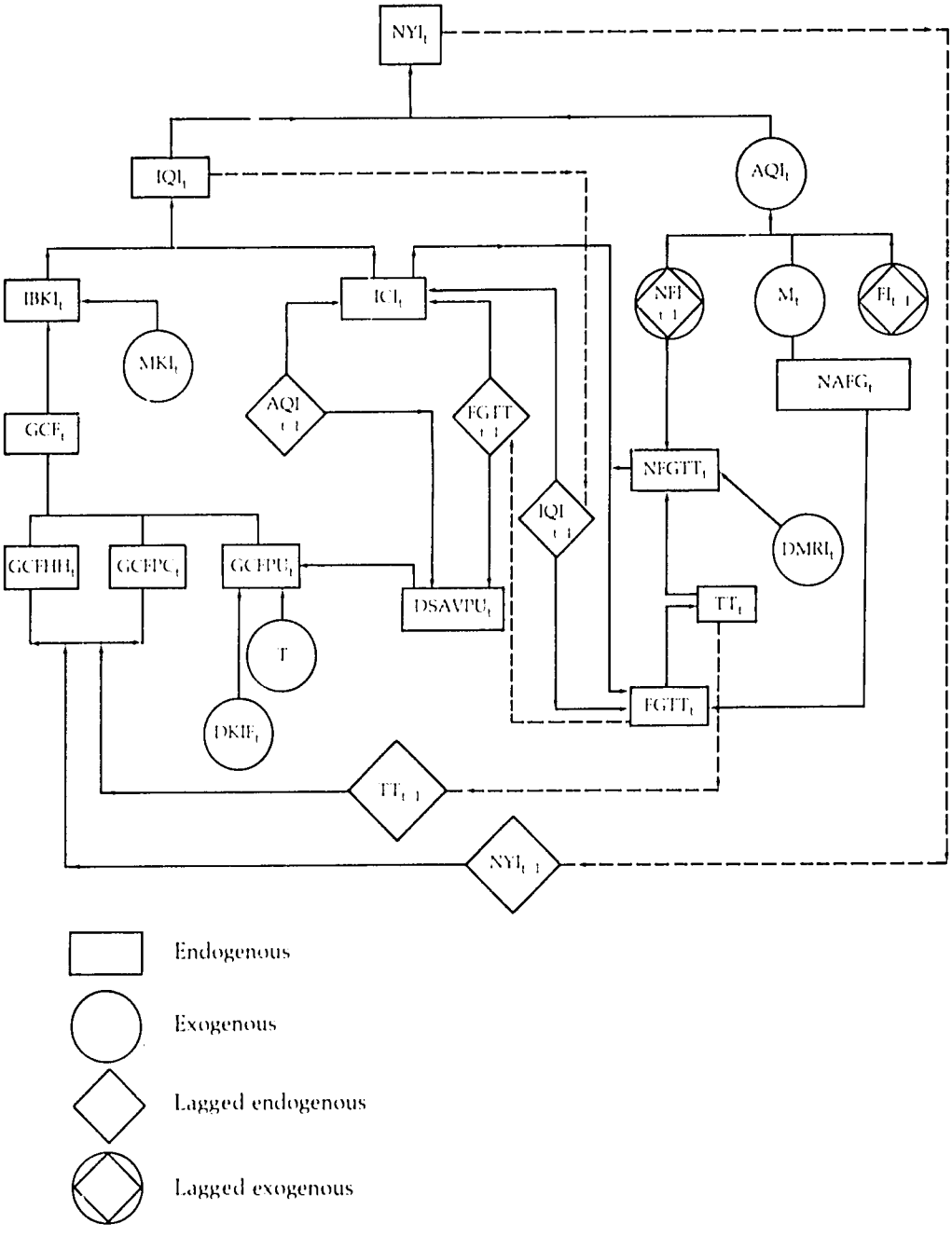
In equation (12), total output of industrial production is made a function of the output of industrial consumption goods and the output of capital goods. Like equation (1), equation (12) is treated as a stochastic equation and not as an identity, because output of intermediate goods is taken to be determined indirectly by the output of industrial consumption goods and of basic and capital goods.

This model does not incorporate the output effect of investment. Nor is money introduced in the model because behavior is linked to relative price ratios. Figure 1 is a diagrammatic representation of how the model works. Total agricultural output—foodgrain output, nonfoodgrain output, capital inflows, imports of foodgrains, raw materials, and capital goods—is treated as exogenous. The terms of trade, the output of industrial consumption goods, the output of basic and capital goods, the output of industrial production, the gross fixed capital formation of the various sectors, and national income are endogenously determined.

The Estimated Equations

The model uses observations for the period 1961-72. This period was chosen because uniform data are available for the

Figure 1—Structure of the model



Note: The segmented lines connect the present and past values of the same variables.

entire period. Although the number of observations is limited, the period represents years of industrial growth as well as decline. After 1972 there was a change in the weights attached to basic and capital goods and consumption goods, making it extremely difficult to construct a series for later years with the earlier weights. Furthermore, consistent data for the components of gross fixed capital formation are not available. The precise definition of the variables used in the model are given in Appendix 1.

All the equations are estimated using ordinary least squares (see Table 4). Because the model is recursive, this procedure is admissible. In addition, the correlations between the residuals have been examined to make sure this procedure is legitimate.[24] In order to test the degree of independence among contemporary disturbances, the correlation matrix of errors was estimated. At the 1 percent level of significance, none of the errors are correlated with one another. At the 5 percent level, there are 4 correlations out of a total of 45 that are significant. When the equations concerned are reestimated using two-stage least squares, the resulting equations are not very different

Table 4—Estimated equations

Equation Number	Equation	R^2	D.W.
1	$NYI_t = 9.664 + \underset{(21.9)}{0.343}\ IQI_t + \underset{(30.72)}{0.542}\ AQI_t$	0.99	2.38
2	$ICI_t = 4.868 + \underset{(9.68)}{0.612}\ IQI_{t-1} + \underset{(3.94)}{0.447}\ AQI_{t-1} - \underset{(1.60)}{0.094}\ FGTT_{t-1}$	0.97	1.94
3	$FGTI_t = 140.274 - \underset{(0.426)}{0.503}\ NAFG_t + \underset{(3.36)}{2.113}\ IQI_{t-1} - \underset{(1.78)}{2.07}\ ICI_t$	0.71	2.00
4	$NFGTI_t = 132.996 + \underset{(3.47)}{0.893}\ ICI_t - \underset{(1.94)}{1.062}\ NFI_{t-1} - \underset{(1.02)}{0.167}\ DMRMH$	0.56	0.88
5	$TI_t = 0.446\ FGTI_t + 0.554\ NFGTI_t$		
6	$GCFHH_t = 2,196.0 + \underset{(3.40)}{11.679}\ NYI_{t-1} + \underset{(6.06)}{18.518}\ TI_{t-1}$	0.93	2.90
7	$GCFPC_t = 535.116 + \underset{(2.33)}{4.430}\ NYI_{t-1} - \underset{(3.07)}{5.261}\ TI_{t-1}$	0.40	2.35
8	$DSAVPU_t = 134.483 + \underset{(3.90)}{6.113}\ NYI_{t-1} - \underset{(1.77)}{1.896}\ FGTI_{t-1}$	0.[illegible]	1.19
9	$GCFPU_t = 245.277 + \underset{(2.06)}{1.180}\ DSAVPU_t + \underset{(2.44)}{39.751} + \underset{(1.86)}{0.665}\ DKIE_t$	0.57	1.38
10	$GCI_t = GCFHH_t + GCFPC_t + GCFPU_t$		
11	$IBKI_t = 1.708 + \underset{(10.22)}{0.060}\ GCI_t - \underset{(1.18)}{0.048}\ MKI_t$	0.98	2.00
12	$IQI_t = 10.189 + \underset{(12.23)}{0.508}\ IBKI_t + \underset{(4.72)}{0.379}\ ICI_t$	0.99	1.17

Notes: The variables are defined in Appendix 1. The numbers in parentheses are t-statistics. The equation numbers refer to the equations in Table 3.

