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INDIRECT EMPLOYMENT AND INCOME DISTRIBUTION EFFECTS OF AGRICULTURAL DEVELOPMENT STRATEGIES: A Simulation Approach Applied to Nigeria

by

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ABSTRACT

The paper proposes a simulation approach to exploring agricultural-nonagricultural interactions in general, and evaluating the indirect effects of agricultural development strategies on output, employment and income distribution in the nonagricultural sectors, in particular. The interrelationships between the agricultural and nonagricultural sectors are first reviewed within the conventional two-sector framework with attention to employment and income distribution variables. It is concluded that a generalized analysis of these interactions requires a model that explicitly considers the several types of interactions in product and factor markets, that analyses the labor market in more detail, that assumes an open economy and that disaggregates the nonagricultural sector into at least a labor intensive sector and a capital intensive sector. Simulation is proposed as a versatile approach to theoretical and applied analysis of this type of economic system.

A simulation model is developed to analyse the indirect effects of alternative food and export promotion strategies in the Nigerian economy. The core of the model is a dynamic ten-sector macro-economic model built on an input-output framework. This is linked to an employment-incomes model to provide detail on the nonagricultural labor market, migration out of agriculture, and income distribution between various groups of the population. An agricultural sector model is used to simulate variables of the agricultural sector including policy instruments. When applied to Nigeria, the model projects a favorable growth of GNP for the 1970's but increased unemployment and wider income disparities if current policies are continued. The evaluation of various agricultural development strategies indicates that a balanced strategy of food and export promotion increases value added in both small-scale and large-scale nonagricultural sectors, significantly reduces migration out of agriculture, produces the largest increase in earnings in nonagricultural small-scale sectors and results in the most equitable income distribution. Overall, the model suggests little conflict between the multiple-development objectives of growth employment and income distribution in the Nigerian economy. Finally various limitations of the model are discussed and several areas for micro-level research are proposed.

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I. INTRODUCTION

The broadening of the concept of economic development to include equity measures, such as employment and income distribution in addition to the conventional output measures, is now firmly established. This changing focus has been hastened by the advent of the Green Revolution which, although it has undoubtedly contributed to increased output in many countries, has often had an adverse effect on employment and income distribution. Subsequently a considerable body of research on agricultural development has been directed toward measuring the impact of new food grains technologies on employment and income distribution in agriculture and formulating agricultural development strategies which ensure rapid increases in agricultural production through application of labor intensive techniques on both large and small farms.[1/] Although there is clearly a need to conduct this partial equilibrium analysis in the agriculture sector, a comprehensive evaluation of agricultural development strategies requires a general equilibrium analysis of the effects of agricultural strategies on growth, employment and income distribution in all sectors of the economy; that is both the direct effects in the agricultural sector and the indirect effects in other sectors of the economy arising from agricultural-nonagricultural interactions. Although the importance of the indirect effects of agricultural development strategies is well recognized (Shaw [1971], Ridker [1971] and Kilby and Johnston [1971]) there has been little empirical analysis of these effects.[2/]

[1/] See, for example, Johnston and Cownie [1969] and Cline [1973].

[2/] Although there has been considerable speculation in India about the indirect effects of the Green Revolution on employment in nonagricultural sectors only Krishna [1973] has attempted empirical measurement in a general equilibrium framework.

The aims of this paper are twofold: first to develop a simulation approach for exploring agricultural-nonagricultural interactions in general and for measuring the indirect employment and income distribution effects of agricultural development strategies in particular, and second, through application of this approach in Nigeria, to evaluate the impact of alternative food and export crop promotion strategies on growth, employment and income distribution within a general equilibrium system. In the next section (Section II) two-sector theoretical models are shown to be deficient for analysing agriculture's role in the development process and particularly for analysis of employment and income distribution. The simulation approach is proposed as an alternative method of providing greater flexibility and realism. In Section III Nigeria's recent development is reviewed with particular attention to unemployment and income distribution. This provides the background for construction of a macro-economic simulation model of the Nigerian economy (Section IV) which explicitly recognizes agricultural-nonagricultural interactions and employment-income distribution variables. The model is then used to project trends in output, employment and income distribution in Nigeria (Section V) and to evaluate the indirect effects of alternative agricultural development strategies on these variables (Section VI). The paper concludes with a discussion of the implications of the simulation analysis for agricultural policy and for further theoretical and empirical research for general equilibrium analysis of employment and income distribution.

II. THEORETICAL ANALYSES OF THE INDIRECT EFFECTS OF AGRICULTURAL DEVELOPMENT STRATEGIES

The indirect effects of agricultural development strategies are the result of interactions of the agricultural and nonagricultural sectors in the product markets for consumer goods, investment goods and goods for intermediate use and in the factor markets for labor and capital. Early efforts at analysing these various interactions in economic development are provided by the well-known dual economy model of Fei and Ranis [1964] and its numerous derivatives. However, most of these models analyse development from a growth perspective with little attention to equity considerations. Moreover, their usefulness is decreased by restrictive or unrealistic assumptions such as institutional wage rates in agriculture and by partial consideration of the many agricultural-nonagricultural interactions.[3/]

The Mellor-Lele Model

Recently, several attempts have been made to incorporate employment and income distribution into two-sector models. Mellor and Lele [1971], in the most important of these attempts, provide a theoretical analysis of the indirect effects of an increase in agricultural output through technological change, on output and employment in the nonagricultural sector. By disaggregating the agricultural population into landlords and laborers, they are able to trace the impact of changing factor shares, and hence income distribution in agriculture, through both the product and

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[3/] For critical reviews of dual economy models, see Ruttan [1969], Reynolds [1969] and Kelley, et. al. [1972].

factor markets. They conclude that an increase in agricultural output resulting from technological change increases nonagricultural employment because of lower food prices and hence urban wages. But if there is a significant labor bias in technological change, this effect is dampened because the relatively high income elasticity of demand for food of agricultural laborers, tends to reduce agriculture's marketable surplus and increase food prices. This of course implies a tradeoff between increased agricultural employment (and reduced agricultural income disparities) and increased nonagricultural employment. However, the validity of these conclusions can be questioned for a number of reasons.[4/] In particular, the Mellor-Lele analysis neglects important agricultural-nonagricultural interactions such as (a) the backward and forward linkages of technological change, (b) the labor intensity of goods consumed by the agricultural population, and (c) interactions in the capital markets. The following consideration of these interactions suggests that a labor intensive agricultural strategy which promotes employment in agriculture <u>is</u> also most conducive to increases in nonagricultural employment.

(a) The Mellor-Lele model considers one product market--the exchange of food for nonagricultural consumer goods. However, the forward and backward linkages of agricultural production are clearly important in evaluating the indirect effects of agricultural development strategies. Agriculture's forward linkages increase nonagricultural employment through the processing and marketing of agricultural output. Moreover, these effects are

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[4/] Timmer [1971] also questions the conclusions of the Mellor-Lele model because of assumptions about the labor market and consumer demand.

dependent on increases in agricultural output rather than income and hence are independent of agriculture's terms of trade.[5/] The backward linkages of agriculture or the demand for nonagricultural inputs in agricultural production are also likely to increase nonagricultural employment. Kilby and Johnston [1971] find evidence that a labor intensive strategy of agricultural development which utilizes limited mechanization using small machines, has the greatest impact on nonagricultural employment since small machines are produced in the rural and urban small-scale sector by labor intensive techniques. Alternatively tractors required for a more capital intensive agricultural strategy are produced in the large-scale sector or imported, providing few indirect employment benefits.

(b) The effect of income distribution in agriculture on the demand for labor intensive nonagricultural consumer goods needs to be considered in evaluating the indirect employment effects of agricultural development strategies. The Mellor-Lele model assumes different food demand elasticities of agricultural laborers and landlords, but it does not analyse the impact of the distribution of income between these two classes of consumers on the demand for nonagricultural goods. Thus, if agricultural laborers consume more labor intensive consumer goods, a labor intensive agricultural strategy will tend to have the greater effect on nonagricultural employment.

[5/] Strictly speaking, the forward linkage effect depends on the marketed surplus. To the extent that this is reduced by a labor intensive strategy, nonagricultural employment will be less.

(c) Agricultural-nonagricultural interaction in the capital market is important in evaluating the indirect effects of agricultural strategies, although it is only partially treated in the Mellor-Lele model. A labor intensive agricultural strategy can provide maximum investment resources for nonagricultural sectors and hence increase nonagricultural employment.[6/] However this effect may be dampened if agricultural savings are reduced by a distribution of income to agricultural laborers with a lower savings propensity.

Further Refinement of Two-Sector Models

The Mellor-Lele model is clearly an important point of departure in analysing employment and income distribution within the framework of two-sector models. However failure to consider the above important interactions in the product and factor markets clearly could affect the conclusions regarding the macro-economic impact of labor intensive versus capital intensive agricultural development strategies. But beyond considering the full range of agricultural-nonagricultural interactions, a comprehensive analysis of the indirect employment and income distribution effects of agricultural strategies requires expansion of the conventional two-sector models in several directions.

First most theoretical models are constructed on the assumption of a closed economy. In many African countries, Nigeria in particular, agricultural exports are important for economic growth. In the situation

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[6/] In fact in the Mellor-Lele model, capital is not an input in the agricultural production function.

where export crops are distinct from food crops but compete for resources such as land and labor, an agricultural development strategy must consider the balance between food crop production and export crop production. Aside from differences in output and employment in the agricultural sector there is reason to believe that the indirect effects of export and food promotion strategies will not be the same. For example, the terms of trade effect of a food promotion strategy and the foreign exchange effect of export promotion affect nonagricultural sectors differently. In addition, the forward linkages of food production are likely to favor small-scale trading and services industries more than export crops which are sometimes produced in an "export enclave."

Second, theoretical analysis of the indirect effects of agricultural strategies must also consider the nature of the product and factor markets. Most theoretical models, including the Mellor-Lele model, only superficially represent the labor market making simplistic assumptions about urban and rural wage determination and rural-urban migration. A notable exception is the model of Harris and Todaro [1970] which portrays the rural wage rate as equal to the marginal productivity of labor in agriculture and the urban wage rate as institutionally fixed at a rate higher than that dictated by market forces.[7/] In addition, in the Harris and Todaro model rural-urban migration as determined by the expected urban income after allowing for the probability that a migrant will be unemployed. Although the model enables important policy implications to be drawn concerning the impact of urban wage and employment policies on urban unemployment, the product market is not sufficiently well developed to enable general

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[7/] Contrast this to the Fei-Ranis model where the rural wage is institutionally fixed and the urban wage competitively determined.

policy conclusions, particularly with respect to the agricultural sector. Thus investment in agriculture, either labor intensive or capital intensive, produces further out-migration from agriculture and urban unemployment since with the economy assumed closed and an inelastic price demand for food, rural incomes fall while the urban wage rate is institutionally fixed.

Third, in all two-sector models, problems invariably arise in defining the sectors. Timmer [1971] notes Mellor and Lele's apparent indecision as to whether the dichotomy is between food grains and nonfood grains or between agriculture and nonagriculture. Other distinctions such as rural-urban and modern-traditional are also common. In fact it is probably unrealistic to assume that a two-sector model will ever be useful for other than partial analysis. To analyse the effect of income distribution on the labor intensity of consumption goods requires the division of the nonagricultural sector into a capital intensive and labor intensive sector as suggested by Oshima [1971] and Reynolds [1969]. Reynolds also recommends that the government be separated out as a fourth sector to reflect the different production functions for the public and private sectors. Likewise Byerlee and Eicher [1972] suggest that a four-sector schema consisting of an agricultural sector, a rural nonagricultural sector, an urban small-scale sector and an urban large-scale sector is necessary for a realistic analysis of labor market interactions in African countries.

The above discussion illustrates the complex system of interactions influencing the indirect employment and income distribution effects of agricultural development strategies. Although various theoretical models generate valuable insights about the system of interactions, most cannot explore the total system. To do this would ideally involve recognition

of the several types of interactions in factor and product markets, more detailed treatment of the labor and capital markets, relaxation of the closed economy assumption and expansion of the analysis to include more than two sectors. However, with a large number of parameters and equations, it is cumbersome or even impossible to obtain a general mathematical solution and consequently, most models compromise by making simplistic assumptions.

The Simulation Approach

The simulation approach provides an alternative method of analysing agricultural-nonagricultural interactions. By using numerical techniques based on computer simulation, a more complex system of interactions can be explored than is possible using analytical solutions. Given a system of equations of time dependent variables the path of important "system" variables such as output and employment can be simulated over time using representative numerical values for parameters. Of course such a method does not yield the theoretical "niceties" of an analytical solution but through sensitivity testing of model parameters theoretical relationships can be established. Moreover added realism can be obtained by relaxing restrictive assumptions imposed by analytical solutions to dual economy models.

The simulation approach requires that parameters of the model be specified numerically. For theoretical analyses of agricultural-nonagricultural interactions numerical values of parameters can be of two types. First, as Reynolds [1969] proposes, parameters values can be set to represent a "typical" developing economy and sensitivity testing con-

ducted within the range of its actual value in developing countries. But as Reynolds recognises, this approach requires more information than is currently available on key parameters such as elasticities of production with respect to capital and labor, price and income elasticities of demand, saving rates, etc. Nonetheless Kelley, Williamson and Cheetham [1972] have conducted pioneering application of this method to trace the long-term growth of a two sector "Asian type" economy which is then tracked against Japan's performance.

