A SIMULATION POLICY ANALYSIS OF THE WESTERN NIGERIAN COCOA INDUSTRY

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ABSTRACT

A SIMULATION POLICY ANALYSIS OF THE
WESTERN NIGERIAN COCOA INDUSTRY

By

Kwong-Yuan Chong

Since cocoa is the major source of Western Nigeria's income, employment, revenue, and foreign exchange, the industry is very important to the regional economy. Over 95 percent of Nigerian cocoa production, covering a total area of approximately 1.6 million acres--cultivated by over 400,000 households, is located in the Western State. Nigerian cocoa production, which is relatively labor-intensive, is almost exclusively a smallholder enterprise. All the cocoa produced is sold to the Nigerian Cocoa Marketing Board, a statutory monopsonist. However, the producer prices farmers receive are generally less than the world prices. Between the world prices and producer prices, the government collects export duties, producer sales tax, and the marketing board collects a trading surplus tax. Additionally, farmers also pay for the operational and handling costs involved in the sale of their output. The total differences in some years may amount to as much as 50 percent of the world price. Hence, most economists recommend the increase in the cocoa producer prices which may, in turn, increase the cocoa output and output capacity.

Furthermore, since the yield of many of the existing Amelonado cocoa trees is relatively low when compared to the recommended higher-yielding Upper Amazon species, the Western Nigerian government is encouraging farmers to grow more of the latter. In addition, the government is encouraging farmers to grow the higher-yielding Upper Amazon cocoa trees in land presently in bush or food.

The primary purpose of this study was to adapt components of the Nigerian Agricultural System Simulation Model developed at Michigan State University to analyze the proposed revamping of the Nigerian cocoa producer pricing policy, and the government-initiated cocoa new planting and replanting production campaigns. Specifically, the system approach accounted for the dynamic interactions and feed-back effects that might occur within the economy as a result of the proposed price-income changes. The cocoa system simulation model has four major components which (1) allocated land use according to the farmers' perceived profitabilities of cocoa and food subject to the land, labor, and capital constraints; (2) calculated the yield and output of cocoa and food, and their respective producer and market prices; (3) provided the instrumental linkages for the government revenue, marketing board trading surplus, and production campaign policies; and (4) generated the performance criteria to evaluate the impact of alternative programs on the cocoa economy through time.

The three major sets of assumptions investigated were (1) alternative world cocoa prices, (2) alternative government revenue and marketing board producer pricing policies, and (3) proposed government cocoa planting and replanting production campaigns. Four world price functions, representing the moderate (most likely), high, low, and cyclical price projections were used. Alternative producer price policies and production campaigns were combined into five basic policy options. They were (a) status quo producer pricing policy with no government-initiated production campaign, (b) status quo pricing policy with replanting and new planting production campaigns, (c) a "dramatic" producer price increase with production campaigns, (d) a more gradual producer price increase with production campaigns, and (e) option "b" with an added predetermined minimum producer price guarantee, supported by previously accumulated marketing board trading surpluses.

The results of the cocoa policy experiments were discussed in terms of the projected time paths (from 1970 to 1995) of six of the more important performance indices incorporated in the model. They were (1) total output of cocoa, (2) total and compositional (traditional and modern) acreages of cocoa trees, (3) foreign exchange generated from cocoa exports, (4) capitalized agricultural land value of the cocoa-food ecological zone, (5) disposable agricultural income per capita, and (6) accumulated government revenue and marketing board trading surpluses.

In general the study demonstrated that (1) the projected outcomes with the government production campaigns were all greater than the base run which assumed no replanting and new planting production campaigns; and (2) the projected outcomes under the various producer pricing alternatives were also significantly different. However, because of the model's present agricultural land allocation and harvest response mechanisms, the time-paths of the cocoa outputs tend to cluster. Nevertheless, the relative differences in the time paths of various performance indices provided a more comprehensive basis for selecting the most efficacious cocoa producer pricing policy. The study also demonstrated that the system simulation approach with a computerized model of the economy which incorporated information from diverse sources, and accounted explicitly for the dynamic interactions and feedbacks that might occur, can be a very useful methodological tool for policy analysis.

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To My Parents and M,

my gratitude

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CHAPTER I

SCOPE AND NATURE OF STUDY

Introduction

Most economists and planners concerned with the Western Nigerian cocoa economy generally agree that (1) cocoa farmers have been responsive in their output to changes in cocoa producer prices, (2) continued low producer prices might be counterproductive, if not adverse to, the cocoa industry, and (3) increases in producer prices and government production campaigns would increase both cocoa output and output capacity and government revenue in the long term. The loss in revenue from the producer tax decrease may be offset by increases in tax base, with the increase in output, income and asset values resulting from the producer price increases and production campaigns (Johnson *et al.*, 1969). However, most of the Nigerian cocoa studies did not provide a comprehensive, dynamic and analytical basis that would allow policymakers and researchers to interact and evaluate policy alternatives in the larger context of how the sector operates through time.

For discussion, these Nigerian cocoa studies are divided broadly into (1) econometric, or more specifically, the statistically estimated simultaneous equations, and (2) the partial budgeting and project appraisal categories. The first category includes such studies by Bauer and Yamey (1959), Stern (1962), Sanders (1968), Ady (1968), Okurume (1970), Olayemi (1970), Oni (1970), and Olatunbosun and Olayide (1971). The second category includes chapters on cocoa development from the Food and Agriculture Organization Study (1966), the Consortium for the Study of Nigerian Rural Development (CSNRD) Report (1969), and the Cocoa Research Institute of Nigeria Report (1971) for the National Agricultural Development Seminar.

The features and limitations of the two approaches will be examined, compared and contrasted with the general system simulation approach in which we propose to study the major economic policy issues confronting the Western Nigerian economy.

Features and Limitations of the Econometric Approach for Cocoa Policy Analysis

The econometric approach is essentially a procedure for estimating the coefficients of an equation or a set of simultaneous equations based on empirical observations of the economic phenomena (Johnston, 1964). The estimated coefficients, in turn, provide an analytical basis for testing hypotheses, policy evaluation and prediction. The empirically-based approach, therefore, depends heavily on the availability of reliable time series and cross-sectional data in order to statistically estimate the coefficient matrices.

Most of the past econometric studies on the Nigerian cocoa economy were motivated by the now passe neoclassic agricultural economic problem of estimating the responsiveness in output of farmers in developing countries with producer price changes. However, the economic thinking of many Nigerian government officials in the 1950s and early 1960s was that the farmers' price elasticity of output was zero. The zero price elasticity assumption therefore provided a comfortable rationale for the government low producer price policy. Hence, these studies were able to show that the price elasticities of the cocoa farmers were positive, thus challenging the rationale for the Marketing Board's low producer price policy. These studies, however, were not able to relate the short-term and long-term output responses of cocoa production and their interrelations with food price and food production in the regional economy.

Many issues remain unanswered in these studies. For example, what was the economic rationale that governed the farmers' decision to allocate their resources between the short-term and long-term returns? When cocoa producer prices were high, did producers attempt to maximize the short-term output by allocating all their labor to harvest the biologically available output in that year? Or did they also attempt to maximize their long-term income potential by expanding their cocoa acreages? Conversely, what did farmers do when their prices were low? Did they increase their short-term output in order to maintain their yearly expected income? Or did the farmers decrease their output because of the lower prices? What about food production? Did they increase food production when the cocoa producer prices were low in order to offset the income decline?

In order to estimate the coefficients of the postulated economic phenomena, most of these studies assumed that (1) the cocoa producers were profit-maximizers, and (2) the economic forces that linked the various components in the cocoa economy were self-equilibrating. However, we have to challenge the validity of these two assumptions if their findings are to be used for policy analysis and prognostication.

First of all, Nigerian cocoa farmers are not really profit maximizers in the neoclassical sense. Their production decisions are determined by the complex interplay among their personal motives, managerial capacity, resource endowments, ability to command additional resources; and in the future, the proposed changes in the marketing board producer pricing policy and the program features of the production campaigns. Hence, the final outcome of the farmers' decision to produce food and cocoa depends on their skill and educational level, psychological aversions for change and risk, the complementaries of other inputs, the physical and financial "lumpiness" of the new technology, and the existing institutional and administrative constraints.[1]

Secondly, the Nigerian cocoa economy would most probably not be in equilibrium since the very purpose of economic development is to set in motion disequilibrating economic forces to transform its underlying structure. Hence, the endogenous variables estimated from

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[1]See Johnson (1972) for a critique of the conventional theorizing of firm behavior which most of these econometric studies of supply responsiveness are built on.

past time series data from the cocoa studies cannot be extrapolated linearly into the future time periods. The anticipated economic changes and conditions of the Nigerian economy have to be accounted for and modeled explicitly for policy analysis as much as possible.

Finally, the capital stock adjustment and the Nerlovian lagged response models used in the cocoa econometric studies were restrictive in explaining the cocoa farmers' decision to invest and disinvest in their cocoa trees. Perennials are partially fixed assets whose value at any one time lies between their establishment cost and salvage value. The revenue generated from cocoa production flows from the stock value of the trees. The asset value of an acre of cocoa trees (without considering location or real estate potential of the land) is highly correlated with the income-generating capacity from the trees, even though the correspondence is not perfect. For example, in the first four years while the trees are gestating, establishment cost is also increasing. The asset value of the trees is very low and may even be negative should the land be converted for other agricultural or residential purposes. Furthermore, the young trees are also more vulnerable to wind, flood, and disease damage. However, once the trees are established, their asset value appreciates. Corresponding to the potential income flow, the asset value remains relatively high throughout the maximal production stage and then begins to decline as the trees grow older.

The asset value of the trees may also change externally with changes in output prices or production costs. However, the farmers do not necessarily contract and expand their cocoa acreages because of the relative inelasticities of transformation between cocoa and other competing crops. Even if the producer price of cocoa declines to less than the minimum average variable cost, farmers would probably continue in production as long as the marginal revenue from the cocoa production is greater than the salvage price of their fixed inputs, and the acquisition price of their variable inputs. In cocoa production, the fixed input is their household labor (whose opportunity cost is very low), and the variable inputs are the harvesting materials. However, if producer prices are persistently low and are expected to remain low in the foreseeable future, some of the cocoa farmers may abandon their less productive cocoa acreages or convert their land use. Thus we see that the investment and disinvestment decisions for cocoa production are not completely symmetrical or reversible. The change in their output capacity depends on the relevant price range and magnitude, direction and time duration of the producers' price changes.

However, one of the fundamental methodological problems faced by the cocoa econometric studies is the nonavailability of time-series and cross-sectional data of the Nigerian cocoa economy to establish the coefficients. Although most of the econometric models were conceptualized in nonlinear and interactive terms, with dynamic feedbacks, the final estimations were linear and additive, because of the data constraints.

Features and Limitations of the Partial Budget and Project Appraisal Approach for Cocoa Policy Analysis

The cocoa project appraisals are generally conducted in rigid geographic, time, and program terms. Some examples are: the assessment of the financial feasibility of a five-year cocoa replanting program in Ife, a subsidized fertilizer distribution scheme for the Western State cocoa farmers, or a government loan program for cocoa spray equipment. The usual criteria used to determine the project's feasibility are the net present value of future returns, the internal rate of return, cost-benefit ratio or the payoff period of the initial investment. These decision criteria can be calculated in terms of one specific input (which is generally the most limiting input) or the total project (Prest and Turvey, 1969).