[24] In a recursive system, ordinary least squares can be used to estimate the equations, provided the error terms of the equations are independent. The Proximity Theorem of Wold somewhat modifies the rigor of these conditions. As Franklin M. Fisher put it, "If all terms above the diagonal in A are *nearly* zero, if cross equation covariance between contemporary disturbances is small and if there is little serial correlation, ordinary least squares will not do too badly." (Franklin M. Fisher, "Dynamic Structure and Estimation in Models," in *The Brookings Quarterly Econometric Model of the United States*, ed. J. S. Duesenberry, E. Kuh, G. Fromm, and L. R. Klein [Chicago: Rand McNally, 1965], p. 598)

from the estimates obtained with ordinary least squares.

The coefficients in the various equations are in agreement with expectations. Output of industrial consumption goods is positively influenced by the industrial output and the agricultural output of the previous year. These two variables represent the effects of income. Both are statistically significant. The foodgrain terms of trade of the previous year have a negative impact. An alternative formulation of the same equation used marketable surplus as an independent variable instead of total agricultural output. This, however, did not explain any more than the equation used.[25]

In determining the foodgrain terms of trade, industrial output of the previous year has a positive effect and the availability of foodgrains has a negative one. The output of industrial consumption goods has a negative sign, as is to be expected, because it must influence positively the denominator of the ratio. The nonfoodgrain terms of trade are positively influenced by the output of industrial consumption goods. This variable affects both the numerator and the denominator of the ratio. The net effect is positive. The availability of nonfoodgrains and the importation of raw materials have negative influences.

The terms of trade positively affect fixed investment by households and negatively affect fixed investment by the corporate sector.[26]

Income has a positive influence on fixed investment by the household and corporate sectors. Public savings are positively influenced by the national income of the previous year and negatively influenced by the foodgrain terms of trade of the previous year. Public sector fixed investment is positively influenced by public savings, capital inflows, and the time trend. Output of basic and capital goods is positively influenced by gross fixed capital formation, which is the sum of gross fixed capital formation in the household, corporate, and public sectors. Imports of capital goods have a negative impact on output of basic and capital goods.

The explanatory power of most of the equations judged by the value of $\bar{R}^2$ is satisfactory. The D.W. statistic is inconclusive in only four equations. For the rest of the equations, the hypothesis of autocorrelation can be rejected. The performance of the model is tested in Simulation I by simulating it for the sample period, using the estimated equations and incorporating the given values of the exogenous variables. The actual and simulated values for all the simulations are given in Appendix 2, Tables 9-14, and charts depicting the behavior of the actual and simulated series are provided in Appendix 3, Figures 2-7.

Simulations of the Model

The two series correspond closely for most of the variables. To compare the performance of the simulated series with the actual series in relation to the endogenous variables, the mean absolute error and the mean absolute percentage error are calculated:[27]

Variable	Mean Absolute Error	Mean Absolute Percentage Error
NYI	1.18	0.954
IQI	3.73	2.47
IBKI	6.68	3.93
ICI	2.63	2.12

Both are found to be small.

It is, however, more instructive to look at the rates of growth. Table 5 gives the growth rates of some of the variables. The actual growth rate of national income was about 3.3 percent and the simulated growth

[25] If marketable surplus is used as an independent variable, one can relate it at the next stage to total agricultural output and income distribution. It may then be possible to study the impact of income distribution on the entire system. The link between marketable surplus and the terms of trade and the relative share of labor is discussed in Uma Lele and John W. Mellor, "Technological Change, Distributive Bias and Labor Transfer in a Two Sector Economy," *Oxford Economic Papers* 33 (November 1981): 426-441.

[26] The explanatory power of the equation relating to gross fixed capital formation in the private corporate sector is not good. However, when the time period is extended to begin in 1952/53, the same equation offers a significantly better explanation, as can be seen in Chapter 3.

[27] The variables are defined in Appendix 1.

Table 5—Actual and simulated growth rates of selected variables, 1961-72

Variable	Actual	Simulation I	Simulation IV	Simulation V
NYI	3.27	3.101	3.122	3.811
IQI	5.00	4.579	4.625	5.079
IBKI	6.02	5.389	5.404	5.803
ICI	4.15	4.016	4.155	4.772

Sources: Calculations from data in India, *Economic Survey*; various issues (Delhi: Controller of Publications, various years); Reserve Bank of India, *Report on Currency and Finance*, various volumes (Bombay: Reserve Bank of India, various years); R. N. Lal, *Capital Formation and Its Financing in India* (Columbia, Mo.: South Asia Books, 1977); Vidya Pitre, "A Study of Trends in India's Imports: 1960-61 to 1974-75," *Economic and Political Weekly*, May 9, 1981, pp. 851-862; and Isher J. Ahluwalia, *Behavior of Prices and Output in India* (Madras: The Macmillan Company of India, 1979).

Notes: The figures in this table are the growth rates of time series that have been computed using semi-log equations. NYI stands for the index of national income; it is in 1960/61 prices. IQI stands for the index of industrial production; 1960 equals 100. IBKI stands for the index of the output of the basic and capital goods industries; 1960 equals 100. ICI stands for the index of the output of the consumer goods industries; 1960 equals 100.

Simulation I is the basic model described in the text. Simulations IV and V use that model, but Simulation IV assumes a steady increase in agricultural output and Simulation V raises the growth rate of agriculture by 1 percent.

rate was 3.1 percent. The actual rate for industrial production was 5.0 percent, whereas the Simulation I rate was 4.6 percent.

The year-to-year rates of growth in national income and different components of industrial production for the actual and simulated series are also computed (see Table 6). The declines in national income in 1965 and 1972 are captured in the simulated series. However, the crucial test of the model is in relation to industrial production. The sharp decline in the rate of growth in industrial production in 1966 is captured by the simulation. In 1967 industrial production showed a small negative growth rate whereas the simulation shows a slight positive change.

Table 6—Actual and simulated annual growth rates in national income and industrial production, 1962-72

	National Income		Industrial Production		Outcome of the Consumer Goods Industries		Outcome of the Basic and Capital Goods Industries	
Year	Actual	Simulation I	Actual	Simulation I	Actual	Simulation I	Actual	Simulation I
1962	1.9	2.0	9.7	7.6	1.3	9.7	18.9	7.5
1963	5.6	3.6	8.3	5.8	2.2	3.1	13.1	8.1
1964	7.5	7.6	8.6	5.4	7.4	3.8	9.9	2.3
1965	-5.1	5.0	9.2	9.3	7.5	7.4	12.1	11.5
1966	0.9	0.3	-0.4	0.6	2.9	-0.05	-2.6	0.9
1967	8.2	11.1	0.4	2.6	4.3	1.9	0.2	5.3
1968	2.9	2.2	6.8	7.1	4.9	8.7	7.8	7.0
1969	6.3	3.7	7.5	1.1	10.1	5.8	6.5	-1.2
1970	5.9	6.6	5.1	7.0	6.4	2.6	4.7	10.1
1971	1.1	1.9	0.9	4.9	3.2	7.9	3.4	3.9
1972	1.3	2.9	7.1	2.2	4.7	3.8	8.4	1.9

Sources: Calculations from data in India, *Economic Survey*; various issues (Delhi: Controller of Publications, various years); Reserve Bank of India, *Report on Currency and Finance*, various volumes (Bombay: Reserve Bank of India, various years); R. N. Lal, *Capital Formation and Its Financing in India* (Columbia, Mo.: South Asia Books, 1977); Vidya Pitre, "A Study of Trends in India's Imports: 1960-61 to 1974-75," *Economic and Political Weekly*, May 9, 1981, pp. 851-862; and Isher J. Ahluwalia, *Behavior of Prices and Output in India* (Madras: The Macmillan Company of India, 1979).

For basic and capital goods, however, there are large differences between the two series in the year-to-year growth rates.

Simulation 1, the basic simulation of the model, assumes that the disturbance term attached to each equation takes on the expected value, which is zero. Such simulations are deterministic. On the other hand, stochastic simulation takes into account the presence of the stochastic element in each behavioral equation. In this type of simulation, a random value from a normal distribution with mean zero and variance equal to the estimated variance of the disturbance is added to each equation.[28] The model is also simulated stochastically for the sample period. Each stochastic simulation experiment is replicated 60 times to obtain the mean values of the variables. Table 7 shows that the mean values obtained through stochastic simulation are in close agreement with the deterministic solution. The mean absolute percentage error between the two series is almost negligible. In the subsequent simulations, which study the effects of certain variables on the total system, only the deterministic simulation is used. In all, five simulations are included. Table 8 compares the simulated trends in national income.

