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Title: AGRICULTURAL DEVELOPMENT AND URBAN UNEMPLOYMENT: A SIMULATION ANALYSIS OF THE NIGERIAN ECONOMY

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The study critically analyzes the implication of various agricultural development policies on urban unemployment and income distribution. More specifically it focuses on the evaluation of agricultural policies at the macro-economic level in the Nigerian economy.

A system science and simulation approach is used to build and test a ten sector macro-economic model of the Nigerian economy to investigate the problem. The model simulates consumption, investment, employment and production endogenously. Validation of the model shows that it is capable of describing the major trends in the Nigerian economy for recent history.

By interacting with a detailed agricultural sector model, the macro-model enables evaluation of agricultural policies in the context of the total economy after taking account of the important interactions

between the agricultural and nonagricultural economies. In particular the model enables some measures of income distribution and employment to be included as targets of economic development planning together with the conventional target of growth.

The model predicts that if current agricultural policies are continued, urban unemployment and income disparities will become increasingly more serious in Nigeria. Furthermore, the income differential between agriculture and nonagriculture is predicted to widen leading to a continuing increase in the rate of labor migration out of agriculture.

The evaluation of two sets of agricultural policies, export crop modernization and food crop modernization, leads to a serious questioning of the present emphasis among development economists on agricultural development as a means of steadying the flow of rural-urban migration and reducing urban unemployment and rural-urban income inequities. Because of the considerable multiplier effects of increased agricultural incomes on nonagricultural incomes, both agricultural policies produced a wider differential between agricultural and nonagricultural incomes stimulating further labor migration out of agriculture. This effect was particularly acute in the case of the food modernization policy where the terms of trade turned against agriculture.

Nevertheless both sets of policies and particularly the export modernization policy improved the disparity in self-employed earnings and wage earnings and produced a steady rise in nonagricultural self-employed earnings which, under current policies, were predicted to stagnate because of rising urban unemployment.

Other policies to restrain wages and increase government employment demonstrated the considerable trade-off between various groups of the population arising out of the complexity of interactions between the agricultural and nonagricultural sectors. The macroeconomic simulation model is suggested as a useful approach to development planning where there is need to consider interactions between sectors and trade-offs between targets of development.

Agricultural Development and Urban Unemployment: A Simulation Analysis of the Nigerian Economy

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I. INTRODUCTION

Agriculture occupies a central position in the economies of the developing world. In most developing countries agriculture employs over half the total labor force and in many produces over half the national output. Furthermore, agriculture in these countries has special characteristics which distinguish it from other sectors of the economy and impart a uniqueness to agricultural development problems. Generally, production techniques are traditional in nature requiring few, if any, purchased inputs and utilizing family labor. Likewise, in subsistence economies, agricultural output is largely used for home consumption giving the household considerable independence of the market place.

Although agricultural development, because of its importance and special problems, is deserving of special attention, it cannot be studied in isolation from the rest of the economy. Indeed, the interaction between agriculture and nonagriculture plays a crucial role in the development process. In particular, the flow of goods and services for consumption purposes is a major interaction between the two sectors. In the early stages of development, food often constitutes over half the consumption expenditure of the nonagricultural population. This provides the most important market for agricultural output and, consequently, the main source of cash income to the agricultural population. Likewise, where over half the total population is in agriculture, the agricultural population is a vital market for expanding the domestic production of consumer goods and services.

Of lesser importance is the flow of goods and services for production. As agricultural modernization proceeds, requirements for inputs, such as fertilizer, and investment goods, such as mechanical equipment, provide an additional market for nonagricultural output. Similarly, industrialization often proceeds through the processing of raw materials, many of which are produced in agriculture (e.g., cotton and rubber).

In addition to the flows of goods and services, the agricultural and nonagricultural economies interact in the factor markets. Capital and foreign exchange are scarce resources which must be allocated between agriculture and nonagriculture. Furthermore, the development process is characterized by a movement of labor from agricultural to nonagricultural occupations.

Economists have sought to understand how agricultural-nonagricultural interactions shape the development process and, more specifically, govern the allocation of resources between the two sectors. To this end, several mathematical models have been constructed using the concept of a "dual economy". The dual nature of the economy arises from the existence of a traditional, low productivity agricultural sector side-by-side with a modern, high productivity industrial sector. The development process is viewed as a transition from a traditional to a modern economy as labor is transferred from agriculture to nonagriculture. The best-known model of the dual economy has been developed by Fei and Ranis (1964) and is based on the assumption that surplus labor exists in agriculture. That is, the marginal product of labor in agriculture is zero.

The Fei-Ranis model serves the interests of the proponents of rapid industrialization since the limiting factor to growth is investment in the nonagricultural economy to absorb the surplus labor in agriculture as fast as possible. Agriculture, at least in the early stages of development, serves merely as a reservoir for the labor force.

As evidence accumulated (e.g., Kao, Anschel and Eicher, 1964, and Schultz, 1964) that the marginal productivity of labor in agriculture was positive (although low), more attention was given to balanced economic growth. Resources should be diverted to agriculture to ensure an adequate supply of food for industrialization which was still regarded as the path to economic development. As Dziadek (1967) has noted, as long as unemployment and underemployment were rural phenomena, it could largely be ignored since subsistence living was generally available, and rural areas of the less-developed countries often lack effective political power.

In more recent years, the Fei-Ranis model and other models of the dual economy have been losing favor among economists. One reason for this is the simplistic nature of these models. They are built on assumptions of a closed economy, institutionally determined wage rates in agriculture and unrealistic (and implicit) assumptions concerning elasticities of supply and demand. Mellor (1967) and others with simpler models which consider explicitly the income and price elasticities of demand, have shown the sensitivity of the terms of trade between agriculture and nonagriculture to variations in these parameters. Nevertheless, Mellor is frustrated by the inability to consider more than a few variables at a time in these simple projections. Other authors such as Dixit (1969) and Hornby (1968) have tried to overcome the restrictive assumptions of the earlier models by building more elaborate models. These efforts have again been ineffective because of the inability to express the complexity of agricultural-nonagricultural interactions in a form amenable to mathematical solution.

Although the models of the dual economy have suffered through unreasonable assumptions, a major downfall has been the growing recognition in recent years of the increasingly serious problems of urban unemployment and income distribution. In most developing countries, rates of urban unemployment in the order of 15 percent are common. In addition, income distribution patterns have been worsening between the low productivity sectors and high productivity sectors in urban areas and between the agricultural and nonagricultural sectors. These problems have occurred despite "satisfactory" rates of growth of national income in many countries. Not only is the problem addressed by the dual economy models of how to move labor from agriculture to nonagriculture irrelevant where there is already surplus labor in the urban areas, but the emphasis on growth as the universal target of development is seriously questioned.

Despite the inadequacy of the present models of the dual economy, there is a pressing need to understand the interactions between agriculture and nonagriculture in a more realistic framework. This is particularly so, since most recent researchers now recognize that agricultural development is a potential means of absorbing the unemployed. Their reasoning is based partly on the need to develop the more labor intensive sectors of the economy, particularly agriculture, and partly on recognition that rural-urban income disparities must be corrected if the rate of rural-urban migration is to be steadied and urban unemployment decreased. In addition, the recent work of Harris and Todaro (1970) seriously questions policies which seek to decrease urban unemployment by expanding employment at the existing wage rate. The present literature with its new emphasis on rural development suggests much research is needed both at the micro-level and the macro-level, to analyze the impact of rural development strategies on output and employment.

It is the aim of this study to explore the implications of agricultural development policies on growth, employment and income distribution at the macro-level. The emphasis will be on the effects of macro-policy variables such as agricultural taxation and investment on both the agricultural and nonagricultural sectors.

A subsidiary aim of the study is to illustrate the use of simulation as a method of exploring the interactions and feedback effects in a complex economic system. Rather than attempt to derive general conclusions for a dual economy, a particular economy, the Nigerian economy, is investigated.

In Chapter 2 the causes and effects of unemployment will be examined and the relationship between agricultural development and urban employment developed from a theoretical viewpoint. The use of simulation methods in representing a complex system is also discussed. The recent history of economic growth and employment in Nigeria is briefly summarized in Chapter 3. Nigeria is presented as an interesting case study of unemployment since it has features common to many developing countries. A simulation model of the national economy is developed and results of tests are presented in Chapter 4. Also in Chapter 4 this macro-model is integrated with a detailed agricultural sector model to analyze the effects of alternative agricultural policies on nonagricultural output and employment. In Chapter 5 the main results of these policy experiments are presented and analyzed. The final chapter discusses critically the results of the model and draws conclusions.

II. URBAN UNEMPLOYMENT: MEASUREMENT, CAUSES AND RELATIONSHIP TO AGRICULTURE

Extent of the Unemployment Problem

Unlike the earlier disputes about the existence of surplus labor in agriculture, there is universal agreement that there is surplus or unemployed labor in the urban areas of developing countries. Part of the reason for the confusion over surplus labor in agriculture arose out of the seasonality of labor usage. The annual supply of labor might considerably exceed the annual demand but, for certain short periods such as harvesting or cultivation, the total labor supply could be fully utilized. In the urban areas such seasonality is generally not a problem in measuring unemployment.

Nonetheless, statistics which quote the rate of unemployment as the proportion of the labor force which is unemployed and actively seeking work are likely to underestimate the problem. Indeed, unemployment is an expression of a much broader problem of underemployment and inequalities in income distribution. In addition to the openly unemployed, there are the underemployed. Although there is no agreed-upon definition of underemployment, it is expressed in the low labor productivity and consequent low incomes in the traditional urban sectors, particularly the crafts, trade and commerce sectors. Typically, there is a widening gap between the incomes of workers (usually self-employed) in these sectors and those employed (usually for wages) in the modern industrial and government sectors. Open unemployment is but a symptom of stagnation and low productivity in the urban traditional sectors.

Seers (1970), in a study conducted in Columbia for the International Labor Organization, sees three dimensions to the problem. Firstly, there are insufficient work opportunities or what is usually called unemployment. Secondly, incomes are low because of the lack of work opportunities. Finally, unemployment constitutes a waste of resources. Seers estimates that insufficient work opportunities effect 25 percent of the urban labor force. In this category there are the unemployed (persons without work and seeking it), the underemployed (persons working less than 32 hours per week and seeking to work longer), the disguised unemployed (persons without work but who would seek it if unemployment were lower), and disguised underemployed (persons working less than 32 hours per week who would seek longer hours if unemployment were lower). In addition Seers estimates that for an arbitrarily defined poverty line, urban poverty affects 12 percent of the urban labor force in addition to the 25 percent lacking sufficient work opportunities.

Given these various categories of unemployment, it is not surprising that statistics are not generally comparable. Not only does the rate of unemployment depend upon the definition of employment used but further uncertainty is added in the definition of a labor force which depends on physical, cultural and economic factors. Nevertheless, several authors have attempted to draw comparisons between countries using rates of open unemployment as a guide. Table 2. 1 provides estimates of open unemployment for various African cities. Most cities have rates of unemployment between 10 and 20 percent with some even higher. These figures are also representative of urban centers in Asia and Latin America.

As emphasized above, statistics on unemployment of the type given in Table 2. 1 will not generally be an adequate measure of the problem. However, the rate of unemployment may be an index of underemployment and low productivity in the urban traditional sectors. This is particularly the case in most African countries where the non-agricultural labor force can be divided into two parts. Firstly, there are the wage earners employed in establishments with ten or more employees and utilizing modern and often capital intensive techniques of production. Wage earners comprise only 20 percent of the nonagricultural labor force in Nigeria but up to 50 percent in Ghana. Secondly, there is a much more heterogeneous category of residual workers, largely self-employed, ranging from skilled craftsmen through petty traders to the openly unemployed.

Corresponding to this division into wage earners and self-employed workers is a division of the labor market into organized and

Table 2.1 Urban unemployment rates in African cities.

Country	City	Year	Urban Unemployment Rate (percent)
Algeria	All cities	1966	26.6
Cameroons	Douala	1966	13.0
	Yaounde	1966	17.0
Ivory Coast	Abidjan	1963	20.0
Ghana	All cities	1960	11.6
Morocco	All cities	1960	20.5
Nigeria	Lagos	1963	15.5
	Ife	1963	19.7
	Onitsha	1963	26.3
	Kaduna	1963	30.8
	Abeokuta	1963	34.6
Congo	Kinshasa	1958	15.0
Tanzania	All cities	1965	12.6
Kenya	Eight cities	1969	17.4

Source: Todaro, 1971, p. 3.

unorganized sectors. In the organized sector wage rates are generally determined by various institutional factors (such as minimum wage legislation) and are largely independent of conditions in the labor market.[1] The average earnings of the self-employed workers are determined in the unorganized labor market and to a much greater extent reflect conditions of labor supply and demand in the urban areas. Consequently government wage rates for unskilled workers are considerably higher than the earnings of the unskilled self-employed workers.

Given the structure of the labor market in urban areas, conditions of rapidly rising labor supply relative to demand are likely to adversely affect the earnings of the self-employed although wage rates may continue to rise. Rising unemployment then is closely associated with declining productivity and underemployment in the urban traditional sectors.[2] Several authors (e.g., Turnham, 1970a) have proposed that low earnings of the urban self-employed rather than unemployment *per se* is the problem which should be addressed since it affects a larger proportion of the urban population.

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[1] Institutional factors affecting wage rate determination in Nigeria are discussed in Chapter 3.

[2] The extent of this association is complicated by many factors such as skill levels and aspirations of the unemployed for a wage job.

The essential point to be made here is that there is no simple dichotomy between the employed and the unemployed. In this study the term "urban unemployment" is used as a generic name for the multiple problems of: (1) high rates of open unemployment in the urban areas, (2) low earnings of the self-employed in the urban traditional sectors, and (3) an increasing disparity in the income distribution between the urban self-employed and urban wage earners. Furthermore, in the next section it will be seen that closely related to the problem of unemployment and income distribution in urban areas is the problem of income disparities between rural and urban populations.

It is not only the magnitude of the employment problem which causes concern but many observers record that unemployment is growing rapidly in most urban areas. Turnham (1970b), in a study of eight countries, concluded that the number of unemployed was growing at eight percent annually. Similarly, there is evidence from Kilby (1969) for Nigeria that together with rising unemployement there has been a decline in earnings in the urban traditional sectors.

Causes of Unemployment

Urban unemployment can be considered as the result of: (1) low growth rates in nonagricultural wage employment relative to the growth of nonagricultural output, and (2) high growth rates of labor supply in urban areas.

Demand Factors in Employment

As discussed in Chapter I, the main thrust of development policy has been directed toward rapid industrialization to move labor from the low productivity agricultural sector to the high productivity modern industrial sector. However, despite relatively high rates of growth of output in the modern nonagricultural sectors, wage employment in these sectors has increased slowly. Table 2.2 illustrates the low growth rate of wage employment in African countries. Indeed, in many cases wage employment has actually declined in recent years. In general, the rate of growth of employment is less than two percent compared with a rate of growth of output in the modern sectors of these countries usually greater than six percent. This divergence can be expressed in terms of the incremental output-employment ratio (IOER). Harbison (1967) estimates that for the manufacturing and public utilities sectors this ratio is about four. That is, for every four percent increase in output, there is only a one percent increase in employment. For other nonagricultural sectors such as government and services, this ratio is closer to unity; but at best, for all modern sectors combined, the ratio is not likely to be less than two.

The difference between growth in output and growth in employment for a sector is termed the "productivity increase" of that sector.

Table 2. 2 Nonagricultural employment indices for African countries.

Year	Nonagricultural Wage Employment (1963 = 100)								
	Cameroons	Ghana	Kenya	Malawi	Nigeria	Sierra Leone	Tanzania	Uganda	Zambia
1955	112	62	117	101	n. a.	73	107	106	107
1956	114	69	115	109	101	73	114	105	116
1957	110	72	115	112	107	77	111	111	116
1958	110	76	110	115	107	81	109	112	116
1959	104	81	110	113	105	83	105	111	109
1960	100	84	112	110	113	85	107	112	108
1961	103	92	108	107	95	89	114	110	105
1962	80	97	107	100	120	94	111	105	101
1963	100	100	100	100	100	100	100	100	100
1964	102	103	122	92	130	104	104	101	106
1965	109	104	123	n. a.	126	113	107	111	119
1966	113	95	137	n. a.	n. a.	114	114	111	n. a.
Average Growth Rate (%)	0. 1	4. 0	1. 4	-1. 0	2. 5	3. 5	0. 6	0. 9	1. 1

n. a. means not available
Source: Frank, 1970, p. 8.

These productivity increases arise from two sources. Firstly, the existing capital stock may be more effectively utilized because of increased job training and experience of employees and management. These autonomous factors are summarized under the notion of Leibenstien's X-efficiency which has been shown by Leibenstein (1966) to be more important in low income countries than high income countries. In addition, there may be considerable economies of scale resulting from the more intensive utilization of capital and labor with increased output.

A second source of productivity increase occurs with new investment incorporating new technology of a lower labor intensity than the existing capital stock. This may occur because of various market imperfections which encourage capital-labor substitution. Most observers agree that wage rates paid by modern industrial firms are high because of the influence of political factors such as minimum wage legislation or social factors such as the need for a foreign corporation to establish a good image. The impact of wage rates on employment is shown by Frank (1968) to be substantial in certain sectors and particularly the public sector because of the fixed government budget to be paid in wages (Berg, 1970). Import policies which protect domestic manufactures but allow free entry of capital goods, and overvalued exchange rates distort factor markets in favor of capital. Furthermore, many fiscal and monetary policies, such as taxation "holidays", depreciation allowances, and low interest rates openly encourage capital intensive techniques.

In addition to market imperfections, the lack of choice of alternative production techniques may be an important factor. Singer (1970) notes that almost all research and development is conducted in the developed countries. These techniques are often unsuited to the factor endowments of the developing countries.

Supply Factors in Employment

A feature of most developing countries has been a high rate of growth of the urban centers. This is illustrated for selected African cities in Table 2. 3. In nearly all cases, these cities have been growing at the rate of six percent or more per year. These high rates of growth reflect, in part, the high rates of growth of the population in most developing countries. However, even allowing for a natural population increase as high as three percent annually, at least half of the six percent urban population growth is attributable to migration from the rural areas.

The phenomenon of rural-urban migration has been the subject of increasing interest in recent years because of its social, political and economic implications in both rural and urban areas. Most studies of the process have been undertaken by sociologists, anthropologists and geographers, with economists taking less interest.

Table 2.3 Rates of growth of urban centers in Africa.

Country	City	Year	Population (thousands)	Annual growth rate (percent)
Kenya	Nairobi	1968	479	7.2
	Mombasa	1968	234	5.2
Tanzania	Dar es Salaam	1967	273	7.5
Zambia	Lusaka	1966	152	11.7
The Congo	Kinshasa	1966	508	8.0
	Lubumbashi	1966	233	5.2
Cameroons	Yaounde	1965	101	10.3
	Douala	1965	200	4.9
Mali	Bamako	1965	165	7.0
Chad	Fort Lamy	1964	99	13.6
Dahomey	Cotonou	1965	111	7.5
Ivory Coast	Abidjan	1964	282	9.3
Ghana	Accra	1968	758	8.1
	Kumasi	1968	340	12.3
Liberia	Monrovia	1962	81	11.9
Senegal	Dakar	1961	375	6.7

Source: Frank, 1970, p. 5.

From studies such as Caldwell (1969), Olusanya (1969), Rempel (1971), Clayton (1970), and Mueller and Zervering (1969) several general observations can be made. Firstly, the rural-urban migrants are younger, better educated and have a higher proportion of males than the general population. Secondly, the most important factors motivating migration are economic considerations, although social and cultural factors are also important. Beals, Levy and Moses (1967) have attempted to quantify the effects of distance, incomes, degree of urbanization and education on migration using regression techniques. They conclude that migration is responsive to all factors, with income factors dominating. However, like most migration studies, their conclusions are based on cross-sectional analysis rather than time series analysis.

The basic economic consideration in migration is the gap between potential rural and urban incomes. There is substantial evidence that this gap has been widening in recent years. Todaro (1971) finds that for the period 1960-1966 urban wages in Kenya increased by 11 percent annually from 97 to 180 pounds, while incomes in rural areas increased at the annual rate of five percent from 57 to 77 pounds. Weeks (1968b) in a study of the rural-urban differential in Nigeria, concluded that this differential has steadily widened since 1950. Similar evidence is provided by Knight (1968) for Uganda and Lewis (1967) for Nigeria.

Undoubtedly, the key factor contributing to the widening rural-urban income differential has been the increasing wage rates in urban areas discussed earlier. This has been coupled with stagnant or declining agricultural prices. In many instances, this reflects an urban bias on the part of governments. In Nigeria, for example, Arthur Lewis (1967, p. 42) reports that:

> The gap has been widening by reducing farm incomes as well as raising urban wages. If we take the average of 1950-52 as a base, the prices paid to southern farmers by the Marketing Boards went down from 100 to 73 in 1961-63 while the minimum wage paid by the Federal government to unskilled labor over the same period went up from 100 to 297. One need not look much further to understand why young people drift out of agriculture to seek part-time work in the towns, although there is a shortage of labor in the country and a surplus in the towns. Urban unemployment is bound to continue growing until this deliberate discrimination against farm incomes is ended.

In addition to low farm prices and high urban wage rates, government urban biases are expressed in provision of social services to urban areas. Olusanya (1969), in a study of rural-urban migration in Nigeria, found that rural people perceived a greater number of amenities existing in the urban areas. This is, to some degree, borne out by the findings of Adedeji (1969) in comparing social emmenities in Nigeria in the largely rural north to those in the west, the most urbanized region of Nigeria.

Perhaps one of the least understood issues in the study of rural-urban migration is the effect of education. Numerous studies, particularly that of Caldwell (1969) in Ghana, show that rural to urban migrants have a higher level of education than the rural population as a whole. Some authors (e.g., Lewis, 1967; and Callaway, 1963) have interpreted this to mean that the educational system needs reorientation toward rural vocations. However, other studies suggest that education and income effects are confounded. Thus, migrants with a higher level of education also have a higher rural-urban income differential. Indeed, Beals, Moses and Levy (1967), in their regression analysis, showed that when income effects were allowed for, higher education tended to decrease migration. Harris and Todaro (1969) also find that urban incomes are 100 percent of rural incomes for persons with primary school education but only 40 percent for persons with no education. On the basis of this evidence, one can only conclude that the role of education in migration deserves closer study.

Policy Implications - Supply and Demand

The above brief review of the factors affecting supply and demand for labor in the urban areas in Africa shows that wage employment is typically growing at less than 1.5 percent annually compared with a growth rate of the urban labor force of over six percent. That is, if wage employment constitutes 40 percent of the labor force, the residual labor force is growing at about nine percent annually. This rapidly growing residual labor force must either be self-employed in urban traditional activities or join the ranks of the openly unemployed.

From this review there emerge several key areas of research needs for recommending various policies to approach the employment problem. These can be subdivided into micro-policy and macro-policy approaches. The former involves research and development on labor-using technologies, both in the agricultural sectors and nonagricultural sectors, the effect of income distribution on consumption and investment, the economic evaluation of birth control programs, the determinants of the industrial wage rate, the effect of education on migration, and so forth. On the macro-side, there is need to understand the interrelationships between such aggregates as the modern and traditional nonagricultural sectors and the food and export crop sectors of the agricultural economy. Only then can the effect of macro-policy instruments on employment be completely evaluated.

It is clear that nonagricultural employment cannot be studied at the macro-level without reference to the total economy. The flow of goods and services between the agricultural and nonagricultural economies has been discussed in Chapter I as being particularly important in the development process. The demand for nonagricultural employment is determined by nonagricultural output which is in turn intimately linked with the agricultural economy. Likewise, the rate of rural-urban migration is a key interaction between the agricultural and nonagricultural economies determining the supply of labor to the nonagricultural sectors.

Macro-policy instruments can conveniently be grouped into those which seek to increase the demand for nonagricultural employment and those whose objective is to decrease the supply of labor in urban areas. In the former group are direct policies such as government hiring or government wage subsidies to employers or indirect policies to generally stimulate the nonagricultural economy by government investment or fiscal policies. In the long run, the supply of labor can be reduced through birth control programs; but in the short run, decreasing the rate of rural-urban migration is the only means of reducing the urban labor supply. Policies suggested for decreasing rural-urban migration are reduction of urban real incomes directly through wage control or, indirectly, by increased food prices. Alternatively, the rural-urban income differential may be reduced by increasing agricultural incomes through agricultural modernization programs or fiscal policies favorable to agriculture. Inevitably, because of the interactions between sectors of the economy, most policies which affect supply will change demand and *vice versa*.

Harris and Todaro Model

Harris and Todaro (1970) give explicit recognition to the interaction of agriculture and nonagriculture in determining urban unemployment. They follow the now-established tradition of looking at the developing economy as a dual economy in the process of transition from a rural subsistence to a modern industrial economy. There are, however, important differences between the Harris and Todaro model and its predecessors, particularly the Fei-Ranis model. Most importantly, Harris and Todaro look at urban employment as a target of development policy in contrast to the earlier emphasis on growth as the unique target of development. In the Harris-Todaro framework, unemployment is assumed to exist in the urban areas unlike the agricultural surplus labor assumption of Fei and Ranis. Furthermore, there is an important difference in the assumptions concerning wage rates. Harris and Todaro assume an institutionally determined wage rate in the modern sector and a wage rate in the agricultural sector equal to the marginal product of labor. This is a direct reversal of assumptions of the Fei-Ranis model where the wage rate is equal to the marginal product of labor in the modern sector and institutionally determined in the agricultural sector (where the marginal product of labor is assumed zero). Finally, the Harris-Todaro model assumes rural-urban migration as the key interaction between agriculture and nonagriculture rather than the flows of food and consumer goods assumed in the Fei-Ranis model.

The basic Harris-Todaro model can be summarized in eight equations.

Agricultural production function:

1. $X_a = q(N_a, \bar{L}_a, \bar{K}_a),\ q' > 0,\ q'' < 0$

where:

X_a = output of the agricultural good

N_a = the rural labor used to product this output

$\bar{L}_a$ = the fixed amount of land

$\bar{K}_a$ = the fixed stock of capital

q' = $\partial X_a / \partial N_a$.

Manufacturing production function:

2. $X_n = f(N_n, \bar{K}_n), \; f' > 0, \; f'' < 0$

where:

X_n = the output of the manufactured good

N_n = the total labor to produce this output

$\bar{K}_n$ = the fixed capital stock.

Price determination:

3. $P = r(X_n/X_a), \; r' > 0$

where:

P = the price of the agricultural good in terms of the manufactured good.

Agricultural real wage determination:

4. $W_a = P\,q'$

where:

W_a = agricultural real wage

Manufacturing real wage:

5. $W_n = f' \geq \overline{W}_n$

where:

W_n = the real wage in manufacturing

$\overline{W}_n$ = the institutionally determined minimum wage.

Urban expected wage:

6. $W_u = \overline{W}_n N_n / N_u, \quad N_n / N_u \leq 1$

where:

W_u = the expected real wage in the urban areas after adjusting W_n for the proportion of the total urban labor force actually employed.

N_u = the total labor force in the urban areas.

Labor endowment:

7. $N_a + N_u = \overline{N},$

where:

$\overline{N}$ = the total labor endowment (assuming no unemployment in the rural areas).

Migration:

8. $\dot{N}_u = g(W_u - Pq'), \quad g' > 0, \quad g(0) = 0$

where:

$\dot{N}$ = time derivative of rural-urban migration.

Equations 1 and 2 represent production functions for agriculture and nonagriculture. The model is essentially static since the capital stocks and population are fixed. The terms of trade between agriculture and nonagriculture are given in equation 3 by the ratio of outputs of each sector. This allows the agricultural wage rate and nonagricultural wage rate to be expressed in real terms in equations 4 and 5. The nonagricultural wage rate is constrained by an institutionally determined minimum wage.

An essential feature of the Harris-Todaro model is the use of an expected urban wage rate. Todaro (1969) postulates that the rate of rural-urban migration is not only a function of the urban wage rate relative to the rural wage rate but also a function of the chance of finding an urban job. That is, the urban wage rate is discounted in equation 6 by the rate of urban unemployment to give an expected wage rate. Equation 7 imposes a constraint on the labor force. Again, the static assumptions of the model are exemplified by the fixed endowment of labor. Finally, in equation 8 the rate of rural-urban migration is assumed to be a function of the differential between the expected urban wage rate and the rural wage rate.

This set of eight equations with eight unknowns, N_a, N_n, N_u, X_a, X_n, P, W_a, W_u can be solved to show (1) that in equilibrium with zero migration ($\dot{N}_u = 0$), unemployment will exist as long as the urban minimum wage ($\overline{W}_n$) is above the rural wage rate (W_a) and (2) that this equilibrium is stable.

Using the model, Harris and Todaro consider the policy implications of: (1) subsidizing wages or government hiring to increase labor demand and (2) restrictions on migration to decrease labor supply. They evaluate the impact of these policies with respect to two targets, urban unemployment and welfare. Their most important conclusions concern policies such as wages subsidies and hiring to increase the demand for urban employment. They set up a welfare function, $U(X_a, X_n)$, to evaluate alternative policies and maximize this subject to the constraints of the model. However, their argument is tautological and is simplified by equation 9 where welfare is measured by total output (implicit in the Harris-Todaro analysis).

$$9 \qquad X_t = PX_a + X_n$$

The distribution of the labor force between agriculture and manufacturing which maximizes X_t is then computed in equation 10.

$$10 \qquad \frac{\partial X_t}{\partial N_u} = Pq' \frac{dN_a}{dN_u} + f' \frac{dN_n}{dN_u} = 0$$

or rearranging and using the fact that $dN_a = -dN_u$

$$f' = Pq' \frac{dN_u}{dN_n} \quad .$$

This means that creating one additional job in the modern sector will increase that sector's output by f', but migration of the amount

dN_n/dN_u will occur, decreasing agricultural output by $Pq'(dN_n/dN_u)$.

The authors conclude that in many African economies, dN_n/dN_u is likely to be greater than one. That is, more than one migrant flows to the city in response to the creation of one additional job. Thus, it will be "optimal for the marginal product of labor in industry to be higher than in agriculture and urban unemployment will be a persistent phenomenon. . ." However, their analysis does show that the rate of unemployment is likely to fall, although the absolute number of unemployed increases with the creation of additional urban jobs.

Finally, Harris and Todaro examine the implications of migration restriction. They conclude that although such a policy might increase aggregate output, problems arise because of the need to compensate the rural sector for the loss of the opportunity to take a higher-paying urban job. They argue that an optimal policy includes both partial wage subsidies (or direct government employment) and measures to restrict free migration.

Critique of the Harris-Todaro Model

The Harris-Todaro model has been dealt with at length here because it is an important contribution to the theoretical literature on the unemployment problem. It recognizes that urban unemployment is not only an urban problem but is largely dependent on interactions between the agricultural and nonagricultural sectors. Furthermore, the assumption that the migration rate depends on the level of unemployment as well as the rural-urban wage differential, although not empirically validated, gives added insights into the phenomenon. There is good evidence at least in the United States, e.g., Lowry (1966), that the probability of finding a job is an important consideration in the decision to migrate. Most importantly, the model gives explicit recognition to employment as a target of policy and so moves away from the old "one target approach" of previous theoretical literature.

Despite the valuable contribution of Harris and Todaro their conclusions are questionable. It is remarkable that, after recognizing urban unemployment as both a rural and urban phenomena, they do not consider agricultural development as an instrument of policy. Their solutions are <u>urban</u> solutions to both an urban and rural phenomenon. For example, they suggest a partial wage subsidy or government hiring as a means of improving total output and employment; but they do not consider the opportunity cost of the alternative uses of the resources in agriculture. It may well be that both output and employment could be increased even more by agricultural development.