Recently, two major developments have been made to strengthen and improve the project appraisal approach for policy analysis. The first is the expansion of the criteria used to determine the efficacies of the project, by including secondary and other indirect costs and benefits that might occur outside of the cocoa sector as a result of the program (Gittinger, 1972). For example, there is the additional employment that may be generated in agriculture-related industries, such as domestic fertilizer plants, resulting from the expansion of the cocoa economy. Unfortunately, many of the indirect costs and benefits may not be tangible, quantifiable or expressible in monetary terms, and their inclusion for project evaluation may still be arbitrary. The second development is to express the values of the crucial factors along with their probability distribution of occurrences in order to arrive at a statistically more complete picture of the anticipated outcome (Reutlinger, 1971).

Since project appraisals are generally conducted and prepared as feasibility studies for funding and administrative purposes, the approach has a strong administrative and accounting bias. These studies typically are very concerned with calculating the financial returns made by both the private and public sectors, the repayment capacities of the project, the general impact on the economy, the personnel and logistics requirements, and the program phases and time table. Such findings on the cocoa economy are obviously of immense interest and concern to the Nigerian Government and international loan agencies like the World Bank, which monitors the progress of the project or loan program.

However, the approach is quite mechanistic in projecting the consequences of the program. Using the principles of partial budgeting, outcomes of alternative programs are projected under different predetermined rates of program expansion and price assumptions. Little attempt is made to capture the motivating mechanisms of the change processes, or the interactions or the positive and negative feedback effects that might modify the postulated consequences as time proceeds. At best, the initial projected results are sometimes re-adjusted to reflect some anticipated, intuitive contingencies. These re-adjustments, however, are generally *ad hoc* using arbitrary discount factors. The initial projected total output of cocoa, for example, may be reduced by 10 percent across-the-board to reflect the less than optimal agronomic conditions. Moreover, such a mechanistic approach may not allow any rigorous analysis or interaction between researchers and policymakers. Hence, it would indeed be very useful if all the intuitive knowledge and qualitative judgment of the subject matter experts would also be incorporated clearly and consistently into a joint analytical framework with the underlying assumptions stated explicitly. As we shall see, the methodological orientation of the system simulation approach is to provide a systematic framework to make use of such information.

General System Simulation Approach as a Tool for Cocoa Policy Analysis

To address ourselves to some of the methodological and policy problems, we propose to use the system simulation approach as a tool for developmental planning and policy analysis of the cocoa economy. The system simulation approach, following the principles of scientific method and problem-solving research, is a formalized process which begins with the identification of the problem under investigation, and ends with the evaluation of feasible alternative solutions.[2] This approach generally includes a mathematical model which enables researchers to express the socio-economic phenomena more precisely for analysis. Once the relevant system with its structural components and functional linkages is identified and the system's values are specified, its validity can be tested, and experiments using alternative policies can be conducted to draw inferences on the impact of these policies.

[2] For more detailed discussion of the philosophy of the general system simulation approach for problem-solving research, see Manetsch et al. (1971), Abkin (1972), and Forrester (1972).

Although the economy can be modeled mathematically by using ordinary and partial differential equations containing linear and nonlinear terms, explicit solutions for the economic model are often very difficult, if not impossible, with the increasing number and complexity of the differential equations. Instead, researchers (aided by large-scale digital computers) have turned to simulation as a possible means of generating numerical solutions that may provide policymakers with information about the likely consequences of alternative economic developmental strategies.

Conceptually, a simulation model of an economic system can be viewed in the following general mathematical form:

$$\psi(t+1)=F[\psi(t),\alpha(t),\beta(t),\gamma(t)]$$

$$\Pi(t) = G[\psi(t),\alpha(t),\beta(t),\gamma(t)]$$

<u>where</u>:

$\psi(t)$ = a set of variables defining the state of the simulated system at any given time. State variables usually involve the level of a variable at a given time and may include such quantities as production capacities, prices, population by subgroups, levels of technology, etc.

$\Pi(t)$ = a set of output variables measuring the system's simulated performances, such performance criteria as output, foreign exchange generated from exports, income, etc.

$\alpha(t)$ = a set of parameters defining the structure of the system. These usually involve rates of change of variables between levels and input-output coefficients, such as technical coefficients, response coefficients, price elasticities, etc.

$\beta(t)$ = a set of environmental variables, such as world prices, etc.

$\gamma(t)$ = a set of policy instruments, such as tax policies, production campaigns, investment alternatives, etc.

The state equation illustrates how the state of the system ψ at t+1 is a function of the state at time t and of the values of α, β and γ at time t. This is a general representation of the difference equation formulation of the system model which describes the state of the system and subsequent performance at discrete points in time. The output equation generates the performance criteria Π used to evaluate the performance of the system over time under various policy alternatives.

There are three distinguishing features of the general system simulation approach particularly useful for the policy analysis of the Nigerian cocoa economy. First, it is a generalized approach which makes use of all available primary information and calculated findings including estimated coefficients and parameters from econometrics, partial budget and project analysis, qualitative judgment and insights of subject matter experts, and descriptive work about the cocoa industry from other social science disciplines. Since the research and model-building process is iterative and flexible, new information can easily be incorporated as it becomes available, and the structure of the model modified accordingly.

Second, in the system approach, the functional relations can be nonlinear, and dynamic with discrete or continuous lags and feedbacks, discontinuous and asymmetric according to the theoretical postulates or empirical findings. In contrast, because of the computing and estimation procedures, most of the econometric relations are generally assumed to be causal, linear, and additive. Hopefully, the flexible mathematical mode used in system simulation will model reality better (Manetsch and Park, 1972).

Third, the approach does not have to assume (but does not preclude) any profit or utility maximizing producers and consumers, or any self-equilibrating economic adjustments. It does not necessarily involve a unique set of optimizing solutions based upon a common objective or a predetermined singular goal, which does not in reality exist. In contrast, the approach is more guided by the problem under investigation. The system simulation approach provides, basically, a conditional feedback framework in which various dynamic interactions and anticipated consequences under alternative policies and programs can be projected through time and thus evaluated. The projected time paths of some of the more important performance indices can therefore provide a composite basis for evaluating alternative strategies for the Western Nigerian cocoa economy.

Research Objectives and Procedure

Background of Study

The present study has two progenitors, both headquartered at Michigan State University under the directorship of Glenn Johnson. The first is the Consortium for the Study of Nigerian Rural Development (CSNRD), whose policy-oriented research on Nigerian agriculture (Johnson *et al*., 1969), took the monumental Food and Agricultural Organization study, entitled *Agricultural Development in Nigeria 1965-80*, as a point of departure. The second is the MSU Agricultural Sector Simulation Team which was motivated to develop a generalized system simulation methodology for agricultural policy analysis (Manetsch _et al._, 1971). In both the studies, the Western Nigerian cocoa industry was treated as one of the major income and revenue-generating agricultural sectors of the Nigerian economy.

The Consortium approach, using pen and pencil (and occasionally, desk calculator!) projections, studied the impact of alternative policies on the future development of the cocoa economy--in conjunction with the other proposed national and regional agricultural policies and programs. While the CSNRD approach provided a very useful analytical framework for Nigerian policymakers, many research questions remain unanswered. To facilitate computations, simple (and perhaps, simplistic) assumptions were made about the technological coefficients (e.g. cocoa yield, input requirements, total acreages), costs and returns of cocoa production, and expected world cocoa prices. Hence, based on their _averaged_ values, the future aggregative impact under alternative cocoa policies and programs were projected to the next fifteen years, with 1970, 1975, and 1985 used as benchmark dates. Because of the time-consuming and tedious nature of the pen and pencil calculations, the study did not: (1) explore the outcome of the proposed policy alternatives under _different_ technological data and farmers' behavioral assumptions, and (2) the projected time paths of other performance indices whose composite outcome might also interest policymakers. Furthermore, as discussed earlier, little attempt was made to show the motivating mechanisms, interactions, and feedbacks of the change processes that might modify the initially projected consequences. For example, CSNRD's cocoa analysis was based on only <u>one</u> set of future world cocoa prices (assumed to decline £10 per long ton stepwise, every five years). Hence, it is eminently conceivable that a different set of world cocoa prices might stimulate measurably different short-term harvest responses and long-term output capacity responses among the cocoa farmers, thus affecting the reported outcome. (Moreover, as we shall see, the interactions between the farmers' short-term and long-term output responses may further modify the projected outcome.) Nevertheless, in fairness to the CSNRD approach, many of these methodological issues may have been taken into account implicitly.

As a result of some of these methodological difficulties, interest was generated by some economists and system scientists in using a computerized system simulation approach for agricultural planning. It was hoped that the approach would provide a more dynamic, rigorous and integrative approach for planning--in contrast to the *ad hoc* pen and pencil, "common sense" approach used in CSNRD. Accordingly, an interdisciplinary research team of system scientists and agricultural economists was assembled at Michigan State University (of which the author is a member[3]). The research objective was

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[3]As a member of the agricultural simulation team, the author assisted in the design, refinement, and validation of the structural and functional linkages of the Southern Nigerian Agricultural Submodel. This involved developing the basic analytical structure and general information and data of Southern Nigerian agriculture which described the behavioral structure of the economy (Manetsch *et al.*, 1971). The author also had the major responsibility for writing Chapter II of the report, which provided the overall ecological, economic, and political problem setting of the study.

to build and test the usefulness of a system simulation model as a tool for economic planning. Nigeria was chosen as the case country because of the reservoir of information and expertise at Michigan State University--thanks to the CSNRD experience. The research, however, is also motivated to be of assistance in the agricultural economic planning of other developing countries that share similar ecological and institutional features, such as the rubber industry in Malaysia, cattle industry in Colombia (Posada, 1973), and the total agricultural sector of South Korea (Rossmiller _et al._, 1973).

In the report by Manetsch _et al._ (1971), our primary concern was in validating the usefulness of the system simulation approach and the Nigerian Simulation Model for developmental planning. The usefulness of the approach was further extended when the Model was used to analyze specific policy issues concerning the likely consequences of alternative Nigerian agricultural developmental strategies (Olayide, Abkin, and Johnson, 1972). Thus, the present study can be viewed as part of the continuing process of the model's development, validation, and application, of the system simulation approach as a tool of planning and policy analysis by focusing specifically on the cocoa sector of South Nigeria.

In addition to the present study's sector-specific focus, there are two new features which were not considered in previous studies. First, world cocoa prices in the previous studies (for the purpose of validating the usefulness of the system simulation approach for developmental planning) were assumed to be constant throughout the planning horizon of the analysis. In this study, we shall interject a little more realism by using alternative world cocoa prices obtained from other studies to analyze their projected consequences in the cocoa economy. Second, we introduce for the first time a rudimentary producer price guarantee (along the recommendation of CSNRD) whereby farmers would be paid a predetermined floor price should their price, after accounting for the taxes and handling costs, go below the level. The cocoa producer price support program would be financed by previously accumulated Marketing Board trading surpluses, or if necessary, from other outside sources. It is postulated that such a producer price guarantee feature would be especially helpful if future world cocoa prices are expected to be low and fluctuating. The price guarantee may thus stabilize the cocoa farmers' income, and perhaps increase their income as well.