A second approach and the one adopted in this paper is to use actual parameter values of a specific economy. This has the advantage of narrowing the range of feasible parameter values, although some generality is lost by a specific application. In this paper, the simulation approach is used to analyse agricultural-nonagricultural interactions within a multi-sectoral model applied to Nigeria. This analysis demonstrates some of the factors that are important in determining the indirect employment and income distribution effects of agricultural strategies and at the same time provides general agricultural policy guidelines for Nigeria.

III. GROWTH, EMPLOYMENT AND INCOME DISTRIBUTION IN NIGERIA: A BRIEF OVERVIEW

Before turning to a description of the simulation model applied in Nigeria it is instructive to look briefly at Nigeria's recent economic performance, emphasising in particular the nature of unemployment and income distribution. This review provides the empirical rationale for certain features of the simulation model such as the choice of agricultural development strategies and the modeling of the nonagricultural labor market.

Agriculture in the Nigerian Economy

The Nigerian economy has experienced a favorable growth rate since independence. Over the period from 1959 to 1966, the economy grew at an average real rate of about 6 percent annually including an average increase in nonagricultural value added of 8.6 percent and in agricultural value added of 3.3 percent (Federal Office of Statistics [1968]). Within the nonagricultural sectors the oil and manufacturing sectors have increased most rapidly with oil in recent years, providing an increasing share of foreign exchange earnings and government revenues.[8/]

In the agricultural sector, the primary "engine of growth" has traditionally been exports of cocoa, groundnuts, palm products and rubber, which have historically been the major source of government revenues and foreign exchange. This agricultural development strategy appears to be

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[8/] The overall growth of the Nigerian economy has been variously reviewed by Helleiner [1965], Eicher and Liedholm [1970] and Clark [1971]. At the sector level, agriculture 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] provides an excellent analysis of the industrial sectors of the Nigerian economy.

based in large part on a "vent for surplus" model of growth which holds that surplus land and labor can be used to produce export crops without reducing the output of food for subsistence purposes (Eicher [1967]). In addition, the relatively small nonagricultural population and low nonagricultural incomes place an effective demand constraint on production of food staples.

Marketing of export crops, unlike staple foods, is controlled by marketing boards which serve as a convenient means of taxation of agricultural producers. In the past this tax has amounted to 20 to 30 percent of the value of export crops although in recent years the rate of taxation has been reduced (Helleiner [1970] and Idachaba [1973]). Marketing board tax revenues are used for development purposes although only a small proportion is reinvested in agriculture for research and extension.

An important agricultural policy issue is the relative emphasis to be placed on export crop production and food crop production. In recent years and particularly since the end of the Civil Crisis there has been a more rapid increase in food prices leading to more emphasis on promotion of food crops.[9/] At the same time the dependence of the Nigerian economy on agricultural exports for foreign exchange is being relieved by the oil industry providing the flexibility to pursue other agricultural objectives such as food production.

[9/] The report of the Consortium for the Study of Nigerian Rural Development (Johnson, et. al. [1969]) recommended continued emphasis on export crops but recent state and national plans and writings of Nigerian scholars (Olayide [1972]) reflect a change in priorities to increased production of staple foods.

Employment and Unemployment

Generally there is little information on employment and unemployment in Nigeria although important recent contributions by Diejomaoh and Orimalade [1971] and Falae [1971] indicate increasing interest in these problems. The Labor Force Sample Survey conducted in 1966/67 provides the most useful data on the labor force. Over 70 percent of the labor force is in agriculture and only 5 percent of the total labor force are wage earners, mostly in the modern or large-scale nonagricultural sectors.[10/] Even in the nonagricultural sectors, the dominant source of employment is in small-scale crafts and services sectors composed of firms with less than ten employees, but in total employing 90 percent of the nonagricultural labor force.[11/] Furthermore less than 10 percent of those employed in these small-scale sectors are wage earners, the remainder being self-employed and family workers (Federal Ministry of Information [1970]).

Unemployment and underemployment in Nigeria are a "serious social problem with political as well as economic consequences" (Lewis [1967]). Open unemployment is concentrated in urban areas although there is considerable seasonal underemployment in rural areas (Norman [1973] and Mueller and Zervering [1969]). Open urban unemployment is widespread in Nigeria and averages as much as 14 percent of the urban labor force (Kilby [1969]).

[10/] Large scale sectors include only those firms with ten or more employees. This distinction has historically been the basis for organizing official statistics although it has recently been changed to a classification system based on the amount of capital investment.

[11/] These figures apply to all nonagricultural activities, some of which occur in rural areas. However, Frank [1967] estimates that even in urban areas, 75 percent of the labor force is employed in small-scale sectors. A breakdown of employment by sector and firm size is provided in Table A.1 of the Appendix.

There is also limited evidence that the rate of unemployment has increased particularly since 1960 (Weeks [1968]). Moreover these figures do not include the substantial amount of underemployment that undoubtedly exists in the urban traditional sectors such as small-scale trading and services. Kilby [1969] believes there has been declining productivity in the urban traditional sector in the last decade indicating increasing underemployment in urban areas.

The reasons for urban underemployment and unemployment in Nigeria are well documented although there is not always agreement on the relative importance of various factors. Frank [1967] shows that, for the period 1956 to 1963, nonagricultural value added grew at a real rate of 8 percent annually, compared with a growth in wage employment in the large-scale sectors of only 1.1 percent annually. In the government sector which employs about half of all wage earners in the modern sector, Frank suggests that an average wage increase of 3 percent annually over this period had a depressing effect on employment because of the limited government budget. In the private sectors, Frank estimates rates of labor productivity increase of up to 7 percent annually, although he did not attempt to relate these productivity increases to capital-labor substitution resulting from increasing wages.

While the demand for wage employment in large-scale sectors has risen slowly at a rate of 1.0 percent annually, the supply of labor in urban areas has, as a result of rural-urban migration, risen at a rate of about 6 percent annually, leaving a large residual to be filled by underemployment in the traditional urban sector and open unemployment. This implies that if employment in large scale sectors constitutes 40 percent of the urban labor force, this "residual" urban labor force is growing at about 10 percent annually.

Despite current deficiencies in our knowledge of Nigerian labor markets, it is clear that rapidly rising urban wage rates in the large-scale sectors have aggregated the urban unemployment problem both by reducing the demand for labor through capital-labor substitution and increasing the urban supply of labor through induced migration. The mechanism by which urban wage earners have achieved these wage increases in the face of rising urban unemployment is debated,[12/] but there is agreement that institutional forces introduced by trade unions and government wage tribunals are the major factor. But although institutional factors dominate wage determination in the large-scale or modern sectors there is agreement that earnings in the urban small-scale sector are competitively determined. What emerges then is a dual labor market in urban areas consisting of (a) a small proportion of the labor force employed at a fixed wage in large-scale sectors, and (b) a large proportion employed in small-scale sectors with earnings determined by supply and demand.

Given this structure of the urban labor market the reasons for <u>open</u> urban unemployment are not readily apparent since employment admittedly at low incomes is available in the urban small-scale sector. However, a complex of interrelated factors which are not well understood can in part explain this phenomena. These factors include (a) the relatively high educational level of the unemployed which increase aspirations for a job in the modern sector (Falae [1971]), (b) the fact that employment in the small-scale sector could reduce the probability of obtaining a job in the modern sector because of reduced time available for job-search

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[12/] See, for example, the debate between Kilby [1967] and Weeks [1968].

(Fields [1972]) and (c) the support commonly available for the unemployed from relatives and friends (Diejomaoh and Orimalade [1971]).

Income Distribution

As with employment and unemployment, there has been little empirical research to measure income distribution and identify relevant income disparities in Nigeria. Essang [1971] shows that policy makers perceive income distribution in terms of the rural-urban income gap. As such income distribution is related to the unemployment problem since the rural-urban income differential is primarily responsible for rural-urban migration and excess labor supply in urban areas. Most rural-urban income comparisons in Nigeria reveal a substantial and widening rural-urban income differential with rural incomes less than half of urban incomes (e.g., Weeks [1968], Kilby [1969], Lewis [1967], and Aluko [1969]. However, the usual basis of comparison is between some index of urban wage rates and a crude index of agricultural incomes such as prices received by farmers for export crops. More rigorous measures of rural incomes by the Rural Economy Research Unit [1972] in northern Nigeria show that rural incomes are about 80 percent of the government's unskilled wage rate. In addition, in comparing rural and urban incomes these studies ignore the fact that the majority of urban workers are employed in small-scale sectors.

Recently there have been some efforts to broaden the measure of income distribution from simple comparisons of rural and urban incomes. Teriba and Phillips [1971] provide evidence of significant skewness of distribution whether incomes are disaggregated on a regional, functional or personal basis. Their admittedly crude estimation of the Gini

coefficient of income distribution for the Western State is 0.47. In the agricultural sector, Essang [1971] has estimated that the corresponding Gini ratio among cocoa farmers is as high as 0.7. Finally the dual structure of the urban labor market noted above leads to significant income disparities in urban areas between those employed in large-scale sectors and small-scale sectors (Kilby [1969]).

In summary, available evidence indicates that urban unemployment and income distribution are serious problems which are now beginning to concern policy makers and researchers in Nigeria.[13/] The current conventional wisdom that these problems can be alleviated through agricultural development strategies to increase rural incomes and reduce rural-urban migration needs to be rigorously analysed. Moreover it is important to conduct this analysis within the context of current agricultural policy issues in Nigeria--particularly the relative emphasis on food crop and export crop production in an agricultural development strategy.

13/ A recent conference of the Nigerian Economic Society on the theme of the "The Nigerian Economy in the 1970's," included several papers on employment and income distribution (Falae [1971], Diejomaoh and Orimalade [1971] and Teriba and Phillips [1971]). Likewise the Nigerian Second National Development Plan places considerable emphasis on employment as an objective.

IV. THE SIMULATION MODEL

The simulation model developed below incorporates as far as possible the significant features of the Nigerian economy identified in the previous section. Nonetheless the model is purposefully broad enough that it can be applied to a variety of economies with only minor modification. The core of the model, represented in Figure 1, is a simple but dynamic macro-economic model built on an input-output framework.[14/] This is supplemented by an employment-incomes model which provides detail on the nonagricultural labor market, migration out of agriculture and income distribution. In addition the macro-economic model is linked to an agricultural sector model developed by Manetsch, et. al. [1971] to provide more detail on the agricultural sector. In isolation the macro-economic model can only provide broad macro-economic projections with limited policy relevance. But through interactions with the employment-incomes model and the agricultural sector model (Figure 1), the macro-economic model becomes a powerful medium for the evaluation of the impact of agricultural policies on output, employment and incomes in all sectors of the economy.

The Macro-Economic Model

The macro-economic model disaggregates the economy into ten sectors which can be further classified into: (a) the agricultural sectors--main agricultural crops and residual crops, (b) the small-scale nonagricultural sectors--small trade-services and small manufacturing and (c) the large-

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[14/] Other macro-economic simulation models have been constructed by Holland, et. al. [1966] for Venezuela, Enos [1970] for Thailand and Kresge [1967] for Pakistan. Only Kresge uses an input-output framework.