A closer examination of the Harris-Todaro model indicates why agricultural development has been ignored. Firstly, the model is essentially a static model with fixed stocks of capital and a constant population. Only in a more dynamic framework can the effects of high population growth rates and allocation of capital between agriculture and nonagriculture be fully explored. Secondly, the model assumes a closed economy. Even within a comparative static analysis it is not difficult to show that given this assumption, investment in agriculture is not likely to increase output and employment since the price of agricultural goods would be decreased. Under the most likely assumption that the price elasticity of demand for food is less than unity, the agricultural wage rate is likely to be reduced by investment in agriculture.[3]

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[3] Since $W_a = Pq'$ it can be shown that:

$$\frac{\partial W_a}{\partial K_a} = \frac{Pq'}{K_a}(N_w + N_x/N_d)$$

where:

N_w = the elasticity of the agricultural wage rate with respect to capital

N_d = the price elasticity of demand for food (assuming, as Harris and Todaro do, that supply is infinitely elastic)

N_x = the elasticity of output with respect to capital.

In the special case of the Cobb-Douglas production function, $N_w = N_x$, and the requirement for an increase in agricultural wage rates is that the price elasticity of demand is greater than unity. Similarly, if the alternative assumption is made that the relevant agricultural income is given by the average productivity rather than marginal productivity for the general production function, $X_a = g(N_a, L_a, K_a)$, the requirement is unambiguously that the price elasticity of demand is greater than unity.

A further difficulty in the static analysis of Harris and Todaro is the nature of the interactions between agriculture and nonagriculture. Although they give explicit recognition to the flow of labor between the sectors, the flow of goods is not treated. Rather, the terms of trade between the sectors are rudimentarily given by the ratio of the outputs of the two sectors without recognition of the different income and price elasticities for each type of output.

Finally, the Harris and Todaro model does not consider the urban traditional sector. Rather, the simplistic assumption is made that the urban labor force can be divided into wage earners and unemployed. The difficulty in defining unemployment in the urban economy where often over half the labor force is engaged in traditional activities has already been discussed. The traditional urban sector and modern urban sector constitute a dual economy within the urban economy which cannot adequately be represented by a single production function as in the Harris-Todaro model.

In summary, the Harris-Todaro model reveals the frustration of policies which seek to decrease unemployment by increasing the <u>demand</u> for employment at the existing wage rate. There are, however, several weaknesses in their analysis in that: (1) they assume a closed economy, (2) the assumptions of a fixed stock of capital and labor give rise to static analysis, (3) they ignore important interactions, specifically the flows of goods and services between the agricultural and nonagricultural economies, and (4) they ignore the urban traditional sectors as a source of employment.

An inference of the Harris-Todaro model is that if unemployment cannot be solved by increasing the demand, then policies which seek to decrease the supply of urban labor are the logical alternative. Such policies as decreasing the urban wage rate, increasing agricultural earnings and, in the long run, decreasing the birth rate offer promising policy alternatives. In fact, recent researchers in economic development are increasingly advocating a reorientation of development policies toward agriculture to approach the problems of growing unemployment and income disparities (e.g., Eicher et al., 1970; Frank, 1970; Todaro, 1971; and Seers, 1970). However, there has been no rigorous theoretical or empirical analysis of the impact of agricultural development policies on employment and income distribution at the macro-economic level.

Relationship of Agricultural Development and Urban Employment

The new emphasis on agricultural development versus industrial development as a means of absorbing the unemployed is logically based on the need to develop the labor intensive sectors of the economy rather than the more capital intensive modern sectors which have historically been the focus of development programs. Furthermore, given the widening gap between earnings in the agricultural sector and wage rates in the modern sector, agricultural development is seen as a means of promoting a more equitable income distribution across the economy. This, by reducing the incentive for rural-urban migration, is also consistent with the aim of reducing urban unemployment.

However, this simple application of static analysis is not a sufficient basis for advocating a full-scale movement toward agricultural development policies. The relationships between agricultural and nonagricultural sectors in a dynamic economy are complex and embrace much more than the movement of labor between the two sectors. Consider, for example, a hypothetical economy consisting of a nonagricultural sector using only modern production techniques and an agricultural sector producing both food crops and export crops. Assume also that the Harris-Todaro model describes migration from rural to urban areas and that the urban labor force consists only of wage earners and unemployed workers. Suppose that agricultural policies to expand export crops are adopted, then there are several possible interactions.

1. Initially, agricultural earnings increase because of the increased incomes to export crop producers. To the extent that this increases the income of potential rural-urban migrants, migration and hence urban unemployment are reduced.

2. Nonagricultural output rises because of the interactions with agriculture. Specifically, agricultural consumers, because of the increased export earnings, demand more nonagricultural goods and services for consumption. Likewise, agricultural producers may demand more nonagricultural goods as inputs into export production and investment. This increased nonagricultural output increases nonagricultural employment opportunities. However, in the Harris-Todaro framework, unemployment may rise because of the response of migration to the new employment opportunities. In a dynamic sense, there is a further series of interactions between the agricultural and nonagricultural economies. The increased nonagricultural incomes will raise the demand for food by the nonagricultural population. This in turn raises the incomes of food producers in the agricultural sector and sets off a second round of effects. The overall result will be a multiple effect of the original increase in export earnings on both the agricultural and nonagricultural economies.

3. The price of food may rise for two reasons. Firstly, to the extent that export crops compete with food the supply of food, will be reduced. Secondly, the nonagricultural population, with a higher income, demands more food. Depending on the price elasticities of supply and demand and the income elasticity of

demand, the terms of trade are likely to favor agriculture. This increased price of food has the effects of: (1) increasing agricultural earnings, particularly food producers, and (2) reducing <u>real</u> wage rates in nonagriculture. These two effects tend to reduce the rural-urban differential and hence unemployment. Again, the dynamic effects of these changes should also be considered.

This brief analysis leads to inconclusive results. The first and third effects act to decrease unemployment, while the second effect tends to increase migration and unemployment. Furthermore, *a priori* it is difficult to say which effect will dominate. In each case the parameters of the model determine the magnitude of the effect. For example, if we assume elastic supply and demand functions for food, the third effect will be negligible since the price of food is not likely to change much.

The same caution should be used in the advocacy of other policies to reduce unemployment. For example, Berg (1970) advocates urban wage restraint as a means of reducing the rural-urban differential. However, in most countries, wage earnings are an important source of effective demand for both food and consumer goods. Reducing wage rates could then reduce effective demand and overall growth. On the other hand, the reduced wage rate may stimulate employment and offset the decrease in effective demand. But in the

Harris-Todaro framework, stimulating urban employment increases rural-urban migration and, possibly, unemployment.

It has not been the aim of this analysis to present a general theory of the relationship between agricultural development and urban employment. Rather, by using one illustration the complexity of the relationship and the difficulties of using static analysis and a few key variables to explore the system have been demonstrated. The simulation approach is now presented as an alternative method of analyzing this system.

Simulation as an Analytical Approach

The previous section illustrated the complex system of interactions relating agricultural policy instruments to the targets of growth and employment. Recent writers (e. g., Dixit, 1969 and Hornby, 1968) have attempted to construct mathematical models of growth in a dual economy which go beyond the Fei-Ranis model in making more realistic assumptions. The difficulty with these models is that with a large number of parameters and equations, it is cumbersome to obtain a generalized mathematical solution to the system. It appears that such a system of equations including, in addition to the Dixit and Hornby models, an employment dimension and assuming an open economy, would be mathematically insoluble.

Reynolds (1969) in a review of the dual economy models recognizes the restrictive assumptions of present models. He is also aware of the limitations of obtaining general analytical solutions to a complex system of equations and proposes computer simulation as a means of exploring such systems. Reynolds (1969, p. 98) states:

> A more useful technique at this stage may be simulation runs, using illustrative values of the key variables in the system, which would permit one to explore the consequences of varying the values of these variables within a prescribed range. This might be regarded as a computerized version of old fashioned Ricardian arithmetic. . . "

Proposing that the economy be divided into agricultural, urban trade-service, government and industrial sectors, Reynolds is interested in using the model to study "the annual increase in national product and the sector distribution of this increase, the size and sector distribution of increases in employment, the behavior of unemployment, and the distribution of unemployment between country and town."

However, Reynolds recognizes that, in order to restrict the number of simulation runs to the key parameters, constructing such a general simulation model would require much more knowledge than is currently available on the production relationships, consumption patterns and employment behavior in the developing countries. He finally proposes several areas of research required before the analysis could be undertaken.

In this study simulation analysis will be used to explore the interactions between agricultural and nonagricultural economies and their implications for growth and employment in a particular economy, the Nigerian economy. By considering a specific case, the data requirements are less formidable since more empirical information is available on the Nigerian economy than the "typical" developing economy considered by Reynolds. However, analyzing a specific economy has the disadvantage that the conclusions will not have the general applicability that Reynolds envisages for his model. However, as will be demonstrated in Chapter 3, Nigeria has much in common with the other developing economies, and the results should be suggestive of some general conclusions.

Simulation and systems science methods are particularly applicable to the problem at hand. Firstly, the simulation-systems science approach gives explicit recognition to the interactions and feedback effects between major sectors of a system. In this case, the problem centers on the interrelationships between agricultural and nonagricultural economies. Secondly, a simulation model is particularly suited to represent a dynamic system. Earlier models of a dual economy are limited by static assumptions. Thirdly, a simulation model does not necessarily involve a single solution such as the maximization of growth or output. In this study the relationships of policy instruments to at least two target variables, growth and employment, are of interest. Finally, the simulation-systems science approach is characterized by flexibility in that the model is not restricted to linear equations or discrete time lags but nonlinear or discrete functions and exponential time lags can be incorporated.

Manetsch _et al._ (1971) suggest a generalized mathematical expression of a simulation model shown in equations 1, 2 and 3. The state of the model at a given time period, S(t+1) is a function of the state of the system in previous time periods, S(t), the parameters describing the structure of the system, a(t), exogenous variables of the system outside the control of the policy maker (e.g., weather, world prices), b(t), and policy instruments of the system (e.g., taxes, public investment), g(t). Note that equation 1 is a difference equation which in successive iterations describes the time path of the state of the system. In equation 2, a set of variables, M(t), is used to measure the ability of the model to describe the state of the real world, $S_w(t)$. These variables will usually be some statistical measure of the "goodness of fit" of the simulated results to real world observations. When the simulation model has been constructed and verified, it can be used to experiment on the system to evaluate the effects of various policy instruments, g(t), on policy targets, P(t), given by equation 3.

1. $S(t+1) = F[S(t), a(t), b(t), g(t)]$

2. $M(t) = H[S(t), S_w(t)]$

3. $P(t) = G[g(t)]$

where:

S = variables defining the state of the system at any point in time

S_w = variables describing the state of the system in the real world.

a = parameters representing the structure of the system

b = exogenous variables

g = policy instruments

M = variables that measure the correspondence of the state variables, S to reality, S_w.

P = variables of interest to the policy maker.

The simulation and systems science approach has increasingly been used to model complex systems. In economics, simulation models have been developed for firms (e.g., Halter and Dean, 1965), for industries (e.g., Manetsch, 1967) and for regions (e.g., Webb, 1969). However, at the macro-economic level, the approach has been used to a lesser extent. The pioneering work of Holland and Gillespie (1963) illustrated the use of a simulation model to take account of dynamic interactions in development planning. In further work, Holland (1967) extended the original model to the Venezuelan economy primarily focusing on monetary policy, inflation, and the relationship between consumption and investment. Kresge (1967) has developed a simulation model of the Pakistan economy based on dynamic input-output techniques.

The model to be presented in the next chapter follows from the work of Kresge with modifications to the determination of consumption and investment. Furthermore, the proposed model will also emphasize agricultural-nonagricultural interactions and nonagricultural employment and income distribution.

Summary

Economists have, in recent years, become increasingly aware of the serious problems of urban unemployment. In many developing countries, particularly in Africa, rates of urban unemployment of the order of 15 percent of the labor force are common. Furthermore, the evidence suggests that these rates are increasing over time. However, open unemployment in the cities is the most obvious expression of a wider problem of underemployment and low productivity in the urban traditional sectors. Closely related, is the problem of income distribution, particularly the increasing gap between earnings in the urban traditional sectors and the modern sectors and the widening differential in agricultural and nonagricultural incomes.

Unemployment in the developing world is the result of slow rates of growth of wage employment and high rates of growth of the urban labor force. A 1.5 percent growth in wage employment coupled with a six percent growth in the labor force implies a growth of the residual labor force of about nine percent per annum which is absorbed as self-employed workers in the urban traditional sectors or is openly unemployed.

There is need for both micro-oriented research and macro-oriented research to formulate policies which give explicit recognition to employment and income distribution as targets of development policy. At the macro-economic level, Harris and Todaro take explicit account of the interactions between agriculture and nonagriculture in determining the rate of rural to urban migration. The Harris-Todaro model reveals the paradox of policies which seek to decrease unemployment, by increasing the demand for employment at the existing wage rate. Rural-urban migration in response to these new employment opportunities may actually increase unemployment.

From the recent literature on unemployment and income distribution there emerges a new emphasis on agricultural development as a means of reducing the rural-urban income differential and steadying the flow of migrants to the cities. However, the present macro-economic analysis of the effects of agricultural development policies on urban unemployment and income distribution are lacking because they do not consider the complexity of interaction between the agricultural and nonagricultural sectors. A simulation analysis of a specific economy, is proposed as a means of approaching the problem.

III. GROWTH AND EMPLOYMENT IN THE NIGERIAN ECONOMY

In this chapter the Nigerian economy is briefly described with an emphasis on those aspects which characterize it as a developing economy and which pertain to the employment problem and its relationship to agricultural policies. It is not intended that this be a comprehensive analysis of the Nigerian economy. Not only is this beyond the scope of the study but excellent analyses of the economy are already available. Detailed descriptions of the overall economy are found in Eicher and Liedholm (1970) and Helliener (1965). The national income statistics are carefully analyzed and their limitations discussed in Clark (1967). At the sector level, the agricultural sector has been extensively studied and reported in the various publications of the Consortium for the Study of Nigerian Rural Development (Johnson et al., 1969) while Kilby (1969) gives an excellent analysis of the industrial sectors of the Nigerian economy.

The first three sections of the chapter summarize relevant features of the national accounts, the agricultural sectors and the nonagricultural sectors. Particular attention is paid to the features of the Nigerian economy which are common to other developing economies. The fourth section includes a fairly comprehensive analysis of the labor market and the employment problem.

National Accounts

Nigeria is the most populous country in Africa with a population of 55 million and an area of 360,000 square miles. The population is estimated to be growing at an annual rate of 2.5 percent, with a tendency for this rate to increase with declining death rates. Total gross domestic product at factor cost in 1965/66 (the last pre-civil war year) is estimated to be Ł 1,457 million[1], giving a per capita income of about Ł 27 or US$90.

National income statistics for Nigeria must be interpreted with caution. Okigbo (1962) estimated national income for the period 1950-1957 but later work by the Federal Office of Statistics (1968b) is based on a different estimation procedure and is not comparable. In addition, after 1966 the figures are distorted by the civil war. This leaves a period 1959-1966 of continual statistics to analyze the Nigerian economy. Even then, there are several difficulties in interpretation. For example, Langley (1968) cites four different and widely divergent estimates of investment for the period 1950-1965.

National income can be disaggregated by expenditure (e.g., consumption, investment, and the trade deficit) and by production sector (agriculture, manufacturing, etc.). In Figure 3.1, gross

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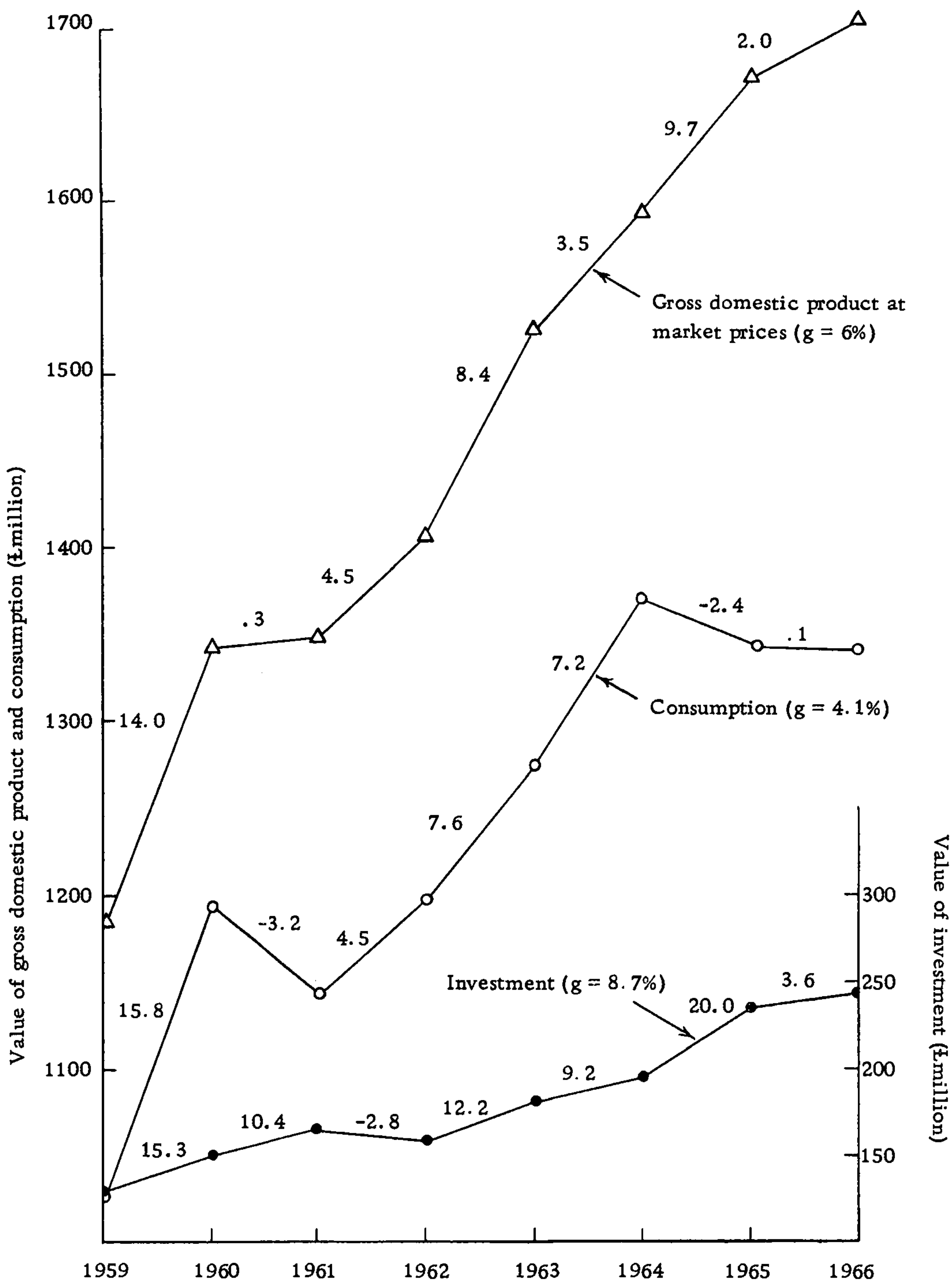
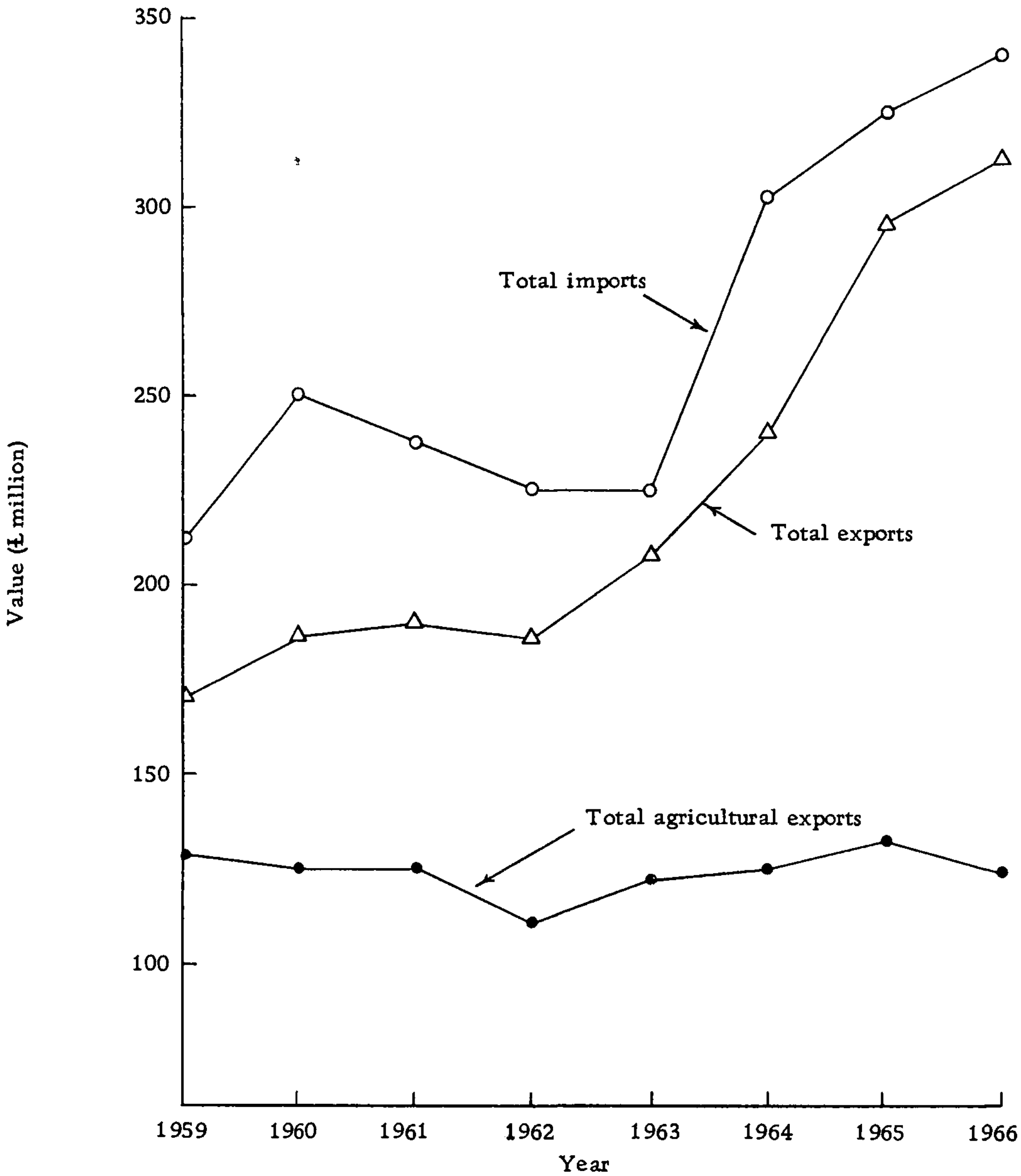
[1] Throughout the study the symbol "Ł" denotes Nigerian pounds. One Nigerian pound is equivalent to US$2.8.



Notes: g = average annual growth rate, 1959-1966. Numbers on the graphs are annual growth rate.

Source: Vielrose, 1970

Figure 3.1 Gross domestic product, consumption and investment in Nigeria, 1959-1966 (at 1962 prices) domestic product is broken down by consumption and investment. Over the period 1959-1966, the economy grew at an average annual rate of about six percent with some sharp fluctuations. Investment grew at an even higher rate of nearly nine percent per annum, increasing its share of gross domestic product from 10 percent to 15 percent. Again, there is a substantial year-to-year variation in investment activity. Consumption, because it is calculated as a residual, must be treated with the greatest caution since it contains all residual errors of estimation. However, if the growth rate averaged four percent as indicated, an improvement of per capita consumption of about 1.5 percent annually is implied (assuming a population growth rate of 2.5 percent). The other accounting variable of gross domestic product expenditure is the trade deficit shown implicitly in Figure 3.2. Total imports have consistently exceeded exports over this period, the balance being supported by a steady inflow of private and public foreign capital. A particularly important structural change over the period is the relative decline in the contribution of agriculture to foreign exchange earnings. Whereas the value of agricultural exports stagnated largely due to unfavorable world prices, oil exports rose dramatically over the period. The actual contribution to foreign exchange earnings of oil relative to agriculture is, however, overestimated in Figure 3.2 since oil production has larger import requirements and a substantial proportion of the profits is remitted abroad.



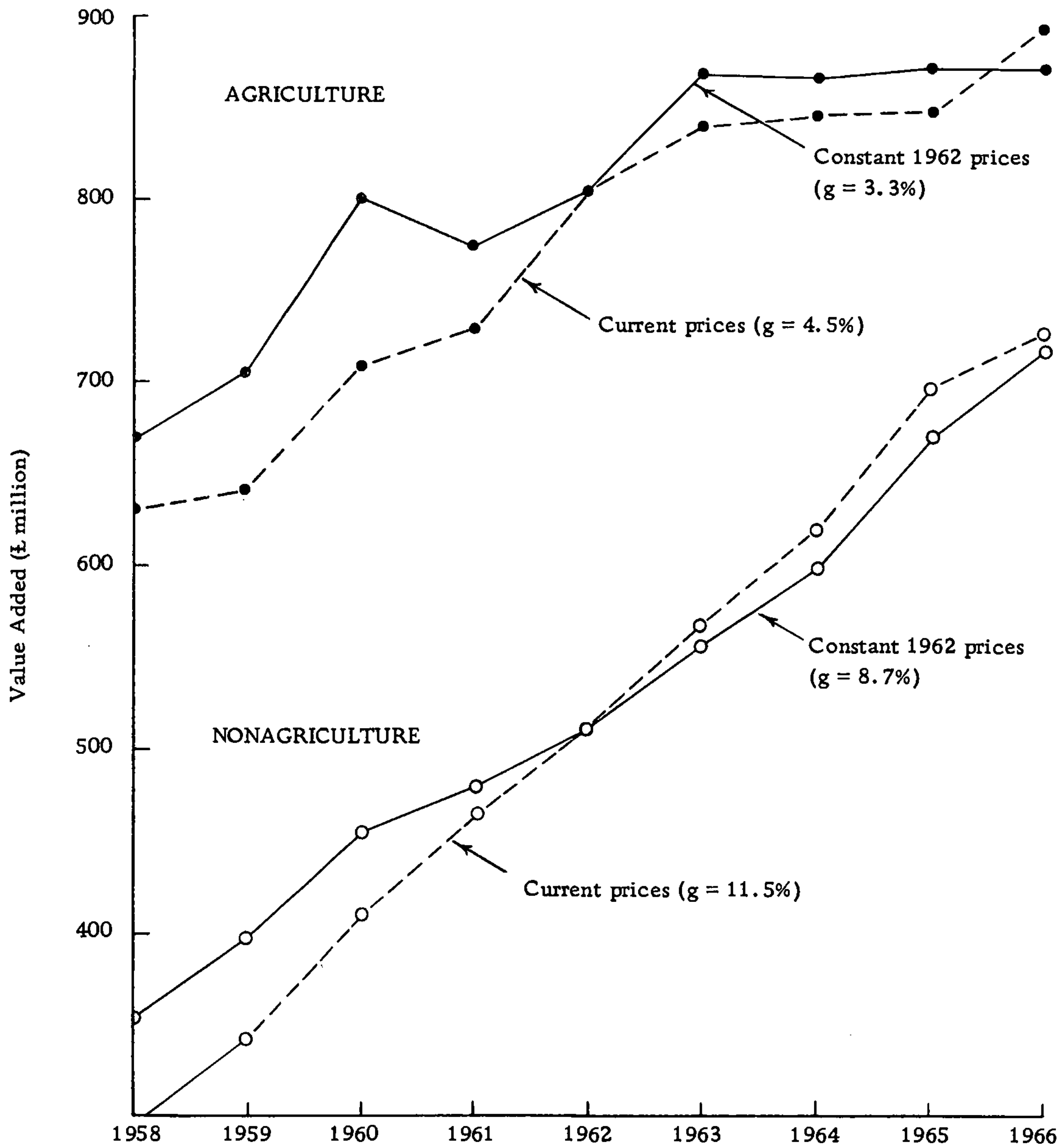
Source: Vielrose, 1970.

Figure 3.2 Growth of exports and imports in Nigeria, 1959-1966.

Gross domestic product can also be disaggregated by production sectors. Figure 3.3 shows value added by agriculture and nonagriculture both at constant prices and current prices. Over the period 1959-66, agricultural value added in constant prices increased at an average rate of 3.3 percent, with only a small increase in prices of 1.2 percent. However, the price increases were high before 1962 while after 1962 prices actually declined. Nonagricultural value added (including government activities) increased considerably faster at an annual rate of 8.7 percent. Again prices were remarkably stable with an annual inflation of only 2.8 percent. This high growth rate in nonagricultural value added meant that agriculture's share of gross domestic produce declined from 68 percent in 1958 to 56 percent in 1966. A further interesting feature of Figure 3.3 is the relatively unsteady growth of the agricultural sector. The fact that this instability occurs whether value added is expressed in current or constant prices suggests that weather variability rather than price fluctuations is largely responsible.

The Agricultural Economy

Nigerian agriculture is characterized by small-holder production. Less than .4 percent of the agricultural labor force is employed on large-scale estates. Most are self-employed, farming plots of land ranging up to ten acres and generally using traditional



Note: g = average annual growth rate, 1958-1966.

Source: Federal Office of Statistics, 1968b.

Figure 3.3 Growth of agriculture and nonagriculture in Nigeria, 1958-1966.

methods of production and family labor.

The staple food crops, yams, cassava, millet, maize, and other root and cereal crops are the most important group of agricultural crops in Nigeria accounting for over 70 percent of the value of agricultural output. Of these crops the major proportion is subsistence production grown for home consumption. Although marketing of the staple foods to the nonagricultural population is the largest source of cash income for the agricultural population, the effective demand for staples is somewhat limited because of the relatively small nonagricultural population (i. e., there are three farm families for each non-farm family). In general, the supply of staples to the market has kept pace with demand increases without significant price increases or imports.

The export crops, cocoa, plam, rubber and groundnut, have historically been the major source of foreign exchange for Nigerian development. As seen from Figure 3. 2, earnings from agricultural exports have averaged about Ł 120 million in recent years. Unlike staple foods, marketing of export crops is controlled by the Nigerian Marketing Boards. Although originally designed to cushion the impact of world price fluctuations on the Nigerian economy, the Marketing Boards have also served as a convenient means of taxation of the agricultural producers. Generally, this tax has amounted to about 20-30 percent of the value of export crops.

Finally, there is a group of miscellaneous products such as livestock, sugar and vegetables. The domestic demand for these foods is small although likely to increase rapidly with increases in income. Furthermore, since some of these products, particularly beef and rice, are imported, potential exists for expanding domestic production.

Ecologically, Nigeria can be broadly classified into the north and south. The north is generally drier with a growing season suitable for annual crops such as food crops, groundnuts and cotton. In addition, the north is characterized as having a surplus of land with labor being the limiting factor in production. In the south the extended growing season enables production of the perennial crops, cocoa, rubber and palm as well as annual crops. Land and capital are limiting factors in agricultural production although labor may be seasonally scarce, often being provided by seasonal migrants from the north. Furthermore, there are regional inequities in the distribution of income and social services between the south and north (Adedeji, 1969) with the southern agricultural populations having higher incomes and less dependence on subsistance production for food needs.