Effects of a One-Time Increase in Agricultural Output

To study the effect of an increase in agricultural output in one year, the index of agricultural output—both foodgrain and nonfoodgrain output—is raised by 1 percent

Table 7—Deterministic and stochastic simulations, 1961-72

Year	NYI		IQI		IBKI		ICI	
	Deterministic Simulation	Mean Stochastic Simulation	Deterministic Simulation	Mean Stochastic Simulation	Deterministic Simulation	Mean Stochastic Simulation	Deterministic Simulation	Mean Stochastic Simulation
1961	105.09	105.02	115.45	115.15	130.99	131.74	102.15	100.88
1962	107.22	106.66	124.20	122.99	140.87	138.99	112.02	111.32
1963	111.03	110.97	131.35	131.14	152.33	151.43	115.51	115.41
1964	119.47	118.76	138.42	136.89	162.97	159.80	119.89	120.41
1965	113.49	112.76	151.31	149.20	181.74	178.24	128.77	127.65
1966	113.84	113.13	152.19	150.53	183.50	180.92	128.71	126.80
1967	126.42	126.25	156.16	155.76	193.19	192.80	126.19	125.52
1968	129.24	128.79	167.22	165.77	206.74	203.37	137.22	137.41
1969	134.02	134.30	168.98	169.62	204.28	205.60	145.16	144.41
1970	142.93	142.83	180.89	180.44	224.88	223.27	148.97	149.66
1971	145.72	145.51	189.83	189.38	233.65	223.02	160.82	159.94
1972	141.49	141.71	194.09	194.69	237.92	239.53	166.24	165.60
Mean absolute error	0.356	0.356	0.917	0.917	1.810	1.810	0.786	0.786
Mean absolute percentage error	0.294	0.294	0.606	0.606	0.997	0.997	0.608	0.608

Sources: Calculations based on data in India, *Economic Survey*, various issues (Delhi: Controller of Publications, various years); and Reserve Bank of India, *Report on Currency and Finance*, various volumes (Bombay: Reserve Bank of India, various years).

Notes: NYI stands for the index of national income; it is in 1960/61 prices. IQI stands for the index of industrial production; 1961-62 equals 100. IBKI stands for the index of the output of the basic and capital goods industries; 1960 equals 100. ICI stands for the index of the output of the consumer goods industries; 1960 equals 100.

[28] For an examination of the role and purpose of stochastic simulation see Eric R. Sowey, "Stochastic Simulation of Macro Econometric Models: Methodology and Interpretation" in *Econometric Studies of Macro and Monetary Relations*, ed. Alan A. Powell and Ross A. Williams (New York: Elsevier-North Holland, 1973), pp. 195-227.

Table 8—Simulated trends in national income, 1961-72

Year	Simulation I	Simulation II	Simulation III	Simulation IV	Simulation V
1961	105.089	105.089	105.089	102.23	105.65
1962	107.224	107.224	107.224	105.97	108.52
1963	111.032	111.595	111.058	109.96	113.13
1964	119.472	119.660	119.483	113.70	123.01
1965	113.488	113.497	113.498	117.96	117.33
1966	113.842	113.883	113.849	123.94	118.39
1967	126.423	126.444	126.428	127.59	132.52
1968	129.241	129.258	129.245	130.24	136.47
1969	134.019	134.030	134.022	132.99	142.61
1970	142.927	142.936	142.929	137.12	153.29
1971	145.724	145.731	145.725	140.45	157.43
1972	141.492	141.497	141.493	143.60	153.66

Sources: Calculations from data in India, *Economic Survey*, various issues (Delhi: Controller of Publications, various years); Reserve Bank of India, *Report on Currency and Finance*, various volumes (Bombay: Reserve Bank of India, various years); R. N. Lal, *Capital Formation and Its Financing in India* (Columbia, Mo.: South Asia Books, 1977); Vidya Pitre, "A Study of Trends in India's Imports: 1960-61 to 1974-75," *Economic and Political Weekly*, May 9, 1981, pp. 851-862; and Isher J. Ahluwalia, *Behavior of Prices and Output in India* (Madras. The Macmillan Company of India, 1979).

Notes: Simulation I is the basic model described in the text. The other four simulations add different assumptions to that model. Simulation II adds a 1 percent increase in foodgrain and nonfoodgrain output in 1963. Simulation III raises the foodgrain terms of trade in 1962 by one. Simulation IV assumes a steady increase in agricultural output. Simulation V raises the growth rate of agriculture by 1 percent.

in 1963, and to study its effect over a period of time, a second simulation is attempted. In 1963, the year in which agricultural output is increased by 1 percent, national income is 0.51 of 1 percent higher under Simulation II than under Simulation I. In the following year income is 0.16 of 1 percent higher (see Table 8). The total effect spread over a number of years will increase income by 0.76 percent. Because income originating in agriculture during this period constituted only 50 percent of the national income, the rest of the increase in income must have been contributed by the effect of agriculture on the rest of the economy.

Effects of Foodgrain Terms of Trade

As stated before, the foodgrain terms of trade affect industrial production through the demand for industrial consumption goods and for basic and capital goods. The effect on consumption goods is direct. The effect on basic and capital goods is reflected through the impact on savings and investment. To assess the total effect on the system, these two effects must be combined.

The foodgrain terms of trade are treated as an endogenous variable in this system. Their effect on the system can be studied by raising the constant term in the foodgrain terms of trade equation by one and then tracing its effect on the total system. Thus, the model is simulated by increasing the constant term by one for the year 1962. This is Simulation III. Then the differences in national income that arise as a consequence are studied (see Table 8). The predicted values for five selected variables are given in Appendix 2, Table 12.

Increasing the foodgrain terms of trade by 1 in 1962 causes the index of national income to rise by 0.023 in 1963. In the second year the index of income goes up by 0.009, in the third year by 0.008, in the fourth year by 0.006, and in the fifth year by 0.004. The negative effect of a rise in the foodgrain terms of trade on consumption goods is almost compensated for by the positive effect such a rise has on savings and investment and therefore on the production of basic and capital goods. Simulation results show that the net effect of a rise or fall in the foodgrain terms of trade on the economy is negligible. It must be noted, however, that the construction of the model ignores the effects of changes in the foodgrain terms of trade on production. If, in fact,

production increases as a result of a rise in the foodgrain terms of trade, the positive effect may increase.[29]

Effects of a Steady Increase in Agriculture

To study the impact on the economy of a steady increase in agricultural output during this period, the actual values of agricultural output are replaced in Simulation IV by the values obtained by fitting a trend line. (Table 5 shows the growth rates of four select variables under this simulation.) The predicted values for five select variables are given in Appendix 2, Table 13. With a steady increase in agricultural output, national income increases by 3.12 percent a year, compared with 3.10 percent in Simulation I (see Table 5). Because no changes have been made in the annual imports of foodgrains, the steady increase moderates the fluctuations in the foodgrain terms of trade. For example, the foodgrain terms of trade according to Simulation I were 155.61 in 1966 and 162.49 in 1967. But with a steady increase in output and the same amount of imports, the foodgrain terms of trade for these two years were 133.99 and 143.23. The foodgrain terms of trade in Simulation IV are higher than in Simulation I in the later years because output is lower in those years, according to the trend.

Effects of an Increase in the Agricultural Growth Rate

What would have been the effect on the economy if the growth rate in agriculture had been 1 percent higher? According to the data for agricultural output, the annual rate of growth during the period studied was 2.35 percent. The model is simulated using a growth rate in agriculture of 3.35 percent. After obtaining trend values for the new growth rate, deviations from the trend are superimposed in the same proportions as in the historical period. This new set of data is used for agricultural output and then the model is simulated (Simulation V). (The growth rates for four select variables from this simulation are found in Table 5.) The effect on national income is shown in Table 8 and Appendix 2, Table 14 and contains the predicted values for five variables. The growth rate of national income in this simulation is 3.81 percent, compared with 3.10 percent in Simulation I. The growth rate of industrial production increases from 4.58 percent to 5.08 percent. The effect on industrial consumption goods is greater than that on basic and capital goods. One can conclude from this, as well as from Simulation II, that a 1 percent increase in agricultural output has the effect of increasing the national income by a little more than 0.7 percent. These results show that agriculture can act to some extent as a stimulus to industrial development.