Objective of Thesis

The main purpose of the present study is, therefore, to adapt components of the Nigerian Agricultural Simulation Model to analyze the effects on the Western Nigerian cocoa economy of (1) alternative world cocoa prices, (2) proposed revamping of cocoa producer pricing policies, and (3) government-initiated cocoa new planting and replanting production campaigns to assist the farmers expand their output capacity.

Specifically, the policy experiments conducted on the model shall consider the effects of (1) four sets of world cocoa prices, and (2) five different combinations of producer pricing policies and production campaigns. Based on the Bateman (1971) study of the world cocoa market, three sets of world prices are used--representing the moderate (most likely), high, and low expectations. The fourth set, a cyclical world price function, has been constructed by the author to evaluate its impact on the model's outcome. It is hoped that the four sets of world prices will capture all the relevant world cocoa price behavior germane to the policy analysis of the proposed cocoa producer pricing changes and production campaigns.

The first of the five policy options is a base run which approximates the present policy. It has a relatively low government revenue tax of 10 percent on the prevailing world price, a 20 percent marketing board trading surplus tax on the market price, and no government-initiated production campaign. The next three policy options compare the effects of the proposed production campaigns with varying producer pricing features. In Run 2, the government initiates the production campaigns with the same tax rates as the base run. The benefits of the production campaigns are obtained by comparing the projected outcome of Run 2 with Run 1.

In Runs 3 and 4, the tax rates are assumed to be slightly higher than the base run at 20 and 30 percent of the respective world and market prices. However, in Run 3, the higher tax rates are cut off the following year, whereas in Run 4, the taxes are phased out linearly over the next five years. The purpose of these two runs is to compare the projected outcome on the cocoa economy of a "dramatic" producer price increase under Run 3 with a more gradual producer price increase under Run 4, in conjunction with the production campaigns. Because of the interactions between the short-term and long-term output responses, under alternative producer pricing policies, the projected outcome may differ.

Finally, Run 5 compares the effects of the rudimentary producer price guarantee feature. The rest of the policy features of Run 5 are identical to Run 2. The study hypothesizes that the outcome of the production campaigns with varying producer pricing features under Runs 2, 3, 4, and 5 would differ accordingly. Their differential income, in turn, would have interesting policy implications.

Among the more important performance indices used to evaluate the projected impact in the cocoa economy (from 1970 to 1995) are: (1) in the producing subsector: the annual total output of cocoa from existing, replanted and newly planted trees, the foreign exchange generated from cocoa exports, the annual agricultural disposable income per capita, and the capitalized value of the agricultural land; (2) in the food subsector: the amount of food produced and its producer and market prices; and (3) in the government and marketing board subsector: the accumulated revenue and trading surpluses collected from the marketed and exported cocoa. Based on the policy experiments using the four sets of world prices and the five combinations of producer pricing and production campaign policies, the study will draw some limited policy implications for the Nigerian cocoa economy.

Thesis Outline

Chapter II provides the problem setting of the study. It discusses the roles and objectives of Nigerian agriculture, the nature of Nigerian cocoa production and the postulated production, consumption and revenue effects that may result from the proposed revamping of the cocoa pricing policies and production campaigns.

In Chapter III, we present a description of the major components of the Southern Regional Submodel of the Nigerian Agricultural Simulation Model (hereafter called the Western Nigerian Cocoa Simulation Model) which are used to conduct policy experiments on the Nigerian cocoa economy.

Chapter IV presents the simulation policy results under the various combinations of world cocoa prices, proposed government tax and marketing board producer pricing policies, and the new planting and replanting production campaigns to expand cocoa output capacity. Based on the results of the policy experiments, this chapter shall discuss some limited policy implications for the Western Nigerian cocoa economy.

In Chapter V, the major methodological and policy conclusions of the study are summarized and possible extensions of the model are presented.

CHAPTER II

PROBLEM SETTING AND ECONOMIC FRAMEWORK OF STUDY

Introduction

In order to better appreciate the problem setting of the study, this chapter discusses first the general objectives of Nigerian agriculture and the nature of cocoa production in Western Nigeria. Secondly, the chapter discusses the postulated production, consumption and revenue effects of the proposed cocoa price-income changes; the interrelations between farmer responses and the proposed government revenue and marketing board, producer-pricing changes; and the government initiated production campaigns to increase cocoa output capacity.

Goals of Nigerian Agriculture

According to Oluwasanmi (1966), CSNRD (1969) and others, there are three basic roles and goals for Nigerian agriculture. First, Nigerians have to be fed adequately and nutritionally both in the rural and urban sectors. The solution to the food problem depends crucially on the interplay among the effective demand of the consumers, the responsive supply of the food producers, and the adequacy of the marketing channels and food distribution system. In order to effectively demand and purchase food, the general population must maintain an adequate income. The farm-gate price of food, in turn, must be sufficiently high to encourage producers to meet the market demand. Finally, the pricing mechanisms and market structure must be such that any long-term changes in food prices and/or output are passed on efficiently to the producers or the consumers without the various intermediaries retaining a disproportionate share of the benefits.

Second, in the next decade or so, agriculture will probably be the chief sector for providing employment opportunities and an adequate income to most of the country's population and labor force. The industrial and service sectors in national development will still be limited because of their relatively high investment requirement and low labor absorption capacity.

Third, in the longer run, agriculture must also be one of the major sources of revenue and resources for the transformation of the country's economic structure, despite the increasing significance of other economic activities, such as the Nigerian petroleum industry.

Importance of Cocoa to Western Nigeria

The cocoa industry is very important to the Western Nigerian economy since it is the major source of its income, employment, revenue, and foreign exchange. In the last ten years, agriculture accounted for over 65 percent of the gross national product--and cocoa contributed 20 percent of that amount. The other major Nigerian agricultural crops, which are also exported, are: ground nuts (grown in the North), rubber (Midwest), and oil palm (throughout the South).

Most of the cocoa produced in Nigeria comes from the Western State (with the exception of Egbada, Oyo, and Okitipupa Divisions) and Afenami Division of the Midwestern State. Cocoa is cultivated by over 400,000 households covering a total area of approximately 1.6 million acres, or nearly 60 percent of the total cultivated land.

Despite the increasing importance of other nonagricultural sources of income and employment, notably in the urban sectors, cocoa production and its marketing still provide for a substantial proportion of the farmers in the region (estimated to be between 30 and 45 percent of the total agricultural population), the chief source of income and employment.

In 1967, cocoa accounted for over 22 percent of Nigeria's total exports, amounting to ₤54.7 million. The export earnings from palm oil and palm kernels totaled ₤13.8 million; groundnuts ₤46.9 million; and rubber ₤6.5 million. The annual average output of cocoa from 1963-67 is about 212,000 long tons (see Table 2.1). Total export duties, producer sales tax and marketing board trading surplus collected from the cocoa sector in 1967 amounted to ₤7 million, ₤.9 million and ₤12.7 million, respectively (see Table 2.2).

Nature of Cocoa Production in Western Nigeria

Nigerian cocoa is produced primarily by smallholders whose typical landholding consists of about 3 acres of cocoa and 2 acres of food. Although there is now increasing evidence and concern that the distribution of landholding size and income level among the cocoa farmers is skewed (Essang, 1971), the distribution is not as

TABLE 2.1.--World Price, Producer Price, Export Quantity and Cocoa Earnings, Nigeria, 1953-1967.

Year	World Price	Producer Price	Export Quantity in	Export Earnings	Percent of Total Export Earnings
	N ₦/long ton	N ₦/long ton	Thousand long ton	₦ N million	
1953	240.0	170.0	104.7	24.9	20.0
1954	392.0	170.0	98.4	39.3	26.3
1955	296.0	200.0	88.4	26.2	19.7
1956	208.0	200.0	117.1	24.0	17.8
1957	208.0	150.0	135.3	24.0	20.3
1958	306.0	150.0	87.7	26.7	19.7
1959	272.0	150.0	142.8	38.3	23.4
1960	208.0	160.0	154.2	36.8	21.6
1961	127.0	112.0	183.9	33.7	19.4
1962	158.0	100.0	194.7	33.4	19.8
1963	168.0	105.0	174.6	32.4	17.0
1964	176.0	110.0	196.8	40.1	18.7
1965	120.0	120.0	255.3	42.7	15.9
1966	136.0	65.0	190.2	28.3	9.3
1967	184.0	90.0	244.3	54.7	20.2

Sources: Eicher and Liedholm (1970), Kriesel (1969), and Olatunbosun and Olayide (1971).

TABLE 2.2.--Export Duties, Produce Sales Tax, Trading Surplus and Administrative Expenses of Western Nigerian Cocoa Export, 1953-67.

Year	Export Duties		Produce Sales Tax		Board's Trading Surplus		Estimated Total Expenses	
	N ₤ million	% of Expected Income	N ₤ million	% of Expected Income	N ₤ million	% of Expected Income	N ₤ million	% of Expected Income
1953/54	11.47	29.22	0.39	0.99	5.62	14.31	1.86	4.74
1954/55	5.57	21.28	0.33	1.26	5.03	19.21	1.90	7.26
1955/56	3.84	16.01	0.42	1.75	- 4.17	-17.38	2.47	10.30
1956/57	3.22	12.37	0.51	1.96	- 1.27	- 4.88	2.94	11.29
1957/58	4.15	15.92	0.29	1.11	4.92	18.88	1.77	6.79
1958/59	7.50	19.59	0.53	1.38	7.83	20.45	2.87	7.50
1959/60	5.48	14.90	0.59	1.60	1.10	2.99	3.13	8.51
1960/61	3.94	11.68	0.73	2.16	- 3.75	-11.11	4.01	11.89
1961/62	3.20	9.60	0.76	2.28	3.16	9.48	4.52	13.55
1962/63	2.91	8.99	0.76	2.35	1.33	4.11	3.79	11.71
1963/64	5.13	12.79	0.79	1.97	3.75	9.35	4.15	10.35
1964/65	3.87	9.06	1.02	2.39	6.42	15.04	5.55	13.00
1965/66	2.29	8.10	0.72	2.54	1.79	6.33	4.96	17.55
1966/67	7.00	12.80	0.90	1.65	12.69	23.21	4.99	9.13

Sources: Eicher and Liedholm (1970), Kriesel (1969), and Olatunbosun and Olayide (1971).

pronounced or inequitable as the Latin America latifundia and minifundia land system.

Cocoa is a perennial which requires from 4 to 8 years of gestation before producing. The output function of a given acre of trees (given its genetic type and cultivation pattern) depends on the age of the trees. Most of the Nigerian cocoa trees belong to the Amelenado type. After the gestation period, the annual output per acre increases from approximately 100 pounds at 7 years old to approximately 300 pounds after 10 years. The maximum of 350 pounds is reached between the ages of 14 and 28, after which the output gradually declines to 250 pounds per acre per year. Although the trees still bear cocoa pods beyond 40 years, it is generally assumed that it is no longer economically feasible to maintain them.