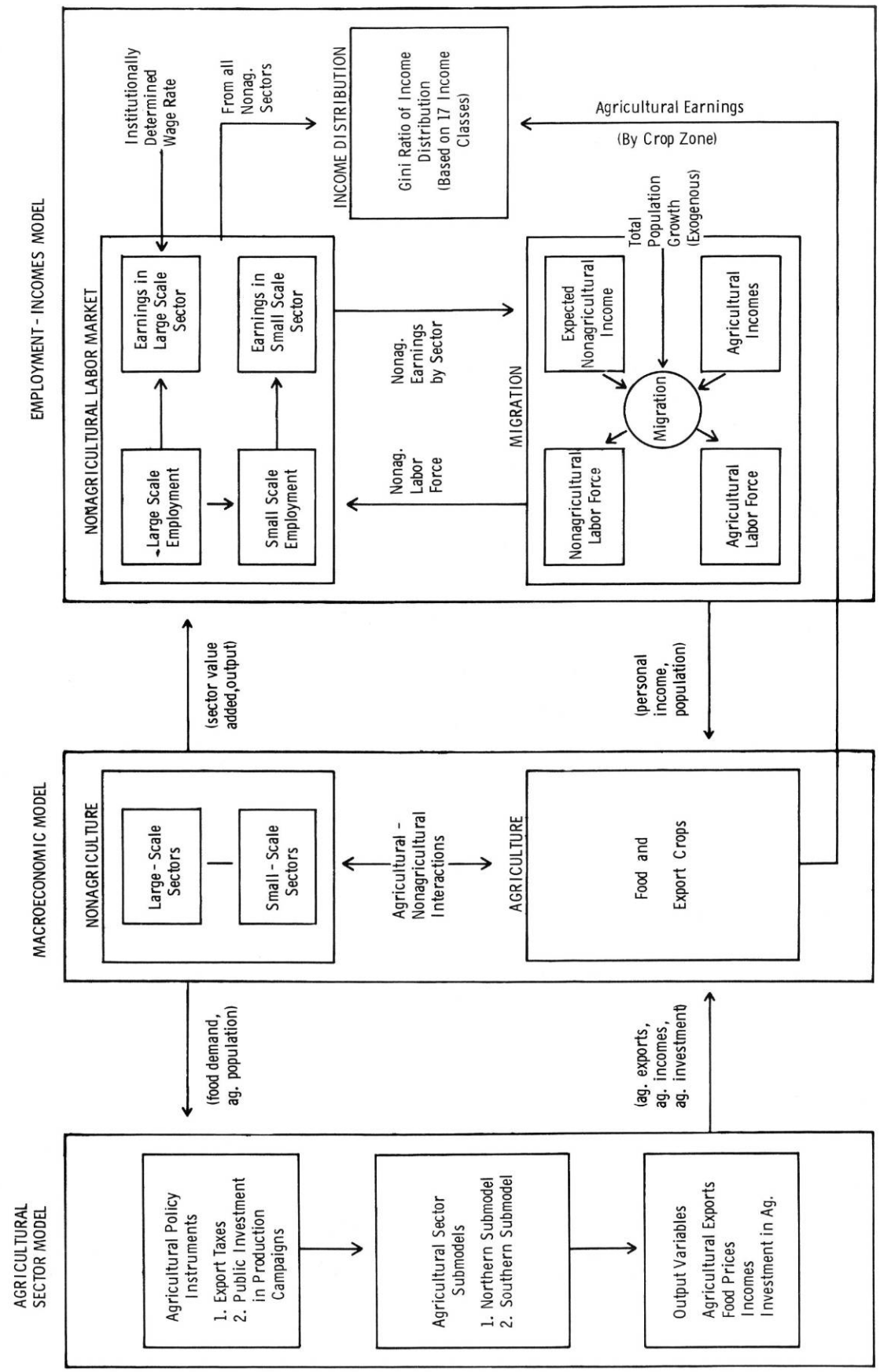

FIGURE 1. Interrelationships Between the Macro-economic Model, the Agricultural Sector Model and the Employment - Incomes Model.

scale nonagricultural sectors--mining, oil, utilities, transport, construction, large manufacturing, large trade services.[15/] The disaggregation of nonagriculture by large-scale and small-scale sectors, corresponding roughly to a breakdown into traditional labor intensive sectors and modern capital intensive sectors, is essential for analysing employment and income distribution (Oshima [1971] and Reynolds [1969]).

The details of the macro-economic model are presented elsewhere in Byerlee and Halter [1973] and a complete listing of the equations is given in the Appendix. Some of the key equations are discussed below to provide a general indication of the model's structure.

Consumption is disaggregated into ten goods corresponding to the ten sectors of the model and two population classes--agriculture and nonagriculture. Thus, $c_{ir}(t)$, the consumption of the i^{th} good by the r^{th} population class is modeled by equation (1) as a function of personal income, $y_r^d(t)$,[16/] and the price of food relative to nonfood goods, $p_f(t)$. The ideal of breaking down consumption into income classes was not possible with the data available but the disaggregation of consumer behavior by agricultural and nonagricultural populations does provide for some variation on consumer behavior by income class.

$$c_{ir}(t) = a_{ir} y_r^d(t)^{\varepsilon_{ir}} p_f(t)^{\eta_{ir}} \qquad i=1,\ldots 10,\ r=1,2 \qquad (1)$$

[15/] Small-scale sectors are composed of firms employing fewer than ten people. The sectoral breakdown is described in more detail in Table A.2 of the Appendix.

[16/] In fact, $y_r^d(t)$ is the exponentially lagged value of personal income, using the equation

$$y_r^d(t) = y_r^d(t-dt)+(dt/L)\ [y_r(t)-y_r^d(t-dt)]$$

where dt is the time interval of a simulation interation, $y_r(t)$ is the current value of personal income and L is the average length of the lag.

where ε_{ir} is the income elasticity of demand for the i^{th} good by the r^{th} population class and η_{ir} is the corresponding elasticity with respect to staple food prices.

Endogenous investment in each sector $\Delta K_j(t)$ is modeled through the use of capital-output ratios, k_j, and the accelerator principle using equation (2). Investment by the public sector and also the oil industry is exogenously determined investment, $\Delta K_j^*(t)$. These investment requirements in the j^{th} sector are then used to determine demand for capital goods, $I_i(t)$ from the i^{th} sector in equation (3).[17/]

$$\Delta K_j(t) = k_j X_j^d(t) \qquad i=1,\ldots 10 \qquad (2)$$

$$I_i(t) = \sum_{j=1}^{10} b_{ij}[\Delta K_j(t) + \Delta K_j^*(t)] \qquad i,j=1,\ldots 10 \qquad (3)$$

where $X_j^d(t)$ is the exponentially lagged value of the output of the j^{th} sector and b_{ij} is the demand for capital goods from the i^{th} sector generated by one unit of investment in the j^{th} sector.

Given investment, consumption and an exogenous specification of exports,[18/] conventional input-output techniques are used to compute output, value added, imports and other national accounting variables such as GNP. For example, the vector of outputs, $X(t)$, is given by equation (4) where I^o is the identity matrix, A is the input-output matrix and $C(t)$, $I(t)$ and $E(t)$ are vectors of consumption, capital good demands and exports respectively.

$$X(t) = [I^o - A(t)]^{-1} [C(t)+I(t)+E(t)] \qquad (4)$$

[17/] This follows the use of the 'B' matrix in input-output analysis.

[18/] In actuality agricultural exports are endogenously determined in the agricultural sector model.

The Employment-Incomes Model

The macro-economic model computes conventional national accounting variables and provides estimates of sector output and value added for use in the three sub-units of the employment-incomes model: (a) the nonagricultural labor market, (b) migration and (c) income distribution. In turn the employment-incomes model provides measure of personal income and the agricultural and nonagricultural population for use in the macro-economic model.

The Nonagricultural Labor Market. The modeling of the nonagricultural labor market follows the dual character described above (Section III). That is, it is disaggregated into (1) employment in the large-scale sector where the wage rate is institutionally fixed and (2) employment in the small-scale sectors where earnings are determined by supply and demand.

Employment, $L_i^W(t)$, in each of the large-scale nonagricultural sectors (i=5,...10) is assumed to grow at the same rate as output of that sector, $X_i(t)$, with exogenous adjustments, r_i, for productivity increases as in equation (5).[19/]

$$L_i^W(t) = l_i(t)X_i(t) \qquad i=5,...10 \qquad (5)$$

where $l_i(t)$ is the labor input per unit of output in the i^{th} large-scale sector and is defined as $l_i(t) = l_i(t-dt)\,[1-r_i dt]$. The money wage rate in each of the large-scale sectors, $\overline{W}_i(t)$, is exogenously specified in the model reflecting the dominance of institutional forces in determining

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[19/] The index i in equation (5) ranges from i=5,...10 corresponding to the six large-scale sectors of the model.

this wage rate. The wage rate in the public sector $\overline{W}_g(t)$ is also exogenously specified. Employment in this sector, $L_g^W(t)$, is determined in equation (6) by the size of the recurrent budget, $G(t)$, and inversely related to the wage rate.

$$L_g^W(t) = G(t)/\overline{W}_g(t) \tag{6}$$

The remainder of the nonagricultural labor force, $L^S(t)$, is assumed to be employed in the small-scale nonagricultural sectors (i=3,4). Average earnings in the nonagricultural small-scale sectors $W_s(t)$--designated here as "small-scale earnings"-- are computed by equation (7), from the sectoral value added, $V_i(t)$, obtained from the production component of the macroeconomic model,

$$W_s(t) = \sum_{i=3}^{4} P_i V_i(t)/L^S(t) \tag{7}$$

where P_i is the proportion of the value added of the i^{th} small-scale sector accruing to workers after reinvestment of profits, taxes, etc.

The model does not compute the rate of <u>open</u> urban unemployment because of the lack of information on the determinants of this variable (see Section III). However, the category of small-scale employment includes workers in urban areas who are unemployed or underemployed, and hence earnings in the small-scale sectors reflect unemployment and underemployment in the urban traditional sector. In fact, several authors (e.g., Turnham [1970] and the International Labor Office [1972]) suggest that low earnings in the small-scale sectors rather than open unemployment <u>per se</u> is the problem which should be addressed since it affects a larger proportion of the urban population. Of critical interest to an analysis of the employment

problem is then both the number of, and the earnings of, the nonagricultural self-employed.

Migration. The modeling of migration of the labor force out of the agricultural sector to the nonagricultural sectors is based on an extension of the Harris-Todaro [1970] model. That is, the proportion of the agricultural population who migrate in a given year, M(t), is determined in equation (8) by an exponentially lagged response, D, to changes in the expected agricultural-nonagricultural income differential, $d[W_a/E(W_n)]/[W_a/E(W_n)]$.

$$M(t) = M(t-dt)\ [1+\beta D\left(d\left[\frac{\frac{W_a}{E(W_n)}}{\frac{W_a}{E(W_n)}}\right]dt\right)] \qquad (8)$$

where W_a is the average real earnings in the agricultural sector, $E(W_n)$ the expected nonagricultural income and, β, $\beta<0$, is the elasticity of migration with respect to changes in the agricultural-nonagricultural differential--an important parameter of the model.[20/] The expected nonagricultural income, $E(W_n)$, is computed in equation (9) from the probabilities that a migrant will find a wage job in the i^{th} large-scale sector, the government sector, or alternatively be forced into lower paying small-scale employment with earnings $\overline{W}_i$, $\overline{W}_g$ and W_s respectively.[21/]

[20/] It is implicit in equation (8) that in the initial time period the rate of migration is in equilibrium with the income differential so that migration will only be affected by changes in the differential rather than the absolute magnitude of the differential.

[21/] W_s, $\overline{W}_i$ and $\overline{W}_g$ are adjusted downward by consumer price indices to reflect the higher cost of living in urban areas particularly for food.

$$E(W_n) = \frac{L^S(t)W_s(t)+H[\sum_{i=5}^{10} L_i^W(t)\overline{W}_i(t)+L_g^W(t)\overline{W}_g(t)]}{L^S(t)+\sum_{i=5}^{10} L_i^W(t)+L_g^W(t)} \qquad (9)$$

where L^S, L_i^W and L_g^W are the number employed in small-scale sectors, in the i^{th} large-scale sector, and in the government, respectively. The parameter H, H>1, is a weighting coefficient to reflect the higher probability that migrants will obtain a job in the large-scale and government sectors because of their above average education.

The natural rate of population growth in the model is exogenously fixed. However, because of migration out of agriculture the rate of population growth in agriculture and nonagriculture become endogenously determined.

The formulation of the labor market assumes that (a) there is underemployed labor in nonagriculture in the sense that changing the labor input will not affect output, and (b) small-scale earnings are influenced by labor supply and demand but wage rates in the large-scale sector are independent of market forces. That is, migration out of agriculture will increase the supply of labor in the nonagricultural labor market and decrease earnings in small-scale sectors. But because of the above assumptions, output of the nonagricultural sectors and wage rates in the large-scale sectors are not affected by labor supply.

Income Distribution. Income distribution can be measured by a variety of measures, depending on society's welfare function (Atkinson [1970]. In this paper two measures of income distribution are employed. First, a broad comparison is made between (a) average agricultural earnings in the northern and southern regions, (b) earnings in the small-scale

nonagricultural sectors [equation (7)] and (c) the institutionally determined wage rate in the large-scale sectors. As an aggregate measure of income distribution these measures, by recognizing employment in small-scale sectors, improves upon the conventional comparison of agricultural earnings and urban wage rates as a measure of rural-urban income disparities and income distribution.[22/]

Second, the model provides a more disaggregated measure of personal income distribution by a functional breakdown of income into seventeen classes in a manner similar to Thorbecke and Sengupta [1972]. These income classes are as follows:

1. Eight classes of agricultural incomes which follow from the breakdown of the agricultural sector model into eight ecological zones based on crop type.
2. Earnings in the nonagricultural small-scale sectors.
3. Wage rates in each of the six large-scale sectors and the government sector.
4. Nonlabor income in the large-scale sectors which is arbitrarily assumed to accrue to 10 percent of the nonagricultural population.

These earnings of various population groups are then converted to a personal income distribution and a Gini ratio computed following Greenwald [1963].[23/] In the calculation of personal income distribution, real per capita incomes are obtained by (a) converting incomes to 1960 price levels, (b) allowing for the larger household size of higher income wage earners,

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[22/] For a recent application of a similar procedure in Kenya, see International Labor Office [1972].

[23/] The Gini ratio, as a measure of income distribution, has some well known deficiencies such as emphasis on one moment of the distribution and its insensitivity to changes in the distribution. Nonetheless because it is widely used in international comparisons of income distribution it is employed here.

and (c) adjusting nonagricultural incomes to reflect high costs of food in urban areas.

This method of constructing personal income distribution of course assumes that each functional income group is homogenous. In fact there are likely to be substantial income disparities within some groups particularly within the agricultural subsectors and within the nonagricultural small-scale sectors. Nonetheless Thorbecke and Sengupta [1972] using a similar approach in Columbia found the overall Gini ratio relatively insensitive to intra-sectoral income disparities.