[29] The possible effects on agricultural output of a rise in the terms of trade in favor of agriculture under conditions of stagnant and changing technologies is discussed in John W. Mellor, "Food Price Policy," pp. 1-26. Ashok Mitra is, however, quite emphatic in his conclusion. He writes, "It is not possible to argue that, in India, the output of most of the principal crops has responded positively to the shift in terms of trade in favour of agriculture." See Ashok Mitra, *Terms of Trade and Class Relations*, p. 121.

6

CONCLUSION

The primary focus of this study is on determining the effects of agricultural performance on industrial growth. Agriculture influences industry in many ways. It provides the raw materials needed by agriculture-based industries. It generates direct demand for the output of consumption goods industries. It creates indirect demand for the output of basic and capital goods industries through its effect on the savings and investment of the different sectors.

In this report a model is constructed to evaluate these interacting effects. Appropriate lag structures are also introduced. The model does not explicitly incorporate the demand for foodgrains that arises as a result of industrial growth. However, a part of this effect is captured through the foodgrain terms of trade. Thus the model does not directly answer the question of what rate of growth in agriculture corresponds to a given rate of growth in industry. It poses the question the other way around. It asks what the impact on industry would be if agriculture grew at a certain rate. Data covering 12 years are used to estimate the quantitative relationships. It must be noted at the outset that the quantitative effects revealed by the data depend on the strategies of development that were actually adopted.

The main conclusion that emerges from this analysis is that agriculture exercises a reasonably strong influence on the growth of industry. The simulations show that a 1 percent growth rate in agriculture can by itself generate a rate of growth of 0.5 percent in industry. This is a strong influence considering that industrial growth is not totally dependent on what happens in agriculture. However, because the ability to raise the agricultural growth rate is limited, industry cannot rely on agriculture alone to stimulate growth.

The effects of agriculture's performance are felt by the consumption goods industries and by the basic and capital goods industries. The effect on demand for industrial consumption goods is direct. The effect on the output of basic and capital goods occurs through savings and investment. The savings and investment of the different sectors are affected by the size of agricultural output as as well as by the terms of trade between agriculture and industry. The effects on the output of the capital and basic goods industries are less strong than the effects on the output of consumption goods industries.

Although agricultural output and the terms of trade both influence industrial output, this study shows that the net effect of a rise in the foodgrain terms of trade on the economy is negligible. The negative effect on the output of consumer goods industries is cancelled out by the positive effect on the output of the basic and capital goods industries.

The importance of agriculture for industry lies not only in the raw materials supplied by agriculture but also in the demand for industrial output it generates. The quantitative estimates of the linkages show that the impulses generated by agriculture can have an important influence on the rest of the economy.

APPENDIX 1
DEFINITIONS OF VARIABLES

AQI: Index of agricultural production; its base period is the triennium ending in 1961/62.

DKIF: Capital inflows; in 1960/61 prices.

DMRMI: Index of inedible crude material imports, except fuel; 1960/61 prices.

DSAVPU: Savings of the public sector; in Rs 10 million.

FGTT: Index of the terms of trade of foodgrains; P_f/P_m.

GCF: Gross fixed capital formation; the sum of GCFHH, GCFPC, and GCFPU.

GCFHH: Gross fixed capital formation of households; in Rs 10 million, 1960/61 prices.

GCFPC: Gross fixed capital formation of the private corporate sector; in Rs 10 million, 1960/61 prices.

GCFPU: Gross fixed capital formation of the public sector; in Rs 10 million, 1960/61 prices.

IBKI: Index of the output of the basic and capital goods industries; 1960 equals 100.

ICI: Index of the output of the consumer goods industries; 1960 equals 100.

IQI: Index of industrial production; 1960 equals 100.

MKI: Imports of capital goods (Rs 10 million) deflated by the unit value index of capital goods imports.

NAFG: Net availability of foodgrains; imports of one year plus domestic production of the year before.

NFGTT: Index of the terms of trade for nonfoodgrains; P_{nf}/P_m.

NFI: Index of nonfoodgrain production; its base period is the triennium ending in 1961/62.

NYI: Index of national income; in 1960/61 prices.

P_f: Price index of foodgrains; 1961/62 equals 100.

P_m: Price index of finished manufactured goods; 1961/62 equals 100.

P_{nf}: Price index of nonfoodgrains; 1961/62 equals 100.

TT: Index of the terms of trade; the ratio of the price of agricultural commodities to the price of manufactured finished products.

APPENDIX 2 SIMULATION TABLES

Table 9—Actual values of six endogenous variables, 1961-72

Year	NYI	IQI	IBKI	ICI	FGTT	TT
1961	103.51	109.2	114.4	106.6	100.00	100.00
1962	105.50	119.8	136.1	108.0	101.94	99.32
1963	111.37	129.7	154.0	110.4	109.52	103.24
1964	119.77	140.8	169.3	118.6	135.20	121.20
1965	113.72	153.8	189.8	127.5	132.75	122.16
1966	114.73	153.2	184.8	131.3	147.58	134.35
1967	124.12	152.6	185.1	125.7	179.53	148.20
1968	12[illegible].70	163.0	199.6	131.9	152.27	135.90
1969	135.84	175.3	212.6	145.3	147.57	139.14
1970	143.98	184.3	222.6	154.1	138.93	135.14
1971	145.50	186.1	230.8	159.7	134.37	124.75
1972	143.62	199.4	250.1	167.2	147.62	130.98

Sources: Calculations from data in India, *Economic Survey*, various issues (Delhi: Controller of Publications, various years); Reserve Bank of India, *Report on Currency and Finance*, various volumes (Bombay: Reserve Bank of India, various years); R. N. Lal, *Capital Formation and Its Financing in India* (Columbia, Mo.: South Asia Books, 1977); Vidya Pitre, "A Study of Trends in India's Imports: 1960-61 to 1974-75," *Economic and Political Weekly*, May 9, 1981, pp. 851-862; and Isher J. Ahluwalia, *Behavior of Prices and Output in India* (Madras: The Macmillan Company of India, 1979).

Notes: NYI stands for the index of national income; it is in 1960/61 prices. IQI stands for the index of industrial production; 1960 equals 100. IBKI stands for the index of the output of the basic and capital goods industries; 1960 equals 100. ICI stands for the index of the output of the consumer goods industries; 1960 equals 100. FGTT stands for the index of the terms of trade for foodgrains, defined as the ratio of the price index of foodgrains (1961/62 equals 100) to the price index of manufactured goods (1961/62 equals 100). TT stands for the index of the terms of trade, defined as the ratio of the price of agricultural commodities to the price of manufactured finished products.

Table 10—Predicted values of six endogenous variables, Simulation I, 1961-72

Year	NYI	IQI	IBKI	ICI	FGTT	TT
1961	105.09	115.45	130.99	102.15	101.24	100.53
1962	107.22	124.20	140.87	112.00	113.22	110.83
1963	111.03	131.35	152.33	115.51	125.04	113.94
1964	119.47	138.42	162.97	119.89	129.41	119.84
1965	113.49	151.31	181.74	128.77	122.65	114.11
1966	113.84	152.19	183.50	128.71	155.61	134.95
1967	126.42	156.16	193.19	126.19	162.49	140.81
1968	129.24	167.22	206.74	137.22	141.45	128.77
1969	134.02	168.98	204.28	145.16	148.92	136.27
1970	142.93	180.89	224.88	148.97	142.76	129.42
1971	145.72	189.83	233.65	160.82	140.89	130.67
1972	141.49	194.09	237.98	166.24	147.57	137.76

Sources: Calculations from data in India, *Economic Survey*, various issues (Delhi: Controller of Publications, various years); Reserve Bank of India, *Report on Currency and Finance*, various volumes (Bombay: Reserve Bank of India, various years); R. N. Lal, *Capital Formation and Its Financing in India* (Columbia, Mo.: South Asia Books, 1977); Vidya Pitre, "A Study of Trends in India's Imports: 1960-61 to 1974-75," *Economic and Political Weekly*, May 9, 1981, pp. 851-862; and Isher J. Ahluwalia, *Behavior of Prices and Output in India* (Madras: The Macmillan Company of India, 1979).