Government policies toward agriculture have been widely criticized. As noted above, the Marketing Board pricing policy enables the government to extract substantial revenues from agriculture. These revenues generally have not been reinvested in agriculture in the form of research and extension programs and agricultural infrastructure, but have been used to support rapid industrialization. Johnson *et al.* (1969), in their summary of the research of the Consortium for Nigerian Rural Development, recommended that agriculture be given greater priority in the overall economic development program. They discuss two broad types of policy recommendations. Firstly, they recommend that farmers be paid higher prices for export crops by eliminating the Marketing Board's profits. Secondly, they urge more investment in research and extension programs, particularly for export crops, to promote adoption of modern production techniques (e.g., fertilizer use) and new higher yielding varieties. However, they estimate that any efforts to increase staple food production at present would be thwarted by limited effective demand, resulting in worsening terms of trade for agriculture and possibly reduced agricultural incomes.

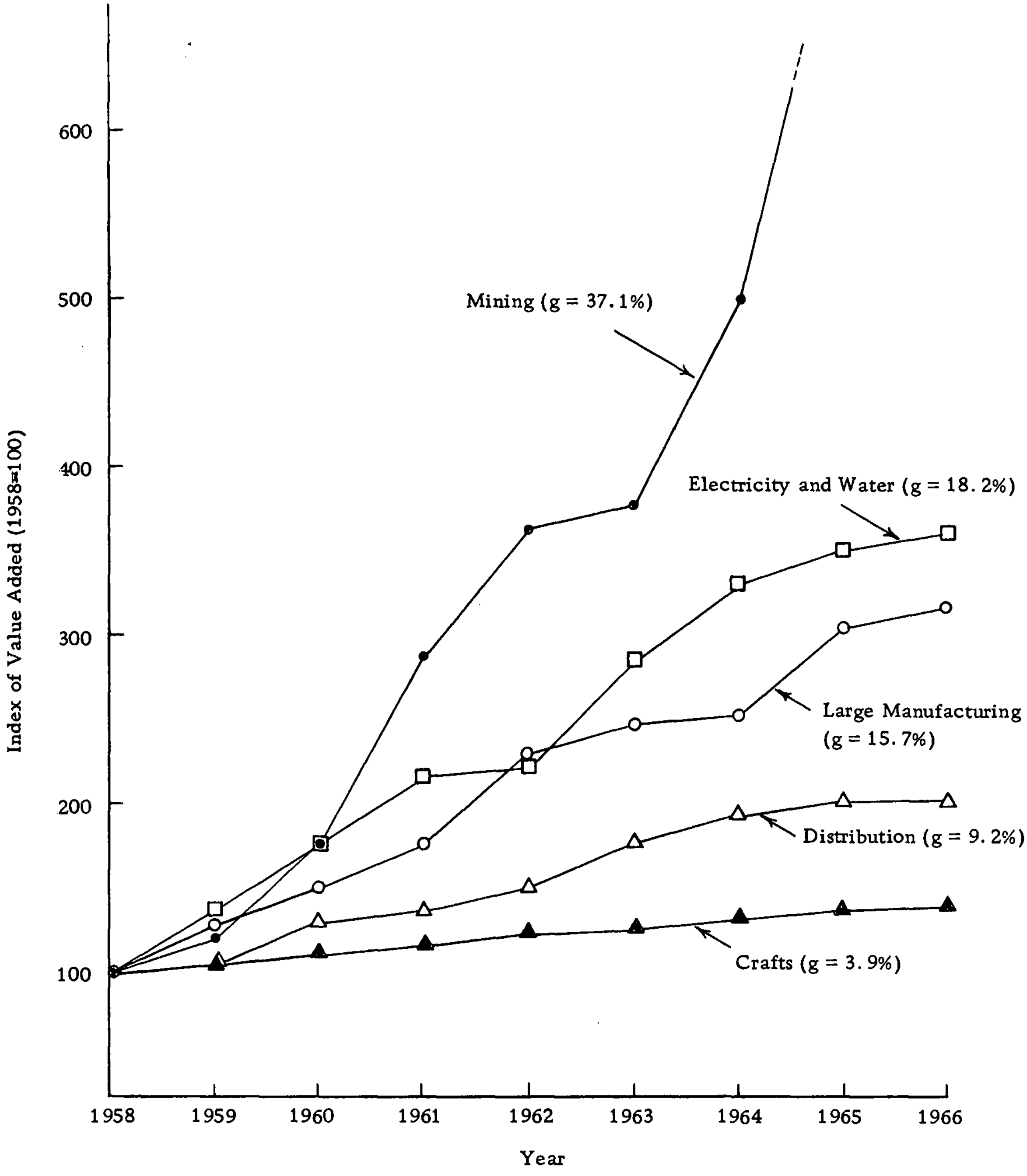
The Nonagricultural Economy

The rapid growth rate of the Nigerian nonagricultural economy can be attributed to several events. Firstly, the government has encouraged investment in the nonagricultural sectors through import substitution policies, tax credits, government loans and government investment programs. Secondly, there was a rapid increase in the value of oil production from less than one million pounds in 1959 to 70 million pounds in 1966.

Figure 3. 4 shows the growth path of several nonagricultural sectors. In addition to the oil industry, the manufacturing and public utilities sectors have grown rapidly at an annual rate exceeding ten percent, partly because of the high income elasticity of demand for these goods and partly through import substitution. However, despite the high growth rate of these two sectors, they still formed only five percent of total gross domestic product in 1966.

Most studies of the nonagricultural sector focus on the modern sectors such as manufacturing, public utilities, construction, transport, mining, and government. A much neglected component of the nonagricultural economy is the traditional small-scale sectors, i. e., trade, services and crafts. Statistics for these sectors are poor but they probably constitute from a third to a half of nonagricultural value added and over two thirds of nonagricultural employment. As seen in Figure 3. 4, the growth of these sectors is much slower than for the modern sectors.

The only comprehensive study of small-scale industry in Nigeria is a survey by Kilby (1969) of several towns in eastern Nigeria. Kilby's results - summarized in Table 3. 1 - show that most firms employ only two or three workers. This labor is usually provided by the family rather than by hiring outside workers for a wage. Most industries shown in Table 3. 1 are crafts such as tailoring, carpentry and shoemaking which use traditional production techniques and skills.



g = average annual growth rate, 1958-1966.

Source: Federal Office of Statistics, 1968b

Figure 3.4 Indices of growth of some nonagricultural sectors in Nigeria, 1958-1966.

Table 3.1 Small industry in fourteen Eastern Nigerian towns, 1961.

Industry	No. of firms	Total employment	Average no. of workers
Tailoring	3,450	7,288	2.1
Carpentry	2,773	7,173	2.6
Shoemaking	298	829	2.8
Shoe repair	390	616	1.6
Motor repair	396	2,968	7.5
Welding	221	848	3.8
Blacksmithing	369	763	2.1
Tinsmithing	491	1,029	2.1
Printing	146	938	6.4
Baking	221	1,341	6.1
Mattress making	266	488	1.8
Radio repair	236	906	3.8
Photography	157	424	2.7
Corn milling	65	131	2.0
Goldsmithing	267	516	1.9
Other (miscellaneous)	966	2,417	2.5
Total	10,728	28,721	2.7

Source: Adapted from data reported in Kilby, 1969, p. 18.

However, a small but significant proportion of small industry such as printing, motor repair and photography utilizes modern production techniques. This modern small industry usually grows more rapidly than the traditional industries in a developing economy.

The Labor Force and Wage Determination

Statistics on population and the labor force in Nigeria are complicated by the lack of agreement on the validity of the most recent population census, conducted in 1963. In this study the preliminary findings of the Labor Force Sample Survey conducted in 1966/67 and reported in the Second National Development Plan (Federal Ministry of Information, 1970) are used.

About 40 percent (25 million people) of the population is estimated to be in the labor force. Table 3.2 shows the pattern of gainful employment between sectors reported by the Survey.[2] Over 70 percent of the total labor force is employed in agriculture. Note also the dominance of women in the commerce sector, a feature common in West Africa. Table 3.3 provides a breakdown by type of employment. If self-employed persons are defined as being own account workers or unpaid household workers, over 90 percent of the labor force is

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[2]No definition of the terms "gainful employment" and "labor force" were given in the report.

Table 3. 2 Sectoral pattern of employment in Nigeria, 1966-67.

Sector	Males (percent)	Females (percent)	Total (percent)
Agriculture	80. 1	62. 1	71. 7
Manufacturing	6. 3	14. 0	9. 6
Construction	1. 1	0. 01	0. 6
Commerce	4. 9	22. 2	12. 9
Transport and Communication	1. 4	0. 03	0. 8
Services	5. 8	1. 7	3. 9
Others	0. 3	0. 02	0. 2
Total	100. 0	100. 0	100. 0

Source: Federal Ministry of Information, 1970, p. 311.

Table 3. 3 Composition of employment in Nigeria, 1966-67.

Type of Employment	Agriculture (percent)	Non-agriculture (percent)	Total (percent)
Employers	0. 2	0. 1	0. 3
Own-account workers	42. 3	21. 6	63. 9
Employees	0. 7	4. 5	5. 2
Unpaid household workers	28. 6	1. 0	29. 7
Unpaid apprentices	--	0. 9	0. 9
Total	71. 8	28. 2	100. 0

Source: Federal Ministry of Information, 1970, p. 312.

self-employed while only 5.2 percent are wage earners. Even in the nonagricultural sectors, which employ almost all the wage earners, self-employed persons comprise 80 percent of the labor force.

A common method of delineating the modern large-scale sectors and the traditional small-scale sectors is in terms of the number of persons employed in a firm. The approximate division of the labor force between establishments employing ten or more persons (the large-scale sectors) and establishments employing less than ten persons (the small-scale sectors) is given in Table 3.4. Of particular interest is the concentration of the labor force in three small-scale and largely traditional sectors - manufacturing (crafts), commerce and agriculture - which employ 94 percent of the labor force.

Unemployment

Unemployment and underemployment have been described by Lewis (1967) as "Nigeria's most serious social problem with political as well as economic consequences." Open unemployment appears to be confined almost exclusively to the urban areas. Both Mueller and Zervering (1969) and the Federal Ministry of Information (1970) report rates of unemployment less than one half of one percent in the rural areas. Of course, as Mueller and Zervering (1969) note, there is a considerable underutilization of labor in the rural areas in certain seasons. In contrast, Kilby (1970) on the basis of the National

Table 3.4 Estimated employment by sector and scale of operation in Nigeria, 1970.

Sector	Total employed (millions)	Employed in large firms[a] (millions)	Employed in small firms[b] (millions)	Percent employed in large-scale firms
Agriculture	16.790	.070	16.720	.4
Mining	.055	.055	.0	100.0
Manufacturing & Utilities	2.930	.165	2.765	5.6
Construction	.136	.105	.031	77.2
Commerce	3.030	.055	2.975	1.8
Transport	.167	.050	.117	29.9
Services	.946	.265[c]	.681	28.0
Total	24.054	.765	23.289	3.2

[a] Firms employing more than ten persons.

[b] Firms employing less than ten persons.

[c] Largely government employment.

Source: Estimated from results of the Labor Force Sample Survey, 1966 reported in Federal Ministry of Information, 1970.

Manpower Survey of 1963 estimates urban unemployment as 14 percent of the total urban labor force. Figures for various regions of Nigeria, given in Table 3.5, show that this rate of unemployment is fairly general throughout Nigeria, varying within a range of 10 percent to 18 percent. In interpreting these figures, it should be remembered that these rates of unemployment do not include the substantial amount of underemployment in the traditional sectors of the urban areas.

Table 3.5 Results of 1963 unemployment survey in large towns in Nigeria.

Statistical region	Estimated total urban population	Estimated total urban unemployed	Percent unemployed
Lagos	577,000	50,776	15.5
North	731,810	45,539	10.6
East	527,600	60,723	17.6
West	1,564,140	86,336	11.6
Midwest	155,180	16,080	17.8
Total	3,555,730	259,454	12.6

Source: Dziadek, 1967, p. 16.

Because of the lack of comparable estimates of unemployment at more than one point in time in Nigeria, it is difficult to determine trends in the rate of unemployment. The limited evidence available suggests unemployment has increased over time. Weeks (1968) in a study of the urban labor market reports that for the period 1947-57 there was a tight urban labor market with negligible unemployment. Only since 1960 has the number of unemployed reached serious proportions. Kilby (1969) on the basis of casual observations believes there has been declining productivity in the urban traditional sectors during the last decade. As discussed in Chapter 2, this is indicative of rising unemployment and unemployment in urban areas.

The reasons for the increasing unemployment are similar to those discussed in Chapter 2 for developing countries in general. Frank (1967) in a study of the demand for <u>wage</u> employment by nonagricultural sectors in Nigeria found that for the period 1956-1963 nonagricultural value added grew at a rate of eight percent annually, compared with a growth in wage employment of 1.1 percent annually. Frank suggests that average wage rate increases of three percent annually had a depressing effect on government employment because of the limited government budget. This effect is an important determinant of wage employment since the government accounts for 40 percent of total wage employment. In the private sectors Frank estimates rates of increase in productivity of up to seven percent annually, particularly in the construction and manufacturing sectors.[3] Unfortunately, these are crude

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[3]Productivity is measured as real output per worker.

estimates since Frank is not able to separate outputs of the traditional sectors from the modern sectors where most of the wage labor is employed. In addition, his analysis provides little insight into the reasons for the high productivity increases in the private sectors. It would be immensely useful to know the relationship of wage rate increases to productivity increases in the private sector.

While the demand for wage employment has risen slowly at a rate of one percent annually, the supply of labor in the urban areas has been increasing at a rate of about six percent annually, leaving a large gap between supply and demand to be filled by underemployment in the traditional urban sectors and open unemployment. Over half the increase in the urban population is the consequence of rural-urban migration. Studies by Mueller and Zervering (1969) and Callaway (1963) indicate that these migrants are relatively young and include many recent school-leavers. Again the limited evidence from Nigeria (Olusanya, 1969, and Weeks, 1968) conforms with evidence from other developing countries in suggesting economic factors as the main motivation. [4]

The rural-urban income differential as a key determinant of migration, is large and widening in Nigeria. Weeks (1968), using export

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[4] A study by Imoagene (1967) suggests that social factors, particularly communications, may be important although it does not negate the importance of economic factors.

prices as a guide to farmers' incomes and government unskilled wage rates to measure urban incomes, concluded that the rural-urban differential has widened consistently since 1955, as seen in Table 3. 6. In 1965 this differential had widened such that average farm earnings were about one third of urban unskilled wage rates.

Table 3. 6 Indices of average earnings in agriculture relative to urban unskilled wage rates for various Nigerian cities (1953=100).

Year	Lagos	Ibadan	Benin	Kano	Kaduna	Enugu
1953	100	100	100	100	100	100
1954	116	100	100	100	100	78
1955	109	58	62	60	60	49
1956	87	44	47	55	55	49
1957	64	44	47	64	64	49
1958	64	44	47	58	57	47
1959	64	43	46	58	56	44
1960	52	38	40	52	52	39
1961	34	24	26	59	59	32
1962	36	26	27	54	54	32
1963	38	27	29	54	54	33
1964	32	25	25	46	46	22
1965	17	13	13	49	49	23

Source: Weeks, 1968, p. 147.

The widening gap between rural and urban incomes has undoubtedly been aggrevated by government neglect of agriculture and falling export prices, but the main factor has been a continual rise in the level of the urban wage rate. The trend in urban wage rates is compared to the increase in national per capita income in Table 3.7. Kilby (1967) estimates that urban wages have risen at an average annual rate of three to six percent since 1953 compared with a growth rate of about two percent in per capita incomes. From these figures it is readily apparent that the gap between the wage earners and self-employed workers in both agriculture and nonagriculture has been widening rapidly in recent years.

Table 3.7 Indices of minimum unskilled real wage rates compared with national per capita income.

	Wage rate by city (1953 = 100)				Per capita
Year	Lagos	Ibadan	Enugu	Kaduna	GDP
1953	100	100	100	100	100
1956	117	139	121	128	106
1959	105	141	113	123	110
1962	118	139	111	127	118
1965	146	185	164	159	126
Av. Annual Growth 1953-1965	3.6%	6.0%	5.1%	4.3%	2.0%

Source: Kilby (1969), p. 281.

The mechanism by which wage earners have achieved these wage increases in the face of rising unemployment is not clearly understood. Kilby (1967) in his well-known article "Industrial Relations and Wage Determination: Failure of the Anglo-Saxon Model" sees a clear division of the labor market into an organized sector and an unorganized sector. The organized sector consists largely of workers employed in firms with ten or more employees. This sector is organized into trade unions who Kilby believes have the bargaining and political power to extract wage rates well above those of the unorganized sector where there is no trade union representation and where most workers are self-employed. Weeks (1968a), on the other hand, believes that the Nigerian trade unions are weak and that high wage rates are the result of government policies to provide employees a better standard of living.

Weeks (1968, p. 12) writes:

> The institutional evidence suggests union impotence. ---. For humanitarian, institutional and ideological reasons, the government commissions a major wage review about every five years. In the absence of such government action, unions are incapable of mustering sufficient pressure to raise wages in the private or public sectors. --- The moral force supporting the wage structure is further strengthened if, as in the case of the 1964 Morgan award, the increases are based on a concept of a living wage.

Whether the wage increases are granted because of employee demands or employer policies, all students of the Nigerian labor market agree that wage rates for unskilled persons in the modern sectors are much higher than earnings in the urban traditional sectors and the rural areas. However, the issue of wage determination is an important one since if wages are to be restrained by government policies, then such restraint would be much easier in the Weeks model than in the Kilby model.

An additional factor to be considered is the responsiveness of wages to price increases. Weeks (1968) has shown that government commissions to review wages have given weight to cost-of-living changes rather than earnings in other sectors in decisions to increase government wage rates. Recent reports (e.g. Labour unrest - Nigeria, 1971) indicate that Nigeria is experiencing considerable labor unrest as the result of the spiralling food costs at the end of the civil war.

Summary and Implications

In this chapter we have sought to describe some of the features of the Nigerian economy relevant to this study. The review has shown that the Nigerian economy has much in common with other developing economies. Agriculture is the dominant sector of the economy with agricultural exports as the "engine of growth" (Lewis, 1967). Output of the food staple crops have expanded slowly largely because of a lack of effective demand. In line with most developing countries, nonagriculture has grown rapidly although Nigeria has the added bonus of a dynamic oil industry. There are large and in many cases increasing disparities in income distribution between agriculture and nonagriculture, regionally within agriculture, as between the north and south, and within nonagriculture as between the modern and traditional sectors.

Finally and most importantly for this study, urban unemployment is a serious and rising problem. Evidence available conforms with the pattern in other developing countries. That is, slow increases in demand for wage labor are coupled with rapid growth in the urban labor force. The latter is undoubtedly aggravated by a high rural-urban income differential.

Nigerian policy makers are aware of the employment problem as indicated in the following passage from the Second National Development Plan (Federal Ministry of Information, 1970, p. 340):

> The wide acceptance that the development of an economy should not only be seen in terms of the growth of the national economy but should also take account of the income distribution pattern calls for considerable attention to the probable employment content of development plans. This requires that development plans should be appraised for their impact on employment. The success or otherwise of a plan depends largely on its employment achievements. Accordingly, manpower planning is an integral part of general economic planning.

Yet there is little evidence from the document that employment was explicitly a target of the plan.[5] Rather it seems that the plan was constructed along "conventional" lines, with growth as the single target, and the employment implications checked out as an afterthought.

However, even if the planners had decided to include employment as a target, they would have found very little research or accepted theory on which to base policy formulation at the macro or micro-levels. At the macro-level, we have seen that the Harris-Todaro model, though not empirically substantiated, opens serious questions regarding policies to increase employment demand in urban areas. Other authors (Frank, 1970; Kilby, 1968); and Harbison (1970) have advocated policies to reduce the supply of labor in urban areas through agricultural development and wage control to reduce the rural-urban income differential. However, no rigorous theoretical or empirical analyses of these policies have been undertaken.

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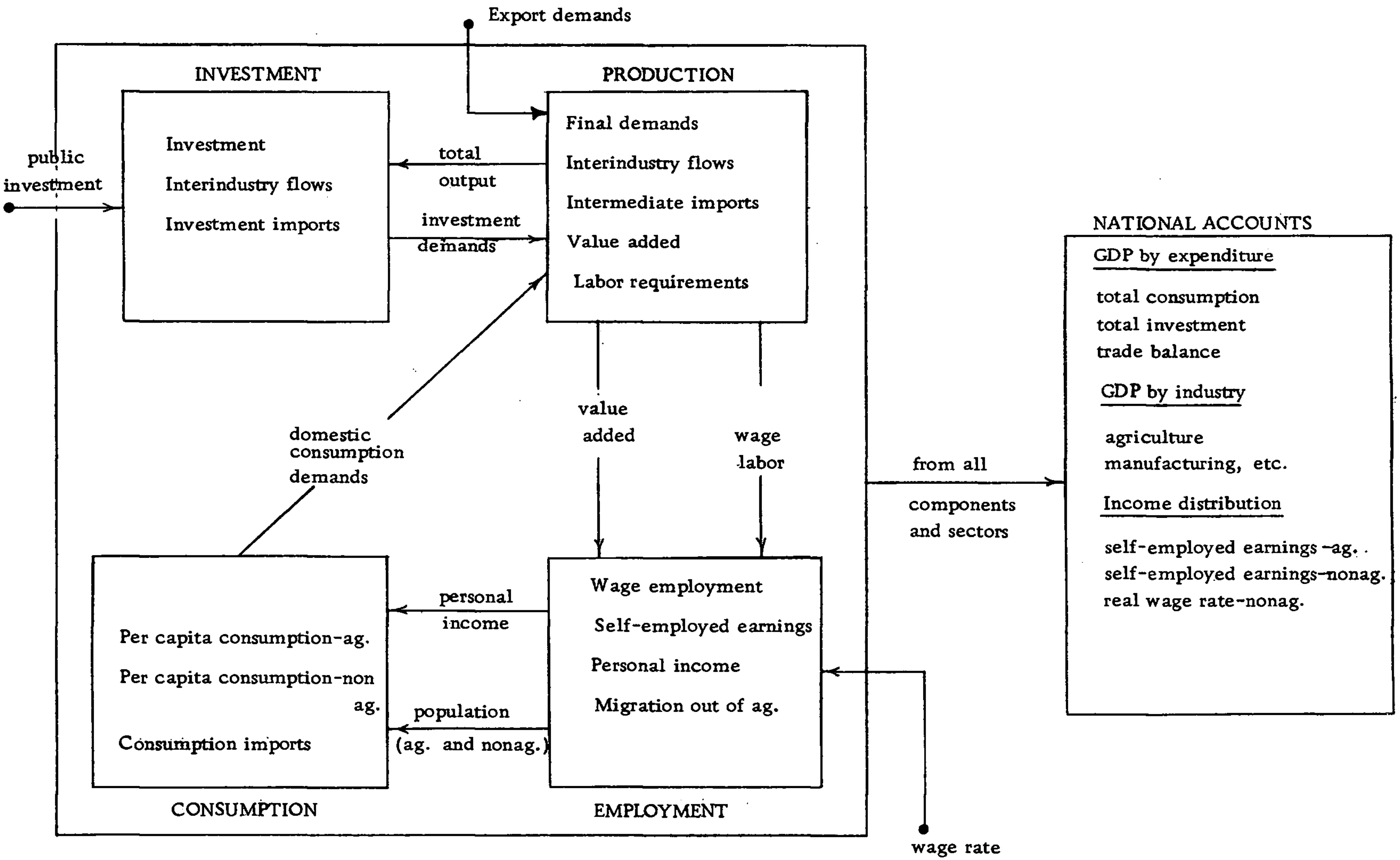
[5] Chapter 33 of the Plan does discuss a Youth Corps designed to remove a "few thousand" unemployed from the city each year.

IV. DESCRIPTION AND TESTING OF THE SIMULATION MODEL

Overview of the Model

In designing and building the simulation model to be used in this study, emphasis has been placed upon successfully modeling the interactions between agriculture and nonagriculture. In the first phase of model building, a simple ten sector macro-economic model of the Nigerian economy was constructed. After preliminary testing, this model was merged with a detailed simulation model of the agricultural sector of Nigeria constructed by the Agricultural Simulation Project at Michigan State University and reported in Manetsch et al. (1971). This detailed agricultural sector model was then used to simulate the effects of agricultural policies on the agricultural sector ; upon merging with the macro-economic model the effects of these policies on the total economy were simulated.

An overview of the macro-model is given in Figure 4. 1. It disaggregates the total economy (in this case the Nigerian economy) into a number of interacting sectors of interest (e. g. , manufacturing, agriculture, services, etc.). At the beginning of each time period, consumption and investment are generated endogenously in separate components of the model. In each case, only a few key variables are considered. For example, consumption is assumed to depend only on population and personal income. Exports are computed exogenously



Note: Exogenous variables denoted by ⟶

Figure 4.1 The components of the macro-model and the main output variable of each component.

and aggregated with consumption and investment to give total final demands from each sector for domestic production. Using conventional input-output techniques these final demands are translated in the production component into inter-industry flows, intermediate imports and value added for each sector. An employment component simulates demands for wage employment, real incomes of the agricultural and nonagricultural self-employed, the real wage rate, and the migration of labor out of agriculture to nonagriculture. These results are then used in the construction of the national accounts and the computation of consumption, investment and employment in succeeding time periods. There are various lags and smoothing processes in the model which reflect the decision-making behavior of producers and consumers and give stability to the system. For example, consumption is assumed to be a function of an exponentially lagged value of income rather than income in the current period.

The above model is an elementary means of describing the total economy. It is static in the sense that many parameters, particularly the input-output coefficients, are exogenous to the system although they may be varied exogenously over time to reflect structural changes in the economy. However, the model does go much further than static input-output analysis in making consumption, investment, imports and employment endogenous in the system. Furthermore, major interactions between sectors are explicitly considered. The input-output table enables flows between the ten sectors for production to be modeled. A matrix of coefficients analogous to the input-output table accounts for intersectoral flows of capital goods. Likewise, consumption demands are simulated for both the agricultural and the nonagricultural populations to account for flows of consumption goods (food and consumer goods) between the agricultural and nonagricultural economies. The migration of labor between these sectors is also considered in the employment component. However, the model is not sufficiently detailed to model the interactions of sectors in the capital market in determining the allocation of investment funds between sectors.

Because of its simplicity the model has little value in detailed national policy formulation, although it may help in making aggregate economic projections and understanding the interactions between sectors. An example will be given later to show the different linkage effects of comparable increases in agricultural exports and oil exports. The essential point is that, although the model can show what the implications of a given increase in agricultural output are for the total economy (after the interactions discussed above are considered), it does not show how such an increase in agricultural output may be achieved.

The present macro-model has been designed to interact with a detailed agriculture sector model. With only minor modifications it could also interact with any other sector model such as a model of small industry. This type of interaction enables detailed policy evaluation within a sector as represented in Figure 4.2. In the macro-model, agriculture is represented by a single sector. However, merging it with a detailed agricultural sector model enables the inputs and outputs of the sector to be computed endogenously taking account of the various ecological regions, commodities, and interactions between these regions and commodities within the sector. Thus, agricultural consumption, investment, exports and employment become functions of agricultural policy instruments. In turn, the nonagricultural sectors feed back to the agriculture sector model relevant variables (such as nonagricultural income which is an element of the demand for food), and these variables become endogenous to the agricultural system. This whole process allows agricultural policy experiments to be evaluated in the context of the total economy.

In the next section the various components of the macro-model are described and the data used discussed. Then some preliminary runs of the model are presented to test its predictive ability and illustrate its usefulness. The merging of the macro-model with a detailed agricultural simulation model is described in a following section. Finally, some sensitivity tests are performed to explore the various interactions and feedbacks in the model.

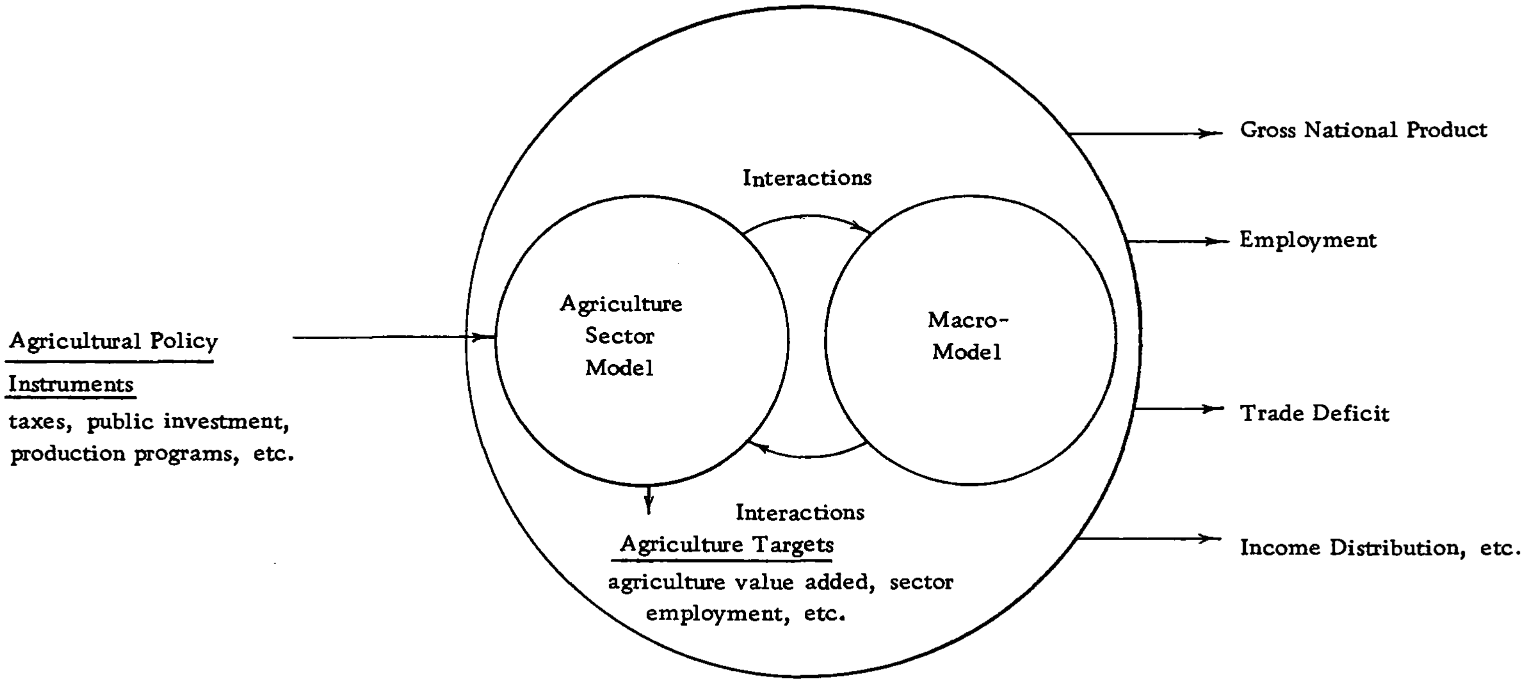


Figure 4.2 The macro-model in a policy framework.

Components of the Model

The model is broken down into various components: (1) exports, (2) consumption, (3) investment, (4) production, (5) employment, and (6) national accounts. There is an additional breakdown of the model by sector within each component. Details of the composition of each of the ten sectors are shown in Table 4.1. There are four small-scale sectors - agriculture, residual agriculture, small industry and small trade-services - composed of firms employing less than ten persons. These firms generally use family labor and traditional methods of production. The remaining sectors include only establishments employing ten or more persons and using wage employment. Modern capital intensive methods of production are common in these sectors.