On the other landholdings, the cocoa farmers grow in the main food for household consumption, with the surplus marketed locally. The typical food crops cultivated are: cassava, yam, and maize. The farmers also harvest wild palm and kola nuts. In addition, some farmers supplement their income with off-farm jobs, such as petty trading and odd jobs in town.

Most labor required for cocoa and food production is provided by the household. However, among the larger farmers, agricultural production depends importantly on hired labor, especially during the critical phases of planting and harvesting. These larger farmers may also specialize in producing cash crops while purchasing all their food.

The Nigerian cocoa economy is confronted with two major problems. The first is the relatively low producer prices, compared to what the economy nets for the exports in the world market. It is generally agreed that the low producer prices may have a depressing effect on output and in the longer term, may discourage many of the cocoa farmers from expanding their cocoa acreages. The second problem is that the yield of many of the present trees is also declining because of age and disease infection. Hence, in order to increase the cocoa farmers income, the government is presently (1) considering the revamping of the producer pricing policy, and (2) encouraging the cocoa farmers to replant their old and declining Amelenado trees with the higher-yielding Upper Amazon trees, and plant land currently in food or bush with the Upper Amazon cocoa trees.

The gestation period for the Upper Amazon trees is shorter. Production begins at age 4 at 200 pounds per acre per annum and increases to about 600 pounds by age 10. Maximal production is from age 11 to 32 at 900 pounds per annum. From age 33 to 40, the yield declines to 800 pounds per annum. Although the trees do not produce any cash income during the gestation period, the asset value of the land with the trees appreciates because of the potential income generated from the trees. The asset increase in turn may increase the farmer's collateral for credit. The cultivation of cocoa trees and other perennials is a very important, although often ignored or underplayed, means of capital formation in economic development. The primary inputs of the capital formation are the farmers' uncultivated land, household labor (whose opportunity cost may be very low) and some purchased inputs, such as cocoa seedlings and chemicals. For cost breakdown, see Table 3.1.

Agricultural Price Policy, Production Campaigns and Cocoa Development

In general, the use of price policy for agriculture is a relatively efficient and fairly effective tool for allocating resources between the agricultural and nonagricultural sectors; and among the various crops and other agricultural economic activities. Barring any institutional and technological constraints, resources would generally be allocated and reallocated to the sector and the commodities whose relative returns are highest and increasing.

In order to generate revenue and stabilize domestic cocoa prices, the government has, through the marketing board, instituted export duties, producer sales tax and the trading surplus in addition to charging farmers for handling and administrative costs. Consequently, Nigerian cocoa farmers are paid a producer price consistently below the world price (see Table 2.1). Because of the pervasive nature of cocoa production in the economy, the price policy directly and indirectly affects the income and welfare of nearly all the farmers in the region (through the linkage and multiplier effects).

Hence the proposed changes in the government revenue and marketing board producer pricing policies would have wide reverberations in the cocoa economy. The final impact of the price changes on the economy can be divided into (1) the cocoa farmers' short-term and long-term price responses in output and output capacity, (2) the effects on the sector's food production and consumption, (3) changes in the farmer's nonfood consumption and savings pattern resulting from the price and subsequent output increases, and (4) government revenue and marketing board trading surplus effects.

Cocoa Output Effects

The output responses caused by a producer price increase can be categorized as short, intermediate, and long-term according to the time-lag adjustments and the additional resources commitment necessary to bring about the changes. A short-term output response would be for cocoa farmers to increase their output in the same year because of a higher prevailing price. The additional costs typically would be the added labor for weeding and harvesting. As long as incremental return is greater than incremental cost, farmers would harvest more of the trees up to their biological potential.

Although we do not examine the effect of the intermediate output response in this study, an example would be for farmers to improve their cultivational and managerial practices by spraying and pruning more frequently because of the higher prevailing price. The additional costs in the intermediate output response are additional labor, materials (mostly chemicals), and the annual amortized cost of the spraying equipment. The rehabilitation of the trees can increase their output potential for the next two to four years.

The long-term output response would be for farmers to expand their output capacity by either planting new cocoa trees or replanting their present lower-yielding trees (according to their resource endowment), as a result of the prevailing favorable price.

With the proposed production campaigns, we can reasonably expect that most of the new trees would be of the higher-yielding Upper Amazon variety. As we shall see, the establishment of new cocoa trees is a major investment involving considerably higher input costs. Since each response has its own cost-return configuration, they very often compete against each other for the farmers' resources.

The final production outcome with the proposed cocoa producer price changes is also interrelated with the supply responses of the various inputs necessary to bring about those changes. For example, the increased demand for labor to assist in harvesting or planting new trees may increase response costs if the labor supply in that year is fairly inelastic, thus increasing the costs of the initial output responses. On the other hand, the increased demand for materials, such as chemicals, may decrease their unit cost, which, in turn, further stimulates their use and thus reduces the final costs of the responses. Alternatively, the decrease in the costs of these inputs, resulting either from their exogenous price decline or a deliberate government subsidized program, may also induce increases in output and output capacity of cocoa and food.

Furthermore, the proposed changes in the producer price would probably affect farmers differentially according to their age, educational background, managerial capabilities, farm size, and resource endowment. Since not all the farms are of the same size or have trees of the same productive age, increases in the producer cocoa price would probably benefit the larger farms more than the smaller farms, and farmers with producing trees more than farmers whose trees are in gestation or declining in yield. Alternatively, some farmers may not have the managerial capabilities, access to suitable land or command over the additional information and financial resources needed to expand their cocoa acreages despite their eagerness resulting from the increased producer prices. Likewise, older farmers (who, because of their age, and hence, shortened planning horizon) would probably not replant their trees despite the producer price increase.

Food Production and Consumption Effects

The second possible effect of the cocoa producer price increase would be on food production and consumption. Since food and cocoa production use basically the same resources, the change in the producer price of cocoa would naturally affect food production. There are two distinctive features concerning food and cocoa production and consumption which govern their interrelationships. The first is that food crops are generally annuals or biennials, whereas cocoa trees are perennials. Although labor and most of equipment can be used for both food and cocoa production, the land used for cocoa is relatively fixed once the trees are established. On the other hand, food land can easily be converted for cocoa production if the soil is suitable and other economic conditions are satisfied. The elasticities of transformation between their production are therefore relatively low and asymmetric. The second distinctive feature is that cocoa is cultivated exclusively for export, whereas food is consumed, sold and sometimes purchased by the farmers.

The interrelationships caused by an increase in cocoa producer prices on food production can be subcategorized into positive, negative, or zero. In the positive situation, cocoa farmers would increase their output and output capacity of food. Since additional labor has to be hired and paid in kind with food, the farmers may also grow more food as they cultivate more cocoa. The negative effect is obviously the opposite. The farmers allocate more of their resources (including hired labor) to cocoa production at the expense of food production. Finally, if we assume that the production decisions for food and cocoa are independent and unrelated, the increase in cocoa producer price has little effect on food output (Okurume, 1970).

Depending on the total equilibrium supply and demand of food, the change in food output in turn affects its price. If the cocoa producer price increase results in a decrease in food production, and the demand for purchased food does not decrease, the market price of food may increase. The change in food price also has a real income effect on the farmers, especially if a large portion of their food is purchased. Conversely, the real income of cocoa farmers may also increase in food output and productivity. Furthermore, the increase in cocoa producer prices (through the real income effect) may also increase the demand for food. Thus, we see the importance of monitoring the effects of the producer price change of cocoa on food production and consumption.

Nonfood Consumption Effects

Finally, the increase in real income caused by the producer price increase may also change the farmers nonfood consumption pattern of durables, nondurables, and services. Earlier, we have discussed the output-investment effects, where the producer price increase may induce the farmers to invest further in production by either harvesting more of the cocoa crop in the same year, or expanding cocoa acreages by newly planting and replanting low yielding trees. However, the real income effect of the producer price increase may also be to increase and change farmers' total consumption and savings pattern.

Government Revenue and Marketing Board Trading Surplus Effects

We shall now turn to the other side of the producer pricing ledger. The increase in producer price, or conversely, the decrease in tax rates, obviously affects the total revenue collected by the government and marketing board. The government and marketing board revenue elasticity, with respect to the producer price change, can be decomposed into its unit tax and quantity elasticities effects. Although the unit tax elasticity is always negative, the total revenue elasticity may be positive if the quantity elasticity is sufficiently positive and offsetting. Hence, the decrease in tax rate may further induce farmers to increase their output in the short-run and output capacity in the long-term, thus increasing their tax base.

Lower Producer Price Effects

A lower producer pricing policy which decreases the farmers' cocoa price, however, would not necessarily have the opposite, symmetrical effects either in magnitude or direction. If the producer price is decreased by the same amount as in a hypothetical price increase, the reduction in output would probably not be symmetrical. As we have indicated earlier, farmers would probably continue producing and not abandon their trees or convert the land to alternative uses, unless disastrous and persistent rock-bottom producer prices prevail. Once the investment is made and trees are established, the asset value of the cocoa land lies between its acquisition and salvage value. The only way to recapture the investment is to continue producing, as long as the marginal returns are greater than the marginal costs. Moreover, the strong ratchet-consumption behavior would probably discourage farmers from appreciably reducing their output.

Marketing Board Producer Pricing Policy

The time-variant output responses of cocoa farmers also depend importantly on the nature of the marketing board operations and its general producer pricing policy. Presently, the two major roles of the marketing board, in addition to regulating the production and marketing of cocoa in the country, are (1) to collect revenues for the public sector, and (2) to buffer the domestic prices from the fluctuations of the world prices through the trading surpluses' operation.

In recent years, the operations of marketing boards, the marketing system and its licensed buying agents and sub-agents and the producer pricing policies have been critically discussed and evaluated in the literature. Among these are Helliener (1968), Kriesel (1968), Johnson et al. (1969), Essang (1971), and Idachaba (1972). More recently, the International Conference on the Marketing Board system held in 1971 at Ibadan was convened once again to assess the role and functions of the marketing boards.

The general consensus discernible from the conference papers are (1) physical operations and administration of the marketing boards can be improved considerably, thus reducing overhead operating costs, (2) price and income stabilization roles of the marketing boards should be separated from their fiscal and tax roles, and (3) marketing board taxes can also be a very effective channel of economic development if they are reinvested directly within the cocoa sector.

Thus, the future of the cocoa producer pricing policy depends crucially on how the roles of the marketing board are viewed and defined. If the marketing board is viewed primarily as a fiscal agent of the government, the criteria to evaluate its role are (1) its effectiveness in generating revenue for the public treasury, (2) its distributional equity on the producers, and (3) its administrative efficiency when compared to alternative forms of taxes. However, if the marketing board or its succeeding organization is viewed primarily as a developmental agency motivated explicitly to assist cocoa farmers, the crucial question then is: in what programs and at what levels of support, should the government invest in or at least provide the leadership and coordination? Such a pro-farmer orientation may entail a net transfer of revenue from other sectors of the economy. Furthermore, CSNRD has recommended that a separate agency funded by previously accumulated trading surpluses should administer the domestic cocoa price and income stabilization problem faced by the Nigerian cocoa economy. In any event, the producer price set by the government and/or the marketing board in any one year (regardless of their objectives) depends importantly on the expected world price Nigeria receives for her exports. And, paradoxically, the government has little direct control over this factor.