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Simulation I is the basic model described in the text.

Table 11—Predicted values of six endogenous variables, Simulation II, 1961-72

Year	NYI	IQI	IBKI	ICI	FGTT	TT
1961	105.09	115.45	130.99	102.15	101.24	100.53
1962	107.22	124.20	140.87	112.00	113.22	110.83
1963	111.59	131.35	152.33	115.51	124.69	113.79
1964	119.60	138.97	163.68	120.39	128.38	118.98
1965	113.49	151.34	181.46	129.20	122.91	114.44
1966	113.88	152.31	183.74	128.69	155.68	134.98
1967	126.44	156.22	193.27	126.25	162.60	140.89
1968	129.26	167.28	206.81	137.25	141.52	128.82
1969	134.03	169.01	204.33	145.18	148.97	136.28
1970	142.94	180.91	224.91	148.99	142.80	129.45
1971	145.73	189.85	233.68	160.83	140.92	130.69
1972	141.50	194.09	237.99	166.25	147.59	137.77

Sources: Calculations from data in India, *Economic Survey*, various issues (Delhi: Controller of Publications, various years); Reserve Bank of India, *Report on Currency and Finance*, various volumes (Bombay: Reserve Bank of India, various years); R. N. Lal, *Capital Formation and Its Financing in India* (Columbia, Mo.: South Asia Books, 1977); Vidya Pitre, "A Study of Trends in India's Imports: 1960-61 to 1974-75," *Economic and Political Weekly*, May 9, 1981, pp. 851-862; and Isher J. Ahluwalia, *Behavior of Prices and Output in India* (Madras: The Macmillan Company of India, 1979).

Notes: NYI stands for the index of national income; it is in 1960/61 prices. IQI stands for the index of industrial production; 1960 equals 100. IBKI stands for the index of the output of the basic and capital goods industries; 1960 equals 100. ICI stands for the index of the output of the consumer goods industries; 1960 equals 100. FGTT stands for the index of the terms of trade for foodgrains, defined as the ratio of the price index of foodgrains (1961/62 equals 100) to the price index of manufactured goods (1961/62 equals 100). TT stands for the index of the terms of trade, defined as the ratio of the price of agricultural commodities to the price of manufactured finished products.

Simulation II adds a 1 percent increase in foodgrain and nonfoodgrain output in 1963 to the basic model described in the text.

Table 12—Predicted values of six endogenous variables, Simulation III, 1961-72

Year	NYI	IQI	IBKI	ICI	FGTT	TT
1961	105.09	115.45	130.99	102.15	101.24	100.53
1962	107.22	124.20	140.87	112.00	114.22	111.27
1963	111.06	131.43	152.55	115.42	125.24	113.98
1964	119.48	138.45	163.01	119.92	129.51	119.89
1965	113.50	151.34	181.79	128.78	122.69	114.13
1966	113.88	152.21	183.53	128.72	155.64	134.97
1967	126.43	156.17	193.22	126.19	162.52	140.83
1968	129.25	167.23	206.75	137.23	141.46	128.78
1969	134.02	168.99	204.29	145.16	148.93	136.25
1970	142.93	180.89	224.88	148.98	142.77	129.43
1971	145.73	189.84	233.65	160.82	140.91	130.68
1972	141.49	194.09	237.98	166.24	147.58	137.76

Sources: Calculations from data in India, *Economic Survey*, various issues (Delhi: Controller of Publications, various years); Reserve Bank of India, *Report on Currency and Finance*, various volumes (Bombay: Reserve Bank of India, various years); R. N. Lal, *Capital Formation and Its Financing in India* (Columbia, Mo.: South Asia Books, 1977); Vidya Pitre, "A Study of Trends in India's Imports: 1960-61 to 1974-75," *Economic and Political Weekly*, May 9, 1981, pp. 851-862; and Isher J. Ahluwalia, *Behavior of Prices and Output in India* (Madras: The Macmillan Company of India, 1979).

Notes: NYI stands for the index of national income; it is in 1960/61 prices. IQI stands for the index of industrial production; 1960 equals 100. IBKI stands for the index of the output of the basic and capital goods industries; 1960 equals 100. ICI stands for the index of the output of the consumer goods industries; 1960 equals 100. FGTT stands for the index of the terms of trade for foodgrains, defined as the ratio of the price index of foodgrains (1961/62 equals 100) to the price index of manufactured goods (1961/62 equals 100). TT stands for the index of the terms of trade, defined as the ratio of the price of agricultural commodities to the price of manufactured finished products.

Simulation III is the basic model described in the text with the foodgrain terms of trade raised by one in 1962.

Table 13—Predicted values of six endogenous variables, Simulation IV, 1961-72

Year	NYI	IQI	IBKI	ICI	FGTT	TT
1961	102.23	114.34	130.99	99.22	110.23	103.88
1962	105.97	121.56	138.33	108.43	120.42	111.86
1963	109.96	129.41	150.43	112.93	124.92	112.32
1964	113.70	136.44	160.20	118.38	128.37	118.92
1965	117.96	144.90	173.08	123.46	131.11	121.96
1966	123.94	158.26	194.87	129.49	133.99	123.23
1967	127.59	164.75	200.89	138.54	143.23	132.74
1968	130.24	168.22	204.54	142.82	148.48	134.98
1969	132.99	171.90	209.67	145.65	149.78	134.69
1970	137.12	179.48	222.08	149.00	149.46	133.37
1971	140.45	184.61	227.77	154.94	152.91	136.48
1972	143.60	189.13	233.60	159.04	155.31	141.18

Sources: Calculations from data in India, *Economic Survey*, various issues (Delhi: Controller of Publications, various years); Reserve Bank of India, *Report on Currency and Finance*, various volumes (Bombay: Reserve Bank of India, various years); R. N. Lal, *Capital Formation and Its Financing in India* (Columbia, Mo.: South Asia Books, 1977); Vidya Pitre, "A Study of Trends in India's Imports: 1960-61 to 1974-75," *Economic and Political Weekly*, May 9, 1981, pp. 851-862; and Isher J. Ahluwalia, *Behavior of Prices and Output in India* (Madras: The Macmillan Company of India, 1979).

Notes: NYI stands for the index of national income; it is in 1960/61 prices. IQI stands for the index of industrial production; 1960 equals 100. IBKI stands for the index of the output of the basic and capital goods industries; 1960 equals 100. ICI stands for the index of the output of the consumer goods industries; 1960 equals 100. FGTT stands for the index of the terms of trade for foodgrains, defined as the ratio of the price index of foodgrains (1961/62 equals 100) to the price index of manufactured goods (1961/62 equals 100). TT stands for the index of the terms of trade, defined as the ratio of the price of agricultural commodities to the price of manufactured finished products.

Simulation IV is the basic model described in the text with a trend line added that shows agricultural output increasing steadily.

Table 14—Predicted values of six endogenous variables, Simulation V, 1961-72

Year	NYI	IQI	IBKI	ICI	FGTT	TT
1961	105.65	115.45	130.99	102.15	100.96	100.34
1962	108.52	124.73	141.56	112.49	111.64	109.78
1963	113.13	132.48	153.52	116.90	122.21	114.72
1964	123.01	141.32	166.91	122.26	126.04	117.59
1965	117.33	154.73	185.35	132.95	120.75	112.47
1966	118.39	156.08	187.83	133.18	151.53	132.12
1967	132.52	160.58	197.85	131.60	157.24	137.41
1968	136.47	173.18	213.26	144.19	131.75	123.00
1969	142.61	175.79	211.11	153.99	139.02	130.62
1970	153.29	189.28	233.75	159.23	130.64	122.40
1971	157.43	199.91	244.21	173.27	125.88	122.32
1972	153.66	205.51	249.73	180.62	135.48	130.66

Sources: Calculations from data in India, *Economic Survey*, various issues (Delhi: Controller of Publications, various years); Reserve Bank of India, *Report on Currency and Finance*, various volumes (Bombay: Reserve Bank of India, various years); R. N. Lal, *Capital Formation and Its Financing in India* (Columbia, Mo.: South Asia Books, 1977); Vidya Pitre, "A Study of Trends in India's Imports: 1960-61 to 1974-75," *Economic and Political Weekly*, May 9, 1981, pp. 851-862; and Isher J. Ahluwalia, *Behavior of Prices and Output in India* (Madras: The Macmillan Company of India, 1979).