The sectoral breakdown used in this model warrants further explanation. Whereas most models built on input-output tables usually define sectors on the basis of industry, the present model emphasizes the scale of operations. Two industries producing very similar outputs may be placed in different sectors. For example, the domestic weaving of cloth is placed in the small manufacturing sector while the large textile firms are placed in the large manufacturing sector despite the fact that both these activities may have almost identical input-output coefficients. This distinction on the basis of scale of

Table 4. 1 The sector breakdown in the macro-model.

Sector	Name	Composition of Sector
1	Agriculture	Main export crops (groundnuts, cotton, cocoa, rubber and palm), food staples, and cattle
2	Residual Agriculture	Residual crops, residual livestock, fishery and forestry
3	Small Manufacturing	Carpentry, weaving, shoe making and other crafts
4	Small Trade-Services	Trading and services excluding large commercial firms
5	Mining	Metal and nonmetal mining and petroleum
6	Construction	Residential housing, private and public construction projects
7	Transport	Rail, boat, road, air
8	Utilities	Electricity and water
9	Large Manufacturing	Processed food, drink, tobacco, chemicals, metal manufacturing, etc.
10	Large Services	Large scale trading companies, banking, insurance, etc.

industry is useful in simulating investment, employment and consumption since the small scale sectors are generally more labor intensive and produce commodities satisfying different consumer tastes.

A verbal description of the components of the model follows while a more complete mathematical description is presented in Appendix A.

Exports

Exports are regarded as exogenous variables in the model. In Nigeria there are two main groups of exports: agriculture and petroleum. Agricultural exports are assumed to grow at a rate of approximately three percent annually reflecting recent historical trends. In the case of oil, future exports are a function of many uncertainties such as the success of exploration and international oil politics. Thus, optimistic and pessimistic time series projections based on the work of Pearson (1968) were used to represent oil exports. These projections presented in Table 4.2 show the rapid increase in oil production expected in the next few years.

Table 4.2 Projections of oil exports for Nigeria.

Year	Low Projection (£ million)	High Projection (£ million)
1968	25	25
1969	75	125
1970	125	275
1971	175	350
1972	225	400
1973	275	450

Source: Pearson, 1970, p. 362.

Consumption

The consumption component simulates the demands by various classes of consumers for domestically produced goods and services and for imports of goods and services. Presently, only agricultural and nonagricultural classes of consumers are considered (approximating the rural and urban populations) although the model has the flexibility to account for different consumption behavior by regions and income levels when data are available. The per capita consumption of goods and services (disaggregated by sectors) is a function of the population and personal income of each class of consumers. The population is assumed to grow at a rate of 2.5 percent annually but, because of migration out of agriculture to nonagriculture (modeled in the employment component), the agricultural population grows at approximately 1.5 percent and the nonagricultural population at five percent annually. Personal income is also computed in the employment component. The income elasticities of demand used in calculating consumption are shown in Table 4.3. Note that the elasticities of demand are low for the small-scale sectors relative to the large-scale sectors.

The demand for goods and services is summed over all consumers and divided between domestic production and imports. The proportion imported is determined exogenously in the model although this proportion is trended downward over time to reflect import substitution. Table 4.3 shows that the proportion of total consumption demand imported is largest for modern manufactured goods.

Investment

Investment in each sector is divided between public investment and private investment. Public investment is modeled as an exogenous variable in the system; this investment tends to be concentrated in the transportation, utilities and service sectors. With the exceptions of agriculture and oil, private investment is endogenously determined using the incremental capital-output ratios for each sector shown in Table 4.4. Inventories and replacement investment are assumed to be a fixed proportion of total gross investment, which are

Table 4. 3 Parameters of the consumption component, 1959.

	Sector	Per capita income elasticity of demand: Ag. Population	Per capita income elasticity of demand: Nonag. Population	Proportion of demand imported
1	Agriculture	.3	.5	.0
2	Residual Agriculture	1.0	1.0	.0
3	Small Manufacturing	1.2	1.0	.314
4	Small Trade	0.6	0.5	.0
5	Mining	a	a	a
6	Construction	a	a	a
7	Transport	1.5	1.8	.0
8	Utilities	1.0	4.0	.0
9	Large Manufacturing	1.5	2.0	.725
10	Large Services	1.8	1.8	.280

[a] Consumption of the output of the construction and mining sectors is negligible.

Sources: Federal Office of Statistics, 1961 and 1962, Clark, 1967.

Table 4.4 Capital-output ratios by sector, 1959.

Sector	Capital-Output Ratio
1. Agriculture	a
2. Residual Agriculture	.3
3. Small Manufacturing	.5
4. Small Trade-Services	2.0
5. Mining - Oil	a
6. Construction	.1
7. Transport	6.0
8. Utilities	4.6
9. Large Manufacturing	1.5
10. Large Services	10.0

[a] Investment is exogenously determined in the agriculture and mining sectors.

Sources: Clark, 1967, p. 169.

E. Vielrose, 1970, p. 16.

reflected in the capital-output ratio.

Agricultural investment is an exogenous variable of the system. Some agricultural investment such as land clearing and cattle breeding are considered to require a negligible amount of purchased goods such as machinery or construction. Since this investment does not create any intermediate demands for goods and services, it is not added to the investment demands for domestic production, but is included in the national accounts..

Investment in the oil industry consists of two types: exploration and production. Since exploration investment (the dominant form of current investment in Nigeria) is a long run process with a highly uncertain outcome, it is impossible to relate investment to output by a capital-output ratio. Hence investment in the oil industry, though private, is assumed to be exogenously determined.

Finally, investment by households in residential construction generates a substantial source of domestic investment demand. This is computed as a function of personal income and population, with a relatively long delay attached to the effect of personal income changes.

These investments demands <u>by</u> each sector must be translated into demands for capital goods <u>from</u> each sector. For example, total investment in the manufacturing sector must be disaggregated into demands for construction, machinery, transport, etc., and imports. A matrix of exogenously specified coefficients (shown in Table 4. 5),

Table 4.5 Coefficients of intersectoral capital flows for Nigeria - the B matrix[a].

	Production Sectors	1	2	3	4	5	6	7	8	9	10
1.	Main Agriculture	.196	.196	.028	.0	.0	.0	.0	.0	.0	.0
2.	Residual Agriculture	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3.	Small Manufacturing	.006	.006	.038	.0	.004	.0	.003	.0	.010	.0
4.	Small Trade-Services	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5.	Mining - Oil	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6.	Construction	.312	.312	.116	.860	.169	.100	.094	.672	.400	.860
7.	Transport	.008	.008	.0	.002	.0	.008	.021	.0	.0	.002
8.	Utilities	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
9.	Large Manufacturing	.005	.005	.048	.049	.004	.009	.592	.0	.100	.049
10.	Large Services	.0	.0	.038	.0	.046	.0	.0	.0	.010	.0
	Imports	.473	.473	.732	.086	.777	.883	.291	.328	.480	.089
	Total	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[a] Each coefficient, b_{ij}, shows the requirements for capital goods produced in the i^{th} sector generated by one unit of investment in the j^{th} sector.

Source: Adapted from: Clark, 1967.

analogous to an input-output table, is used to perform this disaggregation. Note particularly the dominance of construction in investment demands and the relatively high import requirements of investment in most sectors.

Production

The basis of the production component is an input-output table of the economy. For the case of Nigeria, data collected by Carter (1966) for the year 1959, were used to construct an input-output table of the economy with the ten sectors described previously.

The input-output table employed in the model is shown in Table 4.6. This table illustrates some typical aspects of a developing economy. The traditional small-scale sectors are characterized by limited interaction with the rest of the economy relative to the large-scale sectors, although the large-scale sectors also have higher import requirements. However, in a rapidly growing economy such as Nigeria's, the structure of the economy as represented by an aggregated input-output table is likely to change over time. For example, the period 1959 to 1966 in Nigeria was characterized by the rapid growth of the oil industry. Whereas in 1959 the mining-oil sector consisted mainly of coal and tin mining, by 1965 petroleum had become the dominant output of this sector resulting in possible changes in the input-output coefficients of the sector. Without further disaggregation it is not

Table 4.6 Input-output coefficients of the Nigerian economy for 1959[a].

	Small Scale				Large Scale					
Production Sectors	1	2	3	4	5	6	7	8	9	10
1. Main Agriculture	.0	.0	.085	.0	.006	.0	.0	.0	.137	.0
2. Residual Agriculture	.0	.0	.068	.0	.0	.092	.0	.037	.025	.0
3. Small Manufacturing	.001	.001	.0	.008	.006	.021	.045	.068	.015	.010
4. Small Trade-Services	.001	.003	.040	.0	.012	.067	.016	.019	.007	.028
5. Mining - Oil	.0	.0	.001	.0	.0	.051	.008	.079	.007	.0
6. Construction	.0	.0	.0	.003	.007	.0	.0	.004	.002	.019
7. Transport	.003	.063	.037	.018	.018	.079	.0	.054	.027	.013
8. Utilities	.0	.005	.002	.0	.020	.001	.0	.0	.014	.007
9. Large Manufacturing	.0	.0	.021	.002	.007	.029	.023	.023	.0	.011
10. Large Services	.004	.003	.037	.023	.012	.010	.028	.018	.037	.0
Imports	.016	.014	.197	.009	.223	.228	.113	.135	.232	.031

[a] Each column shows the input requirements for production of one unit of output. For example, one unit of agricultural output (column 1) requires the input of .001 units of Small manufacturers and .016 units of imports.

Source: Carter, 1966.

possible to reflect these changes endogenously. Another change in input-output coefficients can come about through import substitution where domestic sources of inputs are substituted for previously imported materials. Again, making these changes endogenous in the system would require that imports be competitive with domestic production (see for example Chenery, 1963).

The processes of building new industries, changing techniques and import substitution are fundamental to economic development. Without making them endogenous in the system, the model can have little value in national policy formulation. However, by reflecting these processes exogenously the growth of the economy can be described and the implications of these changes for development understood.

Given the input-output table, the production component aggregates the final demands of exports, investment and consumption and then by input-output techniques computes value added, imports and total output of each sector. Total output is used in the investment component and value added and imports in the national accounts.

Employment

The employment component firstly computes wage employment in each sector. Because the four small-scale sectors generally depend on family labor, wage employment in these sectors is negligible.

In the large-scale sectors, wage employment in each sector is assumed to grow at the same rate as the output of that sector with an adjustment for productivity increases. As seen from Table 4.7, these productivity increases are highest for the manufacturing, public utilities and construction sectors, where there is the greatest opportunity for capital-labor substitution, and lowest for the services sector. In addition to wage employment in the large-scale sectors, the model computes the wage employment in the government sector which accounts for almost half of the total wage employment. Government employment is computed by exogenously specifying government value added and dividing by the average wage rate.

The wage rate in the model is assumed to increase at an exogenously defined rate reflecting the fact that institutional factors are more important than economic factors in determining the wage rate in Nigeria (see Chapter 3). In the model, the wage rate increase has the effect of decreasing government employment because of the assumption of a fixed government budget. However, no provision is made to relate productivity increases in the private sectors to wage increases.

The remainder of the labor force, after accounting for wage employment, is classified as self-employed. This simple dichotomy follows Kilby's division of the labor force into organized and unorganized sectors as discussed in Chapter 3. Total earnings of the

Table 4.7 Parameters of the employment component.

Sector	Rate of roductivity ncrease in age mployment (percent)	Proportion of alue dded einvested or emitted broad
1. Agriculture	a	.10
2. Residual Agriculture	a	.10
3. Small Manufacturing	a	.10
4. Small Trade-Services	a	.05
5. Mining - Oil	30.0	.95
6. Construction	6.0	.50
7. Transport	4.5	.50
8. Utilities	6.0	.90
9. Large Manufacturing	6.0	.80
10. Large Services	.0	.70

[a] It is assumed that there is no wage employment in the small-scale sector.

Source: Productivity estimates are based on Frank, 1967. Proportion of value added reinvested is from Federal Office of Statistics, 1966b.

self-employed in each sector are computed as a proportion of value added in that sector. This proportion (see Table 4.7) is high for all the small-scale sectors and lower for the large-scale sectors, particularly mining. The remainder of the value added after subtracting wage earnings and self-employed earnings is profits to be reinvested (or remitted abroad in the case of foreign-owned enterprises).

The wage earnings and earnings of the self-employed are summed to give personal income for each sector. Personal income is further aggregated to give the personal incomes of the agricultural and nonagricultural populations used in the consumption component.

The employment component also computes real incomes of various groups of the population as an index of income distribution and trends in unemployment. These measures of real incomes are also used in computing the agricultural-nonagricultural income differential which is the basis for modeling migration out of agriculture to nonagriculture. In agriculture, real income is measured by the average income per worker available for non-food consumption. This corresponds closely to total cash income since most of the food consumed is home produced. In nonagriculture, real income of both the self-employed and the wage earners is measured by the average personal income per worker less the cost of consuming the same quantity of food as the average person in the agricultural population. These adjustments allow for the substantial difference in food prices in rural and urban areas and bring incomes in both areas to a comparable basis so that income distribution between the agricultural self-employed, the nonagricultural self-employed and the nonagricultural wage earners can be studied.[1] Furthermore, for reasons discussed in Chapter 2, the earnings of the nonagricultural self-employed are used in this study as a measure of unemployment and underemployment in urban areas.

The employment component also models the distribution of the labor force between the agricultural and nonagricultural sectors. The modeling of migration between these sectors is based on the Harris-Todaro approach with some important modifications. Expected earnings in the nonagricultural sectors are calculated as the weighted average of wage rates and average earnings of the self-employed. This weighting is based on the number of workers in each occupational category although it may be adjusted to reflect a real or perceived probability of getting a wage-earning job different to the random selection process assumed in the Harris-Todaro model. For example, if the average rural-urban migrant has a higher level of education than

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[1] In fact, the real incomes measured by these adjustments are not a measure of absolute incomes but of disposable real incomes. In agriculture disposable real income corresponds closely to cash income. If an agricultural worker migrates to nonagriculture disposable real income in nonagriculture measures the equivalent cash income of the migrants after purchasing the same amount of food as he was consuming in agriculture.

the average person in the urban labor force, his probabilities of obtaining a wage job are higher than by chance alone. The ratio of average real incomes in agriculture and expected nonagricultural incomes is used to represent the agricultural-nonagricultural income differential. The response of the rate of migration out of agriculture to nonagriculture to this differential is represented by an elasticity coefficient which measures the percentage change in the rate of migration for a one percent change in the income differential. If this elasticity coefficient is set to zero, the rate of migration becomes an exogenous variable in the model, independent of changes in the income differential. That is, either migration is determined by non-economic factors or the measure of the income differential used in the model is not the relevant differential for a potential migrant.

Ideally, the migration process could be greatly disaggregated to take account of the facts that migrants are generally younger, are dominantly male, and are dominated by some ethnic groups. However, there is little quantitative evidence on which to disaggregate further, and thus one parameter measures the responsiveness of migrants to changes in the income differential. The only empirical estimates of this elasticity is -2.0 (Beals, Levy and Moses, 1967) based on a cross-sectional study of Ghana. Because of the uncertainty associated with this estimation the model was tested with a range of values for this parameter.

National Accounts

At the end of each series of computations the model constructs a set of accounts. The national accounts include estimates of gross domestic product by branch of activity (e. g. , agriculture, manufacturing, government, etc.) and by category of expenditure (consumption, investment and the trade deficit). This is a simple accounting procedure aggregating results from all components. Similarly the trade balance is computed as the total of all exports of goods and services less the total of all imports of goods and services, valued at f. o. b. prices. Furthermore, the output of the model includes summaries of employment and earnings of the self-employed in both the agricultural and nonagricultural sectors.

At any point in time the results printed by the model include the national accounting aggregates such as gross domestic product and consumption and a matrix giving the sector breakdown of total output, inputs for production, imports for production, value added, wage labor, wage income, self-employed income, per capita consumption, total consumption, consumption imports, investment requirements, imports of capital goods and exports. In each case the model also prints the growth rate of the variable. These accounts form the basis for evaluating agricultural policies at the macro-economic level.

Validation of the Model

The equations and computations of the model are written in Fortran IV computer language. The model will simulate time series of output variables after being initialized at some given year. Because the input-output table and other data used in the model are based on the year 1959, runs of the macro-model described in this study are initialized in that year. The series of computations described in the previous section are then performed at quarter-year intervals up to the time horizon of interest. From 1959 to 1967 the model simulates results which can be compared with real world data to check the accuracy of the model. When the model has been confidently validated for this period it can be used to predict the future path of the economy under alternative policy assumptions.

The validity of a model is determined by its ability to describe the real world. There are several major problems in validifying the present model. Firstly, the national accounts for Nigeria are continuous only for the period 1959 to 1966 for reasons discussed in Chapter 3. This gives a short period of seven years for comparing simulated results with the real world. This problem is more acute given that the model is initialized in the year 1959 and requires several iterations for the initial conditions to be "worked out" before reaching a steady growth path. This latter problem can be somewhat negated by adjusting the initial conditions to approximate equilibrium levels.

Secondly, the initial final demands (consumption, investment and exports for each sector) are based on the work of Carter (1966) whose national accounting estimates differ considerably from the official estimates. Carter's data include estimates for one year, 1959, and do not provide a time series for comparison with the simulated results. Nor can this problem be resolved by using the official accounts (for which there are time series) for estimating the initial final demands, since the official accounts do not provide the necessary detail.

Finally, the official estimates themselves are subject to substantial error, particularly in those sectors such as distribution and crafts composed largely of self-employed persons. Indeed the Federal Office of Statistics (1968b) categorizes their estimates for these sectors as "poor" although they do not indicate the degree of error implied by this classification.

Because of these difficulties, formal statistical procedures often used for validifying simulation models (e. g. , Naylor, 1970) were not used. Rather, a less formal method was devised where average annual growth rates of several variables simulated by the model were compared with actual growth rates derived from the official accounts. The period 1960-66 was used as a basis for the computation of the average growth rates. That is, one year, 1959, (i. e., four iterations) was allowed for the model to attain a growth path independent of the initial conditions.

The variables used in the validation process are shown in Table 4.8. These include three national income variables, gross domestic product, investment and imports. The other components of national income exports and consumption, are of little use in validation since exports are exogenous in the model and consumption is a residual in the national accounts[2]. Average growth rates in value added by sector were also used to compare simulated and actual results. The sectors defined in the model did not always correspond with the sectoral breakdown of value added in the national accounts and satisfactory comparison could only be made for five sectors: agriculture, total nonagriculture, large manufacturing, construction and transport.

The results from two validation runs of the model are illustrated in Table 4.8. In the first series of runs all coefficients except the import coefficients for consumption were fixed throughout the run. Generally, the growth rates simulated by the model were of the same order of magnitude as observed in the real world. However, from the results some general inferences can be made for improvement of the model's performance. The model simulated a relatively low growth

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[2]Vielrose (1970) makes use of the identity, GDP = C+I+(E-M) to estimate consumption. He estimates gross domestic product (GDP), investment (I), exports (E) and imports (M) and computes consumption (C) as a residual.

Table 4. 8 Comparison of simulated results with real world data.

	Real World Data[a]	Simulated run with fixed coefficients	Simulated run with import substitution
	Annual average growth rates (percent) 1960-1966		
Gross Domestic Product	5. 8	5. 1	5. 4
Total Investment	8. 7	8. 8	9. 0
Total Imports	4. 0	6. 4	6. 0
Value added - agriculture	3. 7	3. 5	3. 6
Value added - nonagriculture	8. 0	6. 5	7. 0
Value added - large manufacturing	14. 0	9. 5	13. 6
Value added - construction	9. 7	8. 5	9. 7
Value added - transport	5. 4	4. 4	4. 6
Wage Employment	2. 5	2. 7	3. 0
Self-employed earnings per worker	<0	-1. 1	- . 5

[a] Source: Growth rates for gross domestic product, investment, and imports are based on data reported in E. Vielrose, 1970. Sectoral growth rates are calculated from estimates in Federal Office of Statistics, 1968b. Growth rates for wage employment and self-employed earnings per worker are from C. R. Frank, 1967.

rate of GDP, a high growth rate of imports and about the same investment rate. This would suggest the model has failed to account for some import substitution. Further checking of growth rates by sector showed that the large manufacturing sector has an actual growth rate much higher than the simulated rate. Since this sector is the main source of import substitution, the results indicate that some coefficients held constant in the model have actually been varying over time as domestic manufactured goods are substituted for imports.

A further series of runs was made with changes in some of the static coefficients. From the study of import substitution in Nigeria by Clark (1967) two major shifts in coefficients can be detected. Firstly, the import content of investment in the craft and textile industries over the period 1959-1965 dropped from 70 percent to 20 percent, with most of the increased domestic production being supplied by the large manufacturing sector. Secondly, the coefficients of the mining - oil sector indicated a relatively greater requirement for domestic manufactures and construction as oil became dominant in this sector.

With further modeling to allow for these two trends in coefficients, the results given in Table 4. 8 show an even closer agreement between simulated and actual growth rates, particularly in the large manufactures sector. Clearly such "tuning up" of the model could be carried on indefinitely, but the limitations of the real world data and the "good fit" of the model did not warrant further adjustments.

The method of validation used here enables considerable confidence to be placed on the model's ability to simulate the major trends in the economy over a six-year period. However, even casual comparison of the model's results with the real world shows that the model is not capable of simulating year-to-year fluctuations. To some extent this may reflect deficiencies in the structure of the model but it is likely that fluctuations in the Nigerian economy are largely due to random disturbances such as weather variability.

Illustrative Runs of the Macro-model

The macro-model has been designed to operate witha detailed sector model to enable policy experiments on that sector to be evaluated at the macro-level. However, operating independently of a detailed sector model, the macro-model has considerable capability in exploring the various interactions in the economy. The validation runs showed the considerable importance of import substitution in the growth of the manufacturing sector. In the following series of runs further illustrations of the model's capability are demonstrated by exogenously varying exports in the model.

In Table 4. 9, run 1 is a base run for the period 1959 to 1966, with exports held at a level approximating the actual level for those years. In run 2 the level of agricultural exports has been exogenously

Table 4.9 Multiplier effects on the economy of an exogenous increase in agricultural and oil exports.

	Agricultural value added	Non-agricultural value added	Total GDP[a] at market prices
	Year 1966/67 - Million Nigerian Pounds		
1. Base run	707	630	1,461
2. Exogenous increase of £ 10 m. in ag. exports 1959-1966.	727	643	1,497
Increase over base run.	20	13	36
3. Exogenous increase of £ 10 m. in oil exports, 1959-1966.	708	640	1,473
Increase over base run.	1	11	12

[a] Includes government value added and indirect taxes.

increased by Ⱡ 10 million for the period, causing a Ⱡ 36 million increase in total gross domestic product. That is, the multiplier effect on gross domestic product is over three times the original increase in agricultural exports. Of the Ⱡ 20 million increase in agricultural value added, Ⱡ 10 million is a direct result of the increase in exports. The remaining Ⱡ 10 million increase is due to the multiplier effects of the original increase in exports. That is, the multiplier effects are actually higher in the nonagricultural economy where the increase in exports causes a Ⱡ 13 million increase in value added.

This is further illustrated in Figure 4.3 where the effects of a Ⱡ 60 million increase in exports is traced over time for both the agricultural and nonagricultural economies.[3] In this case, it takes from three to four years for the full multiplier effects to be achieved due to the various lags built into the model. As expected, value added in agriculture shows a sudden jump as a direct result of the increased exports, while the effect on nonagricultural value added is more gradual.

The multiplier effect observed here is a direct result of the interactions between agriculture and nonagriculture. The increased income of the agricultural population, resulting from the increased exports, is spent largely on nonagricultural goods and services causing a rise in incomes of the nonagricultural population. This in turn

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[3] Note also in Figure 4.3 that nonagriculture grows much more rapidly than agriculture in both runs.

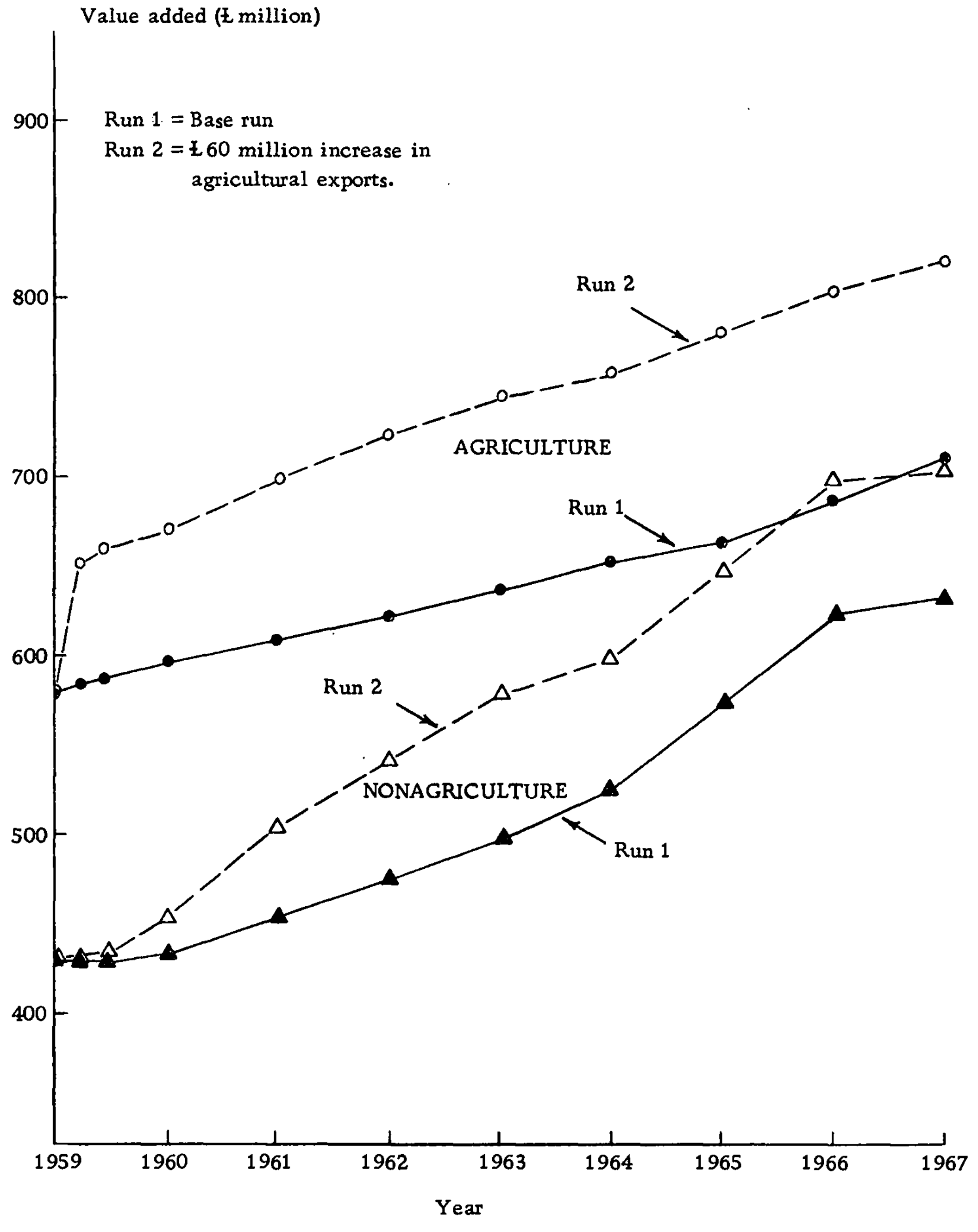

Figure 4. 3 Effect on the agricultural and nonagricultural economies of an exogenous increase of £ 60 m. in agricultural exports.

produces a rise in the demand for food by the nonagricultural population and hence a further increase in agricultural incomes, generating a second round of effects, and so forth. Some of the multiplier effects can also be attributed to the increased demands for intermediate goods and investment goods.

A further characteristic of the multiplier effects of increases in agricultural exports is the relatively small leakages. Run 3 of Table 4.9 shows the results of a similar increase in oil exports. Because of the profits remitted abroad and the high import requirements of oil production, the multiplier effect is considerably smaller.

The value of the model in providing an index of the effect of agricultural policy on the total economy is obvious from these results. Not only is there a large effect on the nonagricultural economy, but effects of agricultural policy on the agricultural economy itself could not be fully realized without explicit recognition of the interactions between the agricultural and nonagricultural economies. Furthermore, the critical importance to the total economy of fluctuations in agricultural exports receipts through price or weather variability can be readily appreciated.

Merging the Macro-model with an Agricultural Sector Model

In the present study, the agricultural simulation model developed at Michigan State University (Manetsch et al., 1971) was used to simulate the effects of various agricultural policies on several variables, such as agricultural exports, investment, disposable income, and food prices. These simulated results then replaced the estimates made independently in the macro-model discussed above. In turn, the macro-model generated estimates of nonagricultural personal income used in the food demand equations of the agricultural simulation model. Because of the size of the agricultural simulation model (over 2000 equations), it cannot be described in full here. Rather, the essential features of the model relevant to the present study are discussed.

The agricultural simulation model consists of two regional submodels to account for the ecological differences between the north and south discussed in Chapter 3. Associated with each submodel is a demographic component to simulate the population and labor force for each region. The population and labor force are further broken down within each region by agriculture and nonagriculture.

The northern regional submodel simulates the production of meat and milk from cattle and the production and marketing of export crops (groundnuts and cotton) and staple food crops (grains and roots).

Cattle, export crops and food crops interact in the submodel. Residuals of agricultural crops provide some of the grazing for the cattle. Likewise, food crops and export crops compete for labor in production. The assumption is made, however, that farmers produce their requirements for household food consumption before allocating labor to production of export crops or cash food. A crucial assumption of the northern submodel is that labor is the limiting factor in production, and land allocation decisions are made on the basis of returns to labor.

In the southern regional submodel, it is assumed that land is the limiting factor in production, with migrant labor being used to augment any labor deficits. Consequently, land is allocated on the basis of returns to land. Again, export crops (cocoa, rubber and palm) and food crops (mostly root crops) compete for land, although, unlike in the northern submodel, farmers may specialize in export crops and buy food for household consumption in the cash food market. The fact that all the export crops considered in the southern submodel are perennial also distinguishes the modeling of crop production in the south from the north.

In both the agricultural submodels prices and marketing of export crops are controlled exogenously to reflect the setting of prices by commodity marketing boards. However, the price of food is determined endogenously in the model through the interaction of supply and demand. The nonagricultural population consumes most of the food produced for the cash market.

The agricultural simulation model is a policy-oriented model. One group of policies considered is the prices paid by the commodity marketing boards for export crops. Presently, these prices reflect about a 25 percent tax on the value of export crops. A second group of policies involves direct government investment in agriculture to promote improvement and modernization of both export and food crops. A modernization component of the model evaluates the effects of a given expenditure on extension campaigns to promote the adoption of improved cultivation practices (e.g., fertilizers) and new higher yielding varieties. The rate of diffusion of these new techniques is modeled endogenously as a function of the profitability of the new techniques relative to the old.

Using this agricultural simulation model, the following variables are simulated and used as variables of the agricultural sector (sector 1) of the macro-model.[4]

1. <u>Consumption of food by the agricultural and nonagricultural populations.</u> Whereas food consumption in the macro-model had previously been computed as a function of income and population, the price of food is now considered in the allocation of consumption expenditure between food and non-food goods.

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[4]Appendix B gives a mathematical description of this linkage.

2. <u>Exports of agricultural crops</u>. The macro-economic model includes exports as exogenous variables. In the agricultural model, exports are a function of agricultural policies. Furthermore, export crops and food crops compete for land and labor.