Production Campaigns to Expand Cocoa Output Capacity

Finally, the anticipated consequences of production campaigns on the cocoa economy also depend on the specific program features of the cocoa production campaigns and the overall governmental policy for the cocoa sector. The latter includes the government's investment in the infrastructure and other supporting ancillary services like a feeder network of roads, schools, vocational education, and agricultural extension. The three basic program instruments the government can use to defray cocoa farmer risks and financial costs in new planting and replanting are: (1) subsidizing the purchase of the seedlings and spraying equipment, (2) providing generous across-the-board low interest loans for the farmers to finance their investment, and (3) direct grant either in cash or kind to the farmers.

Comparison Between Cocoa Producer Price Policy and Production Campaigns

Although the increase in the producer price or the decrease in the input costs by a government subsidy basically increases farmers' private profitability, the costs and effects of the two policy instruments differ. Since the price increase is commodity-specific, the increase in the producer price of cocoa, as was indicated earlier, would probably benefit larger farmers and those with trees that are producing more than smaller farmers and those with trees in gestation or declining in yield. Furthermore, it would not benefit nonproducers and may even affect them adversely, if the producer increase causes the price of other commodities to increase. Nevertheless, the increase in producer price causes the asset value of all the cocoa land to increase.

On the other hand, since there is a considerable amount of input substitution in agricultural production, the benefits of input subsidies depend on farmers actually using the input, and a resultant output increase. The government could do little to prevent farmers from using the subsidized fertilizer or machinery earmarked for one commodity on another whose returns are perceived to be higher. Farmers might even sell the subsidized fertilizer for cash, rather than use it. Furthermore, final adoption of the new technology depends on the availability of other complementary inputs. Thus, it may be necessary for the government to introduce a package program rather than to subsidize one particular input. Very often, low supply levels or the lack of effective demand by the farmers for the other complementary inputs may prevent them from taking advantage of the reduced cost of the subsidized input. For example, farmers may not purchase or use spraying equipment even though it is subsidized, since additional labor has to be hired at the relatively high prevailing wage rate to operate the machinery.

From a program administration viewpoint, the manpower requirement and the financial costs of the two policy instruments also differ. At this juncture, the Western Nigerian Cocoa Marketing Board is responsible for the fiscal role as a tax-collecting agency; the State Ministry of Agriculture and the proposed government-sponsored credit cooperatives are responsible for the production campaigns. The immense problems of organization, coordination, and cooperation necessary for the effective implementation of the two-pronged developmental strategy should not be minimized. These administrative linkages are essential for the expected changes to occur.

CHAPTER III

THE WESTERN NIGERIAN COCOA SYSTEM SIMULATION MODEL

Introduction

Since the Nigerian Agricultural Simulation Model has been described more fully in the report by Manetsch et al. (1971) (to which the author contributed as a team member), this chapter shall describe the major components of the Southern Regional submodel as they relate to the cocoa policy experiments. There are two distinguishing computing features between the models used in this study and in the studies by Manetsch et al. (1971), and Olayide et al. (1972). First, the exclusive focus of the present model is on the Western Nigerian cocoa industry instead of on all the other ecological zones in the South and the rest of the nation. Consequently, the policy entries and performance indices of this study are sector-specific. Because of its exclusive focus on the cocoa ecological zone, the projected outcome of the performance indices differ slightly from the projected outcome that assumed the simultaneous implementation of agricultural policies in the other sectors.

Second, we present for the first time the computing mechanisms and rationale for a rudimentary, producer price guarantee (recommended by CSNRD) which was not considered in previous studies. Cocoa farmers would be paid a predetermined minimum floor price should their cocoa price (after accounting for the various taxes and handling costs, which are subtracted from the world price) fall below the level. The payment would come from previous accumulated marketing board trading surpluses or other government revenue sources.

The Nigerian Agricultural Simulation Model[1] consists of the Northern Regional, Southern Regional, and the Nonagricultural National Accounts submodels as we can see in Figure 3.1. Based on its ecology, Nigeria is divided into the North and South with the former consisting of the six northern states and the latter, the six southern states. The ecology of the North ranges from Savanna to desert, and the South ranges from rain forest to intermediate Savanna. Consequently, the commodities grown and the economic activities in the two regions are different.

Each region is divided further into its specific ecological zone with distinctive agricultural characteristics. As is evident in Figure 3.2, the South is divided into the food, cocoa-food, oil-palm-rubber-food, and oil-palm-food ecological zones. The particular concern of this study is the cocoa-food zone which covers all of the Western State (with the exception of Egbada, Oyo, and Okitipupa Divisions) and the Afenami Division of the Midwestern State.

The Northern and Southern Regional submodels are similar in their basic structural components and computing functions. The basic

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[1]For complete description of the various submodels, see Manetsch _et al_. (1971), Abkin (1972), and Byerlee (1972).

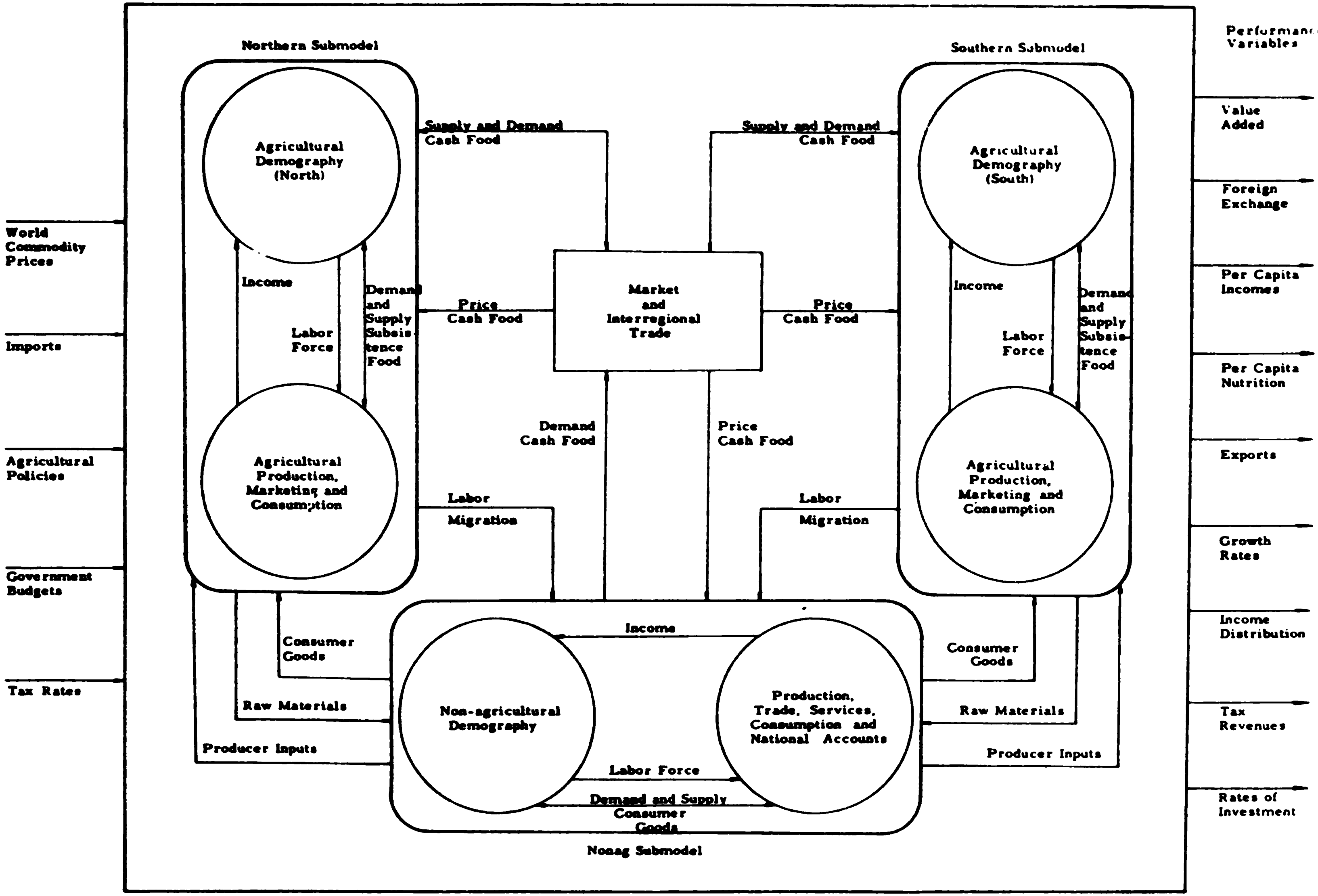

Figure 3.1.--Interacting Submodels of the Nigerian Agricultural Simulation Model.

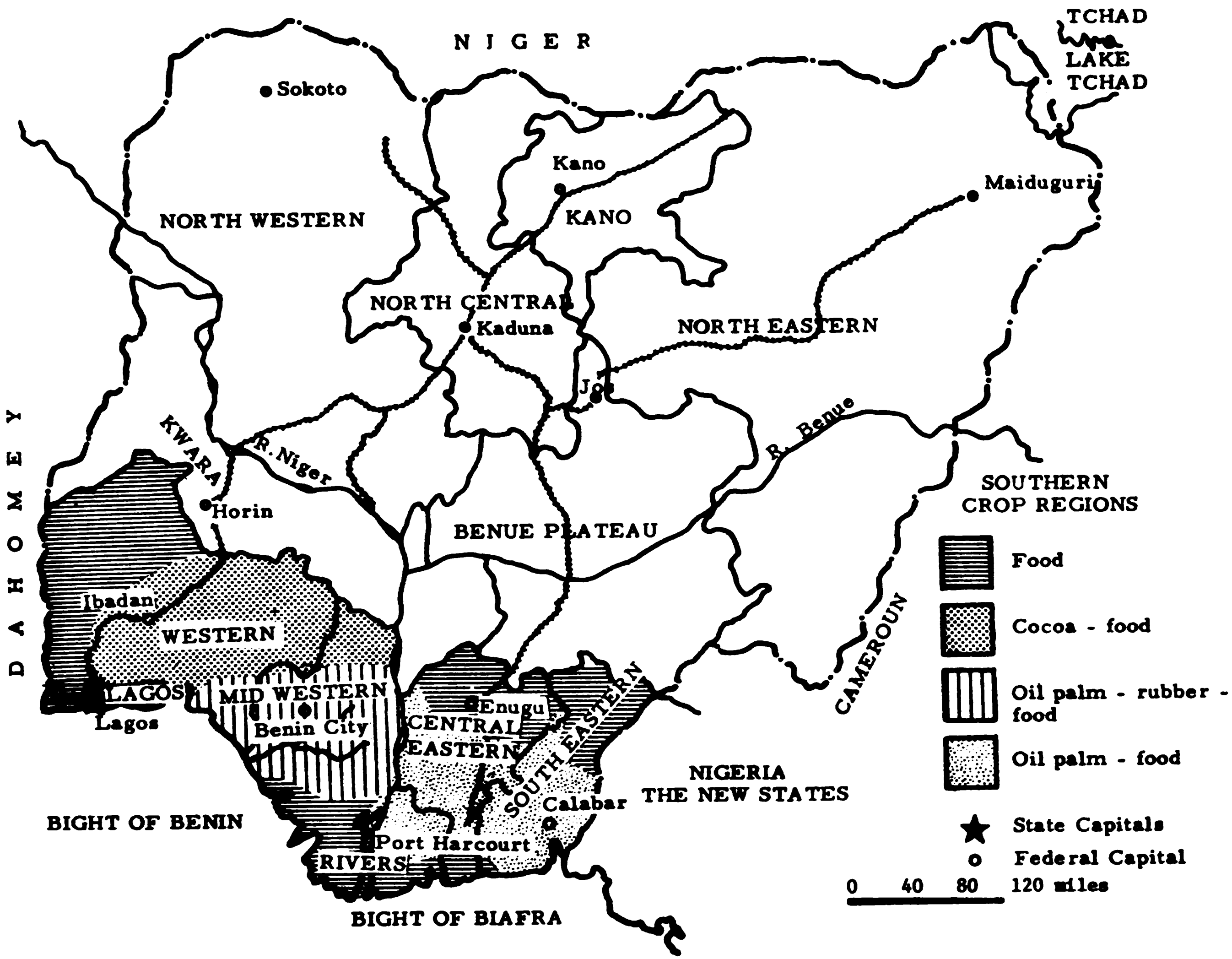

Figure 3.2.--The Four Crop-Regions of the Southern Regional Model.