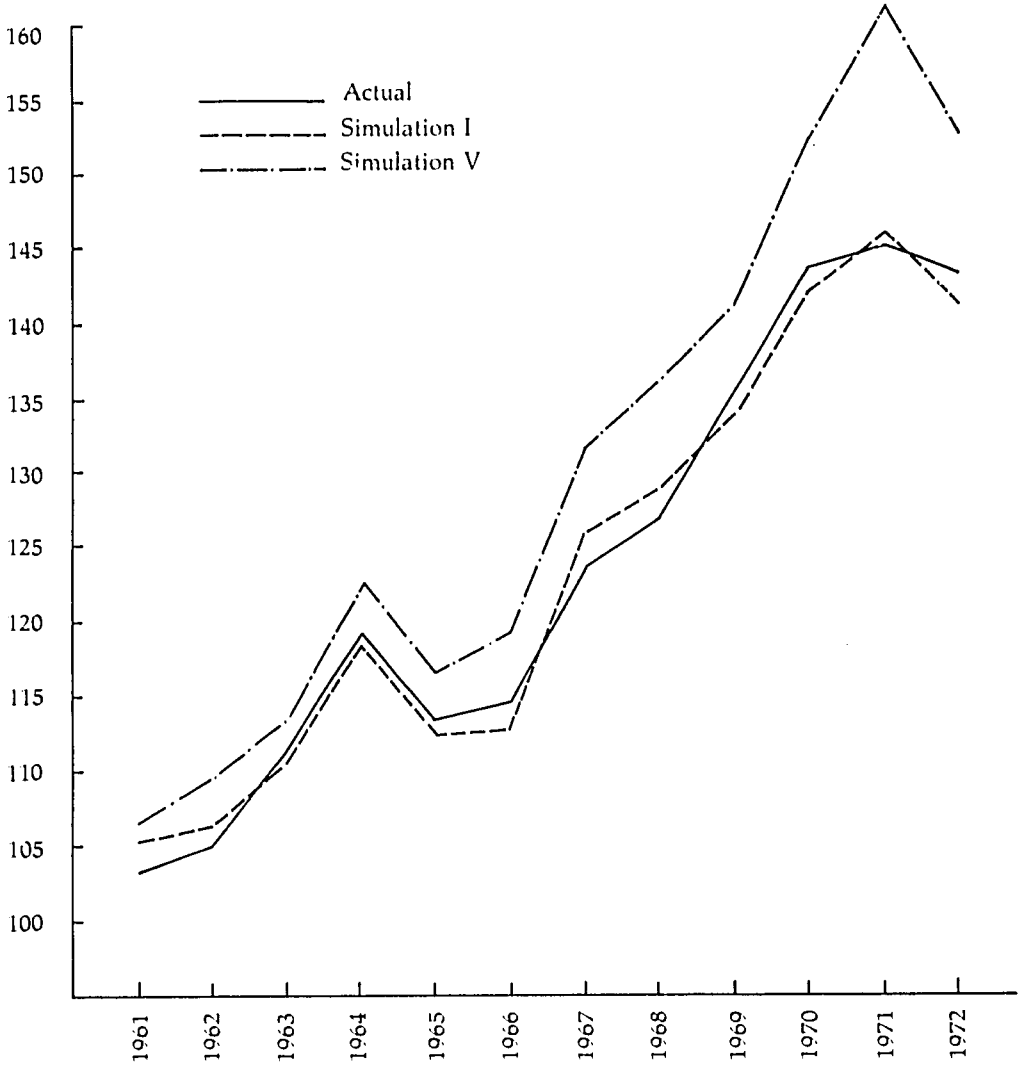
Notes: NYI stands for the index of national income; it is in 1960/61 prices. IQI stands for the index of industrial production; 1960 equals 100. IBKI stands for the index of the output of the basic and capital goods industries; 1960 equals 100. ICI stands for the index of the output of the consumer goods industries; 1960 equals 100. FGTT stands for the index of the terms of trade for foodgrains, defined as the ratio of the price index of foodgrains (1961/62 equals 100) to the price index of manufactured goods (1961/62 equals 100). TT stands for the index of the terms of trade, defined as the ratio of the price of agricultural commodities to the price of manufactured finished products.

Simulation V is the basic model described in the text with the growth rate of agriculture increased by 1 percent.

APPENDIX 3

FIGURES COMPARING ACTUAL AND SIMULATED VALUES

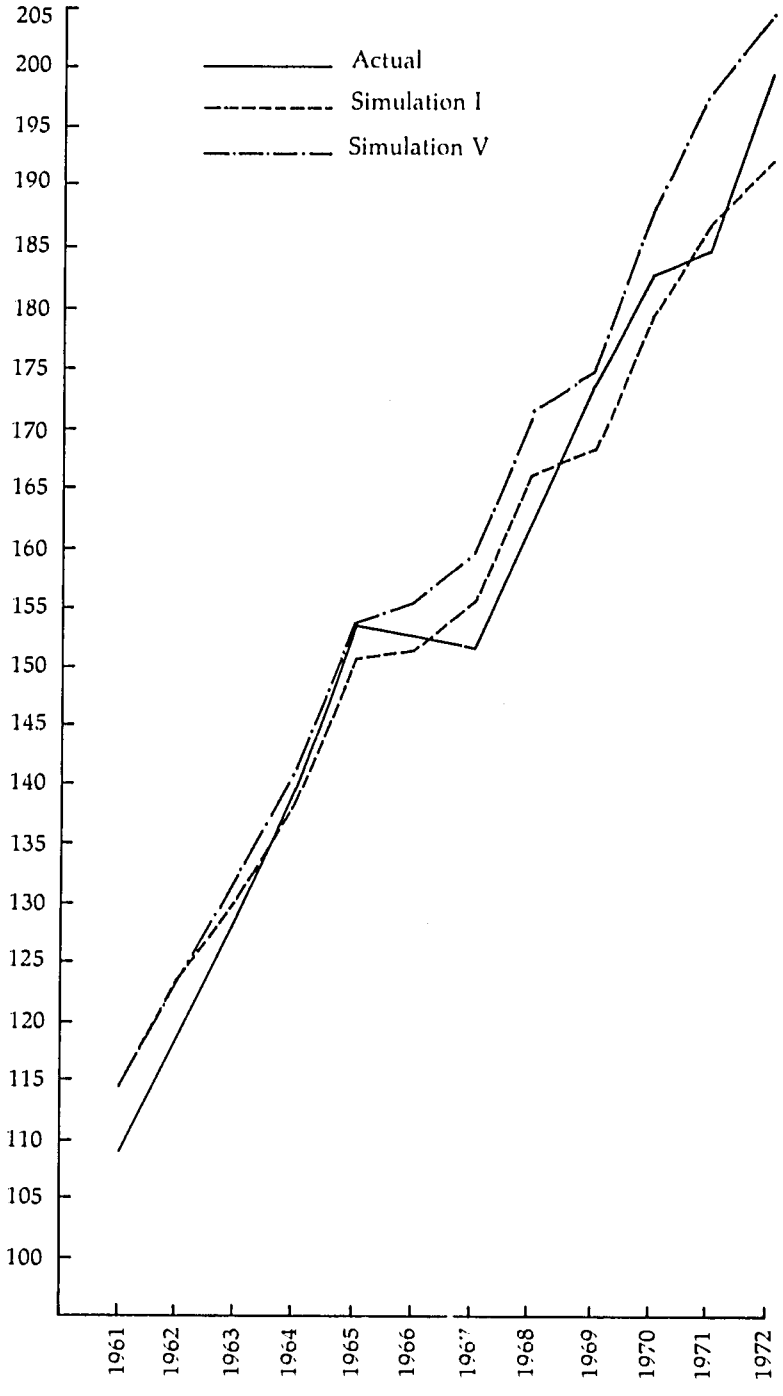
Figure 2 — Index of national income, actual and simulated, 1961–72



Source: India, *Economic Survey*, various issues (Delhi: Controller of Publications, various years).

Note: Simulation I is the basic model described in the text. Simulation V uses the model but increases the growth rate of agriculture by 1 percent.