The Agricultural Sector Model

The agricultural sector model of Manetsch, et. al. [1971] is used to simulate the effects of agricultural policies on variables of the agricultural sector which are then used in the macro-economic model. The agricultural sector model consists of two relatively large sub-models--the northern sub-model and the southern sub-model. Within each sub-model there is further disaggregation by crop zones. Both sub-models compute land and labor allocation between commodities endogenously, although this is simplified by the assumption that land is surplus in the North and labor is surplus in the South. Allocation of land and labor as well as adoption of improved production techniques and new varieties are based on profitability criteria.

Two broad types of policy instruments of the agricultural model are (a) export tax policies to influence the producer prices for export crops and (b) public expenditures in production campaigns to promote improved production methods and adoption of new varieties for both food and export

crops. Variables of the agricultural sector such as agricultural exports, value added, staple food prices and input-output coefficients are computed in the agricultural sector model as a function of agricultural policy instruments and passed to the macro-economic model. In turn the macro-economic model provides the agricultural model with the demand for cash food from the nonagricultural population and migration out of agriculture (see Figure 1).

Summary

The simulation model incorporates several features which are important to the analysis of the indirect employment and income distribution effects of agricultural strategies. These include (a) a breakdown of the nonagricultural sectors into small-scale and large-scale sectors, (b) disaggregation of the nonagricultural labor market, (c) division of consumer behavior by the agricultural and nonagricultural population, (d) endogenous determination of the rate of migration out of agriculture and (e) construction of indices of income distribution. Furthermore it has the ability for dynamic interaction with an agricultural sector model to analyse most of the important interactions of the agricultural and nonagricultural sectors in the product markets and the labor market and to simulate the effects of agricultural policy.

There are of course many deficiencies of the model which are discussed in more detail in Section VII. But in interpreting the results of the model some important limitations should be kept in mind including (a) omission of agricultural-nonagricultural interactions in the capital market, (b) the static nature of input-output coefficients, capital-output ratios, etc.,

(c) the aggregate specification of the migration component and (d) the inability to account for intra-sectoral income distribution.

V. SIMULATED CHANGES IN OUTPUT, EMPLOYMENT AND INCOME DISTRIBUTION IN NIGERIA, 1966-1983

In this section the simulation model is applied to project changes in output, employment and income distribution in Nigeria under status quo policies. By comparing the projected changes in important variables in the planning horizon of interest with historical changes under similar development strategies, potential policy issues can be identified. For example the likely trends in income and employment variables is of critical interest to policy makers. At the same time the projections of output, employment and income distribution under status quo policies provides a useful benchmark for the evaluation in the next section (Section VI) of alternative agricultural development strategies.

The model was initiated in 1959, the first year for which an input-output table was available for Nigeria and variables simulated at quarter year intervals.[24/] Matching of the model's performance to real world time series data and determination of the logical consistency of the model results through sensitivity testing, were the basis for validating the model[25/]

[24/] The input-output table is based on Carter [1966].

[25/] See Byerlee and Halter [1973] for further details of the validation procedure. Extensive sensitivity testing of the model is reported in Byerlee [1971].

From 1960 to 1966 the results of the model can be compared to the actual growth of the Nigerian economy.[26] In fact as shown in Table 1 the model did reproduce accurately the main trends in the Nigerian economy for this period, including growth in GDP, imports, investment and growth of key sectors of the economy such as agriculture, manufacturing, construction and transport. Since there is little actual data on employment and income distribution variables in Nigeria for this period, the validation of the model for these variables depended largely on internal consistency checks of the model.

From 1966 to 1983 the model was used to project the future path of the economy. The year 1983 was chosen as the time horizon since any shorter period would not enable the long run effects of agricultural policies, particularly those relating to perennial crops, to be determined. At the same time a longer time horizon was not feasible given the static assumptions about coefficients of the model. In addition many exogenous variables of the model have to be estimated--particularly total population, oil exports, agricultural export prices and nonagricultural wages.[27] Oil exports were based on the extrapolation of Pearson's [1970] optimistic forecast. They remain as the single largest source of uncertainty in predicting the future path of the economy. Nonetheless it is felt that the model produces results in the right order of magnitude up to 1983.

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[26] Official statistics following 1966 are greatly influenced by the outbreak of the civil crisis and hence are not used in validating the model. Thus projections of the model do not reflect long run structural changes in the economy injected by the crisis.

[27] Basic data for the model and the sources of this data are described in Byerlee [1971]. Much of the essential macro-economic data was obtained from the Federal Office of Statistics [1968], Vielrose [1970], Carter [1966], Clarke [1971] and Frank [1967].

Table 1. Simulated Growth of the Nigerian Economy, 1960-1966, Compared to Actual Growth for That Period[a/]

	Actual Growth Rate	Simulated Growth Rate
	Average Annual Growth Rates, 1960-1966 (Percent)	
Gross Domestic Product	5.8	5.4
Total Investment	8.7	9.0
Total Imports	4.0	6.0
Value Added - Agriculture	3.7	3.6
Value Added - All Nonagriculture	8.0	7.0
Value Added - Large Manufacturing	14.0	13.6
Value Added - Construction	9.7	9.7
Value Added - Transport	5.4	4.6
Large-scale Employment	2.5	3.0
Earnings/Worker in Small-Scale Nonagriculture	<0	-.5

[a/] Source: Byerlee and Halter [1973], p. 37.

The simulated growth of conventional measures of economic development from 1966-1983 is compared with the actual growth of the economy for 1950-1965 in Table 2. Gross Domestic Product is predicted to grow at the relatively high rate of 7.5 percent annually--a significant increase over the period 1950-1965. However, agricultural value added increases only marginally faster at 3.7 percent annually, reflecting a relative stagnation in export growth of 2.4 percent compared to the earlier period (line 2.1, Table 2). Significantly, food production assumes a greater proportion of growth of the agricultural sector as nonagricultural population and incomes increase.

Nonagricultural value added increases at almost 9 percent annually. However, the rates of growth of individual nonagricultural sectors vary sharply. In particular, the large-scale sectors in aggregate grow almost twice as rapidly as the small-scale sectors and within the large-scale sectors, oil and manufacturing grow very rapidly at about 14 percent annually.

These structural shifts in the economy are also reflected in variables relating to employment and income distribution shown in Table 3 and Figure 2. Although few actual data exist for these variables, some general trends are clear. With an overall increase in the growth rate in the total labor force, the rate of growth of the agricultural labor force shows a slight increase in the period 1966-1983 despite an increase in the rate of migration out of agriculture from 1966 to 1983 (shown in Table 4). The nonagricultural labor force which grew rapidly from a very small base in 1950 is projected to grow much faster than the total labor force because of migration from agriculture. Of particular interest is the effect of the rapid growth in manufacturing, oil and government revenues which

Table 2. Simulated Growth of the Nigerian Economy, 1966-1983
Compared to Historic Growth, 1950-1966

Macro-Economic Variable[a]	Actual Growth Rate[b] 1950-1966	Simulated Growth Rate 1966-1983	Simulated Value[c] 1983	Unit
1. Value Added in Agriculture (Current Prices)	4.6	5.1	3126	₦m
2. Value Added in Agriculture (Constant Prices)	3.2	3.7	2242	₦m
2.1. Agricultural Exports	4.0	2.4	246	₦m
2.2. Food Staples	3.0	3.9	1996	₦m
3. Market Price Food Staples	1.4	2.0	.0304	₦/lb.
4. Value Added in Nonagriculture	7.0	8.7	6076	₦m
4.1. Small-Scale Sectors	n.a.	5.8	1378	₦m
4.2. Large-Scale Sectors	n.a.	10.2	4786	₦m
4.2.1. Mining-Oil	7.6	14.2	1414	₦m
4.2.2. Manufacturing	19.4	13.5	716	₦m
5. Total Consumption	4.8	6.0	6518	₦m
6. Total Investment	9.8	7.7	1834	₦m
7. Total Exports	7.5	9.7	2522	₦m
8. Total Imports	9.5	7.5	2092	₦m
9. GDP at Market Prices	5.3	7.2	9704	₦m
10. GDP Per Capita	2.8	4.3	103.4	₦

n.a. indicates not available.

[a] Unless otherwise indicated, variables are measured in constant 1960 prices.

[b] Sources: Helleiner [1965], Vielrose [1970] and Clark [1971].

[c] A Nigerian Naira (₦) is approximately equal to US$1.50.

Table 3. Simulated Growth of Employment and Incomes in Nigeria, 1966-1983 Compared to Historic Growth, 1950-1966

Variable[a]	Actual Growth Rate[b] 1950-1966	Simulated Growth Rate 1966-1983	Simulated Value 1983	Unit
1. Total Labor Force	2.0	2.7	37.90	m
1.1. Agricultural Employment	1.1	1.7	21.60	m
1.2. Nonagricultural Employment	6.0	4.3	15.40	m
1.2.1. Small-Scale	n.a.	4.0	13.50	m
1.2.2. Large-Scale	2.5	5.9	1.80	m
2. Real Earnings/Worker in Agriculture[c]	n.a.	2.0	102.80	₦/year
2.1. North	n.a.	2.0	85.40	₦/year
2.2. South	n.a.	2.0	131.80	₦/year
3. Real Earnings/Worker in Nonagriculture	n.a.	2.5	169.00	₦/year
3.1. Small-Scale	n.a.	1.7	101.20	₦/year
3.2. Large-Scale - Unskilled Wage Earners	3.0	2.8	347.60	₦/year
3.3. Large-Scale - All Wage Earners	n.a.	3.2	676.00	₦/year

n.a. indicates not available.

[a] Income variables are expressed in constant 1960 prices.

[b] Sources: Weeks [1968] and Green and Milone [1972].

[c] Workers are defined as economically active members of the population.

stimulate growth of large-scale employment to exceed the growth of the non-agricultural labor force. This contrasts to the period 1950-60 when large-scale employment stagnated and most of the increase in the nonagricultural labor force was absorbed in the urban small-scale sector.

Despite the lower growth rate of employment in the nonagricultural small-scale sectors and the higher growth rate of nonagricultural value added, Figure 2 indicates that earnings in the small-scale sectors will stagnate particularly after the "oil boom" of the early 1970's is assumed to level off. As discussed earlier this is an indication of increasing unemployment and declining productivity in the nonagricultural small-scale sectors.

In contrast to earnings in nonagricultural small-scale sectors, the earnings of agricultural workers in both the North and South--where workers are defined as economically active members of the population--show a steady upward trend, with incomes in the South being about 50 percent higher than in the North (line 2, Table 3). Incomes of wage earners in large-scale sectors are exogenously specified to grow at about the same rate between 1966 and 1983 as in the earlier period, 1950-66; that is, about 3 percent annually. In fact, it is this assumed increase in wage rates that acts as the stimulus to migration out of agriculture thereby depressing the incomes in small-scale sectors.

Finally, Table 4 shows some parameters measuring structural changes in the economy. With the oil industry providing substantial increases in government revenues and savings, investment increases from 17 percent of GNP in 1960 to 26 percent in 1983. At the same time the percentage of GNP originating in agriculture declines to 32 percent although 58 percent of the labor force is still employed in agriculture by 1983. The

Figure 2. Simulated Projections of Earnings of Agricultural and Nonagricultural Workers in Nigeria to 1983.