3. <u>Investment in agriculture</u>. Agricultural investment is exogenous in the macro-model, but in the agricultural model, investment decisions include such factors as discounted future cash flows.

4. <u>Disposable income of the agricultural population for non-food consumption</u>. This is computed in the macro-economic model as a proportion of value added. In the agricultural model, the agricultural population may supplement current earnings with borrowed money or savings for present consumption.

5. <u>Population variables</u>. The demographic components of the agricultural sector model provide a much more disaggregated modeling of the Nigerian population than the macro-model However, the rate of migration out of agricultural to nonagricultural is determined endogenously in the macro-model.

Sensitivity Runs of the Merged Model

Merging of the macro-model with the detailed agricultural sector model did not significantly alter the results of the validation tests reported earlier. However, before policy runs were undertaken, a series of sensitivity runs was conducted on the merged model. Each sensitivity run involved varying one or more parameters of interest and noting the effect on selected results of the model.

Sensitivity analysis of the model has several useful functions in the overall process of model building. Firstly and most importantly for a model of this magnitude and complexity, sensitivity analysis is necessary for understanding the behavior of the model and checking its logical consistency. For example, in the initial testing, the model was found to be particularly sensitive (and at times unstable) to parameters affecting consumption. Further checking revealed that consumption tended to exceed available personal income. Modifications of the model to constrain consumption by income corrected this deficiency. Furthermore, sensitivity analysis is a useful device for exploring the complexity of interactive and feedback effects in detail. Only through a complete understanding of these processes can the policy implications of the model be fully interpreted.

Secondly, sensitivity analysis helps in exploring the various policy implications of the model. By varying parameters dependent on agricultural policy, tentative policy conclusions can be reached. Some of these parameters such as the yield of food can be explicitly treated in policy runs of the model where various modernization programs increase yields. Other parameters such as the proportion of marketing loss for food or the population growth rate are not explicitly linked with policy instruments at present but are set exogenously in the model. However, if the model proved to be very sensitive to these parameters, further model building to include the relevant policy instrument explicitly (e.g., food storage program or birth control programs) would be desirable.

Finally, the sensitivity runs are useful in identifying the data requirements of the model. Because much uncertainty is associated with many parameters of the model, it is of interest to know if this is of consequence in policy formulation. In the present sensitivity analysis, each parameter was varied over a range including the most likely value and an estimated standard deviation about that value to reflect the uncertainty associated with a given parameter.

The runs reported here are summarized in Table 4.10. The parameters tested have been classified into two groups: (1) parameters of the agricultural sector model,[5] and (2) parameters of the macro-model. In the presentation of the results, six key macroeconomic variables have been selected. The first two variables of Table 4.10, agricultural and nonagricultural value added in current prices, reflect the distribution of income between the agricultural and nonagricultural populations. Gross domestic product is presented at current prices and also converted to constant prices to measure real output. The price of food is an indicator of major shifts in demand

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[5]Further sensitivity testing of the parameters of the agricultural model are reported in Manetsch _et al._ (1971).

Table 4.10 Results of sensitivity tests on the merged model.

Run	Definition of Parameter	Value in base run	Value in sensitivity run	Performance Variable: Percent departure from base run: Value added in agriculture	Value added in nonagriculture	Gross domestic product (current prices)	Gross domestic product (constant prices)	Price of food	Total agricultural exports	Mill £ from base run: Trade surplus
1	Yield of modern groundnuts (lbs/acre)	1000	1250	7.2	8.5	7.8	7.2	2.1	34.6	327
2	Yield of traditional food in the cotton-groundnuts zone (lb/acre)	600	750	3.3	3.9	3.6	3.4	..5	13.2	100
3	Yield of modern food in the food only region of the north (lb/acre)	9000	10,700	-16.0	-.2	-6.7	6.8	-42.8	.0	86
4	Migration out of agriculture - north (% of ag. population/year)	.65	1.60	7.7	-4.5	.1	-6.4	26.5	-3.8	178
5	Migration out of agriculture - south (% of ag. population/year)	1.5	2.7	-2.1	.9	-.3	.0	-1.4	1.1	2
6	Price elasticity of demand for food staples - north	-.3	-.6	-3.5	-.2	-1.1	-.2	-2.8	.0	-8
7	Income elasticity of demand for food staples - north	.32	.60	4.5	3.1	3.6	1.6	6.0	.0	-11
8	Growth of the non-agricultural wage (%/year)	3.0	0	-4.0	-4.2	-4.1	-3.0	-3.5	.0	50
9	Capital-output ratio in small manufacturing	.5	.75	.1	.0	.0	.0	.0	.0	-17
10	Income elasticity of demand of the agricultural population for small trade - services	.6	1.0	1.9	8.9	5.7	5.4	1.4	6.7	-48
11	Income elasticity of demand of the nonagricultural population for large manufactures	1.0	1.3	-1.0	-.1	-.4	-.4	-.1	.0	-216

and supply of food. The final two columns show changes in agricultural exports and the trade surplus (total exports minus imports). These changes will not always be in the same direction since the trade surplus includes changes in total imports. In all cases except the trade surplus, results are given as the percentage deviation from the base run in year 1985 (i.e., a simulation run of 26 years). Because the trade surplus may be positive or negative, percent changes from the base run are not always meaningful and the result shown is the deviation from the base run in millions of Nigerian pounds.

A series of sensitivity analyses on the parameters affecting yields of export crops and food crops is presented in run 1 through run 3. Run 1 shows that an increase in the yield of groundnuts has large effects on the national variables due to a 35 percent increase in total agricultural exports. This run is an excellent illustration of the importance of the interactions between agriculture and nonagriculture discussed earlier in the chapter. Since exports account for about 17 percent of the value added in agriculture, the 35 percent increase in exports causes a direct increase of 5.9 percent in agricultural value added. The remaining 1.3 percent increase in value added in agriculture of the total increase of 7.2 percent is explained by the increased demand for food. This occurs because of an increased demand for nonagricultural goods generated by the groundnut producers and a consequent increased demand for food by the nonagricultural population.

Note particularly that the effect on agricultural value added is relatively greater. The price of food in this run increases significantly because of both supply and demand effects. Since groundnuts and cash food compete in the northern regional submodel, the increased profitability of groundnuts relative to food tends to decrease the supply of food. Likewise, the demand for cash food is increased by the higher incomes of the nonagricultural population. This combination of decreased supply and increased demand raises prices.

In run 2 increasing the yield of traditional food in competition with groundnuts and cotton has decreased the land and labor required for subsistence purposes and enabled a 13 percent increase in exports. The increase in the price of food here is an interesting example of how supply and demand interact in the food market. The increased food yield has, of course, increased the supply of food. However, because of the resulting increase in exports and nonagricultural incomes, the demand for food is also increased, offsetting the supply response and raising food prices slightly.

In contrast with run 2, an increase in the yield of food in the food-only zone (middle belt) of the north in run 3 has a depressing effect on the economy. Because there are no export crops in competition with food in this zone, there is now no corresponding increase in exports and, hence, food demand. The effect, then, of the increased yields is a sharp drop in food prices. Because the price elasticity of demand for food is less than one, value added in agriculture also drops. Thus demands for nonagricultural goods by the agricultural population is decreased. However, because of the decreased food prices, the nonagricultural population spends less on food and more on nonagricultural goods. The net result of these two opposing effects is a negligible change in nonagricultural value added. In terms of real income, total gross domestic product is increased although this occurs in the nonagricultural sector at the expense of the agricultural sector.

Run 1 to run 3 provide some tentative policy conclusions. In regard to export crops these runs show that efforts to increase the output of exports crops are likely to produce strong positive effects on the total economy. However, increasing the output of food has the effect of redistributing income from agriculture to nonagriculture, unless there is a concomitant increase in agricultural exports. Finally, we note that some of the parameters varied in these runs, particularly yields of export crops, produce relatively large changes in the performance variables of the model. Thus the predictive ability of the model is likely to be increased by further data collection to provide estimates of these paramters with a smaller variance.

Run 4 and run 5 show particularly interesting results for an exogenous increase in the rate of agricultural to nonagricultural migration.[5] In run 4 this rate is increased for the northern region. Because the agricultural model assumes that labor is the factor limiting production in the north, the supply of food is decreased, producing a 26 percent rise in the price of food. The total effect on the economy is a sharp drop in real output but with agriculture benefiting relative to nonagriculture. When the rate of migration is increased in the south in run 5, the effect is smaller and in the opposite direction. Recalling that the southern agricultural submodel assumes a labor surplus, increased migration will not affect food supply. However, demand is decreased slightly because under the current assumptions, the model produces a lower level of nutrition for the nonagricultural population than for subsistence farmers.

Run 6 shows the results of assuming a higher price elasticity of demand for cash food. Because the model predicts rising prices for food there is a decline in food consumption and hence agricultural value added. However, as in run 3 the net effect on nonagricultural value added is negligible. In run 7 the income elasticity of demand for food staples is doubled producing only a moderate rise in

[5]In the sensitivity runs reported here, the elasticity of response of migration to the agricultural-nonagricultural income differential is assumed to be zero and the rate of rural-urban migration is an exogenous parameter.

agricultural and nonagricultural value added and food prices. This is because with a high rate of population growth in the nonagricultural sector, there is a very slow rate of increase in per capita income and hence the income elasticity of demand has little effect.

The results of a change in the rate of growth of the nonagricultural wage rate from three percent per year to a zero growth rate are shown in run 8. Because wage earnings are an important source of effective demand both agricultural and nonagricultural value added decline. This result is subject to the assumption of the model that a decrease in wage payments does not stimulate investment.

Variation in the capital-output ratios used in the nonagricultural model produced negligible effect on the economy (run 9). However, the model was quite responsive to variations in the income elasticities of demand for nonagricultural goods in run 10 and run 11. An increase in the elasticity of demand of the agricultural population for small trade-services in run 10 produces significant positive effects on the economy. However, a similar increase in the elasticity of demand for large manufactures in run 11 has negative effects because there is a substitution of goods with a high import content and produced by capital intensive processes for goods domestically produced by labor intensive techniques. This is shown by the decrease in the trade surplus in run 11 despite the fact that a decrease in agricultural and nonagricultural value added would normally cause imports to fall.

Summary and Critique of the Macro-model

The macro-model simulates behavior in the real world over the period 1959-66 with reasonable accuracy. Ideally, however, a longer period than seven years and more reliable national accounts would be required for confident validation. Because only key variables were used in each component, the model is not generally able to simulate year-to-year fluctuations in the economy, although longer term trends are accurately reflected.

The essential usefulness of the macro-model is its capability of interacting with detailed sectoral models to enable modeling of intersectoral multiplier effects and policy evaluation with respect to the total economy. The model also has value in making macro-economic projections, taking into account interactions between sectors. This promises improvement over conventional economic planning projections where such interactions are not formalized or are ignored. Furthermore, the model does enable a more complete description of the economic growth process, since it disaggregates the economy by production sectors (e.g., agriculture, manufacturing, oil, transport, etc.) and allocates the output of each sector by end use (i.e., consumption, investment, exports, and intermediate products). This matrix of interacting sectors and uses identifies explicitly the growing points of the economy.

The degree of disaggregation determines the data requirements of the model. Corresponding to each component of the model is a key set of parameters, the input-output coefficients of the production component, capital-output ratios of the investment component and income elasticities of demand of the consumption component. Increasingly input-output tables describing inter-industry flows of goods and services are becoming available in developing countries. Similarly, data for estimating aggregate consumption elasticities will not usually be a limiting factor, although disaggregation by rural and urban populations may not always be possible. Data on capital-output ratios and the determinants of investment probably involve the highest degree of uncertainty because often many factors affect the relationship between investment and output.

While aggregation of the economy into fewer sectors reduces the data requirements,[6] it also reduces the model's ability to describe the economy. A high degree of aggregation necessarily entails lumping together a number of diverse industries into one sector. In a dynamic economy, each of these industries will be growing at different rates, changing the composition of that sector and hence the parameters describing overall sector behavior. The oil industry in

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[6]Since there are several matrices of parameters, particularly the input-output table, disaggregation will tend to increase the data requirements exponentially rather than linearly.

Nigeria is an example of a rapidly growing industry which is likely to change the parameters of the mining - oil sector. In the short-run, such changes may be modeled exogenously, particularly if parameters such as input-output coefficients can be estimated at two or more points in time.

It is these changes in parameters over time which are difficult to incorporate in the model. For Nigeria in the year 1959 we had reasonable estimates of most parameters used. In addition, the work of Clark (1967) provided a basis for modeling changes in the input-output coefficients and intersectoral flows of capital goods between the years 1959 and 1965. After 1965 there is little basis for changing these parameters and the predictive ability of the model is limited by the static assumption concerning parameter values,

There are many directions in which the model could be extended to make it more realistic and useful. Firstly, more variables could be introduced into the determinants of consumption and investment. For example, Holland and Gillespie (1963) in a simulation model of the Venezuelan economy incorporated the notion of expectations in investment behavior by including oil exports as an element of an aggregate investment equation. While a similar argument may hold for investment in Nigeria, for the present purposes this would detract from the generality of the model. However, in any application to planning a specific country such adjustments may be necessary to account for the uniqueness of that economy. What has been proposed in the present model is a skeletal framework of a few key variables upon which further refinements can be made in more specific applications.

Secondly, the model needs to be further developed to include prices as endogenous variables of the system. In Holland's model of Venezuela, prices are a function of capacity utilization where capacity is defined in terms of the capital stock. Again the generality of this approach is questionable since many other factors are likely to be important in determining the supply function of an industry. Indeed, in the case of Nigeria, Kilby (1969) has argued convincingly that entrepreneural ability is a critical determinant of supply response in Nigerian manufacturing. Furthermore, for Nigeria, where price movements both absolute and relative were not substantial during recent history, the model's results are not greatly affected by the assumption of constant prices. However, a great deal of generality could be gained by including an additional component incorporating money supply, exchange rates and price determination. This is necessary for the model to be applied to countries with significant price instability.

V. RESULTS OF THE SIMULATION ANALYSIS

The simulation model described in the previous chapter consists of a macro-model of the total economy which can be merged with an agricultural sector model of the agricultural economy. In this chapter the results of using the agricultural sector model to simulate the effects of alternative agricultural policies on agricultural variables such as exports and food consumption are evaluated in the context of the macro-model. The emphasis is on the macro-economic implication of agricultural policies. More detailed descriptions of the effect of agricultural policies on the agricultural sector are described in Manetsch et al. (1971). Firstly the predictions of the simulation model given present government policies will be analyzed and subjected to the sensitivity analysis. The results of two sets of agricultural policies (an export crop expansion policy and a food crop expansion policy) are then presented. Finally the effects of some nonagricultural policies, such as wage restraint and government hiring are simulated.

The output variables used in evaluating the alternative policies include measures of economic performance such as gross domestic product, foreign exchange earnings, and value added by sector at constant and current prices. In addition to these "conventional" targets of economic policy, employment and income distribution will be explicitly considered. The model computes measures of wage employment, agricultural self-employed earnings (by north and south), nonagricultural self-employed earnings, and the nonagricultural wage rate. In this study the earnings of the nonagricultural self-employed are of particular interest, since these earnings reflect underemployment and open unemployment in the urban traditional sectors.

Predictions for the 1970's Under Current Policies[1]

Some of the limitations of the model for prediction have already been discussed in Chapter 4, particularly the problem of changes in parameter values over time. A further complication in the case of the Nigerian economy is the intervention of the civil war. Although the war may cause only a temporary disturbance in the economy, there are likely to be some permanent changes in the structure of the economy which will not be simulated by the model. In any event, there is presently no information available on the short or long run economic effects of the war. Consequently, the results presented below are not immediately applicable to Nigeria. However, the results should have some general usefulness because the Nigerian economy for the pre-war period had many features in common with other developing

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[1] Present government policies toward agriculture are discussed in Chapter 3.

countries. Furthermore, for many of the model's results, sensitivity tests were conducted to determine if the results are general over a range of parameter values.

The predictions of average growth rates for the period 1966-1983 of key macro-economic variables are compared in Table 5. 1 with actual growth rates for the period 1950-1966. The model predicts an acceleration of the growth of the economy to an annual growth rate of gross domestic product of 6. 5 percent, compared with the pre-war growth rate of 5. 3 percent. Much of this increase results from a non-agricultural growth rate of eight percent stimulated to a large extent by the continuing expansion of the oil industry. Relative to nonagriculture, agriculture has a much slower rate of growth of 4. 7 percent annually and continues to decline as a proportion of gross domestic product. Food prices are predicted to rise at a moderate rate of 1. 7 percent reflecting the ability of agricultural producers to supply food to a rapidly growing nonagricultural population. [2]

The model predicts investment to grow faster than consumption, although since investment and gross domestic product grow at the same rate, investment does not increase its share of gross domestic

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[2]Recent reports from Nigeria indicate that the model is clearly in error in predicting food prices. For the immediate post-war period food prices have been rising at rates in excess of five percent annually (Rake, 1971).

Table 5.1 Predictions of the simulation model for the 1970's[a] assuming no change in agricultural policies.

Variable	Actual growth rate 1950-1966[b] (percent)	Simulated growth rate 1966-1983 (percent)	Value in 1983	Unit
Agricultural value added	3.2	4.7	1.34	£ billion
Nonagricultural value added	7.0	8.0	2.33	£ billion
Gross domestic product (market prices)	5.3	6.5	3.97	£ billion
Total consumption	4.8	5.4	3.0	£ billion
Total investment	9.8	6.5	.7	£ billion
Average staple food price	1.4	1.7	.014	£/pound
Total wage employment	2.5	4.5	1.35	million
Nonagricultural population	6.0	5.0		million

[a] All values are given in current prices.

[b] Source: Clark, 1967; and Vielrose, 1970.

product (i.e., about 18 percent of gross domestic product).[3] The 5.4 percent average increase in consumption expenditure indicates a steady rise of about three percent in per capita expenditure.

One of the most significant predictions of the model is the rapid growth in total wage employment relative to the period 1950-1966. This is largely due to increased government employment as a result of the additional oil revenues. In fact, the growth of wage employment at a rate of 4.5 percent annually is only a little less than the predicted growth rate of the nonagricultural population (5.0 percent) but is still only half the growth rate of nonagricultural value added.

Figure 5.1 shows the predicted pattern of income distribution for the economy over the period 1966 to 1983. Earnings of agricultural workers increase steadily at an annual rate of 1.3 percent in the south and 3.4 percent in the north. This reflects the fact that under status quo policies the main source of growth in the agricultural economy is cash food which is increasingly produced in the north. In the nonagricultural economy, earnings of the self-employed rise for a short period as a result of the stimulus given to the economy by the

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[3] These results depend upon the assumptions about the government allocation of oil revenues between consumption and investment. Presently the model assumes continuation of current government spending patterns.

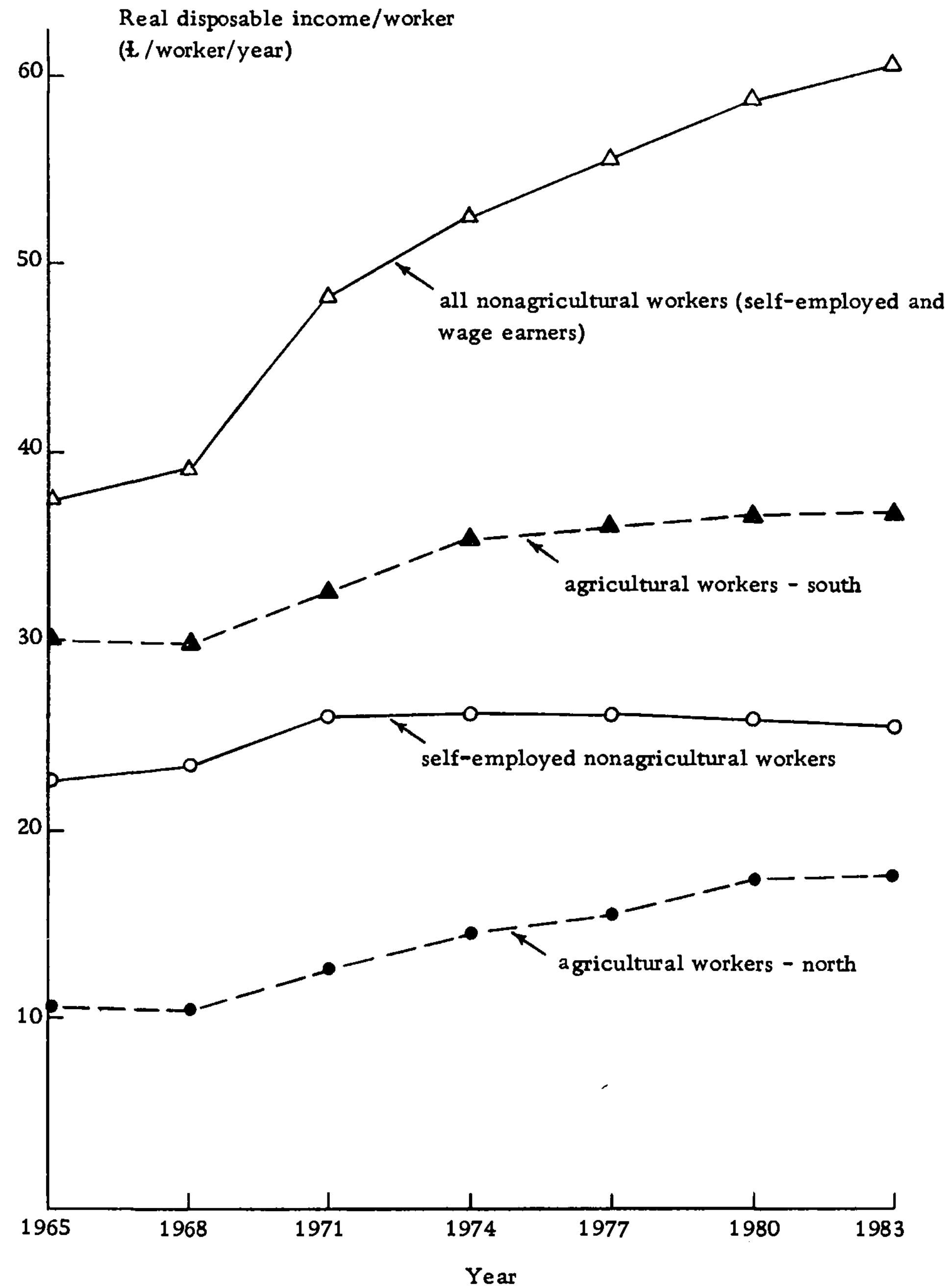

Figure 5.1 Predictions of average incomes of various classes of workers, 1965-1983.

rapid increase in oil production and revenues. After this initial phase, earnings of the self-employed stagnate and over the whole period increase at a rate of less than one percent annually with a tendency to decline in the 1970's. Nonetheless, because of an assumed annual increase in wage rates of three percent, the average income of the total nonagricultural labor force (upper line of Figure 5.1), including both self-employed and wage earners, continues to rise. Figure 5.2 shows that the ratio of agricultural to nonagricultural incomes declines steadily, leading to a continuing increase in the rate of migration out of agriculture.

The overall result predicted by the model under current policies is a widening gap between earnings of the self-employed (both agricultural and nonagricultural) and the wage earners. The self-employed nonagricultural workers show a tendency for absolute as well as relative incomes to decline, and the problem of urban unemployment is likely to become increasingly more serious. Within agriculture, however, the model predicts a slow convergence of incomes in the north to the higher-income south.

Sensitivity tests were made to investigate the impact on employment and income distribution of varying crucial parameter values assuming the same status quo policies. Three sets of parameter values are likely to have the most effect on employment and income distribution patterns: (1) the elasticity of demand for the output of

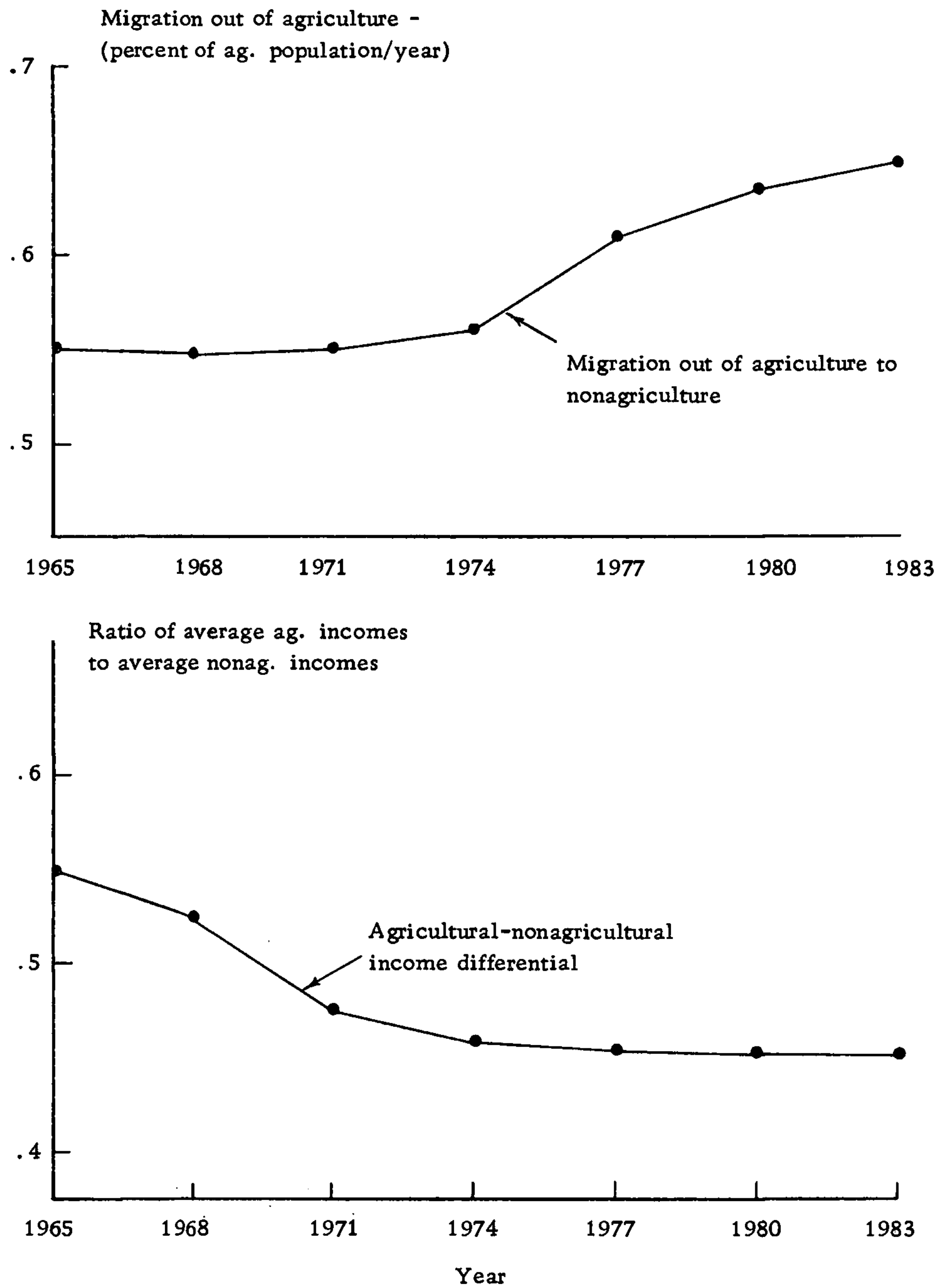

Figure 5.2 Predictions of the rate of migration out of agriculture and the agricultural-nonagricultural income differential.

the small-scale nonagricultural sector, (2) the growth of the wage rate and (3) the elasticity of response of migration to the agricultural-nonagricultural income differential.

In Table 5.2, line 1 through line 3 show a set of sensitivity tests assuming a relatively elastic response of migration out of agriculture to the agricultural-nonagricultural income differential. When the income elasticity of demand for the output of the small trade-services sector (line 1) is increased, there is a 25 percent rise in the earnings of the self-employed nonagricultural workers. This together with a 2.2 percent rise in the number of wage earners produces a 7.1 percent increase in the rate of migration out of agriculture. Notice that the average agricultural-nonagricultural income differential changes little because the higher proportion of low income self-employed workers, resulting from the increased migration, lowers average nonagricultural earnings.

Lowering the growth of the wage rate to zero (line 2) had the expected result of decreasing migration out of agriculture and increasing the earnings of the self-employed. The large increase in wage employment (57 percent) in this run is attributable to an increase in government employment. Recall that the model assumes a fixed government budget for wage expenditures and hence government employment, the major component of wage employment, is responsive to wage rates. Raising the growth of the wage rate to six percent

Table 5.2 Effect of variation of some parameters on income distribution and employment.

Parameter varied	Value Base Run	Value sensitivity run	Percent deviation from base run: Real income nonag. self-employed	Total no. of wage earners	Rate of migration out of ag.	Ratio of ag. to nonag. incomes
Elastic Migration Response						
1. Income elasticity of demand of the ag. population for small trade-services	.6	1.0	25.0	2.2	7.1	- 1.2
2. Annual growth of the nonag. wage rate	3%	0%	13.0	57.0	-12.6	6.7
3. Annual growth of nonag. wage rate	3%	6%	-6.1	-22.6	25.7	-11.9
Inelastic Migration Response[a]						
4. Income elasticity of demand of the ag. population for small trade services	.6	1.0	52.1	1.4	.0	-14.1
5. Annual growth of nonag. wage rate	3%	0%	12.0	56.2	.0	12.6
6. Annual growth of nonag. wage rate	3%	6%	10.6	-23.8	.0	-21.7

[a]Migration out of agriculture fixed exogenously at .82 percent per year

annually had the reverse effect of raising the rate of migration by 25.7 percent and lowering the earnings of the self-employed.

Line 4 through line 6 report a similar set of sensitivity runs but assuming an inelastic migration response. That is, the rate of migration is fixed exogenously in the model. In this case an increase in the elasticity of demand for the output of the small trade-services sector (line 4) increased self-employed earnings by 52 percent compared with the 25 percent increase in the case of the elastic migration response (line 1). This is because where migration is fixed, there is no corresponding increase in migration out of agriculture to partly offset the increase in self-employed earnings.

A decrease in the rate of growth of the wage rate to zero (line 5) increases the number of wage earners and hence decreases the number of people in the self-employed nonagricultural labor force. The effect is to increase average earnings of the nonagricultural self-employed despite a reduction in overall effective demand caused by the lower wage rate. When the growth of the wage rate is doubled (line 6) wage employment decreases but less than the increase in line 5, and the effect of a larger number of self-employed workers on self-employed earnings is outweighed by the increased effective demand resulting from the increased wage rate. The net effect is a 10.6 percent increase in self-employed earnings. Note that this contrasts with a 6.1 percent <u>decrease</u> in self-employed earnings with an elastic migration response (line 3) where the higher wage rate induced further migration out of agriculture.

The above sensitivity analysis shows that generally the results are fairly sensitive to some key parameters. However, the parameter variations represent rather extreme assumptions. For example, it is most unlikely that the growth of the urban wage rate would be zero over an 18 year period. Furthermore, the largest effect on self-employed earnings was an increase of 52 percent (line 4) resulting from increasing the elasticity of demand for output of the small trade-services sector and assuming a fixed migration rate. Over an 18 year period, 1965-1983, this is equivalent to an increase in the average growth rate of self-employed earnings from .5 percent to 2.5 percent annually, still less than the three percent annual increase in wage rates.