features (1) allocate land according to the profitabilities the farmers perceive for the various commodities subject to the land, labor, and capital input constraints; (2) calculate the yield, output responses, the amount of the produce that is consumed in the household, marketed, and exported; (3) provide the policy instrument linkages; and (4) generate the performance criteria to evaluate the impact of alternative agricultural policies (see Figure 3.3). In addition, the population component of the model simulates the birth, death, and migration rates of the population of the two regions by their age-sex cohorts; and the market and inter-regional trade component models the regional demand, supply price, and shipment of food.

The Southern Regional Submodel with Special Reference to the Western Nigerian Cocoa-Food Ecological Zone[2]

The Southern Regional submodel has the capability of simulating from one to all four of the commodity ecological zones. Since the particular concern of this study is to adapt the major analytical features of the Southern submodel to conduct policy experiments of the cocoa industry, the following discussion will focus on the cocoa ecological zone. The functions and linkages of the analytical components are shown in Figure 3.4.

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[2]The author is indebted to Michael H. Abkin for paraphrasing from his thesis. For a complete description of the Southern Regional submodel and its components, see Abkin (1972).

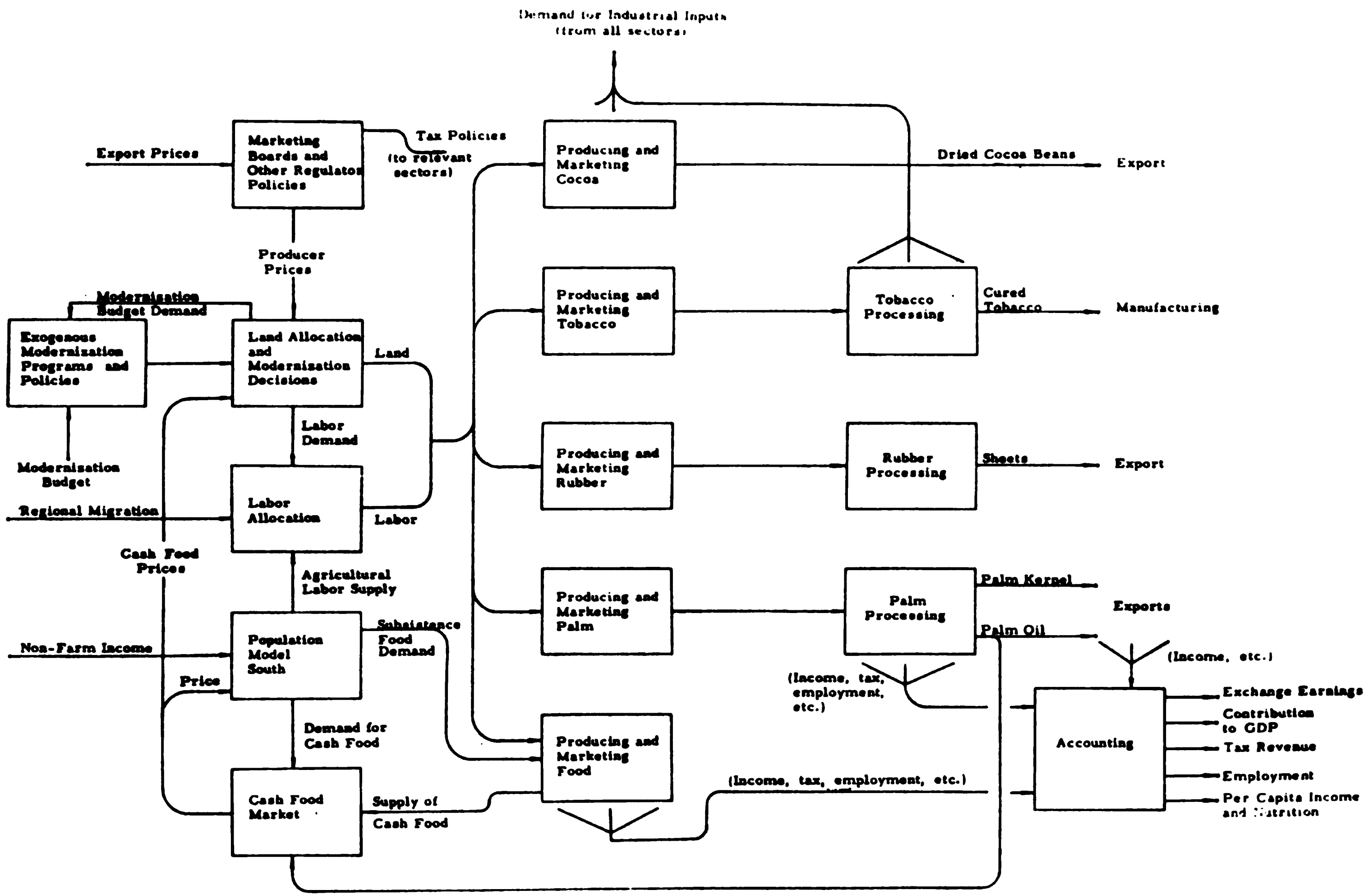

Figure 3.3.--Major Sectors and Interactions of the Southern Nigerian Agricultural Model.

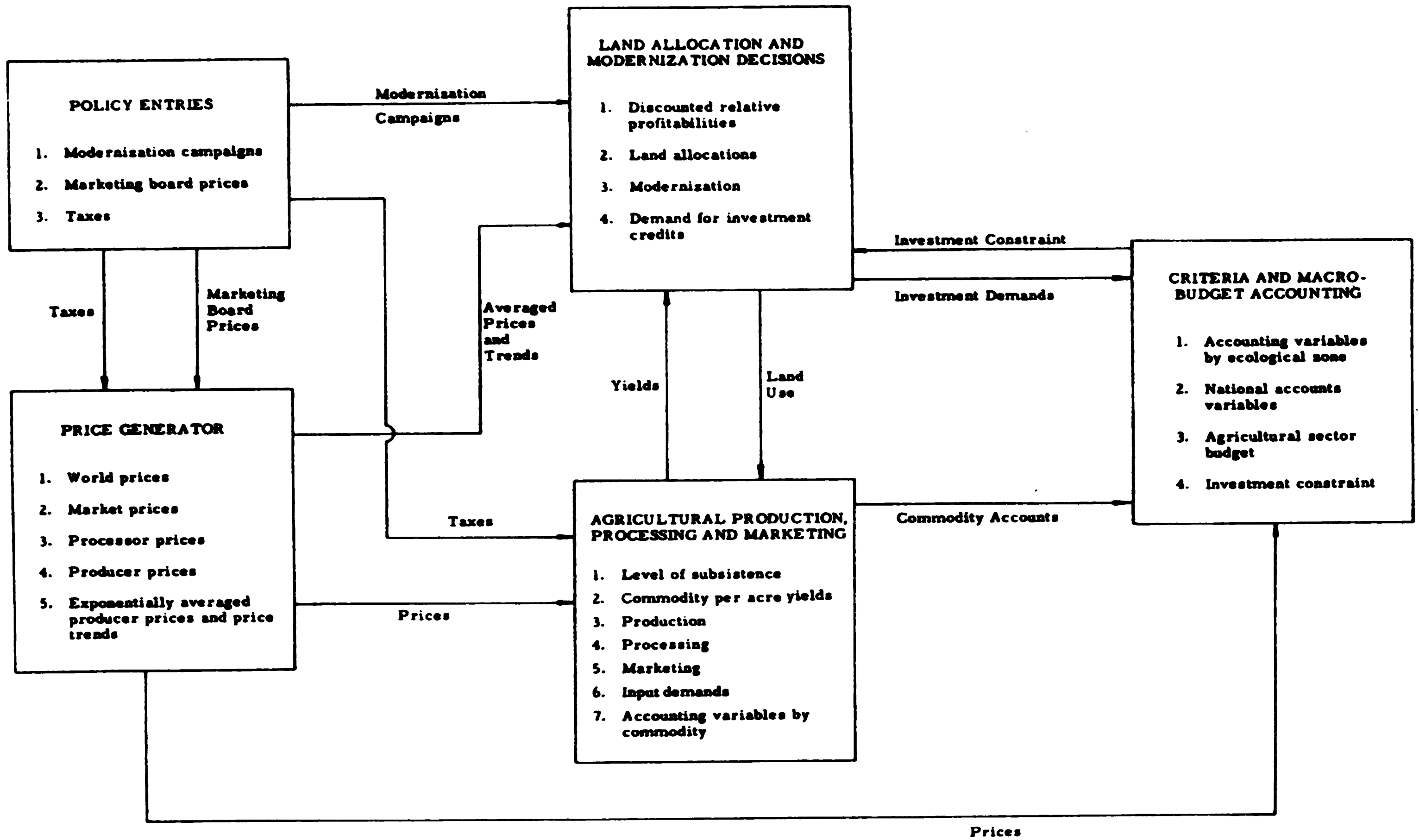

Figure 3.4.--Building Blocks of the Southern Regional Model.

According to Abkin (1972), the data used in the model falls into three categories: system parameters, technological coefficients, and initial conditions. System parameters are primarily parameters which reflect the behavioral characteristics of the system being modeled, and along with the structural equations, define the system. Little data exists for most of the behavioral system parameters since field research necessary to estimate the coefficients has not been conducted. (Moreover, their estimated values depend on the conceptual framework and the research methodology used to obtain them.) Consequently, many of their values in the initial stage of model building and testing were educated guesses based primarily on published sources and interactions with knowledgeable Nigerian and developmental economics experts. Despite the uncertainty of their actual values, system parameters play an important role in the validation of the model in time-series tracking and sensitivity analysis. Sensitivity tests conducted by varying the values of the parameters showed that some of them have little affect on the projected outcome of the model, while in others, the projected outcome changed appreciably. Some examples of the system parameters used in the model are the land use profitability response and profitability discount rates.