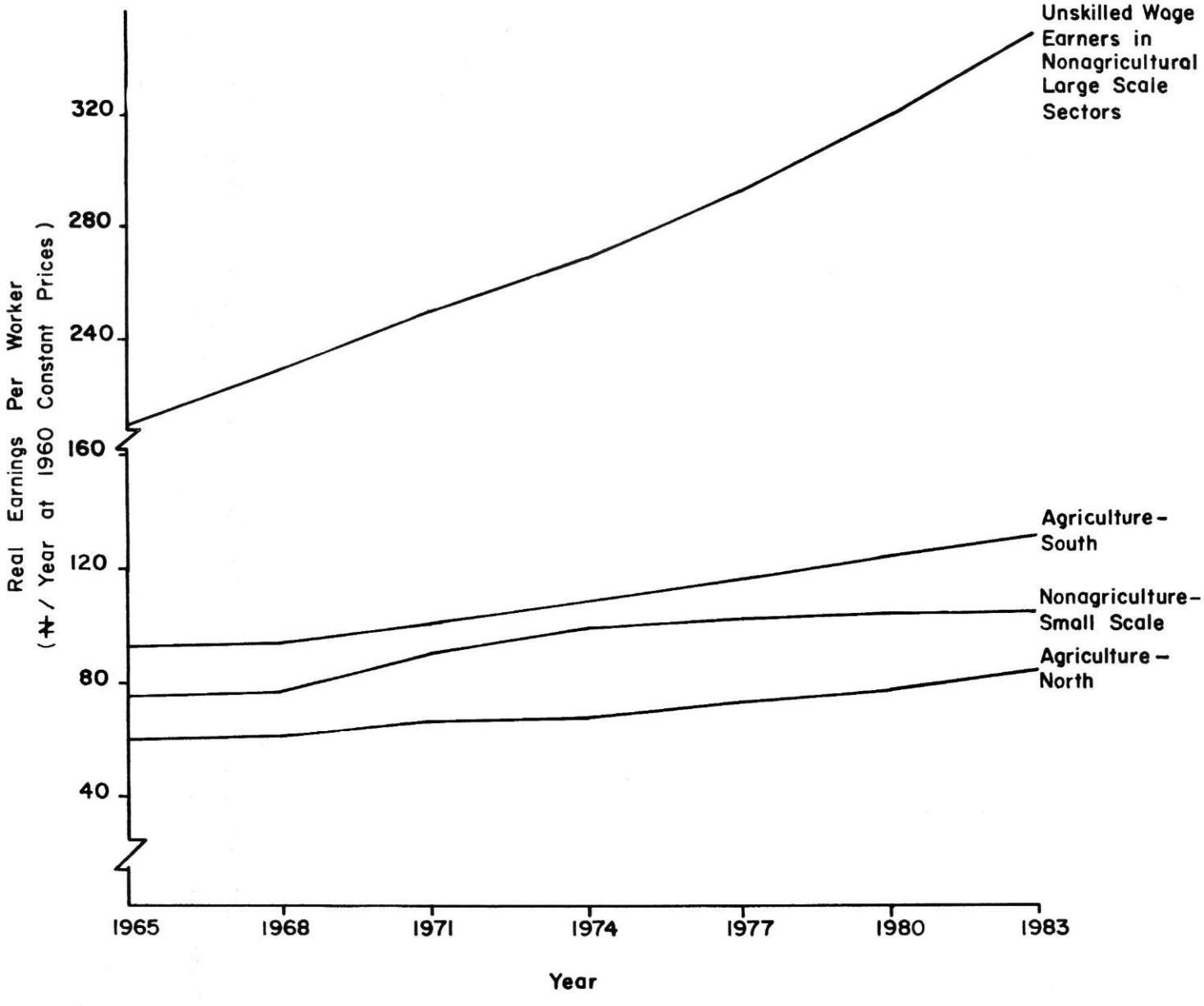

Table 4. Simulated Structural Changes in the Nigerian Economy Between 1960 and 1983

Parameter	1960	1983
1. Investment/GNP[a/]	17.00	25.90
2. Percent Agriculture in GNP[a/]	56.70	31.70
3. Percent Labor Force in Agriculture	71.00	58.20
4. Percent Out Migration of Agricultural Population/Year	.75	.99
5. Percent of Nonagricultural Employment in Large-Scale Sectors	9.00	12.00
6. Northern Agricultural Incomes as Percent of Unskilled Wage Rate[b/]	31.00	24.60
7. Southern Agricultural Incomes as Percent of Unskilled Wage Rate[b/]	46.00	38.00
8. Nonagricultural Small-Scale Earnings as Percent of Unskilled Wage Rate[b/]	45.00	29.00
9. Gini Ratio of Income Distribution[c/]	.49	.64

[a/] GNP at factor cost at 1960 prices.

[b/] Minimum wage paid by the Federal Government.

[c/] Constructed from 17 income classes detailed in Table A.3 in the Appendix.

proportion of large-scale employment in nonagricultural employment increases, but by 1983 it constitutes only 12 percent of the nonagricultural labor force. All groups of the labor force experience a decline in earnings relative to the large-scale sectors with the nonagricultural small-scale workers having the largest decline.

The Gini ratio of income distribution indicates an increasing disparity in income distribution from 1960 to 1983.[28/] Despite the crudeness of data used in the construction of the Gini ratio, these results are in accordance with the Gini ratio and trends in income distribution observed by Teriba and Phillips [1971]. The increased income disparities arise for several reasons including (a) the assumed continued rise in nonagricultural wage rates, (b) the stagnation of the incomes in the small-scale sectors, (c) the increase in the proportion of wage earners employed in high wage sectors such as government and manufacturing, and (d) increasing disparities within agriculture, particularly in the North as the middle belt region becomes a main producer of cash food.

In summary, the growth of the Nigerian economy to 1983 is greatly influenced by the oil industry. Agriculture continues to play an importantrole, particularly in employing the majority of the labor force, but food production will become a greater source of growth in the agricultural sector relative to export crops. Because of expected rapid growth of large-scale industries and the wage rate in these industries, migration out of agriculture increases and earnings in small-scale sectors stagnate indicating underemployment and declining productivity in these sectors. Furthermore the index of income distribution indicates widening disparities

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[28/] See Figure A.1 in the Appendix for Lorenz curves illustrating this change in income distribution.

in income distribution for the total economy. Given these expected trends in the economy, alternative agricultural development strategies are evaluated in the next section focusing particularly on the indirect effects of these strategies on migration, earnings in small-scale industries and income distribution.

VI. EVALUATION OF THE INDIRECT EFFECTS OF NIGERIAN AGRICULTURAL DEVELOPMENT STRATEGIES

Agricultural development strategies are generated through manipulation of the policy instruments in the agricultural sector model. The agricultural model is capable of simulating a wide range of agricultural policies. To facilitate the analysis of the indirect employment and income distribution effects of agricultural policies, two broad strategies emphasizing agricultural export promotion and food promotion respectively are considered. A third "balanced" strategy emphasizing both export and food promotion is also evaluated. Specific values of policy instruments such as export crop taxes and public expenditures on agricultural production campaigns are shown for each simulation "run" in Table 5.

Export Promotion Strategies

The removal of agricultural export taxes, Run 1, has a significant impact on the economy. As shown in Table 6, agricultural value added is almost 10 percent higher than the base run in 1983, largely as a result of a 17.7 percent rise in agricultural exports. Significantly, food prices

Table 5. Policy Instruments of Simulation Runs

Run	Total Expenditure on Agricultural Production Campaigns[a]	Expenditure on Export Crop Production Campaign[b]	Expenditure on Food Crop Production Campaign[c]	Average Taxation of Export Crops	Average Annual Rate of Growth of Nonagricultural Wages
	₦m	₦m	₦m	Percent	Percent
Base Run	--	--	--	25	3.0
Export Promotion Strategies					
Run 1	--	--	--	0	3.0
Run 2	25.0	25.0	--	0	3.0
Food Promotion Strategy					
Run 3	25.0	--	25.0	25	3.0
Balanced Strategies					
Run 4	25.0	17.0	8.0	0	3.0
Run 5	25.0	17.0	8.0	0	1.5

[a] Relative to base run. Expenditures are spread over a ten-year period beginning in 1965.

[b] The export crop promotion strategy involves the promotion of new production techniques for cotton, groundnuts, oil palm, cocoa and rubber.

[c] The food promotion strategy emphasises the introduction of higher yielding varieties of food staples (e.g., maize, sorghum) and the use of fertilizers, chemicals, etc.

fall slightly, largely because of the reduced rate of migration out of agriculture (lines 5 and 6) which increases food supply and reduces demand for food from the nonagricultural population.[29/] There is a smaller but important increase in value added in nonagriculture with the large-scale sectors, where most of the processing and marketing of export crops takes place, gaining most. The removal of export taxes results in a 2.3 percent increase in the agricultural labor force and a 3.3 percent reduction in the nonagricultural labor force. Within nonagriculture, employment in small-scale sectors is reduced by 4.0 percent, both because of a reduction in the rate of migration out of agriculture and an increase in employment in large-scale sectors.

Table 6 and Figure 3 show the effect of the reduced export taxes on earnings of various groups of the population. In agriculture, earnings per worker rise by 5.5 percent with approximately equal increases in the North and South. In nonagriculture, earnings in the small-scale sector increase by 11 percent as a result of (a) an increase in demand for the output of the small-scale sectors induced by the increase in agricultural incomes, (b) a reduction of the rate of out-migration from agriculture and (c) a fall in the price of food staples which increases real incomes.

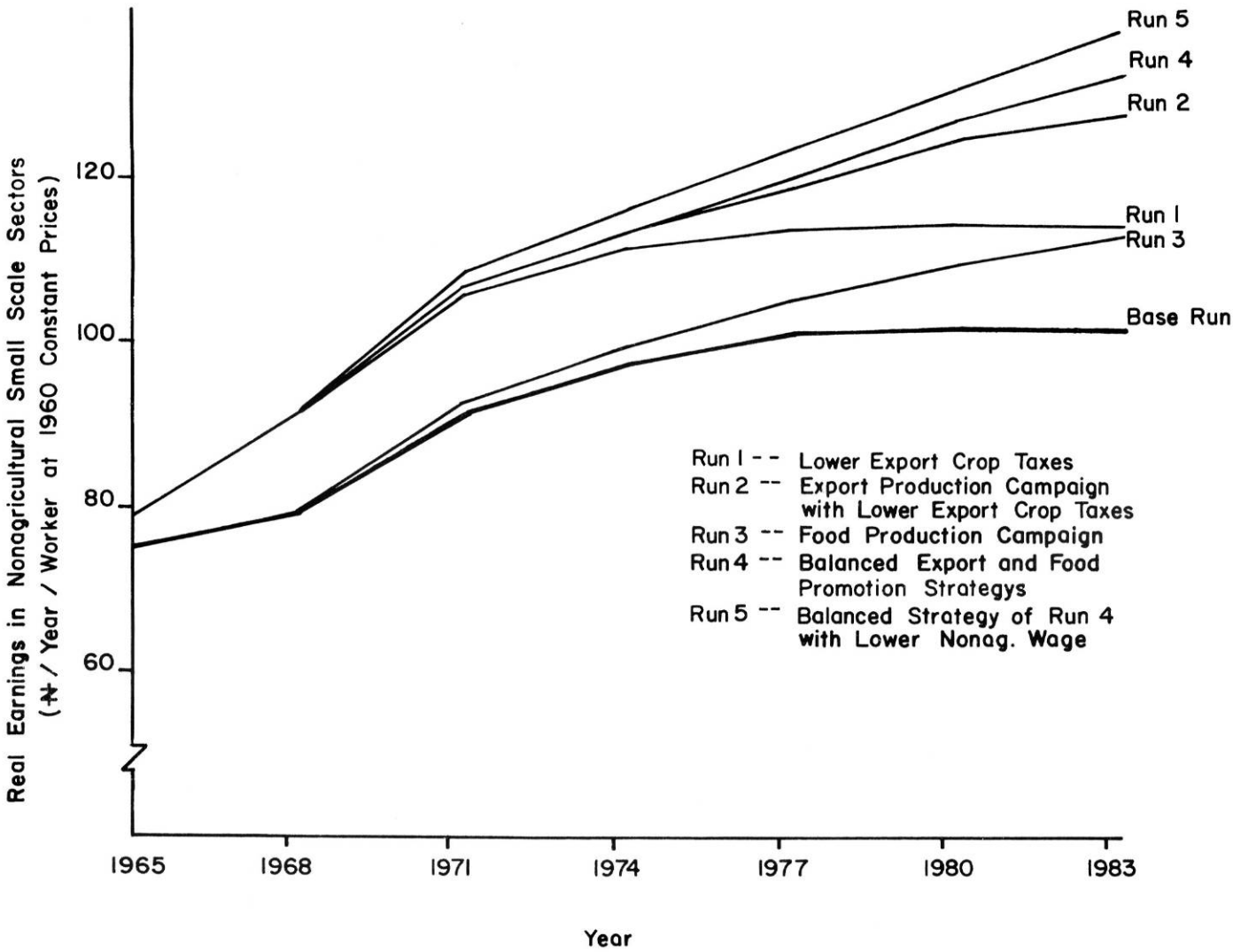
[29/] There are a number of complex factors operating here. On the supply side a rise in export prices is expected to cause substitution of export crop production for cash food production. However, in 1983 most cash food is produced in regions where export crops are not important--particularly the Middle Belt--and little substitution is likely. However, the migration component of the model is only broadly disaggregated by northern and southern regions, and not cropping regions--hence increases in export prices reduce out migration in both cash food crop and export crop regions and increase cash food supply. It is likely that if migration were further disaggregated to crop region there would be little change in food prices. On the demand side, the demand for food depends on the income elasticity for food staples of the agricultural population which is assumed to be inelastic in this run.