Results of Agricultural Policy Runs

The agricultural model is capable of simulating the effects of a large number of alternative agricultural policies. For the purposes of this study two sets of policies are selected to examine in detail. The first policy aims to increase agricultural exports through a ten-year government program of £100 million to (1) modernize groundnuts and cotton, (2) apply modern production techniques to traditional palm trees, (3) replace traditional rubber with modern rubber, and

(4) promote new planting of cocoa on bush land. The second policy involves a ten-year government program of £ 40 million to increase the output of food staples in the food-only zone of northern Nigeria through an extension campaign to encourage the use of new higher yielding varieties. The results of the policy runs in the year 1983 are presented in Tables 5.3 and 5.4, and the simulated time paths of some of the important variables are presented in Figures 5.3 to 5.4. Table 5.3 shows the effects of the two policies outlined above on the key macro-economic variables both in absolute and relative terms, and Table 5.4 shows their relative effects on income distribution and employment variables. It is assumed in these policy runs that migration of workers from agriculture to nonagriculture is responsive to the income differential in the two sectors. Because food prices change between runs, some of the variables are adjusted to the prices in the base run to measure real changes.

Export Modernization Policies

The export modernization policy in Table 5.3 almost doubles the value of agricultural exports at world prices (line 6). Note, however, that only half of the increased value of agricultural exports acrues to the farmer (line 7), the difference between world prices and producer prices being divided among the transport and marketing sectors and export taxes collected in the form of marketing board

Table 5.3 Effect of export and food modernization policy on key macro-economic variables with elastic migration response.

Macro-economic variables	Value Base Run £M	Export Modernization Policy: Value 1963 £M	Export Modernization Policy: Deviation from Base Run, 1983 £M	%	Food Modernization Policy: Value 1983 £M	Food Modernization Policy: Deviation from Base Run, 1983 £M	%
1. Value added in agriculture (current prices)	1338	1554	216	16.1	1213	-125	- 9.3
2. Value added in agriculture (adjusted prices)[a]	1338	1474	136	10.2	1438	100	7.5
3. Value added in nonagriculture	2330	2597	267	11.4	2314	- 16	- .6
4. Gross domestic product (current prices)	3969	4507	538	13.5	3826	-143	- 3.6
5. Gross domestic product (adjusted prices)[a]	3969	4410	441	11.1	4052	83	2.1
6. Total agricultural exports (world prices)	218.3	431.2	212.9	97.5	218.2	- .1	.0
7. Total agricultural exports (producer prices)	115.2	224.3	109.1	94.7	115.2	.0	.0
8. Total imports	758.8	861.9	103.1	13.5	752.1	- 6.7	- .8
9. Total food consumption	1092	1178	86	7.3	965	- 12.7	-11.7
10. Agricultural requirements for domestically-produced capital goods	12.8	13.8	1.0	7.8	13.7	.9	1.0
11. Agricultural requirements for domestically-produced imports	8.3	9.8	1.5	18.0	7.3	- 1.0	- 1.2

[a]Values in adjusted prices are computed by converting results of policy runs to equivalent base run prices to measure real changes in output.

profits. Of the L 216 million increase in agricultural value added (line 1), L 109 million is due to a direct effect of increased exports (line 7), and the remaining L 107 million increase results from the multiplier effect on food consumption. However, because of a seven percent increase in food prices (Table 5.4, line 1) most of the increase in value of food consumption is due to price increases. Of the L 267 million increase in nonagricultural value added (Table 5.3, line 3), L 103 million is directly attributable to transport, marketing and export taxes associated with the increased exports, and L 164 million is the result of indirect multiplier effects.[4] This is consistent with the results of the macro-model reported in Table 4.9 of Chapter 4; that is, the multiplier effects are highest on the nonagricultural economy. The overall multiplier effect of the increased exports on gross domestic product is 2.4 in current prices and 2.1 in constant prices.[5] As seen from Figure 5.3 there is a considerable lag between the time of policy implementation (1965) and the first noticeable effects on value added in year 1974. This is because of the various lags in

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[4]The difference between the increase in agricultural exports at world prices and agricultural producer prices is L 103 million.

[5]This multiplier is less than that reported in Chapter 4 for independent runs of the macro-model. One possible reason is that the agricultural model assumes (implicitly) that the income elasticity of the agricultural population for staple food is zero.

Table 5.4 Effect of export and food modernization policies on income distribution and employment variables with elastic migration response.

Variable	Value Base Run 1983	Unit	Percent deviation from base run, 1983: Export modernization policy	Percent deviation from base run, 1983: Food modernization policy
1. Average price of food staples	.0138	L/lb	7.0	-20.0
2. Agricultural disposable real income per worker - north	18.1	L/year	14.8	-1.1
3. Agricultural disposable real income per worker - south	37.0	L/year	24.3	-18.1
4. Nonagricultural disposable real income per worker - self-employed	30.5	L/year	21.4	14.8
5. Nonagricultural disposable real income per worker - unskilled wage earners	145.0	L/year	-2.6	6.2
6 Average nonagricultural disposable real income per worker	61.2	L/year	13.1	7.4
7. Ratio of agricultural to nonagricultural incomes - north	.296	-	1.6	-7.7
8. Ratio of agricultural to nonagricultural incomes - south	.604	-	9.9	-23.8
9. Total wage employment	1.35	mil	11.2	-.2
10. Rate of migration out of agriculture to nonagriculture	.599	%/year	6.0	19.6

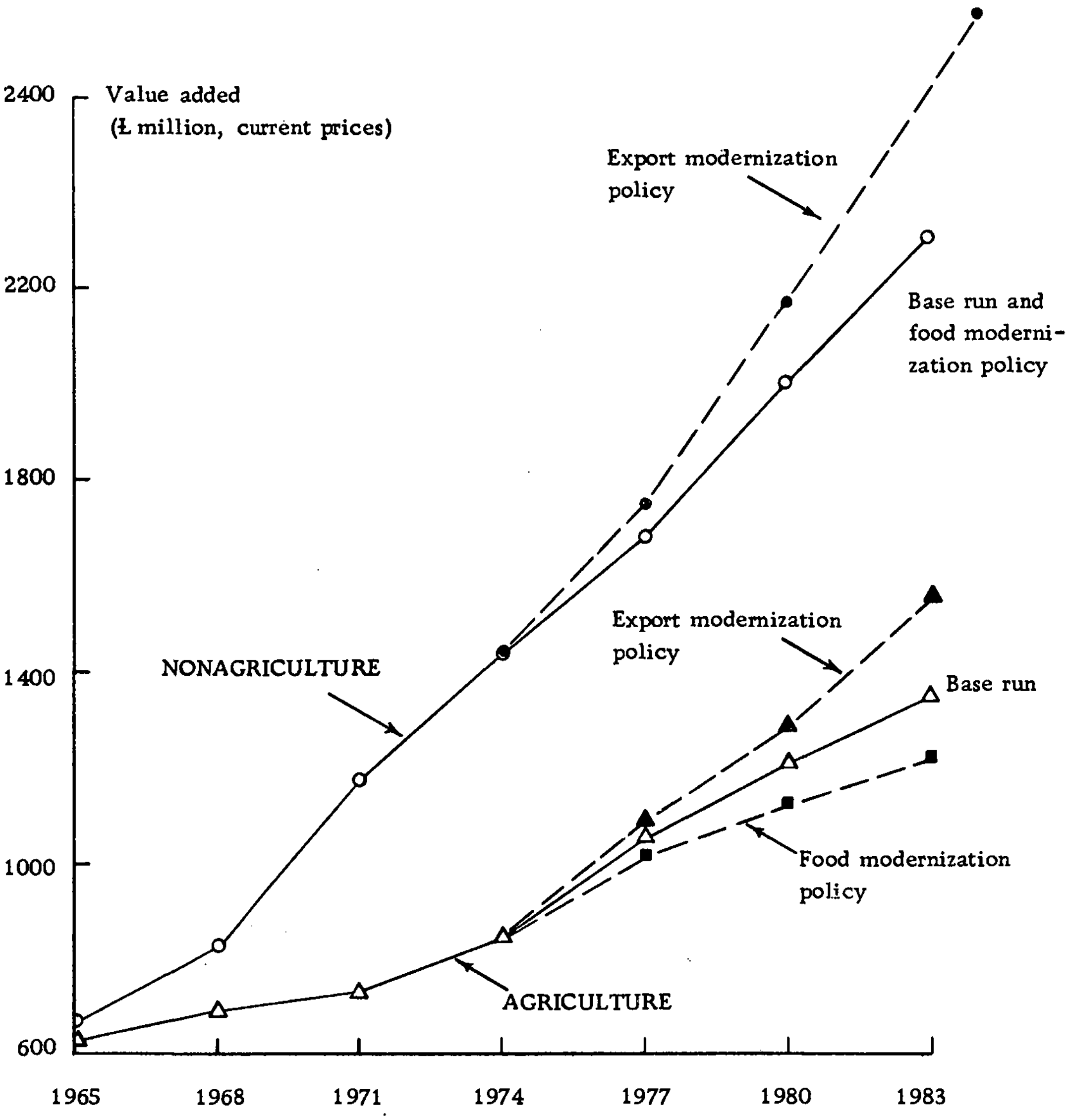

Figure 5.3 Effect of agricultural development policies on agricultural and nonagricultural value added (at current prices).

the model, particularly the lag in diffusion of modern production techniques in agriculture.

Line 8 of Table 5.3 shows that, of the increase of £213 million in foreign exchange earnings (line 6) as a result of the export modernization program, almost half is spent on imports required for the higher levels of consumption, investment and production. From lines 10 and 11 it is apparent that the increased requirements of the agricultural sector for intermediate and capital goods generates only a small demand for domestically produced nonagricultural goods and services, most of the fertilizer and equipment required for modernization being imported. That is, most of the increased output of the nonagricultural sectors is the result of the multiplier effects of a rise in consumer demands of the agricultural population rather than demands for intermediate and capital goods.

The seven percent rise in food prices occurring with export modernization (Table 5.4, line 1) can be explained by two effects. Firstly, the higher income of the nonagricultural population leads to an increase in the demand for food. Secondly, because of the higher profitability of export crops, food producers may switch to export crops and decrease the supply of food. This combination of decreased supply and increased demand raises prices.

Lines 2 through 5 of Table 5.4 show the effect on income distribution of the export modernization policy. Average earnings of agricultural workers increase significantly in both the north and south but with a larger effect in the south because this is the dominant export crop region. Because earnings in the south are twice as high as the north initially, the export modernization policy tends to widen the regional income differential. In the nonagricultural sectors, the export modernization policy causes a significant increase of 21.4 percent in self-employed earnings (line 4) because of the multiplier effects on nonagricultural output discussed above. However, the real wage rate declines by 2.6 percent because of the increased food prices (line 5) and hence the gap between the earnings of the self-employed and the wage-employed is narrowed by this policy. Furthermore, from Figure 5.4 it is apparent that the export modernization policy causes the earnings of the self-employed to rise steadily over time in contrast to the declining earnings predicted for <u>status quo</u> policies. The ratio of average agricultural incomes to nonagricultural incomes changes very little for the north but increases significantly in the south. Because of the increased nonagricultural output, wage employment is stimulated, increasing by 11.2 percent (line 9).

One of the most interesting results for this policy run is the <u>increase</u> in migration out of agriculture accompanying the export promotion policy (line 10 and Figure 5.4). This is due to the multiplier effects on self-employed earnings and wage employment increasing expected nonagricultural incomes (line 6). Most of this increase in

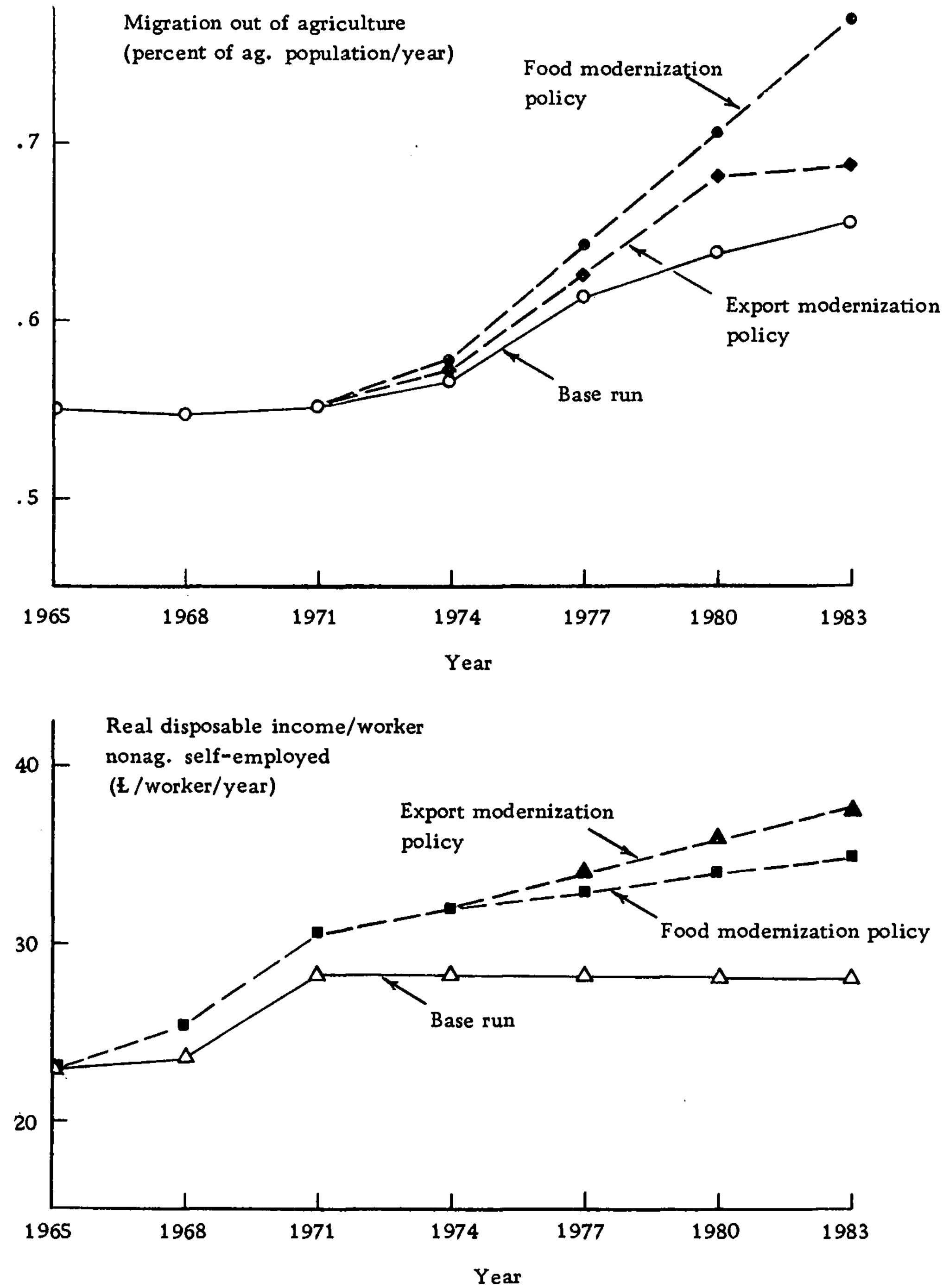

Figure 5.4 Effect of agricultural development policies on the earnings of the nonagricultural self-employed and migration out of agriculture.

migration is likely to have originated in the north where there is a smaller increase on agricultural earnings.

Food Modernization Policy

The results in Table 5.3 of the effects of a food modernization program in the food-only region of the north show that in current prices value added in agriculture (line 1) and gross domestic product (line 4) decline. This is caused by the sharp drop of 20 percent in food prices (Table 5.4, line 1) explained by the two assumptions of the agricultural model that: (1) Nigeria is self-sufficient in food staples but production costs are too high to export food, and (2) the price elasticity of demand for food is less than one. In real terms, agricultural value added increases by 7.5 percent (line 2).

Significantly, the food modernization program had a negligible effect on value added in nonagriculture (see particularly Figure 5.3). Although the low food prices enable the nonagricultural population to purchase more nonagricultural goods, the decline in agricultural incomes accompanying the change in food prices counterbalances this effect. That is, purchasing power for nonagricultural goods is redistributed from the agricultural to the nonagricultural population.

Because the food modernization program was focused on a food-only region, there was little or no effect on agricultural export crops (line 7).[6] However, total food consumption in real terms increases by 8.3 percent, almost all the increase being consumed by the nonagricultural population.[7]

Income distribution effects of the food modernization policy are shown in Table 5.4. Earnings of agricultural workers decline slightly in the north (line 2) but sharply in the south (line 3) because the food modernization program in the north increases the north's share of total cash food production at the expense of the south. This leads to a narrowing of the regional disparity in agricultural earnings. In the nonagricultural sectors real earnings rise because of the lower food price (line 6) although total money income as measured by nonagricultural value added is constant (Table 5.3, line 3). Because food expenditures are a higher proportion of total incomes for the self-employed than the wage earners, the relative increase in self-employed earnings (line 4) is greater than wage earnings (line 5).

Overall, self-employed workers in nonagriculture (line 4) are better off relative to other groups in the population although not as

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[6] Other policy runs of the agricultural model reported in Manetsch <u>et al.</u> (1971) indicated that food modernization in a region where food competes with exports releases land and labor for export crop production.

[7] Line 9 of Table 5.4 shows that food consumption at current prices decreases by 11.7 percent. Food prices have declined by 20 percent and hence, real food consumption rises by 8.3 percent.

well off as under the export modernization policy. However, the gap between agricultural earnings and nonagricultural earnings (line 7 and line 8) is widened by this policy. This leads to a rise of 20 percent in the rate of migration out of agriculture to nonagriculture (line 10), but not enough to offset the rise in nonagricultural real incomes (line 6) with lower food prices.

Agricultural Policy Runs with Migration Exogenous

The above policy runs were subjected to sensitivity analysis as in the case of the predictions of the model in the first section of this chapter. Sensitivity analysis on the parameter determining migration response to income differentials is chosen for purposes of illustration because: (1) a high variance is attached to the estimation of this parameter, (2) it is likely to be a crucial parameter determining the effects of agricultural policies on employment and income distribution, and (3) setting the migration rate to a fixed rate as in the following runs represents a hypothetical government policy to control the migration rate. Results of a run where migration is exogenously determined are shown in Table 5.5 and Table 5.6. In nearly all cases the effects are in the same direction as in Table 5.3 and 5.4 but in some cases the magnitude of the effects is significantly different. The export modernization policy produced a sharper rise in exports (line 7) and agricultural value added (line 1); since with migration fixed

Table 5.5 Effect of export and food modernization policies on key macro-economic variables with inelastic migration response.

Macro-economic variables	Value Base Run £M	Export Modernization Policy: Value 1983 £M	Export Modernization Policy: Deviation from Base run, 1983 £M	Export Modernization Policy: Deviation from Base run, 1983 %	Food Modernization Policy: Value 1983 £M	Food Modernization Policy: Deviation from Base run, 1983 £M	Food Modernization Policy: Deviation from Base run, 1983 %
1. Value added in agriculture (current prices)	1357	1587	230	16.9	1228	-129	-9.5
2. Value added in agriculture (adjusted prices)[a]	1357	1512	155	11.4	1464	107	7.9
3. Value added nonagriculture	2278	2587	309	13.5	2262	- 16	- .7
4. Gross domestic product (current prices)	3928	4526	598	15.2	3781	-147	-3.7
5. Gross domestic product (adjusted prices)[a]	3928	4450	522	13.3	4018	90	2.3
6. Total agricultural exports (world prices)	211.0	425.7	214.7	102.0	211.0	.0	.0
7. Total agricultural exports (producer prices)	111.5	221.6	110.1	98.7	111.5	.0	.0
8. Total imports	725.4	850.2	124.8	17.2	718.8	- 6.6	- .9
9. Total food consumption	1125	1219	94	8.3	994	-131	-11.7
10. Agricultural requirements for domestically-produced goods	12.7	13.8	1.1	8.0	13.6	.9	1.0
11. Agricultural requirements for domestically-produced imports	8.5	10.0	1.5	18.0	7.5	- 1.0	-1.2

[a]Values in adjusted prices are computed by converting results of policy runs to equivalent base run prices to measure real changes in output.

Table 5.6 Effect of export and food modernization policies on income distribution and employment variables with inelastic migration response.

Variable	Value Base Run 1983	Unit	Percent deviation from base runs: Export modernization policy	Percent deviation from base runs: Food modernization policy
1. Average price of food staples	.0144	£/lb.	6.4	-20.6
2. Agricultural disposable real income per worker - north	20.7	£/year	12.5	- .1
3. Agricultural disposable real income per worker - south	42.2	£/year	23.7	-21.3
4. Nonagricultural disposable real income per worker - self-employed	21.3	£/year	35.3	25.7
5. Nonagricultural disposable real income per worker - unskilled wage earners	145.0	£/year	-2.2	6.7
6. Average nonagricultural real income	49.3	£/year	18.7	11.8
7. Ratio of agricultural to nonagricultural incomes - north	.420	-	-5.2	-10.7
8. Ratio of agricultural to nonagricultural incomes - south	.857	-	4.2	-29.6
9. Total wage employment	1.33	mil.	12.6	- .2
10. Rate of migration out of agriculture to nonagriculture	.820	%/year	.0	.0

exogenously, the export modernization policy does not increase migration and hence relatively more people remain in agriculture rather than joining the surplus labor pool in the cities. Likewise, because migration does not increase, incomes of the self-employed (line 4) rise by 35 percent compared with the 21 percent in the case of an elastic migration response (Table 5.4). Also, food price changes are less in the case of food modernization because the higher agricultural labor force increases food supply and the lower nonagricultural labor force decreases food demand.

Further Policy Results

Other macro-policies often advocated to tackle the urban employment problem include reducing real wages through price inflation or government wage restraint, or increasing wage employment through a government hiring program. The results of simulating these policies are described below.

Food Price Inflation to Reduce Real Wages

Kilby (1968, 1969) has often advocated food price inflation as a means of reducing real wages and hence the rural-urban income differential. A policy run was made where a domestic price support to producers of approximately 20 percent was placed on food marketed to the nonagricultural population.[8] The resulting distribution of real incomes is shown in Table 5.7. Because food prices have increased by 20.8 percent, the incomes of the agricultural population are raised significantly while the real wage rate and earnings of the self-employed experienced a sharp decline. Consequently, the rate of migration out of agriculture is also significantly reduced partly offsetting the higher incomes in agriculture and the decline in nonagricultural incomes. This policy run does improve the distribution of income between the agricultural workers and the nonagricultural wage earners; but, at the same time, the gap in nonagriculture between self-employed earnings and wage earnings is widened.

Wage Restraint

An alternative method of redistributing income from the wage earners and stimulating employment is a government policy of wage restraint. This assumes that such a policy is feasible - an assumption seen in Chapter 3 to be debatable. Again, the rate of migration out of agriculture is considerably reduced (Table 5.7). However, the income distribution effects are different to the policy of reducing wages through price inflation. In this case, because of the increased number

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[8] Any excess supply generated by this policy is assumed to be exported by the government for a loss.

Table 5.7 Effect of policies to reduce the nonagricultural real wage rate.

Variable	Value base run 1983	Unit	Percent deviation from base run 1983: Policy to increase food prices	Policy of government wage restraint
Agricultural disposable income per worker - north	18.3	Ł/year	6.6	- 5.5
Agricultural disposable real income per worker - south	37.1	Ł/year	11.7	- 5.6
Nonagricultural disposable real income per worker - self-employed	29.9	Ł/year	-16.4	13.0
Nonagricultural disposable real wage rate - unskilled wage earners	145.0	Ł/year	- 6.8	-95.0
Average price of food staples	.0138	Ł/lb	20.8	- 3.2
Rate of migration out of agriculture to nonagriculture	.645	%/year	- 7.9	-14.1
Total wage employment	1.35	million	0.	55.9

of people in agriculture and the reduced effective demand for food with the lower wage rate, agricultural workers are not as well off as previously. However, the reduction in migration has increased the earnings of the self-employed in nonagriculture despite a reduction in the effective demand. Overall, earnings of the self-employed increase relative to the wage earners but more so for the nonagricultural self-employed than the agricultural self-employed.

Government Hiring Program

A policy often considered for alleviating unemployment is a government program of hiring for public works. Recall that this was one of the main considerations of the Harris-Todaro model. Figure 5.5 shows the time path effects of a policy of increasing government current expenditures by Ł40 million. Note that because of the stimulus given to the nonagricultural economy by the expenditure, self-employed earnings initially show a significant increase over the base run. However, with migration out of agriculture responsive to incomes in the nonagricultural sector, the higher migration rate after an initial delay depresses self-employed earnings until by the end of the run there is very little change from the base run. The rate of migration also converges to the base run, although more slowly because of a delay function in the model. That is, there is a tendency for migration and self-employed earnings to reach the equilibrium

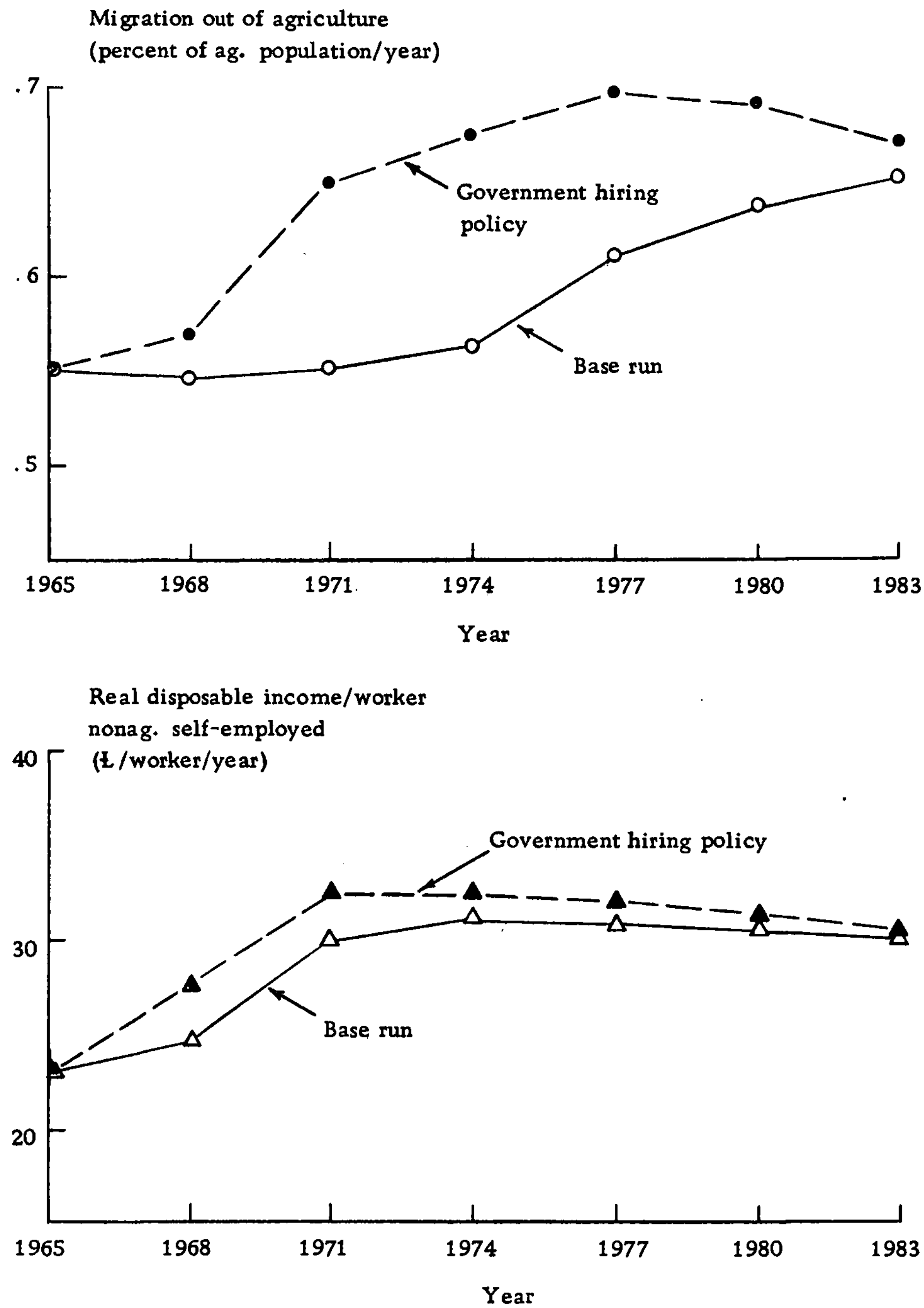

Figure 5.5 Effect of a government hiring policy on migration out of agriculture and earnings of the self-employed.

values of the base run. These results are consistent with the Harris-Todaro model although their model considers only the static effect of higher wage employment on migration. The present model enables the dynamic effects and, particularly, the multiplier effects of government spending on the rest of the economy to be explored.

There is one other important conclusion from this result. Harris and Todaro (1970) concluded that under the most likely assumptions concerning parameters of the model, unemployment would be increased by a policy of stimulating nonagricultural employment. In the present model, the government hiring program in nearly all cases <u>increased</u> the earnings of the self-employed (used here as an index of unemployment). This is shown in Table 5.8 where a high elasticity of migration response is required before there is a drop in the level of self-employed earnings. Furthermore, the increase in government spending increases the incomes of agricultural workers because of: (1) the increased demand for food, (2) the increased price of food resulting from this demand, and (3) the lower number of workers in agriculture as a result of the higher migration. The latter explains the greater effect on agricultural incomes the higher the elasticity of migration response.

Table 5.8 Effect of a policy of increasing government employment with varying elasticity of migration response.

Variable	Elasticity of migration response[a] -1.0	-2.0	-3.0
	Percent deviation from base run, 1983		
Agricultural disposable real income per worker - north	3.1	3.8	3.9
Agricultural disposable real income per worker - south	3.1	4.0	4.3
Nonagricultural disposable real income per worker - self-employed	3.3	1.6	-.9
Nonagricultural disposable real income per worker - unskilled wage earner	-.4	-.4	-.4
Total wage employment	8.2	8.1	8.0
Average price of food staples	1.4	1.4	1.4
Rate of migration from agriculture to nonagriculture	3.5	3.5	0.

[a] The elasticity of migration response is the percent change in the rate of migration out of agriculture for a one percent change in the ratio of agricultural to nonagricultural incomes.

Discussion of the Results

By considering some of the dynamic interactions between sectors of the economy, the results presented above lead to a serious questioning of the present literature which advocates agricultural development policies to raise agricultural income relative to nonagricultural income and slow the rate of migration to the cities where unemployment is prevalent. Indeed, the analysis of export modernization and food modernization strategies in Nigeria suggests that both the agricultural-nonagricultural income differential and migration out of agriculture may be increased by these policies. What is lacking from previous analyses is the consideration of the multiplier effects of agricultural-nonagricultural interactions other than labor migration, particularly the flow of goods and services between the two sectors.

All the results of the model showed that an increase in agricultural value added caused a large effect on nonagricultural value added through the multiplier effects of the various interactions between the two sectors. A simple mathematical model of a two-sector economy given in Appendix C shows that this effect can be largely explained by the high income elasticity of demand of consumers for nonagricultural goods relative to agricultural goods such as staple foods. That is, any increase in agricultural cash income is spent largely on nonagricultural goods and services, but because of an income elasticity of demand for food of less than unity, only a small portion of the increased nonagricultural income is returned to agriculture through higher food consumption. This increase in value added in nonagriculture increases _expected_ nonagricultural incomes through (1) higher wage employment and (2) higher earnings of the self-employed. To the extent that migration is responsive to economic incentives, this increased income may stimulate further migration out of agriculture.