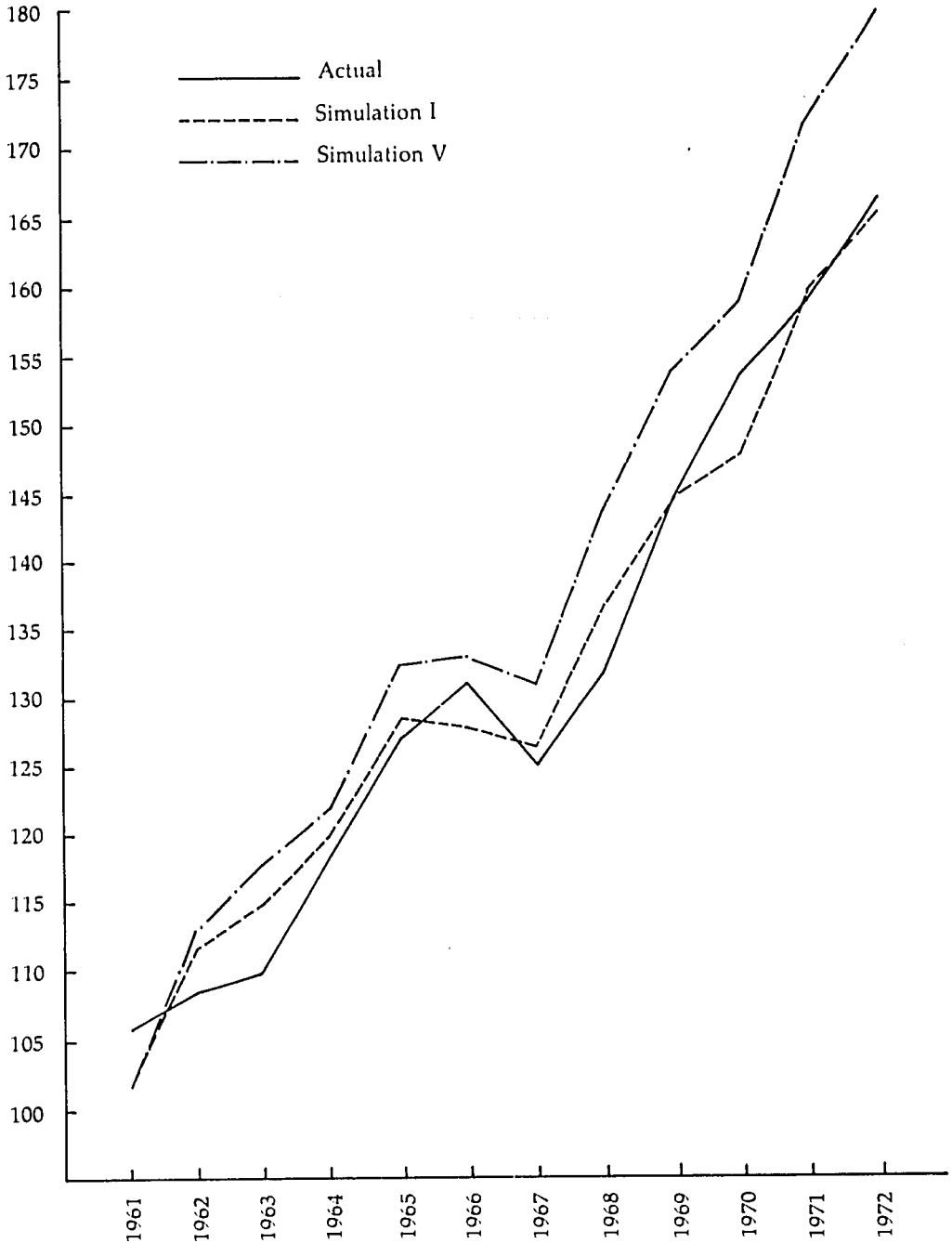
Figure 3—Index of industrial production, actual and simulated, 1961-72



Source: Reserve Bank of India, *Report on Currency and Finance*, various volumes (Bombay: Reserve Bank of India, various years).

Note: Simulation I is the basic model described in the text. Simulation V uses the model but increases the growth rate of agriculture by 1 percent.

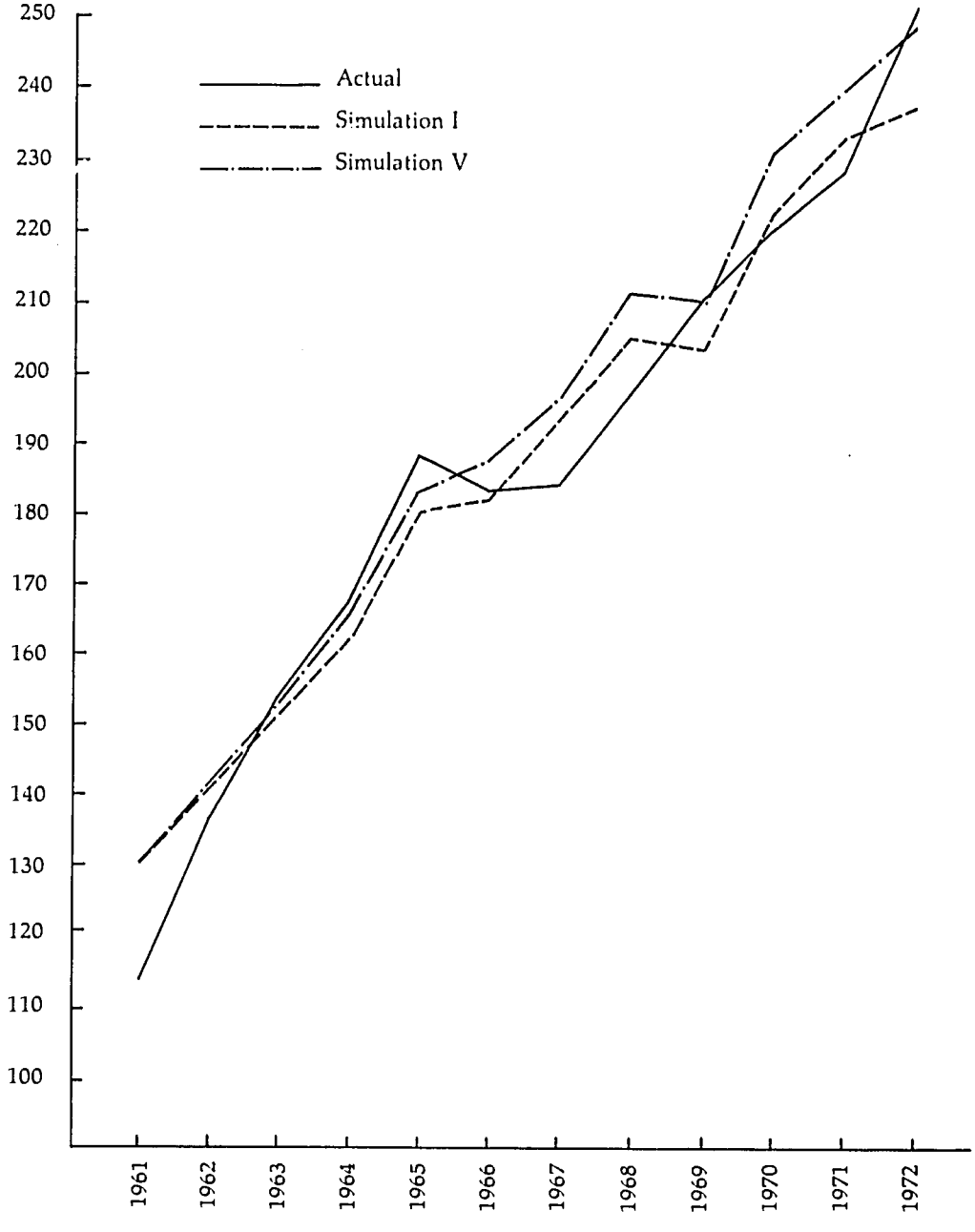
Figure 4—Index of the output of the consumer goods industries, actual and simulated, 1961-72



Source: Reserve Bank of India, *Report on Currency and Finance*, various volumes (Bombay: Reserve Bank of India, various years).

Note: Simulation I is the basic model described in the text. Simulation V uses the model but increases the growth rate of agriculture by 1 percent.