Table 6. Simulated Effects of Alternative Agricultural Policies on Macro-Economic Variables, Employment and Income Distribution in Nigeria

Variable[a]	Value in Base Run 1983	Unit	Run 1 Lower Export Crop Taxes	Run 2 Export Production Campaign and Lower Export Taxes	Run 3 Food Production Campaign	Run 4 Balanced Food and Export Promotion Strategy	Run 5 Balanced Strategy of Run 4 with Lower Nonag. Wage Rate
			--- Percent Deviation from Base Run ---				
Macro-Economic Variables							
1. Value Added in Agriculture	2242	₦m	9.9	34.8	6.1	37.3	36.4
1.1. Agricultural Exports	424	₦m	17.7	144.2	-.1	136.7	137.7
1.2. Food Staples	1608	₦m	2.4	5.7	8.2	10.6	10.4
2. Market Price of Staple Foods	.0304	₦/lb.	-2.0	2.6	-20.4	-9.9	-11.1
3. Value Added in Nonagriculture	6164	₦m	3.1	12.1	.5	11.5	9.7
3.1. Small-Scale Sectors	1378	₦m	1.5	7.5	1.0	7.7	6.8
3.2. Large-Scale Sectors	4786	₦m	3.6	13.0	.3	12.6	10.5
4. GDP at Market Prices	8820	₦m	4.6	17.3	1.9	17.5	16.0
Employment							
5. Migration Out of Agriculture	.575	m/yr.	-8.9	-15.9	11.7	-10.7	-15.6
6. Rate of Migration Out of Agriculture	.992	%/yr.	-11.3	-18.2	12.6	-12.9	-18.3
7. Agricultural Employment	21.6	m	2.3	2.5	-.7	2.2	3.0
8. Nonagricultural Employment	15.4	m	-3.3	-3.6	1.0	-3.1	-4.6
8.1. Large Scale	1.81	m	2.4	8.9	.1	8.4	31.5
8.2. Small Scale	13.5	m	-4.0	-5.2	1.1	-4.6	-8.7
Incomes and Income Distribution							
9. Real Earnings/Worker in Agriculture	102.8	₦/yr.	5.5	26.5	-6.8	21.8	19.2
9.1. North	85.4	₦/yr.	6.4	21.3	.6	17.8	15.9
9.2. South	131.8	₦/yr.	4.7	32.0	-14.9	26.2	23.2
10. Real Earnings/Worker in Nonagriculture	169.0	₦/yr.	8.0	17.4	7.0	20.5	16.0
10.1. Small Scale	101.2	₦/yr.	11.0	25.2	11.3	30.5	38.9
10.2. Large Scale-Unskilled Wage Earners	347.6	₦/yr.	.4	-.4	3.5	1.8	-32.1
11. Gini Ratio of Income Distribution	.64	--	-7.7	-12.7	-.5	-15.4	-20.3

[a] All income variables are expressed in constant 1960 prices unless otherwise indicated. One Nigerian Naira is approximately equal to $US 1.50.

Figure 3. Simulated Effect of Agricultural Policies on Earnings in Nonagricultural Small Scale Sectors in Nigeria, 1965 - 1983.



At the same time, the real wage rate in the large-scale sectors increases marginally because of the fall in food prices.

The Gini ratio of income distribution indicates an improvement of income distribution under the lower export taxes. This results largely from a significant increase in earnings in agriculture (5.5 percent) and nonagricultural small-scale sectors (11.0 percent) versus a minor increase in incomes of the nonagricultural wage earners (.4 percent).[30/]

When removal of export taxes is combined with an export crop production campaign (Run 2, Table 5) the effects on both macro-economic variables and employment and incomes is much more pronounced. Thus, agricultural value added increases by 34.8 percent and nonagricultural value added by 12.1 percent (Table 6). However, in contrast to Run 1, the large increase in nonagricultural incomes and hence food demand results in a rise in food prices. Again, the rate of migration out of agriculture is reduced sharply by 18 percent (Figure 4). In addition the total employment in large-scale sectors increases by almost 9 percent (Table 6, line 8). Real earnings of agricultural workers in both the North and South increase significantly although the increase is largest in the South where export crop production is more important. For similar reasons to those discussed above, (Run 1), earnings in the small-scale sectors rise by 25 percent although wage earnings in large-scale sectors decline slightly because of a rise in food prices. Thus, the Gini ratio of income distribution declines by 13 percent to .56.

[30/] Because the export taxes are reduced on all crops there is a fairly general increase in incomes in each agricultural subregion as shown in Table A.3 of the Appendix. However, the reduction of export taxes may well increase income disparities within a crop sector such as cocoa (Chong [1972]).

Food Promotion Strategy

The food production strategy, Run 3, causes a marked decline in food prices of 20 percent relative to the base run because of an assumed price inelastic demand for food staples.[31/] Nonetheless total food production increases by 8.2 percent resulting in a 6 percent increase in agricultural value added. There is only a slight increase in nonagricultural value added with the largest increase being in the small-scale sectors where most processing and marketing of food takes place. The decline in food prices causes a transfer of purchasing power from agricultural consumers to nonagricultural consumers. The small increase in value added in the large-scale nonagricultural sectors is a result of the higher income elasticity of nonagricultural consumers for goods produced in the large-scale sectors. At the same time the lower agricultural incomes (line 9, Table 6) decreases the demand for consumer goods produced in the small-scale sectors, partly offsetting the increase in value added in these sectors as a result of food marketing and processing.

The fall in agricultural incomes and the concurrent rise in real nonagricultural incomes (line 10, Table 6) causes an increase in the rate of migration out of agriculture of 12 percent (Figure 4). Almost all the additional nonagricultural labor force is absorbed in small-scale sectors since there is virtually no change in large-scale employment. Nonetheless real earnings in small-scale sectors increase significantly largely because of a drop in food prices but also because of an increase in output in the small-scale sectors. Because food is a much smaller proportion of the

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[31/] It is also implicitly assumed that production and marketing costs are too high to export food staples.

expenditure of wage earners in large-scale sectors, the real increase in earnings in large-scale sectors resulting from lower food prices is much smaller than in small-scale sectors. In agriculture, earnings increase slightly in the North where by 1983 most cash food is grown, but decrease in the South. Largely because of the increase in earnings in small-scale sectors and earnings of agricultural workers in the North, there is a minor decrease in the Gini ratio of income distribution indicating a slightly more equitable income distribution.

A Balanced Food and Export Promotion Strategy

The division of the public investment of ₦25 m between food crop and export crop production campaigns combined with lower export taxes has favorable effects on all sectors of the economy (Run 4).[32/] Value added in agriculture increases by 37 percent both as a result of higher exports and expanded food production. Combined with an 11.5 percent increase in nonagricultural value added, this strategy produces the largest increase in GDP of all runs tested by the model.

The rate of migration out of agriculture declines markedly although not as much as for the export promotion strategy alone. This is because a 10 percent drop in food prices tends to lower agricultural incomes and increase real nonagricultural incomes. Within the nonagricultural sectors, large-scale employment increases by 8.4 percent and small-scale employment decreases by 4.6 percent. All groups of the population experience

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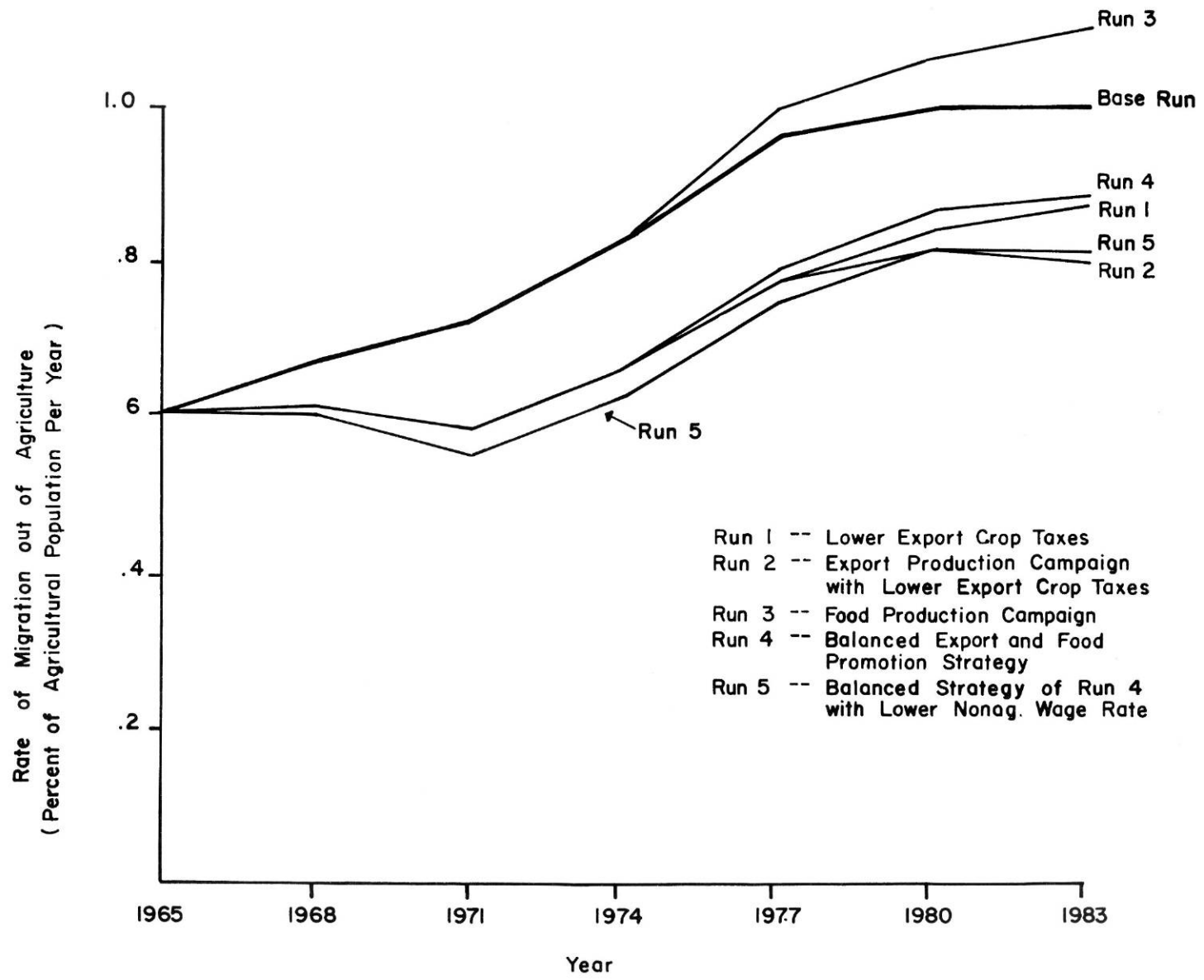
[32/] In fact, this strategy still emphasises export promotion since approximately two-thirds of the public investment is spent on export crop production campaigns and one-third on food crop campaigns. This follows the results of Manetsch, et. al. [1971] that such a strategy produces the largest increase in agricultural output given the demand constraints.

an increase in incomes with the largest increase of 30.5 percent in the nonagricultural small-scale sectors, partly as a result of the 10 percent decline in the prices of food staples. Since agricultural incomes also increase significantly, the Gini ratio indicates the most equitable distribution of income of all the runs. However, the Gini coefficient in 1983 is .54 for this run and still represents some increase in income disparities from 1960.

Finally the balanced food and export promotion strategy is repeated under the assumption that the growth of the urban wage rate is decreased to a rate comparable to the increase in agricultural incomes (i.e., 1.5 percent per year). Most macro-economic variables show a minor decline compared to the previous run, since wage income is a major source of effective demand. However, as expected, migration out of agriculture declines markedly resulting in the smallest nonagricultural labor force of all the policy runs (line 8). The higher agricultural labor force results in lower food prices and increased exports compared to Run 4. Because of the reduced wage rate in the government sector, large-scale employment increases by 31.5 percent. This combined with reduced migration and lower food prices produces a sharp increase in earnings in small-scale sectors (see Figure 4).

Real earnings in agriculture are not as high as in the previous run both because of a decline in effective demand for food and an increase in the number of people in the agricultural labor force. But because of a large reduction of 32 percent in the nonagricultural wage rates, the Gini ratio of income distribution decreases by 20 percent to .51 which is only slightly larger than in 1959. That is, an agricultural develop-

Figure 4. Simulated Effect of Agricultural Policies on Migration out of Agriculture in Nigeria, 1965 - 1983.



ment strategy combined with lower urban wages is necessary if income disparities are not to become wider in the 1970's.[33/]

Implications for Agricultural Policy

The various agricultural policies tested by the simulation model all produce significant increases in agricultural output although because of an inelastic price demand for food, a food promotion strategy alone has the least effect on output. The largest increase in agricultural value added resulted from a balanced food and export promotion strategy, suggesting that Nigeria should give relatively more emphasis to increasing food production to meet expanding population and incomes than it has in the past.

All export promotion strategies sharply increases agricultural incomes; but because of lower food prices, the food promotion strategy had a mixed effect on agricultural incomes, increasing incomes in the North slightly and significantly reducing incomes in the South.

In the nonagricultural sectors, the export promotion strategies in particular, produced large increases in value added as a result of the backward and forward linkages of agriculture, and increases in consumption and investment induced by higher agricultural incomes.[34/] The food promotion strategy produces only a minor increase in nonagricultural value added although unlike exports, this increase favors the small-scale sectors.

[33/] See Figure A.1 in the Appendix.

[34/] Byerlee and Halter [1973] show that within the present input-output structure of the Nigerian economy the backward and forward linkages of agriculture are relatively insignificant and most increases of nonagricultural value added are the result of induced consumption and investment.

In all the agricultural strategies, the earnings in nonagricultural small-scale sectors increased significantly. The importance of this result in indicating less unemployment and underemployment in nonagriculture has been discussed earlier. Significant too is the fact that the balanced strategy of food and export promotion which produces the largest increase in GDP also produces the largest increase in earnings in small-scale sectors. Furthermore any agricultural policy which reduces food prices, has a large effect on small-scale earnings since food expenditures are a major proportion of consumer expenditures of this group. In this sense there is a trade-off in incomes of agricultural workers who are adversely affected by lower food prices and workers in the nonagricultural small-scale sector who constitute the urban poor.