There are two factors not explicitly considered in the model which may alter the interpretation of these results. _Firstly_, the model does not provide a breakdown into rural and urban areas. Although agriculture is located almost entirely in rural areas, small-scale nonagricultural output may be produced in both rural and urban areas. Thus, the interactions discussed above between agriculture and nonagriculture do not correspond to rural-urban interactions. In particular, migration out of agriculture does not necessarily constitute rural to urban migration. Ideally, to analyze this problem would require a further breakdown of the small-scale nonagricultural sectors between rural and urban areas. However, there is very little information on agricultural-nonagricultural interactions in rural areas and the interactions between rural and urban economics. Nonetheless, the model does contain six large-scale sectors located almost exclusively in urban areas and the income elasticity of the agricultural population for these goods tends to be quite high suggesting considerable linkages between the rural and urban economies.

Secondly, the model has a high degree of aggregation which may overlook some effects. In particular, if there is a wide spectrum of income distribution in agriculture with potential rural-urban migrants at the lowest end of this spectrum, and agricultural policies increase the incomes of this group relative to other rural groups, the rural-urban income gap relevant to the potential migrants may be narrowed. An example of this type of response may be a land reform policy to redistribute land to tenant farmers. However, given the present income distribution in Nigerian agriculture and the agricultural policies considered, this is not likely to be a major limitation of the analysis.

Although the results do not support agricultural development policies as a means of increasing agricultural incomes relative to nonagricultural incomes and decreasing migration out of agriculture, the overall impact of the modernization policies on nonagricultural income distribution and employment was favorable. Total wage employment and self-employed earnings in nonagriculture increased, suggesting a decrease in unemployment, despite the greater nonagricultural labor force. In particular, self-employed earnings increased steadily for both agricultural policies considered in contrast to the stagnant earnings of this group of workers under status quo policies. In addition, the gap between self-employed incomes and wage incomes in nonagriculture was decreased by both agricultural policies considered.

These effects were even more pronounced where there was a change in food prices. For example, the food modernization policies produced an even greater increase in the nonagricultural labor force and a larger decline in agricultural real incomes relative to nonagricultural real incomes. The effect of a decline in food prices is to redistribute real income from agricultural to nonagricultural consumers. The benefits acrue to the nonagricultural population, particularly the low income self-employed group where food expenditures are a large proportion of the consumption budget. Thus, real incomes of this group increased relative to the wage earners with a food modernization policy.

Overall, the export modernization policy produced greater increases in output in both money and real terms than the food modernization policy. Furthermore, the export modernization policies produced a smaller increase in the agricultural-nonagricultural income differential, less migration out of agriculture and a larger increase in self-employed earnings than the food modernization policy. These results are generally consistent with the recommendations of the Consortium for Nigerian Rural Development (Johnson *et al.*, 1969) that export modernization be given highest priority in agricultural development strategies. The present study, by introducing income distribution and employment variables, gives added weight to this recommendation.

From the above results it appears that the only means of increasing agricultural incomes relative to nonagricultural incomes is to increase food prices. Although such a policy did cause a decline in nonagricultural real incomes relative to agricultural incomes and consequently a reduction in migration out of agriculture, the nonagricultural self-employed earnings showed a much greater decrease than the wage earners, further aggrevating the unequal distribution of income between wage earners and the self-employed in nonagriculture. Furthermore, such a policy depends on the assumptions concerning wage rate determination. There is some evidence, particularly in Nigeria, that wage rates are responsive to cost of living changes. If this is the case, then a policy of high food prices would adversely affect only the nonagricultural self-employed.

One overriding factor in all the policy runs considered here is the trade-off in earnings between various groups. Only one policy, that of export modernization, increased the incomes of self-employed persons in agriculture and nonagriculture and, at the same time, decreased the real wage rate. However, export modernization policies increased the regional disparity in agricultural incomes. In other cases there was a trade-off between agricultural earnings and self-employed earnings in nonagriculture, particularly where there was a change in food prices. Cash food income is a dominant source of cash income in agriculture but, at the same time, is the major expenditure of self-employed workers in nonagriculture.

Finally these general results are true for both migration determined endogenously and migration fixed exogenously in the model. However, the effects of the agricultural policies on self-employed earnings was greater where there was no increase in migration. Also where migration out of agriculture is fixed the agricultural-nonagricultural income differential is relatively wider as a result of the agricultural policies.

VI. SUMMARY AND CONCLUSIONS

Summary of the Model

The objective of this study has been to explore the interactions between agriculture and nonagriculture in a developing economy with particular emphasis on the effects of various agricultural policies on income distribution and employment. The study has been motivated by the notion, currently popular in the literature, that the urban unemployment crisis is largely the result of disparities in rural-urban income and should be corrected by agricultural development policies to stem the tide of migration out of agriculture. In considering this question, the Nigerian economy has been analyzed in the framework of a dual economy, although in contrast to earlier models, explicit attention has been given to income distribution and employment questions.

The model used in the present study is a simple ten-sector macro-model of the Nigerian economy. This model explicitly treats the flows of goods and services between agriculture and nonagriculture for consumption, production and investment. In addition, migration out of the agricultural to the nonagricultural labor force may be endogenously determined in the model by the income differential between these sectors. One important agricultural-nonagricultural interaction not considered in the model is the competition for investment funds between the two sectors.

A distinctive characteristic of the present model is a sectoral breakdown of the economy into small-scale and large-scale industries. This takes account not only of the duality between agriculture and modern industry but also of the dual nature of the nonagricultural economy. That is, small labor intensive industries often using traditional skills and techniques exist together with large, capital intensive modern firms. This enables a breakdown of the income distribution pattern between agriculture, small-scale nonagriculture and large-scale nonagriculture. It is the largely self-employed workers in the small-scale nonagricultural sector where urban underemployment and unemployment are prevalent.

The macro-model of the Nigerian economy is not a policy-oriented model. However, by interacting with a detailed agricultural sector model the impact of agricultural policy experiments on national targets can be simulated. In particular, the macro-model enables the evaluation of agricultural policies with respect to two sets of policy targets: (1) output targets such as gross domestic product and (2) income distribution and employment targets such as wage employment and self-employed earnings. The model is limited in considering nonagricultural policies, particularly the returns to investment in nonagriculture. However, some policy experiments such as government wage rate restraint or increased government employment can be performed.

In summary the macro-model enables most of the interaction between agriculture and nonagriculture to be incorporated into agricultural policy evaluation. Furthermore, by disaggregating the economy into small-scale and large-scale sectors some income distribution and employment effects can be considered in policy formulation, specifically the effects on wage employment and wage rates, and self-employed earnings in agriculture and nonagriculture. Finally, the model was able to describe the major trends in the Nigerian economy with reasonable accuracy and should be generally adaptable to the analysis of similar questions in other developing countries.

Conclusions from the Simulation Approach

The simulation-systems science approach used in the model building and operation enabled valuable insights into the problem. The model by performing computations at quarter-year intervals constructs time paths and enables the dynamic interactions and feedbacks of the various policies to be studied. Such properties as the existence of a stable equilibrium and the rate of convergence to this equilibrium give added insights to the system's behavior. Furthermore, when looking at several targets such as output and income distribution it may not always be desirable to use a maximization procedure in solving the equations of the model. The simulation approach does not seek to solve a system of equations. Rather the exogenous variables of the system (initial conditions, policy instruments, etc.) are set, and the model traces the time path of output variables of interest and enables the trade-offs between these variables to be studied.

A valuable feature of the simulation approach is the ability to model behavioral relationships whose parameters are particularly uncertain. For example, in the present study the response of migration out of agriculture to income differentials is a little-understood behavioral relationship. However, many of the runs presented in this study were repeated assuming various degrees of migration response to determine the effects on the policy conclusions. Of course, this type of analysis can only be performed for a few key variables. With too many "unknown" parameters, it is difficult to obtain any conclusive results.

Finally, the simulation approach is an efficient analytical procedure in terms of computational cost. The macro-model, running independently of the larger agricultural sector model, required less than ten seconds on a CDC6500 for a 30-year simulation run (i.e., 120 iterations). This efficiency enables a large number of runs and sensitivity testing to fully explore the model's behavior.

Conclusions on the Effects of Agricultural Development on Urban Unemployment

The simulation analysis of the Nigerian economy suggested that policies to stimulate agricultural output will not decrease the existing income differential between agriculture and nonagriculture. Indeed, it is likely to increase this differential and, hence, migration out of agriculture. This effect is particularly acute if the increased agricultural output causes agriculture's terms of trade to deteriorate as in the case of a food modernization policy. These results lead to a reevaluation of policy recommendations which propose to decrease urban unemployment by stimulating agricultural output as an incentive for potential rural-urban migrants to remain in agriculture.

Nonetheless, both sets of agricultural policies analyzed and particularly the export modernization policy reduced the disparity between self-employed earnings and wage earnings and produced a steady rise in nonagricultural self-employed earnings, which under current policies were predicted to stagnate because of rising urban unemployment. But these effects were due to the increases in demand for nonagricultural employment rather than a reduction in the urban labor supply. These results underline the need to consider the dynamic nature of agricultural-nonagricultural interactions in agricultural policy evaluation.

Policies which reduced the real wage rate in nonagriculture did decrease the differential between agricultural and nonagricultural earnings and reduced migration (if it was responsive to this differential). However, policies which reduce real wages through higher prices reduce real earnings of the nonagricultural self-employed more. Likewise, reducing the absolute wage rate decreased effective demand for goods from other sectors.

Finally, the results demonstrated the considerable multiplier effects of increasing agricultural output. Most of these multiplier effects resulted from increased demands for consumer goods. The increase in demand for goods for production and investment in agriculture was negligible, although in later stages of development their significance may increase.

Directions for Future Research

One of the areas of further research suggested by this study is the interaction of agriculture and nonagriculture in rural areas and the interaction between the rural and urban economies. Traditionally, national accounts have broken down the economy by sectors; but, in order to look at problems of income distribution and employment, one must have more information on other dimensions of the economy such as the breakdown by rural and urban location or by small-scale and large-scale industries. In particular, small-scale nonagricultural activities are usually ignored in surveys of the economy despite regular censuses of large-scale firms.

The question of rural-urban migration is clearly deserving of closer attention. Most of the results presented here were quite sensitive to the elasticity of response of off-farm migration to the agricultural-nonagricultural income differential, but the factors determining this elasticity are not understood. Certainly, in the macro-economic analysis of this study the subject has not been adequately treated, but sensitivity testing of this parameter has enabled some general conclusions to be drawn.

Wage rate determination is another question of prime importance in analyzing policies to alleviate urban unemployment problems. The Kilby-Weeks debate on this topic is far from settled. If, as Kilby maintains, trade unions have considerable political power, efforts to reduce urban wages in real or money terms may be difficult, and the problem of rural-urban income inequities is likely to continue.

Finally, the macro-economic simulation model presented here has enabled valuable insights into the effects of interactions between sectors and the trade-offs between target s of development. It is suggested that the model is sufficiently flexible to apply to other developing economies with similar problems. Such application may enable some more general conclusions to be drawn concerning the long run solutions to the urban unemployment and income distribution problems.

BIBLIOGRAPHY

Aboyade, Ozetunji. 1962. A general critique of the plan. Nigerian Journal of Economic and Social Studies. 4:110-115.

____________. 1966. Foundations of an African economy. London, Praeger. 366 p.

Adedeji, Adebayo. 1969. Nigerian federal finance: its development, problems and prospects. New York, Hutchinson Educational Ltd. 308 p.

Ajayi, Peter. 1971 (April). More pay would bring greater productivity. African Development. p. 27.

Althabe, G. 1967. Psychological conclusions to a study of unemployment in Brazzaville. In: Readings in African psychology from French language sources, ed. by F. R. Wichert, East Lansing, African Studies Center, Michigan State University. p. 217-243.

Aluko, S. A. 1970. The case for rapid industrialization in Nigeria. Quarterly Journal of Administration 4:301-322.

Anthonio, Q. B. O. 1967. Food consumption and income relationships in Nigeria: Engle's curve functions. Bulletin of Rural Economics and Sociology 2:52-67.

Baer, Werner and Michael E. A. Herve. 1966. Employment and industrialization in developing countries. The Quarterly Journal of Economics 80:88-107.

Balopoulos, Elias T. 1970. Labour force implications of successful population planning. In: Proceedings of the Meeting of Directors of Development Training and Research Institutes, Montebello, Canada. 15 p.

Beals, R. E., M. B. Levy and L. N. Moses. 1967. Rationality and migration in Ghana. Review of Economics and Statistics 49:480-486.

Berg, Elliot J. 1965a. The development of a labor force in Sub-Saharan Africa. Economic Development and Cultural Change 13:394-412.

Berg, Elliot J. 1965b. Major issues of wage policy in Africa. In: Industrial relations in economic development, ed. by Arthur M. Ross, London, Macmillan. p. 185-208.

_______________. 1969. Urban real wages and the Nigerian trade union movement: 1939-60. Economic Development and Cultural Change 17:604-617.

_______________ 1970. Wages and employment in less developed countries. In: Proceedings of the Meeting of Directors of Development Training and Research Institutes, Montebello, Canada. 24 p.

Berry, Sara and Carl Liedholm. 1970. Performance of the Nigerian economy, 1950-62. In: Growth and development of the Nigerian economy, ed. by Carl Eicher and Carl Liedholm, East Lansing, Michigan State University Press. p. 67-85.

Brown, L. R. 1970. Seeds of change: the green revolution in the 1970's. New York, Praeger. 205 p.

Caldwell, J. C. 1969. African rural-urban migration: the movement to Ghana's towns. New York, Columbia University Press. 255 p.

Caldwell, J. C. and C. Okonjo (ed.). 1968. The population of tropical Africa. London, Longmans, Green and Co. 457 p.

Callaway, A. C. 1960. School-leavers for the farms. West Africa, No. 2258. p. 1021.

_______________ 1963. Unemployment among African school leavers. Journal of Modern African Studies 1:351-371.

_______________ 1967. Education expansion and the rise of youth employment. In: The city of Ibadan: a symposium on its structure and development, ed. by P. C. Lloyd, A. L. Mabojunje and B. Awe, London, Cambridge University Press. p. 191-211.

Carter, N. G. 1966. An input-output analysis of the Nigerian economy, 1959-1960. Cambridge, 150 p. (School of Management, Massachusetts Institute of Technology).

Chenery, H. B.. and P. Clark. 1962. Interindustry Economics, New York, Wiley and Sons, 380 p.

Clark, Peter. 1963. Economic planning for a country in transition: Nigeria. In: planning economic development, ed. by E. Hagen, Homewood, Ill., Richard Irwin. p. 252-293.

____________ 1967. The choice of optimal import substitution patterns for Nigeria. Doctoral dissertation. Cambridge, Massachusetts Institute of Technology. 351 numb. leaves.

Clayton, E. S. 1970. Agrarian reform, agricultural planning and employment in Kenya. International Labour Review 102:431-453.

Clignet, Remi. 1969. Preliminary notes of a study of unemployment in modern African urban centers. Manpower and Unemployment Research in Africa 2:12-17.

Costa, E. 1966. Back to the land: the campaign against unemployment in Dahomey. International Labour Review 93:29-49.

Cownie, John B. 1968. Nigerian national income accounts: historical summary and projections to 1985. East Lansing, Mi., 40 p. (Consortium for the Study of Nigerian Rural Development Report No. 14, Michigan State University).

Dantwala, M. L. 1970. Definition of unemployment and problems of its measurement in developing countries. In: Proceedings of the Meeting of Directors of Development Training and Research Institutes, Montebello, Canada. 12 p.

Desai, Meghnad and Dipak Mazundar. 1970. A test of the hypothesis of disguised unemployment. Economica 37:39-53.

Dixit, A. K. 1969. Marketable surplus and dual development. Journal of Economic Theory 1:203-219.

Doctor, Kailas C. and Hans Gallis. 1966. Size and characteristics of wage employment in Africa: some statistical estimates. International Labour Review 93:149-173.

Dziadek, F. 1967. Unemployment in the less developed countries. Washington, D.C. 40 p. (Agency for International Development, Discussion paper No. 16)

Eicher, Carl and Glenn L. Johnson. 1970. Policy for Nigerian agricultural development in the 1970's. In: Growth and development of the Nigerian economy, ed. by Carl Eicher and Carl Liedholm, East Lansing, Michigan State University Press. p. 376-392.

Eicher, Carl and Carl Liedholm (ed.). 1970. Growth and development of the Nigerian economy. East Lansing, Michigan State University Press. 456 p.

Eicher, Carl, et al. 1970. Employment generation in African agriculture. East Lansing. 66 p. (Institute of International Agriculture, College of Agriculture and Natural Resources Report No. 9, Michigan State University)

Eke, I. I. U. 1967. Unemployment in Nigeria: a study of the strategy of development for Nigeria. Enugu. 47 p. (Economic Development Institute, University of Nigeria)

Elkan, W. 1960. Migrants and proletarians. London, Oxford University Press. 149 p.

__________ 1970. Urban unemployment in East Africa. International Affairs 46:517-528.

Federal Ministry of Economic Development. 1962. National development plan, 1962-68. Apapa, Nigerian National Press Ltd. 362 p.

__________ 1964. National development plan - progress report. Apapa, Nigerian National Press Ltd. 201 p.

Federal Ministry of Information. 1963. Manpower situation in Nigeria. Lagos, Government Printer. 20 p.

__________ 1970. Second national development plan, 1970-74. Lagos, Government Printer. 341 p.

Federal Ministry of Labour. 1961. Report on employment and earnings enquiry. Lagos, Government Printer. 40 p.

Federal Office of Statistics. 1959. Report on employment and earnings enquiry. Lagos, Government Printer. 28 p.

____________ 1963. Urban consumer surveys of Nigeria in Lagos, 1959-60. Lagos, Government Printer. 79 p.

____________ 1965. Urban consumer survey in Nigeria, Enugu 1961-62. Lagos, Government Printer. 80 p.

____________ 1966a. Annual abstract of statistics. Lagos, Government Printer. 266 p.

____________ 1966b. Industrial survey of Nigeria 1963. Lagos, Government Printer. 125 p.

____________ 1966c. Urban consumer survey in Nigeria, Kaduna 1962-63. Lagos, Government Printer. 79 p.

____________ 1967a. Urban consumer survey in Nigeria, Onitsha 1963-64. Lagos. 79 p.

____________ 1967b. Urban consumer survey in Nigeria, Akure, Ondo, Owo 1964-65. Lagos, Government Printer. 79 p.

____________ 1968a. Economic indicators. Lagos, Government Printer. 40 p.

____________ 1968b. Gross domestic product of Nigeria, 1958/59 - 1966/67. Lagos, Government Printer. 34 p.

____________ 1968c. Rural demographic sample survey. Lagos, Government Printer. 48 p.

____________ 1969. Review of external trade. Lagos, Government Printer. 38 p.

Fei, J. C. H. and G. Ranis. 1964. Development of the labor surplus economy. Homewood, Ill., Irwin. 324 p.

Fletcher, Lehman B. 1968. Pricing and allocative efficiency in agricultural development. American Journal of Agricultural Economics 50:1294-1306.

Foster, Phillips and Larry Yost. 1969. A simulation study of population, education and income growth in Uganda. American Journal of Agricultural Economics 2:576-591.

Frank, C. R. 1967. Industrialization and employment generation in Nigeria. Nigerian Journal of Economic and Social Studies 9:277-297.

__________ 1968. Urban unemployment and economic growth in Africa. Oxford Economic Papers 20:250-274.

__________ 1970. The problem of urban unemployment in Africa. Princeton, N. J. 36 p. (Woodrow Wilson School, Princeton University, Discussion Paper No. 16)

Ghai, Dharam. 1968. Income policy in Kenya: need, criteria and machinery. East African Economic Review 4:19-34.

__________ 1970. Employment performance, prospects and policies in Kenya. In: Prospects for employment opportunities in the nineteen seventies - Overseas Studies Committee Conference, 1970. Cambridge, U. K. 21 p.

__________ 1971. Unemployment: the national obsession. African Development, January:13-16.

Green, R. H. 1967. Wage levels, employment, productivity and consumption. In: Education, employment and rural development, ed. by James R. Sheffield, Nairobi, East African Publishing House. p. 214-238.

Gregory, Joel. 1971. Migration in Upper Volta. African Urban Notes 4:44-52.

Gulliver, Paul H. 1955. Labor migration in a rural economy. Kampala, Uganda. 45 p. (East African Institute of Social Research)

Gutkind, J. N. 1969. Tradition, migration, urbanization, modernity and unemployment in Africa, the roots of instability. Canadian Journal of African Studies 3:343-365.

Gutkind, P. 1967. The energy of despair: social organization of the unemployed in two African cities: Lagos and Nairobi. Civilizations 17:186-211.

Halter, A. N. and G. W Dean. 1965. Simulation of a California range-feedlot operation. 45 p. (Giannini Foundation Res. Rep. 282, University of California)

Halter, A. N. and S. F. Miller. 1966. River basin planning - a simulation approach. 117 p. (Oregon State University. Oregon Agr. Exp. Sta. Spec. Rep. 224)

Halter, A. N., M. L. Hayenga and T. J. Manetsch. 1970. Simulating a developing agricultural economy: methodology and planning capability. American Journal of Agricultural Economics 52:272-284.

Hance, W. A. 1970. Population, migration and urbanization in Africa. New York, Columbia University Press. 450 p.

Harbison, F. H. 1967. The generation of employment in newly developing countries. In: Education, employment and rural development, ed. by J. R. Sheffield, Nairobi, East Africa Publishing House. p. 173-193.

__________ 1970. From Ashby to reconstruction: manpower and education in Nigeria. In: Growth and development of the Nigerian economy, ed. by Carl Eicher and Carl Liedholm, East Lansing, Michigan State University Press. p. 393-409.

Harris, J. R. and M. P. Todaro. 1968. Urban unemployment in East Africa: an economic analysis of policy alternatives. East African Economic Review 4:17-36.

__________ 1969. Wages, industrial employment and labour productivity in a developing economy: the Kenya experience. Eastern Africa Economic Review 1:29-46.

__________ 1970. Migration unemployment and development. American Economic Review 60:126-142.

Helleiner, Gerald K. 1965. Peasant agriculture, development and export instability: the Nigerian case. In: African primary products and international trade, ed. by I.G. Stewart and H. D. Ord, Edinburgh, University of Edinburgh Press. p. 218-232.

__________ 1966. Peasant agriculture, government, and economic growth in Nigeria. Homewood, Ill., Richard D. Irwin, Inc. 600 p.

Helleiner, Gerald K. 1970. The fiscal role of the marketing boards in Nigerian economic development, 1947-1961. In: Growth and development of the Nigerian economy, ed. by Carl Eicher and Carl Liedholm, East Lansing, Michigan State University Press. p. 119-155.

Hill, Polly. 1968. The myth of the amorphous peasantry: a northern Nigerian case study. Nigerian Journal of Economic and Social Studies 10:239-260.

Holland, E. P. 1962. Simulation of an economy with development and trade problems. American Economic Review 52:408-430.

Holland, E. P. and Robert W. Gillespie. 1963. Experiments on a simulated underdeveloped economy: development plans and balance-of-payments policies. Cambridge, Massachusetts Institute of Technology Press. 286 p.

Holland, E. P., et al. 1966. Dynamic models for simulating the Venenzuelan economy. Caracas. 266 p. (The Simulmatics Corporation, Universidad Central de Venenzuela)

Hollister, R. G. 1969. Manpower problems in Sub-Saharan Africa. International Labour Review 99:515-532.

Hornby, J. M. 1968. Investment and trade in the dual economy. Economic Journal 78:96-107.

Hunter, Guy. 1970. Methods of rural development. In: Prospects for employment opportunities in the nineteen seventies - Overseas Studies Committee Conference, 1970. Cambridge, U. K. 12 p.

Hymer, S. H. and S. Resnick. 1969. A model of an agrarian economy with nonagricultural activities. American Economic Review 59:493-506.

Imoagene, S. 1967. Psycho-social factors in rural-urban migration. Nigerian Journal of Economic and Social Studies 9:375-386.

International Labour Office. 1970. Towards full employment. Geneva, Vaudoise, SA. Lausanne. 470 p.

Johnson, Glenn L., et al. 1969. Strategies and recommendations for Nigerian rural development, 1969-1985. East Lansing. 158 p. (Consortium for the Study of Nigerian Rural Development, Rep. No. 33, Michigan State University

Johnson, H. G. 1967. Economic policies toward less developed countries. New York, Praeger. 279 p.

Johnson, R. W. M. 1967. Disguised unemployment in the village economy. African Social Research 3:228-233.

Johnston, B. F. and J. Cownie. 1969. The seed fertilizer revolution and labor force absorption. American Economic Review 54:569-582.

Jolly, Richard. 1970. Rural-urban migration: dimensions, causes, issues and policies. In: Prospects for employment opportunities in the nineteen seventies - Overseas Studies Committee Conference, 1970. Cambridge, U. K. 12 p.

Jorgenson, D. W. 1961. The development of a dual economy. Economic Journal 71:309-334.

Kao, Charles, Kurt Anschel and Carl Eicher. 1964. Disuised unemployment in agriculture: a survey. In: Agriculture in economic development, ed. by Carl Eicher and L. Witt, New York, McGraw-Hill. p. 129-143.

Kilby, Peter. 1967. Industrial relations and wage determination: failure of the Anglo-Saxon model. Journal of Developing Areas 1:489-520.

____________ 1968. A reply to John F. Week's comment. Journal of Developing Areas 3:19-26.

____________ 1969. Industrialization in an open economy: Nigeria, 1945-1966. Cambridge, U. K., University Press. 399 p.

____________ 1971. Further comment on the Kilby/Weeks Debate; Final Observations, Journal of Developing Areas, 5:175-176.

Knight, J. B. 1968. Earnings, employment, education, and income distribution in Uganda. Bulletin of the Oxford University Institute of Economics and Statistics 30:267-297.

Kresge, David T. 1967. A simulation model for economic planning. A Pakistan example. Cambridge. 46 p. (Economic Development Rep. No. 81, Harvard University)

Kuper, H. (ed.) 1965. Urbanization and migration in West Africa. Berkeley, University of California Press. 227 p.

Labour unrest - Nigeria no. 1. 1971. Quarterly Economic Review. London. p. 5. (The Economics Intelligence Unit)

Langley, Kathleen M. 1968. The external resource factor in Nigerian economic development. Economic and Social Studies 10:153-182.

Leibenstein, Harvey. 1966. Allocative efficiency vs. x - efficiency. American Economic Review 56:392-415.

Lewis, W. A. 1954. Economic development with unlimited supplies of labor. The Manchester School 22:139-191.

__________ 1967. Reflections on Nigeria's economic growth. Paris. 65 p. (Organization for Economic Cooperation and Development, Development Centre)

Lowry, I. S. 1966. Migration and metropolitan growth. San Francisco, Chandler Co. 118 p.

Lux, Andre. 1969. Unemployment in modern African urban centers, a rejoinder. Manpower and Unemployment Research in Africa 2:33-36.

Manetsch, T. J. 1967. The United States plywood industry - a systems study. Transactions of Systems Science and Cybernetics S. I. C. -3:92-101.

Manetsch, T. J., et al. 1971. A general simulation approach to agricultural sector analysis with special reference to Nigeria. East Lansing, Mi. 569 numb. leaves. (Michigan State University. Contract no. csd-1557 of the Agency for International Development)

Mellor, John W. 1966. The economics of agricultural development. Ithaca, Cornell University Press. 403 p.

Miracle, Marvin p. 1970. On the economic significance of unemployment in Africa. Manpower and Unemployment Research in Africa 3:18-21.

Morse, David A. 1970. Dimensions of the employment problem in developing countries. In: Prospects for employment opportunities in the nineteen seventies - Overseas Studies Committee Conference, 1970. Cambridge, U. K. 17 p.

Mueller, P. and K. H. Zervering. 1969. Employment promotion through rural development: a pilot project in Western Nigeria. International Labour Review 100:111-130.

McQueen, A. J. 1969. Unemployment and future orientations of Nigerian school leavers. Canadian Journal of African Studies 3:441-461.

Naylor, Thomas H. (ed.) 1969. Design of computer simulation experiments, Durham, N. C., Duke University Press. 417 p.

Nelson, Joan M. 1969. Migrants, urban poverty, and instability in developing nations. Cambridge. 81 p. (Occasional Papers in International Affairs No. 22, Harvard Center for International Affairs)

Nigerian budgetary development and reconstruction. 1971. Afro-Asian Economic Review 13:55-57.

Norbye, O. D. K. 1967. Long term employment prospects and the need for large scale rural works programmes. In: Education, employment and rural development, ed. by James R. Sheffield, Nairobi, East African Publishing House. p. 239-268.

Norman, D. W. 1969. Labour inputs of farmers: a case study of the Zaria Province of the North-Central State of Nigeria. The Nigerian Journal of Economic and Social Studies 11:3-14.

Odufalu, J. O. 1970. Company taxation and small scale entrepreneurship in Nigeria. Quarterly Journal of Administration 4:323-334.

Oherlihy, C. St. J. 1970. Wages and employment. In: Proceedings of the Meeting of Directors of Development Training and Research Institutes, Montebello, Canada. 11 p.

Okigbo, P. N. C. 1962. Nigerian national accounts, 1950-1957. Enugu, Government Printer. 206 p.

__________ 1965. Nigerian public finance. Evanston, Ill., Northwestern University Press. 245 p.

Olusanya, P. O. 1969. Socio-economic aspects of rural-urban migration in Western Nigeria. Ibadan. 164 p. Nigerian Institute of Social and Economic Research, University of Ibadan)

Oluwasanmi, H. A. 1966. Agriculture and Nigerian economic development. London, Oxford University Press. 240 p.

Pearson, Scott. 1970. Nigerian petroleum: implications for medium-term planning. In: Growth and development of the Nigerian economy, ed. by Carl Eicher and Carl Liedholm, East Lansing, Michigan State University Press. p. 353-375.

Rake, Alan. 1971. (April). Huge postwar boom sweeps Nigeria. African Development p. 3-5.

Ranis, G. and J. C. H. Fei. 1961. A theory of economic development. American Economic Review 51:533-556.

Rempel, Henry. 1971. The rural-urban migrant in Kenya. African Urban Notes 6:53-72.

Reynolds, Lloyd G. 1965. Wages and employment in a labor-surplus economy. The American Economic Review 55:19-39.

__________ 1969. Economic development with surplus labor. Oxford Economic Paper 21:89-103.

Schapera, I. 1947. Migrant labour and tribal life. London, Oxford University Press. 248 p.

Schultz, T. W. 1964. Transforming traditional agriculture. New Haven, Yale University Press. 212 p.

Seers, D. 1970. New approaches suggested by the Columbia Employment Program. International Labour Review 102:377-389.

Sen, A. K. 1966. Peasants and dualism with or without surplus labour. Journal of Political Economy 74:725-750.

Shaw, Robert d'A. 1970. Jobs and agricultural development. Washington, D.C. 75 p. (Overseas Development Council, Monograph No. 3)

Sheffield, J. R. (ed.) 1967. Education, employment and rural development. Nairobi, East African Publishing House. 499 p.

Singer, H. W. 1970. Dualism revisited: a new approach to the problems of the dual society in developing countries. Journal of Development Studies 7:60-78.

______________ 1970. International policies and their effect on employment. In: Prospects for employment opportunities in the nineteen seventies - Overseas Studies Committee Conference, 1970. Cambridge, U. K. 17 p.

Singh, S. K. 1970. Aggregate employment function: evaluation of employment prospects in LDC's. Washington, D.C. 106 p. (International Bank for Reconstruction and Development)

Smith, L. D. 1971. (Jan.) Can agriculture absorb the unemployed? African Development p. 9-13.