The technological coefficients of the model are primarily the production figures used to compute the profitability of food and cocoa (see Table 3.1). The values of the initial conditions in 1970 (the base year of the present policy experiments), are based on the estimated values of the model from 1953 to 1965, projected to 1970.

The values of these variables change as a function of the simulated time during the course of a run, and must be reset at the start of each run. Some of the more important variables and their values will be examined in greater detail as they occur in the following discussion of the major computing components of the model.

1. Land Allocation and Modernization Components

The two major commodities grown in the West are (1) cocoa, a tree crop cultivated mainly for cash and the export market, and (2) a composite of food crops, annuals or biennials, cultivated both for household and the cash food market. In order to make the analysis more tractable, the study lumps all the major staples into a food composite class, and further assumes that their relative weights would remain constant in the future with no change in consumer preference or production patterns. The weights used to compute the food composite yield, caloric food value and input requirements are: yam = .315; maize = .278; cassava = .310, and cocoyam = 0.097, based on estimates by Phillips (1964), Ilori (1967), Gusten (1967), Thodey (1960), and Yaghoobi-Rahmatabadi (1971). The caloric yield of food is calculated to be 827 calories per pound.

The major purpose of the agricultural system simulation model is to analyze the long-term developmental implication of the aggregative economy under alternative policies and behavioral assumptions. In order to do this, two simplifying analytical assumptions are made. First, the basic unit of analysis is an acre of land with a given homogenous production function, where the proportion of the inputs used are fixed and nonsubstitutable even should their factor costs change within the year. The aggregate output from the cocoa land and food land in the sector are obtained by multiplying the respective acreages by their unit values without considering explicitly the internal economy of scale of production that may exist within each farm-firm. In reality, the aggregate cost curve may not be horizontal or perfectly elastic, but rather U-shaped. However, since our primary interest is in the relative differences of the projected outcome under different policy alternatives, and not the absolute values of the projected outcome, this assumption may not be very serious. Short of segmentizing the industry by farm size and resource endowment to find the weighted averages, we cannot ascertain whether the present conceptualization of linear relationships reflects an upward or downward bias of the true values.

Secondly, the basic unit of time in the conceptual model is one year. No explicit consideration is given the seasonal fluctuations of food prices, the intra-annual supply and demand for short-term agricultural credit, and the monthly distribution and varying demand of agricultural labor according to the production cycles of cocoa and the food crops. To consider the farmers allocative decision using a smaller discretized time unit of less than a year would increase the model's computations considerably. Instead, the annual values of the production functions are averaged to account for the intra-annual variations.

Cocoa Trees

The cocoa trees are first divided into the traditional and modern streams whose major differences are in their biological yield capabilities, secondary growth attributes, and their managerial and cultivational practices.

The traditional stream is further divided into the improved and the unimproved substreams to distinguish the yield and cultivational practices. The improved-traditional substream consists of the traditional, lower-yield Amelenado trees which use improved cultivational practices. Their output level is higher than that of the unimproved traditional trees. The unimproved-traditional substream would be the Amelenado trees cultivated and managed by traditional methods. Their production coefficients are shown in Table 3.1. In 1970, the base year for the cocoa policy experiment, the total acreages under the improved-traditional and unimproved-traditional substreams (based on the model's projection from 1965) are 1.55 million and 63,000 acres. Because of the rehabilitation programs carried out by the government in the 1950-60s, most of the farmers have adopted improved cultivational practices.

The modern stream is divided into the replanted and newly planted substreams. The former consists of the higher-yielding Upper Amazon trees which are recommended to replace the lower-yielding Amelenado trees. The latter consists of the Upper Amazon trees to be planted in land presently in food or bush. As seen in Table 3.1, the output, establishment and production requirements of the two substreams differ. The yield from the newly planted trees is

TABLE 3.1.--Average Annual Yield and Input Requirements for Traditional and Modern Cocoa Production Per Acre by Age-Cohort, Nigeria.

TRADITIONAL

	Streams	Age				
		0-6	7-13	14-28	29-42	Over 42
Yield (lb.)	Improved	0	300	525	350	175
	Unimproved	0	250	350	250	100
Labor Input[a] (man-days)	Improved	40	20	18	18	6
	Unimproved	25	12	12	12	6
Materials[b] Input (lbs.)	Improved	.0730	10.4	16.3	16.3	16.3
	Unimproved	0	0	0	0	0

MODERN

	Streams	Age				
		0-3	4-11	12-32	33-40	Over 40
Yield (lbs.)	New Planting	0	600	950	850	750
	Replanting	0	500	850	750	650
Labor[a] (man-days)	New Planting	60	33	42	42	42
	Replanting	80	33	42	42	44
Material[b] (lbs.)	New Planting	.0730	210	296	296	296
	Replanting	165	10.4	16.3	16.3	16.3

Sources: Abkin (1972), FAO (1966), CRIN (1972).

[a]Does not include harvest labor. Harvest labor is .0117 man-days/lb.

[b]Composite materials including chemicals and fertilizer.

generally considered to be higher than that of the replanted trees because the soil where the replanted trees are cultivated is more depleted, and thus agronomically less suitable. Similarly, the cost of establishing an acre of replanted trees is also higher because of the additional labor required to fell the existing trees before the replacement trees can be planted. On the other hand, labor required to clear the bush land or food land for the new trees is much lower. The operating and maintenance costs per acre for trees of the two substreams, however, are assumed to be the same. Finally, the government may also have to build better roads to the agronomically suitable bush land for the new planting whereas most of the replanting would occur on farms already established. In this study we shall assume that none of the higher-yielding trees were present at the beginning of the experiment. However, this is not entirely true since some of the more innovative farmers had replaced their trees with the Upper Amazon variety in the 1960s.

Food Land

The food land is also divided into traditional and modern substreams, each with its own separate production functions. The output per acre of the traditional substream using approximately 100 man-days labor is 6,550 pounds. Based on the model's projections from 1965, the total food acreage in the sector in 1970 is 1.03 million acres. Although there is no modern food production sector in Western Nigeria at present, this feature is built in to test the possible effects of a food modernization program on the economy.

2. Allocative Decisions of Land Use Component

This component presents the economic rationale and motivating mechanisms that govern the farmers allocative agricultural decisions for land use. As we have discussed in Chapter II, it is postulated that the rate of land use expansion and contraction depends primarily on the outcome of the interactions among the farmers' social and economic attributes, resource endowments, and their responses to the marketing board producer price policy and the government production campaigns. In addition to the expansion that is caused by the deliberate allocative decisions made by the present farmers, agricultural expansion also occurs as a result of new agricultural decision makers from the increasing population. However, based on a more detailed analysis of the projected results of the present policy experiments, the rate of land use expansion resulting directly from the population increase accounts for less than one percent of the total projected agricultural expansion. This figure may indeed be reasonable if we assume a net outflow of young rural people away from agriculture.

Economic Decision

The major factors that determine the farmers' long-term output capacity agricultural land use expansion are (1) perceived relative financial profitabilities of each alternative, (2) promotion and diffusion effects of the production campaigns in reaching the farmers, and (3) availability of land, labor, and capital for the expansion.

Relative Financial Profitabilities

First of all, the economic decision to expand their agricultural land use depends on how farmers perceive the relative financial profitabilities when compared to the present use. The viable production alternatives are (1) for land presently in traditional cocoa: the higher-yielding Upper Amazon trees, (2) for land presently in traditional food: Upper Amazon or modern food, and (3) for land presently in bush land: traditional cocoa, modern cocoa, traditional food, or modern food. The perceived relative financial profitabilities in each acre of land are obtained by comparing the net discounted present value of the various alternatives. In turn, the net discounted present value is obtained by summing the difference between the expected annual revenue and annual cost over the planning horizon discounted to the present period for comparison.

The discount rates used to compute the present value of future returns are behavioral parameters which vary for each productive alternative in order to reflect (1) the farmers differential time preference for food crop (which has a shorter growth cycle and financial turnaround time) over cocoa, a perennial (which has a relatively long gestation, and therefore a longer payoff period), and (2) the varying risks in each alternative. For example, future returns from the present cocoa trees need only be discounted for the time preference whereas future returns from the replanted trees must account for both the time preference and additional risks the farmers perceive in planting. The rates used to discount the future returns of the various production alternatives to the present period are: 3 percent per annum for the present land-use, 6 percent for cocoa replanting, and 7 percent for new planting.

The annual total revenue in each production alternative is obtained by multiplying the annual expected output by the producer price farmers expect to receive for the commodity. The annual total cost is the sum of all the costs used in the production of the commodity, including hired labor and materials (such as chemicals and seedlings), and the amortized cost of the fixed inputs (such as tools and spraying equipment).

In this study, we assume that 5 percent and 20 percent of the total labor required to produce food and cocoa are hired. The wage rate (increasing at 1 percent per annum) in 1970 is assumed to be 5 shillings per man-day. Analytically, we would have expected the noninclusion of the household labor in computing total production costs to have created a bias in favor of the more labor-intensive crops by making their relative profitability higher. However, subsequent sensitivity tests which changed the values of some of the model's parameters (including increasing the total labor costs to account for the household labor cost) did not appreciably affect the rate of agricultural land expansion. Instead, as we shall see, this rate of agricultural land expansion is governed primarily by the threshold response value. Hence, the main rationale for dividing labor into household and hired labor is to account for the wages that are paid to agricultural workers. These wages are used to compute the annual total cash income accrued to the sector.

Communications Effects

In this study, we have conceptualized the rate of agricultural expansion to depend also on the communication effectiveness of the government production campaigns which can be divided into the direct promotional effects, and the indirect diffusional effects (Rogers, 1962). The effects of the first group would be the expanded acreages that result directly from the government production campaigns. The effects of the second group would be the expanded acreages that result with a time-lag from the demonstration effects emanating from the first group. The communication inputs of the production campaigns are informational units expressed in extension agents equivalent to show that there are other equally effective combinations of media and channels. These might be radio forums, printed materials and other audio-visual aids that can disseminate the new information promoted by the production campaigns. Hence, a more effective promotional program of the production campaigns, provided other conditions are positive, can increase the rate of agricultural expansion.

Availability of Suitable Agricultural Land

Although there is no shortage of suitable agricultural land for cocoa and food expansion in Western Nigeria, the effective land available would probably be limited for the following reasons. First, the human settlement pattern, economic infrastructure, and other supporting social services in the region are not uniformly distributed. It is highly unlikely that many cocoa trees would be cultivated in the sparsely populated Ondo Province in the foreseeable future, regardless of agronomically suitable land there, unless a major investment in infrastructural development is also undertaken.

Second, the allocative decisions between food and cocoa production among the Western Nigerians at present, and in the foreseeable future, would be such that no matter how financially profitable cocoa production may be compared to food, not all the food land would be reallocated for cocoa. In the aggregate, the farmers would always allocate at the outset a proportion of their total land for food production for the household in order to spread their productive risks. This subsistence proportion may vary (as we shall see in the discussion on the agricultural production and marketing component) if other food marketing conditions are met. Nevertheless, it is clear that not all the potentially suitable land now in food production would be converted to cocoa production. Finally, the Nigerian farmers would always reserve a proportion of the bush land in food fallow. As good available agricultural land decreases, the cycle of the food fallow may shorten and the land-use intensify.