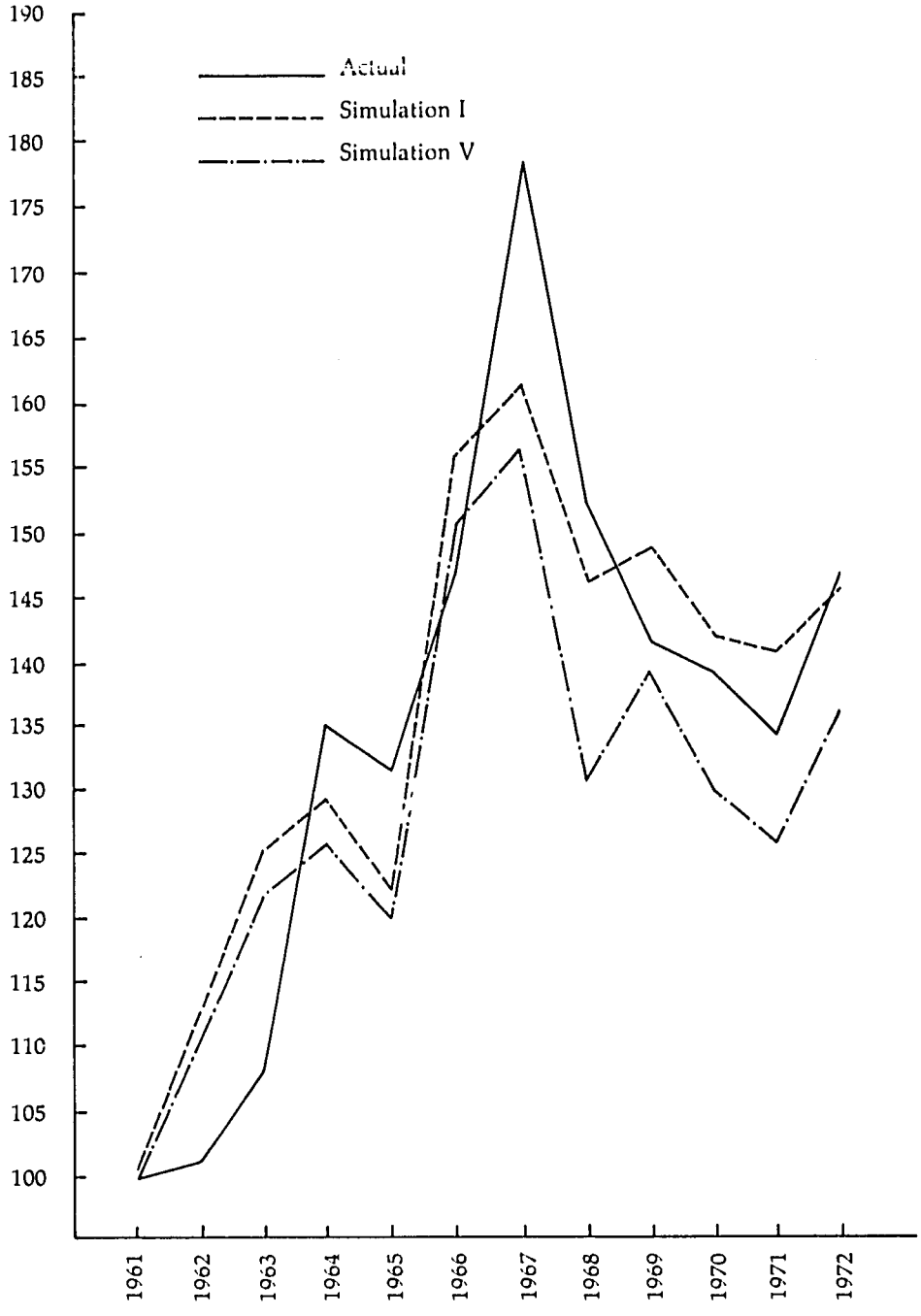
Figure 5—Index of the output of the basic and capital goods industries, actual and simulated, 1961-72



Source: Reserve Bank of India, *Report on Currency and Finance*, various volumes (Bombay: Reserve Bank of India, various years).

Note: Simulation I is the basic model described in the text. Simulation V uses the model but increases the growth rate of agriculture by 1 percent.

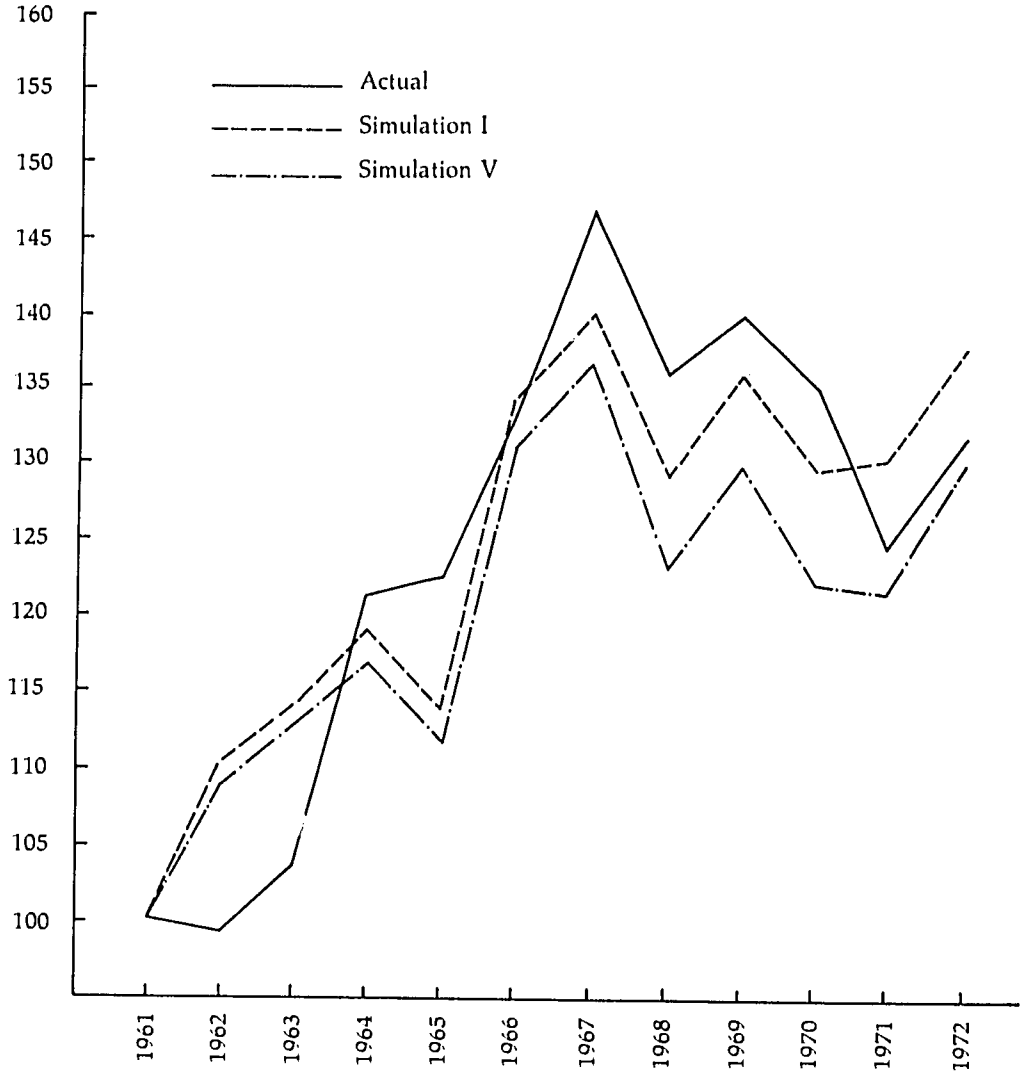
Figure 6—Foodgrain terms of trade, actual and simulated, 1961-72



Source: India, *Economic Survey*, various issues (Delhi: Controller of Publications, various years).

Note: Simulation I is the basic model described in the text. Simulation V uses the model but increases the growth rate of agriculture by 1 percent.

Figure 7—Terms of trade, actual and simulated, 1961-72



Source: India, *Economic Survey*, various issues (Delhi: Controller of Publications, various years).

Note: Simulation I is the basic model described in the text. Simulation V uses the model but increases the growth rate of agriculture by 1 percent.

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