Stewart, Frances and Paul Steeten. 1970. Conflicts between output and employment objectives. In: Prospects for employment opportunities in the nineteen seventies - Overseas Studies Committee Conference, 1970. Cambridge, U. K. 32 p.

Stewart, I. G. 1963. Consumer demand in Nigeria. In: African studies in income and wealth, ed. by L. H. Samuels, London, Bowes and Bowes. p. 307-318.

Stiglitz, J. E. 1969. Rural-urban migration, surplus labour and the relationship between urban and rural wages. Eastern Africa Economic Review 1, 2:1-28.

Stolper, W. F. 1966. Planning without facts: lessons in resource allocation from Nigeria's development. Cambridge, Harvard University Press. 348 p.

______________ 1970. Economic growth and political instability in Nigeria: on growing together again. In: Growth and development of the Nigerian economy, ed. by Carl Eicher and Carl Liedholm, East Lansing, Michigan State University Press. p. 328-351.

Taylor, L. J. 1969. Development patterns: a simulation study. Quarterly Journal of Economics 83:220-241.

Thormann, P. H. 1970. The rural-urban income differential and minimum wage fixing critieria. International Labour Review 102:127-147.

Todaro, M. P. 1969. A model of labor migration and urban unemployment in less developed countries. American Economic Review 59:138-148.

__________ 1971. Industrialization and unemployment in developing nations. In: Workshop on Economic; Social and Political Consequences of the Green Revolution, New York State College of Agriculture, Cornell University, 30 p.

Turnham, David. 1970. The definition of unemployment in developing countries. In: Proceedings of the Meeting of Directors of Development Training and Research Institutes, Montebello, Canada. 19 p.

__________ 1970. The employment problem in less developed countries: a review of evidence. Paris. 58 p. (Organization for Economic Cooperation and Development, Development Centre)

Uchendu, V. C. 1970. The extended family and employment. In: Proceedings of the Meeting of Directors of Development Training and Research Institutes. Montebello, Canada. 13 p.

Vielrose, Egon. 1970. Factors limiting Nigeria's economic growth. Ibadan. 18 p. (Nigerian Institute of Social and Economic Research)

Warren, W. M. 1968. Urban real wages and the Nigerian trade union movement. Economic Development and Cultural Change 15:21-36.

Webb, Thomas R. 1969. A systems model for market development planning: northeast Brazil. Doctoral dissertation. East Lansing, Michigan State University. 364 numb. leaves.

Weeks, John F. 1968a. A comment on Peter Kilby: industrial relations and wage determination. Journal of Developing Areas 3:7-18.

Weeks, John F. 1968b. Wage behavior, rural-urban income trends and wage policy in Nigeria. Doctoral dissertation. Ann Arbor, University of Michigan. 251 numb. leaves.

________________ 1971. Further Comment on the Kilby/Weeks Debate: An Empirical Remainder. Journal of Developing Areas 5:165-174.

Yesufu, T. M. 1962. An introduction to industrial relations in Nigeria. London, Oxford University Press. 190 p.

________________ 1970. Social and economic policies for alleviating urban unemployment. In: Prospects for employment opportunities in the nineteen seventies - Overseas Studies Committee Conference, 1970. Cambridge, U. K. 38 p.

APPENDICES

APPENDIX A

MATHEMATICAL DESCRIPTION OF THE MACRO-MODEL

This appendix gives a mathematical description of the model presented in the body of Chapter 4. As in the verbal description, the model is partitioned into several components: (1) consumption, (2) investment, (3) production, (4) employment, and (5) national accounts. The equations in each component are designated by the letters C, I, P, E and N, respectively. Throughout the description the subscripts j and k designate sectors of the economy detailed in Table 4.1. Variables which are functions of time or vary over time are written in the form x(t) where x is the variable name. Multiplication of two variables is denoted by "*".

Consumption

The consumption component firstly computes the per capita disposable income of each class of consumers. Personal income of the agricultural and nonagricultural population is computed in the employment component as wages and salaries for those employed in large-scale sectors and average earnings for those self-employed in small-scale sectors.

(C1) $PDSINC_1(t) = PINCAG(t)/POP_1(t)$

where:

$PDSINC_1$ = total per capita personal income in agriculture-Ŀ/person/year

POP_1 = total agricultural population--thousands (from equation (E17) of the employment component)

PINCAG = personal income generated by the agricultural sectors - thousand Ŀ /year [computed in the employment component in equation (E5)]

(C2) $PDSINC_2(t) = PINCNA(t)/POP_2(t)$

where:

$PDSINC_2$ = total per capita personal income of the nonagricultural population - Ŀ/person/year

PINCNA = total personal income earned by the nonagricultural population - thousand Ŀ/year [computed in the production component by equation (E6)]

POP_2 = total nonagricultural population--thousands.

Consumption demands for goods and services are determined in Equation (C3) by the elasticity of demand with respect to per capita income. That is, the relative prices are assumed constant. Consumption demands are computed separately for two classes of consumers - the agricultural and nonagricultural populations.

(C3) $PCON_{i,j}(t) = ACON_{i,j}*PDSIND_i(t)^{ELAST_{i,j}},$

where:

$PCON_{i,j}$ = the per capita consumption of the j^{th} commodity by the i^{th} class of consumers - Ł/year

$ACON_{i,j}$ = an empirically determined constant

$PDSIND_i$ = the exponentially lagged value of per capita personal income, $PDSINC_i$ - Ł/year

$ELAST_{i,j}$ = the income elasticity of demand of the i^{th} class of consumers for the j^{th} commodity.

Total consumption of each commodity is then simply the sum of the consumption of each class of consumers in Equation (C4).

$$\text{(C4)} \qquad TCONS_j(t) = \sum_i POP_i(t) * PCON_{i,j}(t)$$

where:

$TCONS_j$ = total national consumption of the j^{th} commodity - thousand Ł/year

Equations (C5) and (C6) divide this consumption into domestically produced goods and imported goods. Imports are assumed to be a proportion of total consumption, although this proportion is varied exogenously over time to represent import substitution.

$$\text{(C5)} \qquad CIMP_j(t) = CIMPP_j(t) * TCONS_j(t)$$

where:

$CIMP_j$ = imports of the j^{th} commodity - thousand Ł/year

$CIMPP_j$ = proportion of the total consumption of the j^{th} commodity imported.

(C6) $DCD_j(t) = TCONS_j(t) - CIMP_j(t)$

where:

DCD_j = demand for domestically produced consumption goods from the j^{th} sector - thousand Ł/year

Domestic consumption demand, DCD_j, becomes part of final demand for domestic production while total consumption, $TCONS_j$, and imports, $CIMP_j$, are used in the construction of the national accounts.

Investment

Exogenous investment consists largely of public capital formation in the utilities, transportation and services sectors. In each time period, both the total amount of public investment and the allocation between sectors are exogenous variables. Investment in petroleum exploration and production is included as an exogenous time series projection since investment in this sector is largely determined by factors outside of the economy. Investment in the agricultural sector is also exogenous in the model.

Endogenous investment is computed by Equation (I1). Because of the lack of data no effort was made to separately compute replacement investment and inventories. Rather the assumption was made that these investments form a fixed proportion of total investment which is included in the capital-output ratios.

(I1) $ENDOG_j(t) \quad PENDOG_j * CYMR_j * ROUTD_j(t)$

where:

$ENDOG_j$ = total endogenously derived investment in the j^{th} sector - thousand Ŀ/year

$PENDOG_j$ = proportion of output privately produced in the j^{th} sector

$CYMR_j$ = marginal gross capital-output ratio in the j^{th} sector - thousand Ŀ/thousand Ŀ

$ROUTD_j$ = smoothed rate of change of output of the j^{th} sector - thousand Ŀ/year [from Equation (P1) of the production component].

Total investment in each sector excluding households is given in Equation (I2) as the sum of exogenous and endogenous investment.

(I2) $RINV_j(t) = TEXOGI_j(t) + ENDOG_j(t)$

where:

$RINV_j$ = total investment in the j^{th} sector - thousand Ŀ/year

$TEXOGI_j$ = total exogenous investment in the j^{th} sector (private and government) - thousand Ŀ/year.

These investment requirements of each sector are translated into demands for capital goods from each sector by Equation (I3). A matrix, B, of endogenously specified coefficients measures the demand for capital goods from the j^{th} sector generated by one unit of investment expenditure in the k^{th} sector. An analogous set of coefficients determines the demands for imports of capital goods.

(I3) $DIND_j(t) = \sum_k B_{j,k} * RINV_k(t)$

$RIIMP_j(t) = BIMP_j * RINV_j(t)$

where:

$DIND_j$ = the demand for domestically produced capital goods from the j^{th} sector - thousand Ⱡ/year

$B_{j,k}$ = the demand for the j^{th} good generated by one unit of investment in the k^{th} sector

$RIIMP_j$ = the demand by the j^{th} sector for imports of capital goods - thousand Ⱡ/year

$BIMP_j$ = the demand for imports of capital goods generated by one unit of investment in the k^{th} sector.

and:

$$\sum_j B_{j,k} + BIMP_k = 1.$$

Investment by households in residential construction is generated in Equation (I4). This investment is part of domestic investment demand for construction (sector 6) and is added in Equation (I5) to that generated by Equation (I3). Domestic investment demand then becomes an element of final demand.

(I4) $RESIN(t) = ARESIN * TPOP(t) * PCINCD(t)^{RESELY}$

where:

RESIN = investment in residential construction - thousand Ⱡ/year

ARESIN = empirically determined constant

TPOP = total population - thousands

PCINCD = exponentially lagged value of average per capita income - Ł/year [computed in the national accounts component by Equation (N7)]

RESELY = demand elasticity for residential construction.

(I5) $DIND_6(t) = DIND_6(t) + RESIN(t)$

where:

$DIND_6$ = investment demand for construction - thousand Ł/year.

Finally, some investment such as investment in land clearing is considered non-intermediate investment in the sense that intermediate inputs are negligible. This investment does not enter final demand but for national accounting purposes is included in total investment by Equation (I6).

(I6) $TINV(t) = \sum_j RINV_j(t) + RESIN(t) + ONIINV(t)$

where:

RINV(t) = total national gross investment - thousand Ł/year

$\sum_j RINV_j$ = investment in all production sectors - thousand Ł/year

RESIN = investment of households in construction - thousand Ł/year

ONIINV = other non-intermediate investment - thousand Ł/year (an exogenous variable of the model).

Production

Total final demand is the sum of the various demands for domestic production given by Equation (P1).

(P1) $FDY_j(t) = DCD_j(t) + DIND_j(t) + EXTD_j(t)$

where:

FDY_j = total final demand for the j^{th} commodity - thousand Ł/year

$DCD_j(t)$ = domestic consumption demand for the j^{th} commodity - thousand Ł/year [computed in the consumption component by Equation (C6)]

$DIND_j(t)$ = domestic investment demand for the j^{th} commodity - thousand Ł/year [computed in the investment component by Equation (I5)]

$EXTD_j(t)$ = export demand for the j^{th} commodity - thousand Ł/year (an exogenous variable of the model).

Given this vector of final demands, total output including intermediate demands is computed by means of the input-output table in Equation (P2).

(P2) $OUT(t) = [I - AIO]^{-1} * FDY(t)$

where:

OUT = row vector [OUT_j, j = 1, 10] of outputs of each sector - thousand Ł/year

I = the identity matrix

AIO = input-output matrix [$AIO_{j,k}$, j = 1, 10, k = 1, 10] where each element, $AIO_{j,k}$, represents the input of the j^{th} sector required in the production of one unit of the k^{th} good

FDY = column vector [FDY_k, k = 1, 10] of final demands from the k^{th} sector - thousand Ŀ/year.

Given the total output of each sector, imports for intermediate uses are computed by Equation (P3).

$$\text{(P3)} \quad RIMP_j(t) = RIMIO_j * OUT_j(t)$$

where:

$RIMP_j$ = imports required for the production of the j^{th} commodity - thousand Ŀ/year

$RIMIO_j$ = imports required for the production of one unit of the j^{th} commodity.

The inputs of domestically produced intermediate goods are calculated in Equation (P4). Value added is then given in Equation (P5) as the difference between total output and total inputs and represents the returns to the factors of production; namely, land, labor and capital. Value added also shows the contribution of each sector to gross national product in the national accounts.

$$\text{(P4)} \quad RINID_j(t) = \sum_k AIO_{j,k} * OUT_j(t)$$

where:

$RINID_j$ = total of domestically produced inputs in the j^{th} sector - thousand Ŀ/year.

(P5) $VALAD_j(t) = OUT_j(t) - (RINID_j(t) + RIMP_j(t))$

where:

$VALAD_j$ = value added in the j^{th} sector - thousand Ł/year.

Employment

Personal income of each sector is the total sum of income of the wage earners and income of the self-employed. Earnings of the self-employed are given by Equation (E1) as a proportion of total value added. This proportion is very low for the large-scale sectors where wage earnings predominate and very high for the small-scale sectors.

(E1) $SINC_j(t) = (1 - P_j)*VALAD_j(t)$

where:

$SINC_j$ = value of earnings of the self-employed in the j^{th} sector - thousand Ł/year

P_j = proportion of value added reinvested or remitted abroad in the j^{th} sector

$VALAD_j$ = value added in the j^{th} sector - thousand Ł/year [computed in the production component by Equation (P5)].

Earnings from wage employment are given by Equation (E2). Changes in wage labor productivity are accounted for in Equation (E3).

(E2) $WINC_j(t) = RLAB_j(t)*OUT_j(t)*WAGE_j(t)$

where:

$WINC_j$ = value of earning from wage employment in the j^{th} sector - thousand Ⱡ/year

$RLAB_j$ = the number of labor units of wage employment required to produce one unit of the j^{th} output [see Equation (E3)] - thousand man-years/thousand Ⱡ

OUT_j = total output of the j^{th} sector - thousand Ⱡ/year [from Equation (P1) of the production component]

$WAGE_j$ = the average wage rate in the j^{th} sector - thousand Ⱡ/man-year (determined by an exogenously fixed growth rate).

(E3) $RLAB_j(t) = (1 - DT*RPROD_j)*RLAB(t-DT)$

where:

$RLAB_j$ = as defined in Equation (E2) above

$RPROD_j$ = rate of increase in labor productivity in the j^{th} sector - percent/year.

DT = time interval of a simulation iteration.

Personal income is then the sum of wage earnings and earnings of the self-employed as in Equation (E4).

(E4) $PINC_j(t) = SINC_j(t) + WINC_j(t)$

where:

$PINC_j$ = personal income of all workers in the j^{th} sector - thousand Ⱡ/year

Personal income of the agricultural population is computed by Equation (E5). Equation (E6) sums personal income of the nonagricultural sectors and government. Government value added is exogenously determined.

(E5) $$PINCAG(t) = PINC_1(t) + PINC_2(t)$$

(E6) $$PINCNA(t) = \sum_{i=3}^{10} PINC_i(t) + GOVALD(t)$$

where:

PINCAG = personal income of the agricultural population - thousand Ł/year

PINCNA = personal income of the nonagricultural population - thousand Ł/year

GOVALD = government payments of wages and salaries - thousand Ł/year (an exogenous variable of the model).

In addition to the breakdown by agriculture and nonagriculture, personal income in nonagriculture is also divided between the self-employed and wage earners by Equation (E7). Personal income of wage earners includes wage and salary payments in both the private and public sectors.

(E7) $$PINCN_{iwemp}(t) = \sum_{j} WINC_j(t) + GOVALD(t)$$

$$PINCN_{isemp}(t) = \sum_{j=3}^{10} SINC_j(t)$$

where:

$PINCN_{isemp}$ = personal income of the nonagricultural self-employed - thousand Ł/year

$PINCN_{iwemp}$ = personal income of wage earners - thousand Ł/year

GOVALD = government payment of wages and salaries - thousand Ł/year (an exogenous variable of the model)

In order to calculate the average earnings per worker in nonagriculture the total number of self-employed persons and wage earners in the nonagricultural sector is computed. The number of wage earners is the total of wage earners in the private and public sectors given by Equation (E8). The number of self-employed is then the residual of the total nonagricultural labor force after subtracting the number of wage earners.

(E8) $$TLAB_{iwemp}(t) = \sum_j WEMP_j(t) + (GOVALD(t)*1000/GVWAGE(t))$$

$$TLAB_{isemp}(t) = TLABNA(t) - TLAB_{iwemp}(t)$$

where:

$TLAB_{iwemp}$ = total number of wage earners in nonagriculture - thousands

$TLAB_{isemp}$ = total number of self-employed in nonagriculture - thousands

$WEMP_j$ = number of wage earners in the j^{th} sector - thousands

GOVALD = as defined above in Equation (E7)

GVWAGE	=	average government wage rate - £/year (an exogenous variable of the model)
TLABNA	=	total nonagricultural labor force - thousands [see Equation (E18) below].

Average earnings per worker could be calculated using these estimates of personal income and the size of the labor force. However, this method does not allow for the price differences for agricultural and nonagricultural consumers, particularly the price of food. Since we are interested in a comparison of incomes in agriculture and nonagriculture, incomes in each sector are brought to a comparable basis. In agriculture, cash income or income available for non-food expenditure is used as an index of real income. In nonagriculture, the expenditure necessary for maintaining the average food consumption level of the agricultural population is subtracted from total cash income to give a measure of "adjusted" real income comparable to agricultural cash income. Equation (E9) calculates the expenditures per capita in nonagriculture required to consume the average agricultural caloric intake. This is then used in Equation (E10) to compute the total food expenditure required of each class of workers in nonagriculture (self-employed and wage earners).

(E9) PFCRN(t) = CALPP*APRFD(t)/CAPLB

where:

PFCRN = per capita expenditure required in nonagriculture to maintain an average caloric intake - Ł/person/year.

CALPP = calories per person consumed by the agricultural population - calories/year

APRFD = average market price of staple foods - Ł/lb (an exogenous variable of the model)

CAPLB = conversion factor - calories/lb.

(E10) $FDEXP_i(t) = TLAB_i(t) * PFCRN(t) * DRH_i$

where:

$FDEXP_i$ = food expenditure of the i^{th} class of workers - thousand Ł/year

$TLAB_i$ = as defined in Equation (E8)

DRH_i = dependency ratio for the i^{th} class of workers.

This enables the calculation of disposable real incomes of nonagricultural workers for both self-employed workers and wage earners as in Equation (E11).

(E11) $RAINCN_i(t) = (PINCN_i(t) - FDEXP_i(t))/TLAB_i(t)$

where:

$RAINCN_i$ = disposable real income of the i^{th} class of the nonagricultural workers - Ł/worker/year

$PINCN_i$ = as defined in Equation (E7)

$TLAB_i$ = as defined in Equation (E8)

A similar series of calculations gives the adjusted real incomes of the agricultural workers [Equation (E12)].

(E12) RAINCA(t) = (PINCAG(t) - POP_1(t)*CALPP*APPFD(t)/CALPB)/TLABAG(t)

where:

RAINCA	=	disposable real income per worker in agriculture - Ł/worker/year
PINCAG	=	as defined in Equation (E5)
POP_1(t)	=	total agricultural population - thousands [see Equation (E17) below]
CALPP	=	as defined in Equation (E9)
CAPLB	=	as defined by Equation (E9)
APPFD	=	average <u>producer</u> price of food staples - Ł/lb (an exogenous variable of the model)
TLABAG	=	total agricultural labor force - thousands [see Equation (E18) below].

Equation (E13) computes the _expected_ or _perceived_ nonagricultural income used in computing the rate of migration out of agriculture into nonagriculture. This expected income takes account of the probability of getting a high-paying wage job versus the alternative and lower paying self-employed occupation. A coefficient, CEDUC, may change the weighting of these two sources of income if, for example, the average migrant has a higher educational level than the general population and, therefore, a higher probability of obtaining a wage job.

(E13) $EINCN(t) = (TLAB_1(t)*RAINCN_1(t) + CEDUC*TLAB_2(t)*RAINCN_2(t))/TLABNA(t)$

where:

EINCN = expected nonagricultural income perceived by migrants - £/worker/year

$TLAB_i$ = as defined by Equation (E8)

CEDUC = weighting coefficient

TLABNA = total labor force in nonagriculture - thousands [see Equation (E18) below]

The relevant agricultural-nonagricultural income differential is computed as a ratio in Equation (E14) and exponentially lagged by Equation (E15).

(E14) $RUDIF(t) = RAINCA(t)/EINCN(t)$

where:

RUDIF = ratio of average agricultural earnings to expected nonagricultural earnings.

(E15) $RUDFGL(t) = RUDFGL(t-DT) + DT/MD*(RUDIFG(t) - RUDFGL(t))$

where:

RUDFGL = exponentially lagged value of the rate of change of the income differential - percent/year

DT = time interval of a simulation iteration - years

MD = average time delay - years

$$RUDIFG(t) = ((RUDIF(t)/RUDIF(t-DT)-1)/DT$$

The rate of migration out of agriculture is given by Equation (E16) as a function of the exponentially lagged agricultural-nonagricultural income differential and the elasticity of response of migrants to this differential. If ARUM, the elasticity of response, is set to zero, the rate of migration out of agriculture is an exogenous variable of the model.

$$\text{(E16)} \quad RUM(t) = (1 + ARUM*RUDFGL(t)*DT)*RUM(t-DT)$$

where:

RUM = rate of migration of the agricultural population to nonagriculture - percent/year

ARUM = elasticity of response of migration to the agricultural-nonagricultural income differential.

This rate of migration out of agriculture is used in Equation (E17) to compute the population in agriculture and nonagriculture.

$$\text{(E17)} \quad POP_1(t) = (1 + DT*(GPOP - RUM(t))*POP_1(t-DT)$$

$$POP_2(t) = (1 + DT*GPOP)*POP_2(t) + DT*RUM(t)*POP_1(t-DT).$$

where:

POP_1 = total agricultural population - thousands

POP_2 = total nonagricultural population - thousands

GPOP = average population growth rate - percent/year

Finally, the labor force in agriculture and nonagriculture is computed as a proportion of the population in each category by Equation (E18).

(E18) $$TLABAG(t) = PLAB*POP_1(t)$$

$$TLABNA(t) = PLAB*POP_2(t)$$

where:

TLABAG = total agricultural labor force - thousands

TLABNA = total nonagricultural labor force - thousands

PLAB = proportion of the population in the labor force.

The National Accounts

The national accounts component computes gross domestic product and the trade balance. Gross domestic product at factor cost is given in Equation (N1). Both non-intermediate investment and government value added are exogenous in the model.

(N1) $$GDPF(t) = \sum_j VALAD_j(t) + ONIINV(t) + GOVALD(t)$$

where:

GDPF = gross domestic product at factor cost - thousand Ł/year

$VALAD_j$ = value added in the j^{th} sector - thousand Ł/year [computed in the production component by Equation (P5)]

ONIINV = other non-intermediate investment - thousand Ł/year

GOVALD = value added by all governments and marketing boards - thousand £/year.

In order to estimate gross domestic product at market prices, total exports and imports must first be calculated at f.o.b. prices since values of imports in each component include import duties. Total imports at f.o.b. prices are computed by Equation (N2) by summing imports for investment, consumption and production and correcting for import duties.

$$\text{(N2)} \quad TIMP(t) = (\sum_j RIMP_j(t) + \sum_j RINIMP_j(t) + \sum_j CIMP_j(t))* (1 - DUTIMR)$$

where:

TIMP = total imports at f.o.b. prices - thousand £/year

$RIMP_j$ = imports for intermediate use in the j^{th} sector at market prices - thousand £/year [computed in the production component by Equation (P3)]

$RINIMP_j$ = imports for investment use in the j^{th} sector at market prices - thousand £/year [computed in the investment component by Equation (I3)]

$CIMP_j$ = imports of the j^{th} commodity for consumption use at market prices - thousand £/year [computed in the consumption component by Equation (C5)]

DUTIMR = average rate of import duties.

Similarly total exports are computed by Equation (N3).

(N3) $TEXTD(t) = \sum_j EXTD_j(t) + VALDMB(t) + DUTEX(t)$

where:

TEXTD = total exports at f.o.b. prices - thousand Ł/year

$EXTD_j$ = value of exports of the j^{th} commodity at producer prices - thousand Ł/year

VALDMB = value added by marketing boards - thousand Ł/year (an exogenous variable of the model)

DUTEX = duties on exports - thousand Ł/year (an exogenous variable of the model)

The trade surplus on current account is then the difference between exports and imports as in Equation (N4).

(N4) $DEFCT(t) = TEXTD(t) - TIMP(t)$

where:

DEFCT = the trade surplus on current account - thousand Ł/year

Given the trade balance, gross domestic product at market prices is given by Equation (N5). It will exceed gross domestic product at factor cost by the total of indirect taxes.

(N5) $GDPM(t) = \sum_j TCONS_j(t) + TINV(t) + DEFCT(t)$

where:

GDPM = gross domestic product at market prices - thousand Ł/year

$TCONS_j$	=	total consumption of the j^{th} commodity - thousand Ł/year [computed by Equation (C4) of the consumption component]
TINV	=	total gross investment - thousand Ł/year [computed by Equation (I6) of the investment component].

Gross domestic product is adjusted by factor payments abroad to give gross national product. Most factor payments abroad are made by the oil industry and are included as an exogenous time series.

(N6) $GNPM(t) = GDPM(t) - NFPA(t)$

where:

GNPM	=	gross national product at market prices - thousand Ł/year
NFPA	=	net factor payments abroad - thousand Ł/year.

Finally, national per capita income is obtained by dividing gross domestic product by the total population.

(N7) $PCINC(t) = GDPM(t)/(POP_1(t) + POP_2(t))$

where:

PCINC	=	national per capita income
POP_1	=	total agricultural population - thousands [computed in the employment component by Equation (E17)]
POP_2	=	total nonagricultural population - thousands [computed in the employment component by Equation (E17)].

APPENDIX B

LINKAGES OF THE MACRO-MODEL AND THE AGRICULTURAL SECTOR MODEL

In policy runs of the macro-model the agricultural sector simulation model is used to generate the effects of agricultural policies on output variables of the agricultural sector, such as export and production. If a switch in the macro-model is set, these output variables of the agricultural model are used in the main agricultural sector (sector 1) of the macro-model to replace independent estimates of these variables. These linkages are described below for the various components of the model.

Exports

In the macro-model agricultural exports are exogenous variables but equation (B1) enables exports simulated in the agricultural model to be made endogenous in the macro-model.

(B1) $EXTD_1(t) = \sum_i VALXPP_i(t)$

where:

$EXTD_1$ = total value of agricultural exports at producer prices - thousand Ł/year

$VALXPP_i$ = value of agricultural exports in the i^{th} region - thousand Ł/year (generated in the agricultural sector model)

Investment

Investment in the agricultural sector is computed in equation (B2) to replace exogenous estimates of investment in the macro-model.

$$\text{(B2)} \quad RINV_1(t) = \sum_i CAPDP_i(t) + CAPDPP(t)$$

where:

$RINV_1$ = total investment in machinery and equipment in agriculture - thousand £/year

$CAPDP_i$ = investment in agricultural production in the i^{th} region - thousand £/year (generated in the agricultural sector model)

$CAPDPP$ = investment in agricultural processing in the southern region - thousand £/year (generated in the agricultural sector model)

Consumption

In the agricultural model food staple consumption is computed as a function of price and income. Personal income of the nonagricultural population computed in the macro-model, PINCNA, is used in the demand equation of the agricultural model. Demand and supply then determine the total food consumed and the price of food. Per capita food consumption is then given in the macro-model by equation (B3).

(B3) $PCON_{1,1}(t) = \sum_i TFCAG_i(t)/POP_1(t)$

$PCON_{1,2}(t) = \sum_i TFCNA_i(t)/POP_2(t)$

where:

$PCON_{1,1}$ = per capita consumption by the agricultural population of food staples - Ł/year

$PCON_{1,2}$ = per capita consumption by the nonagricultural population of food staples - Ł/year

$TFCAG_i$ = total food consumed by the agricultural population in the i^{th} region - thousand Ł/year (generated in the agricultural sector model)

$TFCNA_i$ = total food consumed by the nonagricultural population in the i^{th} region - thousand Ł/year (generated in the agricultural sector model)

POP_1 = total agricultural population - thousands (from the employment component of the macro-model)

POP_2 = total nonagricultural population - thousands (from the employment component of the macro-model)

Employment

The agricultural sector model estimates the disposable income in each region by subtracting food purchases (if any), taxes and debt services from cash income. This is used in the macro-model as a measure of real income in agriculture as in equation (B4).

(B4) $RAINCA_i(t) = TAGDIP_i(t)/TLABA_i(t)$

where:

$RAINCA_i$ = real disposable income per worker of the agricultural population in the i^{th} region - Ł/worker/year

$TAGDIP_i$ = total disposable income of the agricultural population in the i^{th} region - thousand Ł/year (generated in the agricultural sector model)

$TLABA_i$ = total agricultural labor force in the i^{th} region - thousands.

The agricultural sector model also provides estimates of the agricultural population, $POP_1(t)$ and the nonagricultural population, $POP_2(t)$ to the employment component although the rate of migration out of agriculture, RUM, is determined endogenously in the macro-model and fed to the population component of the agricultural sector model.

Finally the agricultural sector model provides estimates of average food prices used in determining nonagricultural real incomes in the employment component of the macro-model.

APPENDIX C

MULTIPLIER EFFECTS IN A TWO SECTOR ECONOMY

This appendix gives a simple example of the computation of multiplier effects in a two sector economy consisting of agriculture (sector 1) and nonagriculture (sector 2) represented by the following equations:

$$Y_i = C_i + E_i, \; i = 1, 2$$

$$Y = Y_1 + Y_2$$

where:

Y_i = output of the i^{th} sector

C_i = consumption of the i^{th} good

Y = total output of the economy

E_i = other exogenous demands for the i^{th} good (e.g., exports, investment).

It is assumed that consumption is endogenously determined as a function of total income, Y. If there is an exogenous increase in agricultural exports, dE_1, then the following equations show the multiplier effects on the economy.

$$\frac{dY_1}{dE_1} = \frac{dC_1}{dY} \cdot \frac{dY}{dE_1} + 1$$

$$\frac{dY_2}{dE_1} = \frac{dC_2}{dY} \cdot \frac{dY}{dE_1}$$

$$\frac{dY}{dE_1} = \frac{dY_1}{dE_1} + \frac{dY_2}{dE_1} \quad .$$

Rearranging and substituting gives:

$$\frac{dY_1}{dE_1} = \frac{1-c_2}{1-c_1-c_2}$$

$$\frac{dY_2}{dE_1} = \frac{c_2}{1-c_1-c_2}$$

$$\frac{dY}{dE_1} = \frac{1}{1-c_1-c_2}$$

where:

$c_1 = \frac{dC_1}{dY}$, the marginal propensity to consume for the i^{th} good.

and:

$$c_1 + c_2 < 1.$$

That is the increase in agricultural output is less than the increase in nonagricultural output if;

$$\frac{dY_1}{dY_2} = \frac{dY_1/dE_1}{dY_2/dE_1} > 1$$

i. e. $\frac{1-c_2}{c_2} < 1$

or $c_2 > 1/2$

and $c_1 < 1/2$, since $c_1 + c_2 < 1$.

In terms of income elasticities of demand, e_i, this means that if food consumption, C_1, is about half of the total national output, Y, (as in Nigeria), the conditions for the multiplier effects of an increase in agricultural output to be highest on the nonagricultural economy are: $e_1 < 1$ and $e_2 > 1$, since $e_i = c_i Y/C_i$.

That is under the most likely assumption that the income elasticity of demand for nonagricultural goods is greater than unity, an increase in agricultural export will cause a greater increase in nonagricultural income than agricultural income. -