All strategies excluding food promotion alone, result in reduced out migration from agriculture with the largest reduction in the case of a food and export promotion strategy combined with lower nonagricultural wages. However, even in this case the nonagricultural labor force is only reduced by 3.0 percent by 1983 compared to the base run. This can be explained by the fact that increases in agricultural incomes which tend to reduce out-migration from agriculture are in fact counterbalanced by increases in nonagricultural incomes resulting from the indirect effects of agricultural policies. In fact, if reducing out migration from agriculture is to be an overriding goal of policy makers, the most effective means for accomplishing it, is through shifting the terms of trade in favor of agriculture thereby concurrently increasing agricultural incomes and reducing real nonagricultural incomes. However, because food consumption constitutes a much higher proportion of the incomes in small-scale sectors compared to large-scale sectors, most of the reduction in real

nonagricultural incomes with higher food prices is born by the lower income nonagricultural workers in small-scale sectors, thereby widening the income disparities in nonagriculture. Presumably, a more important concern of policy makers than reducing migration per se is unemployment and underemployment in the small-scale sectors which in the present model is best alleviated by the balanced food and export promotion policy because of several factors such as reduced food prices and increased demand for output of the small-scale sector, in addition to reduced out-migration from agriculture.

All policy runs of the model showed a reduction in income disparities as measured by the Gini ratio. Again, the balanced food and export promotion strategy provided the largest reduction in income disparities compared to the base run. Finally it is significant that the food and export promotion strategy combined with lower urban wages, produces the largest reduction in migration out of agriculture and the greatest increase in earnings in small-scale sectors and was the only strategy not to register wider income disparities between 1960 and 1983 as measured by the Gini ratio. This suggests that successful approaches to employment and income distribution problems will require a balance of agricultural and nonagricultural policies.

In summary, the results of the simulation analysis indicate that more emphasis should be given to food production than in the past through a balanced strategy of food crop and export crop production. At present, effective demand limits a full scale shift in priorities to food production. A balanced food and export promotion strategy not only produces the largest increase in GDP, but also the largest increase in earnings in nonagricultural small-scale sectors and the most equal distribution

of income. These results suggest that the multiple developmental objectives of output, income distribution and employment are complementary within the current Nigerian economic structure, although we would want more concrete theory and empirical information to substantiate and generalize from this conclusion.

VII. MODEL LIMITATIONS AND RESEARCH IMPLICATIONS

The results of the simulation analysis can only be regarded as preliminary policy guidelines pending further improvements in the structure and the empirical base of the model. However the model in attempting to analyse a variety of macro-economic relationships affecting employment and income distribution has an important role in identifying gaps in our theoretical apparatus and empirical knowledge. In this way, the model provides a convenient framework for focusing and organizing future research efforts to analyse the indirect impacts of agricultural policies on employment and income distribution. More specifically the major limitations in our previous analysis concern (a) sectoral disaggregation, (b) the labor markets, (c) interactions in the capital market, (d) income distribution and (e) long run structural changes in the economy. These limitations are examined to determine to what extent they affect the results of the simulation analysis and to indicate directions for further research.

Sectoral Disaggregation

The industrial division of the macro-economic into small-scale and large-scale sectors, based on number of employees, has acted as proxy for labor intensive and capital intensive sectors and for disaggregating the nonagricultural labor market into an organized market with an institutionally determined wage, and a competitive market. However, in assembling data on small-scale sectors, it was readily apparent that there is very little information in Nigeria on input-output relationships, production and employment in these sectors, even though they employ about a fourth of the total labor force. An extension of the regular surveys of large-scale industries to cover small-scale industries would do much to alleviate this data gap.[35/] This could also provide a method for defining the small-scale/large-scale division on the basis of more meaningful criteria such as capital/labor ratios.

A logical extension of our breakdown of nonagriculture into large-scale and small-scale sectors is a further subdivision of the small-scale sectors by rural and urban location.[36/] This is important for two reasons. First, the supply and demand configuration for these industries in rural and urban areas differ. In rural areas, nonfarm activities depend upon seasonal supplies of labor (Norman [1972]) and entrepreneurs have substantially different educational and occupational backgrounds (Liedholm [1973]. Furthermore the demand for the output of rural industries and

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35/ The Industrial Research Unit of the University of Ife, Nigeria has recently completed a survey of small-scale industries which provides some much needed data on the extent, size and type of small-scale activity. See Aluko [1973].

36/ All agricultural activities take place in rural areas and most large-scale nonagricultural industries are located in urban areas. Only small-scale industries are important in both rural and urban areas.

services is related to agricultural incomes and production which also vary seasonally. Second, there is a growing concern with urban unemployment, rural-urban migration and rates of urbanization (e.g., Green and Milone [1972]). These problems cannot be analysed by the agricultural-nonagricultural dichotomy of the present model.

A rural-urban division of the macro-economic model could have important implications for the results of the simulation exercise. For example, the model only considers migration from agriculture to nonagriculture. If agricultural policies have a stronger effect or rural nonagricultural activities compared to the urban economy, there may be a more pronounced reduction in rural-urban migration and urban unemployment than predicted by the model. This disaggregation of the economy by scale of operation and by rural-urban location could be accomplished by a reorientation of national accounting systems which are presently rooted to a traditional industrial classification.[37/]

The Labor Market

There are several deficiencies in the representation of labor markets in the simulation model. First an understanding of the long-term determinants of wages in the large-scale nonagricultural sectors is essential in analysing employment. It has been assumed that institutional factors such as government wage tribunals will continue to cause the wage rate to increase regardless of supply and demand factors. But in the long run, we would expect economic factors to have some effect on wage

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[37/] Since there is now a clear need for updating the input/output table of the Nigerian economy, these considerations could be readily combined with the construction of a new input-output table.

rates. This is particularly important for agricultural strategies which result in rapid increases in production of food staples. The resulting shift in the terms of trade against agriculture and increased out-migration from agriculture may lower nonagricultural wage rates and increase output and employment in the nonagricultural sectors through the "invisible" transfer of savings from agriculture (Lee [1971]). Furthermore if, as expected, wage rates are downwardly more flexible in small-scale sectors compared to large-scale sectors, such a strategy could impart a comparative cost advantage to products from small-scale sectors versus large-scale sectors further stimulating nonagricultural employment.[38/]

Second, the elasticity of employment with respect to wages is an important parameter affecting the nonagricultural demand for labor. In Africa, and Nigeria in particular, there have been a few studies (Harris and Todaro [1969], Roemer [1970] and Frank [1967]) addressing this issue in specific industries but no general analysis of capital-labor substitution possibilities in both small and large-scale sectors and in government. In addition, in the long run, changes in wage rates and factor prices may also affect the direction of technological change and possibly the development of labor using technology. The present model by incorporating wages and productivity changes in the large-scale sectors exogenously underestimates the contribution of food production strategies to nonagricultural employment.[39/]

[38/] The present model does account for more flexible wages in small-scale sectors but because prices of nonagricultural goods are fixed this effect is not analysed.

[39/] It should also be noted that the agricultural sector model does not relate capital-labor substitution to factor prices in agriculture. This could have significant implications for the direct effects and ultimately the indirect effects of agricultural policies, if for example the use of mechanical technologies are an integral part of an agricultural production campaign.

Finally rural-urban migration is an important interaction between agriculture and nonagriculture. In a country the size and diversity of Nigeria there is a need to go beyond the simplistic representation in the present model to disaggregate migration by several different regions and even crop zones. Furthermore, there is almost no available empirical estimates of the elasticity of migration with respect to the rural-urban income differential even though this is a critical parameter in evaluating the effect of agricultural policies on migration (Byerlee [1971]).

Interactions in the Capital Market

The simulation model is particularly deficient in modeling agricultural-nonagricultural interactions in the capital market. This may affect the results in several ways. First increases in agricultural incomes could provide savings for investment in nonagriculture. Second, no account is made of the opportunity cost in nonagricultural sectors of public and private investments in agricultural production campaigns. Third the loss of marketing board revenues with lower export taxes may reduce the investible surplus for nonagriculture. Finally changes in agriculture's terms of trade affect nonagricultural wages, particularly in the small-scale sectors, and hence profits. The net effect of these interactions for a given agricultural policy depends upon the savings propensity of various groups of the population and the returns to investment (private and public) in nonagricultural sectors--parameters for which there is little empirical information. The growing recognition of the importance of capital as an input into agricultural production and of agricultural-nonagricultural capital transfers, suggest that research be directed toward incorporating interactions in the capital market in both theoretical and applied models.

Income Distribution

The simulation model analyses income distribution by comparing earnings of various groups of the population and also by constructing a Gini ratio of income distribution between seventeen different groups in the population. Together these approaches provide insights into the effects of agricultural policies on income distribution and are a significant improvement on earlier crude comparisons of rural incomes and urban wages. However, the earnings in the small-scale sectors were one of the largest groups that could not be further disaggregated. A rural-urban breakdown of the small-scale sectors proposed earlier would partly alleviate this problem. In addition, it would be useful to account for changes in intra-sectoral income distribution, particularly in agriculture where the largest intra-sectoral income disparities are likely to exist.[40/] Thus the reduction in income disparities with the removal of export taxes predicted by the model could be dampened if such a policy aggravates income distribution within agriculture.

Finally the simulation model only rudimentarily incorporates important "feedbacks" from income distribution to other economic variables. First as Mellor and Lele [1972] show, consumption of labor intensive goods is a function of income distribution, with lower income households consuming more labor intensive goods. Second, savings propensities may also vary with income distribution. Third, rural-urban migration is likely to depend not only on average rural incomes but also income distribution in rural areas. If, for example, migrants originate in low income households, but

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[40/] Other factors affecting income distribution should also be considered including the distribution of public services and cultural factors such as urban-rural remittances of incomes and the support of relatives and friends by those who have secure jobs.

agricultural policies such as export promotion primarily benefit larger farmers, the reduction in migration out of agriculture predicted by the model may be severly dampened. Again, incorporation of these effects is dependent on micro-level research to estimate consumption elasticities, savings propensities and migration elasticities.

Long Run Structural Changes in the Economy

A final caveat with respect to the simulation model concerns its ability to simulate long run structural changes in the economy. In particular, the structural rigidities imposed by static input-output coefficients, import coefficients and capital-output ratios limit the time horizon for which the model can be confidently used to make projections. Moreover, some of the agricultural policies involving agricultural production campaigns require a longer time horizon than used in the analysis to allow the economy to reach a new equilibrium growth path. Finally the model is not able to incorporate dynamic processes of growth involving substitution between imports and domestic production and between small-scale and large-scale sectors. These substitution effects are influenced by changes in factor and product prices and therefore related to agricultural development strategies.

VIII. CONCLUSIONS

The Indirect Effects of Agricultural Strategies

In a developing economy such as Nigeria's, where agriculture contributes a large proportion of GNP and foreign exchange, agricultural development strategies have substantial indirect effects on other sectors of the economy which need to be considered in any evaluation of alternative strategies. Increases in agricultural incomes induce increases in nonagricultural value added through increased demand for nonagricultural goods by the agricultural population. Because a food production strategy turns the terms of trade against agriculture, this indirect "income effect" is greater for export crop production than food crop production. Nonagricultural value added may also be stimulated by backward and forward linkages of increases in agricultural output. The forward linkages such as processing and marketing of agricultural output, produce a significant effect on nonagricultural value added, with the largest effect in the small-scale sectors in the case of a food promotion strategy. However, the backward linkages of agricultural development strategies are minor because there is little use of nonagricultural inputs such as fertilizer in Nigerian agriculture.

The focus of this paper, however, has been on the indirect effects of agricultural development strategies on employment and income distribution in nonagriculture. The indirect effects of agricultural policies on real earnings in the small-scale sectors--a critical variable in measuring unemployment and income distribution--depend upon on a number of factors including the relative effects on (a) output of small-scale and large-scale sectors, (b) the number employed in small-scale sectors and

(c) changes in the price of food staples. Furthermore, these factors are interrelated since the number employed in small-scale sectors depends on (a) the number employed in, and hence the output of, large-scale sectors and (b) the rate of migration out of agriculture, while food prices are related to income, which determine demand for food, and migration which influences both demand and supply. The simulation analysis of this complex of factors in the Nigerian economy indicates that a balanced food and export promotion strategy has the most favorable indirect effects on employment and earnings in the small-scale sectors since it stimulates output of small-scale sectors while at the same time reducing migration out of agriculture and lowering food prices. A balanced food and export promotion strategy was also shown to have strong indirect effects on nonagricultural value added suggesting that tradeoffs between developmental objectives of output and equity are not important within the current structure of the Nigerian economy. Of course, this conclusion must be accepted with caution given the imperfect measures of equity used in the analysis, and the limitations of the model. Thus in the long run, the model probably underestimates the indirect effects of a food promotion strategy because of failure to incorporate important interactions in the capital market.

The Simulation Approach

The simulation approach has the advantage of flexibility in exploring a number of dynamic relationships between sectors. The simulation model developed here is based on a dynamic multi-sectoral model built on an input-output framework. Despite the limitations of this model it has the advantage of being relatively simple, but at the same time providing insights

that cannot be obtained in a static input-output analysis. Furthermore the linkage of the macro-economic model with an agricultural sector model and an employment-incomes model provides a degree of disaggregation and policy relevance not usually associated with input-output type models.

The simulation approach used in this paper is better suited to relatively short run analysis of agricultural-nonagricultural interactions in a particular country. With further theoretical refinements to include nonagricultural production functions, technological change, etc. a longer run view of the development process would be possible. As more data is obtained from several countries we can conceive of progressively moving to a more general and longer run simulation model to provide a theoretical tool for the analysis of the development process in Tropical Africa.[41/]

Integrating Micro-Level Research and Macro-Economic Policy Analysis

Consideration of important limitations in the simulation analysis leads to a research agenda that emphasises micro-level research to measure income elasticities, capital-labor substitution, the elasticity of migration with respect to rural-urban income differences, etc., and to disaggregate the small-scale nonagricultural sector by rural and urban location. All of these research areas are suggested by current deficiencies in the ability of the simulation model to analyse employment and income distribution. In Nigeria, if micro-level research to measure various parameters and improve the model's structure is forthcoming (as, for example, through the African Rural Employment Network), the macro-economic

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[41/] This, of course, is what Reynolds [1969] envisages in this advocation of the simulation approach.

policy analysis could be updated and refined. This process can be viewed as iterative, as the updated simulation model is likely to suggest new areas for micro-level research. However, the advantage of proceeding from the macro-level to the micro-level by first building an aggregate model is in forcing the micro-level research to be relevant to the policy questions at hand. The present model is a beginning toward policy relevant research in the important areas of employment and income distribution.

APPENDIX

EQUATIONS OF THE MACRO-ECONOMIC MODEL

Consumption
Investment
Output
National Accounts
Endogenous Variables
Exogenous Variables
Exogenous Variables but Endogenous in Other Components
Model Parameters
Other Variables

TABLES

A.1. Estimated Employment by Sector and Firm Size in Nigeria, 1970

A.2. The Sector Breakdown in the Macro-Economic Model

A.3. Real Per Capita Personal Incomes of 17 Sectorally Defined Population Groups Under Alternative Agricultural Policies in Nigeria

FIGURE

A.1. Lorenz Curves of Income Distribution for Balanced Agricultural Strategy Compared to Base Run

EQUATIONS OF THE MACRO-ECONOMIC MODEL

Consumption

$$c_{ir}(t) = a_{ir} y_r^d(t)^{\varepsilon_{ir}} p_f(t)^{\eta_{ir}}$$

$$C_i(t) = \sum_{r=1}^{2} N_r(t) c_{ir}(t)$$

$$M_i^c(t) = m_i^c(t) C_i(t)$$

Investment

$$\Delta K_j(t) = k_j X_j^d(t)$$

$$I_i(t) = \sum_{j=1}^{10} b_{ij}[\Delta K_j(t) + \Delta K_j^*(t)] \qquad i=1,\ldots 10,\ i \neq 7$$

$$I_7(t) = \sum_{j=1}^{10} b_{7j}[\Delta K_j(t) + \Delta K_j^*(t)] + \sum_{r=1}^{2} a_r^h N_r(t) y_r^d(t)^{\varepsilon_r^h}$$

$$M_i^I(t) = m_i^I(t) I_i(t)$$

Output

$$X(t) = [I^o - A(t)]^{-1} [C(t) + I(t) + E(t)]$$

$$M_i^N(t) = m_i^N(t) X_i(t)$$

$$V_i(t) = X_i(t) - \sum_{j=1}^{10} a_{ij} X_i(t) - M_i^N(t)$$

National Accounts

$$GDP(t) = \sum_{i=1}^{10} V_i(t)+G(t)$$

$$M^T(t) = \sum_{i=1}^{10} [M_i^C(t)+M_i^I(t)+M_i^N(t)]$$

$$B = E^T(t)-M^T(t)$$

Endogenous Variables

c_{ir} = per capita consumption of i^{th} good by r^{th} population

C_i = total consumption of i^{th} good

M_i^c = imports of i^{th} consumer goods

ΔK_j = endogenously determined investment in j^{th} sector

I_i = demand for i^{th} capital goods

I_7 = demand for construction

M_i^I = imports of i^{th} capital goods

X_i = total output in i^{th} sector

X_j^d = exponentially lagged value of j^{th} output, X_j

m_i^N = imports of i^{th} intermediate goods

V_i = value added in i^{th} sector

GDP = gross domestic product at factor cost

M^T = total imports

B = trade balance

C = vector of domestic demands for consumption goods

I = vector of domestic demands for capital goods

X = vector of sector outputs

Exogenous Variables

ΔK_j^* = public investment in j^{th} sector

E = vector of exports $[E_1, E_2 \ldots E_{10}]$, where E_1 is endogenous (see below)

E^T = total exports

G = government value added

Exogenous Variables but Endogenous in Other Components

y_1^d = per capita personal income in agriculture (computed in the agricultural sector model)

y_2^d = per capita personal income in nonagriculture (computed in the employment-incomes model)

N_r = r^{th} population (computed in the employment-income model)

P_f = price of food staples (computed in the agricultural sector model)

E_1 = agricultural exports (computed in the agricultural sector model)

Model Parameters

ε_{ir} = income elasticity of demand of i^{th} good and r^{th} population

η_{ir} = demand elasticity with respect to food prices for i^{th} good and r^{th} population

k_j = incremental capital-output ratio in j^{th} sector

ε_r^h = income elasticity for residential construction for r^{th} population

m_i^c = proportion of i^{th} consumer goods imported

m_i^I = proportion of i^{th} capital goods imported

m_i^N = imports of intermediate goods to produce one unit i^{th} output

b_{ij} = demand for i^{th} capital goods generated by one unit of investment in j^{th} sector

A = matrix of input-output coefficients, a_{ij}

Other Variables

a_{ir} and a_r^h are constants

I^o is the identity matrix

i and j are indices for sectors where i, j=1,...10 as in Table A.2

r is an index for population class where r=1 represents the agricultural population and r=2 represents the nonagricultural population

Table A.1. Estimated Employment by Sector and Firm Size in Nigeria, 1970

Sector	Total employed (millions)	Employed in large firms[a] (millions)	Employed in small firms[b] (millions)	Percent employed in large firms
Agriculture	16.790	.070	16.720	.4
Mining	.055	.055	.000	100.0
Manufacturing and 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 ten or more 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.

Table A.2. The Sector Breakdown in the Macro-economic Model

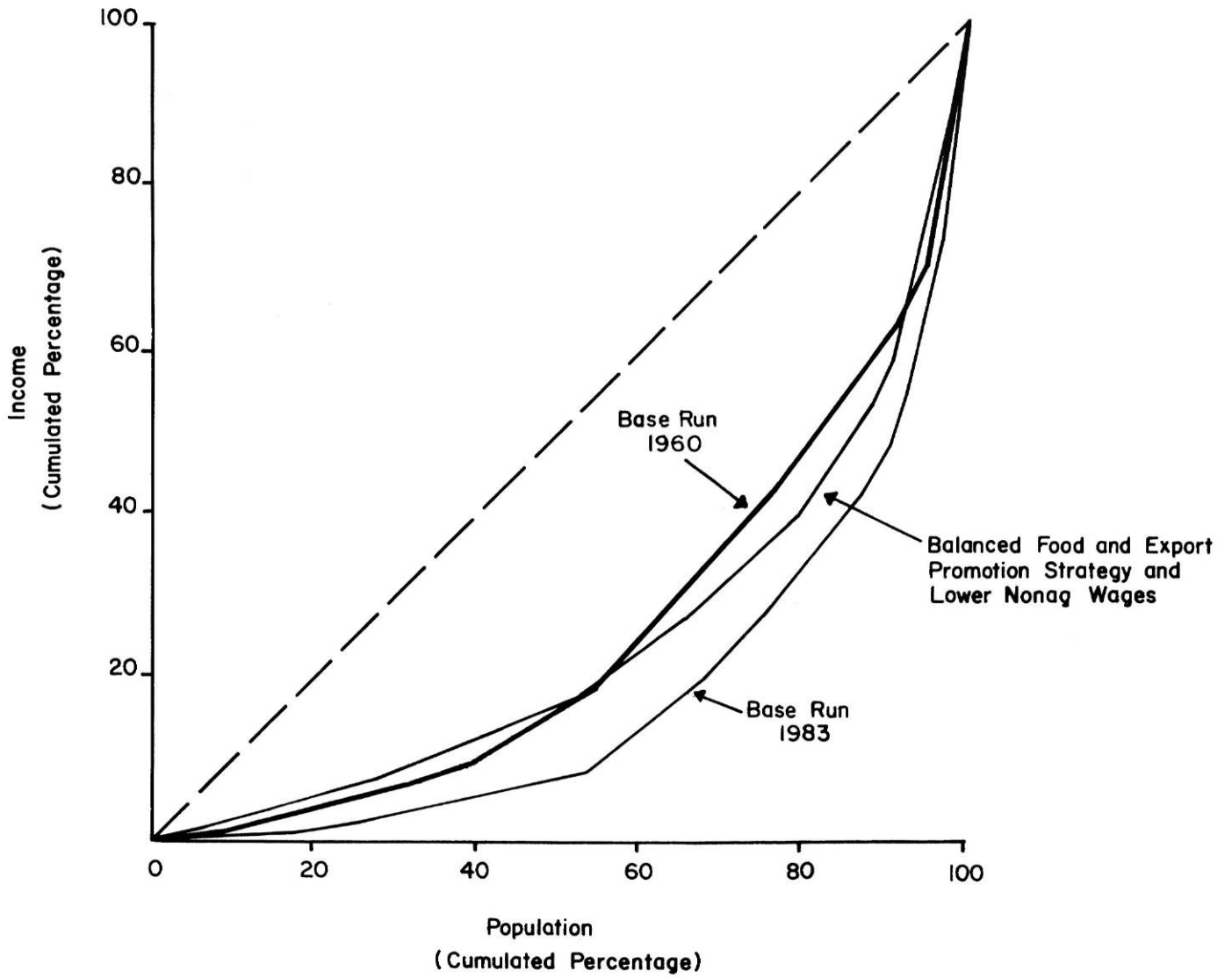
Sector	Name	Composition of Sector
1	Agriculture	Main export crops (i.e., groundnuts, cotton, cocoa, rubber and palm), food staples, and cattle
2	Residual Agriculture	Residual crops, residual livestock, fisheries and forestry
2	Small Manufacturing	Carpentry, weaving, shoe making, tailoring and other crafts
4	Small Trade Services	Trading and services excluding large commercial firms
5	Mining-Oil	Metal and nonmetal mining and petroleum
6	Construction	Residential housing, private and public construction projects
7	Transport	Rail, boat, road and 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.

Table A.3. Real Per Capita Personal Incomes of 17 Sectorally Defined Population Groups Under Alternative Agricultural Policies in Nigeria

Sector	Base Run 1960	Base Run 1983	Run 1 Lower Export Crop Taxes	Run 2 Export Production Campaign and Lower Export Taxes	Run 3 Food Production Campaign	Run 4 Balanced of Food and Export Promotion Strategies	Run 5 Balanced Strategy of Run 4 with Lower Money Wage Rate
	---------- ₦ per capita/year (1960 constant prices) ----------						
Agriculture - North by Crop Zone[a/]							
1. Groundnuts/Food	18.64	17.74	22.64	29.06	17.72	28.02	28.00
2. Cotton/Food	17.00	18.10	22.94	28.38	18.10	28.12	27.88
3. Groundnuts/Cotton/ Food	18.46	17.74	21.46	26.04	17.72	25.34	25.32
4. Food - Middle Belt	24.56	59.90	56.04	58.60	60.48	56.72	55.16
Agriculture South by Crop Zone[a/]							
5. Cocoa/Food	28.80	53.32	58.96	90.06	42.36	86.78	84.82
6. Palm/Food	32.46	44.50	44.84	48.28	39.74	46.98	45.86
7. Rubber/Palm/Food	54.50	61.52	64.36	67.82	58.50	67.74	66.40
8. Cash Annuals/Food	17.34	44.82	45.22	51.66	33.96	47.66	46.06
Nonagriculture - Small-Scale Sectors							
9. Employed in Small-Scale Sectors	35.74	21.04	23.74	25.04	26.64	28.02	31.72
Nonagriculture - Large-Scale Wage Earners							
10. Oil	76.72	156.48	157.32	155.94	162.98	159.94	108.08
11. Construction	80.02	156.48	157.32	155.94	162.98	159.94	108.08
12. Transport	116.96	232.18	233.02	231.64	238.68	235.62	160.80
13. Utilities	137.10	272.16	274.30	272.92	279.96	276.92	195.42
14. Manufacturing	96.14	189.56	190.28	189.00	196.02	192.96	131.08
15. Trade-Services	96.80	190.88	191.72	190.36	197.38	194.34	132.04
16. Government	143.80	287.22	288.06	286.68	293.72	290.68	199.14
Nonagriculture - Large Scale							
17. Nonlabor Income	90.24	202.98	225.34	265.36	203.86	263.44	271.36

[a/] For further specification of crop zones, see Manetsch, et. al. [1971].

Figure A.1. Lorenz Curves of Income Distribution for Balanced Agricultural Strategy Compared to Base Run.



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