Transitional Responses

Changes in the land use pattern reflect farmer responses to the perceived profitabilities of the relevant production alternatives. The assumption is made that the most profitable alternative is most likely to be chosen first, and so on in order of decreasing profitability. We have combined the effects of the perceived profitability and the communication effects into a profitability response function which determines the amount of land that an information unit can reach per year for land use conversion according to the relative profitability of each production alternative. In Figure 3.5, the y-axis represents the maximum number of acres (expressed as a proportion) which an informational unit can reach as a function of a given relative profitability. Although the maximum proportion is 1.0, there are generally other interacting constraints, such as effective land availability whose net effects reduce the attainable maximum. The rates of farmer responses to the relative profitabilities of the relevant alternatives depend on the value of the threshold and response rate parameters.

The response threshold in the relative profitability axis is to account for the often observed phenomenon of farmers needing a safety margin as a buffer against added risks before adopting a proposed favorable production alternative.

The investment decision threshold for each alternative depends on (1) the relative importance of the productive asset in the farmers' financial structure; (2) the nature of the productive asset and its cash inflow and disbursement profile; (3) the cost of financing the investment; and (4) the farmers' general attitudes towards government administration.

The following examples illustrate how some of these factors influence the values of the response threshold points. If cocoa production is a major source of farmer income, then replanting the present trees deprives them of the major income source for a relatively long period during the gestation stage of the new trees.

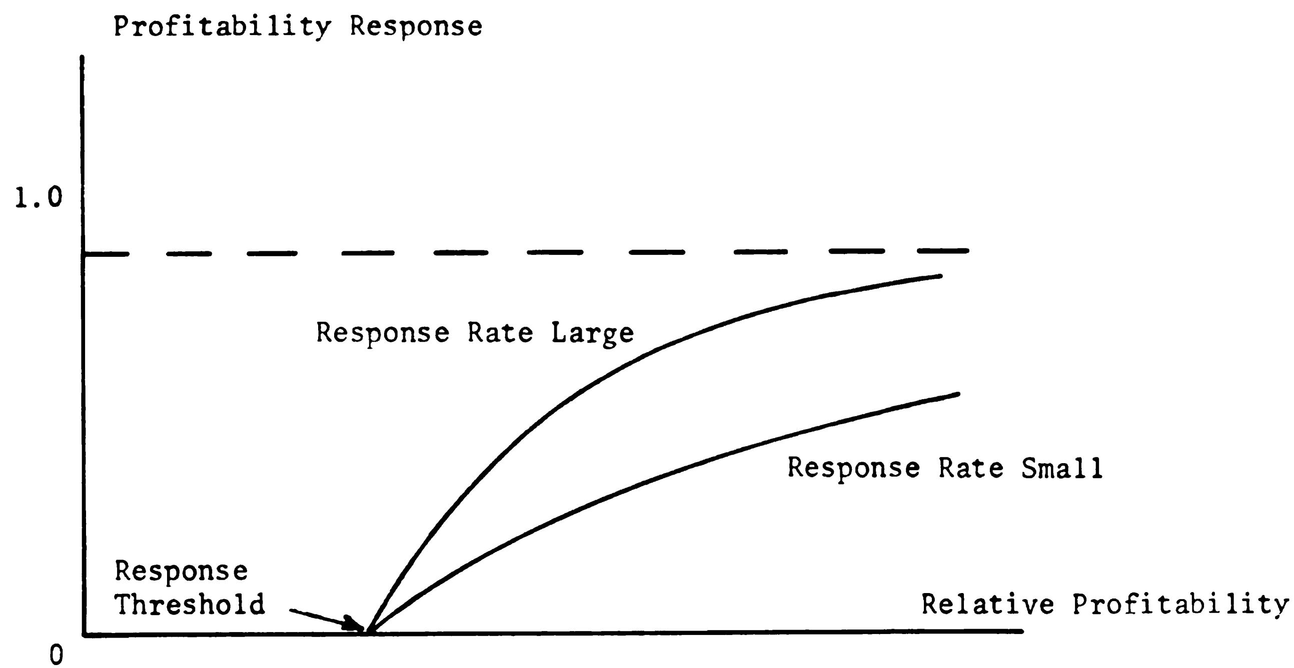

Figure 3.5.--Diagram Showing Profitability Response Function in Agricultural Land Reallocation Decisions.

Moreover, cocoa replanting not only deprives the farmers of their major income source, but also requires additional financial outlay. Hence, if the farmers have to borrow externally for the new production alternative (either from private or public sources) they would be reluctant to do so since the total investment costs must now include the interests and other carrying charges, and the additional risks from insolvency or foreclosure of assets that are offered as collateral to secure the loan.

The cash inflow and outflow generated for food production is quite different from cocoa production. The financial payoff period or turnaround time of food production occurs typically within the year, whereas the payoff period of trees generated from the cash inflow derived from their output does not occur until some years after the trees' gestation stage. Furthermore, the elasticities of transformation among food crops as annuals or biennials are much greater than between food crop and cocoa, because of the partial fixity or the less liquid nature of the latter's asset structure. In the extreme case, should output prices decline, and farmers decide to grow another commodity, the salvage value of the trees may not only be very low, it may be negative since additional cost is necessary to remove the trees.

Finally, farmers typically tend to be more realistic (and skeptical!) in evaluating the relative profitabilities by imputing their own discount functions to further reduce the calculated returns. This healthy pessimism is based on past unfavorable experience with the government extension service. Since they have to bear the major burden of loss should the productive alternative recommended by the government fail, they are naturally more cautious and financially conservative. The response threshold values between land presently in traditional cocoa production and modern (replanted) cocoa is 0.4. This means that before the farmers would replant their present trees with the higher-yielding trees, the expected returns from the replanted trees have to be 40 percent greater than the expected income from the present trees. The response threshold value between the present food land and modern cocoa (new planting) is 0.4.

Capital and Credit Constraints

In order to compute the final land use allocation transition rates, the response functions are constrained by the availability of capital necessary for the production alternatives. The two major sources or potential sources of capital in the cocoa industry for agricultural expenditures are (1) savings from disposable income (after accounting for consumption) within the sector that could be channeled into investment, and (2) the increased credit or collateral value from the increased capitalized value of cultivated land, which in turn may increase the flow of capital, public or private, from outside the cocoa industry.

However, there are two major caveats in this conceptualization for the Nigerian context. First, there may not be any financial institutions and intermediaries that can channel the capital flow or appreciably mobilize the untapped financial resources inside or outside the cocoa-food zone for agricultural expansion. Although the sectorial aggregate accounts may show the income (after accounting for production and consumption) to be positive, because of the skewed distribution of income and asset ownership within the sector, and the outside linkages some of the larger farmers may have with the urban sector, the net savings may be channeled into investments outside of agriculture, rather than inside the sector. These investments, such as urban housing, have higher and quicker financial returns. Hence, the potential capital source within the private sector of the economy may not be effectively available to the majority of the farmers for agricultural expansion.

Second, even if these financial institutions or mechanisms exist, they are rudimentary because of the present limited scope of their operations. For example, the actual credit extended to cocoa farmers may be far below their collateral level; or conversely, the costs of borrowing may be exorbitant and not reflect the attendant risks of such financial transactions.

The demand for capital in any one year for agricultural expansion is the annual establishment costs required to maintain the crop before production. The total demand for capital for each alternative is then compared with the total capital available from the two above sources, to determine the effects of the capital constraint. This finally determines the amount of land allocated and reallocated for agricultural expansion.

Asymmetric Response

In this model, we have also built the mechanisms that would determine the rate of abandonment of cocoa land that may result from adverse cocoa producer prices. The abandonment would begin to take place if the current returns are negative, and the remaining expected profitability from the trees is below an abandonment threshold level (see Figure 3.6). The abandonment threshold level of the cocoa trees (analogous to the investment threshold level) depends on the farmers behavioral characteristics, financial attributes, and the alternative uses of the present resources of land, capital, and labor. The abandonment rate would increase up to a predetermined maximum as the profitability continues to fall. The values of the threshold and abandonment points (which attempt to capture by proxy the farmers' investment and disinvestment decisions) are not symmetrical. Their values, together with the values of the positive response and abandonment response rate, depend on the computed relative profitability of the commodities.

3. Agricultural Production and Marketing Component

This component determines (1) the amount of food that is produced and consumed within the household and sold and purchased in the market; (2) the amount of cocoa that is produced, marketed, exported; and (3) the agricultural input requirements and some of the major economic performance indices used to evaluate the cocoa economy.

Determination of the Subsistence Level of Food Production

The amount of food produced and consumed in the sector depends on the interactions between the effective demand and responsive supply of the food market. Nigerian food prices fluctuate daily and

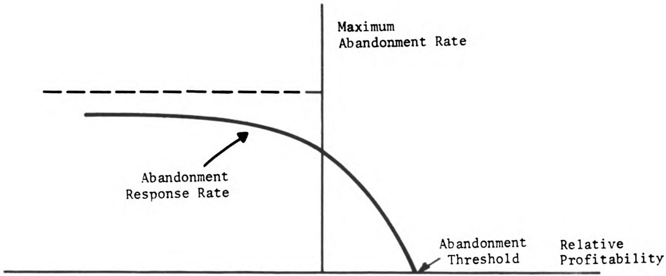

Figure 3.6.--Diagram Showing Abandonment Response Function in Agricultural Land Abandonment Decisions.

seasonally because of the weather's effects on production, and in the longer term because of the ineffectiveness of the cash food market with its many intermediaries between the producers and consumers. However, in this study, we are more concerned with the annual food price behavior. The total staple food produced in the cocoa-food sector can be divided into the subsistence and the cash food proportions. We will assume that 80 percent of the food produced on farms is also consumed on farms. The rest of the food is sold and purchased in the cash food market.

The degree the farmers would rely on the cash food market is determined by the agricultural population's total demand for calories, the stability of cash food prices, the food price level, and the farmer's total cash income from cocoa. For example, if annual cash food prices fluctuates a great deal, it will increase the farmers reliance on their own production to meet their consumption. In addition, the reliance also depends on the ratio between the value of the cash food consumed by the agricultural population, and the total cash income farmers obtain from cocoa. Thus, decreases in either the market price of food or costs of agricultural production, or increases in cocoa output or cocoa price would increase farmers reliance on the cash food market.

Annual Average Yield of Output

The three factors that determine the annual average yield of food and cocoa are (1) the secular trend effect as past experience, improves farmer production methods; (2) the intermediate change in yield potential resulting from adoption of new, improved, cultivational and managerial practices in the preceding years, and (3) farmers' short-term harvest response to the prevailing price.

The inclusion of the first factor is an attempt to model the often-observed phenomenon where yields from established trees increase in time as farmers, learning from one another and personal experience, improve on their cultivational methods, without necessarily adopting any new technology. The yield would thus move towards its biological potential as a function of a time-variant learning curve. Although the effect of the time-variant output increase is very small, we have included its contribution in computing the annual average yield of cocoa and food.

When farmers rehabilitate their present cocoa trees by using improved cultivational methods, the output increase is often lagged. For example, the use of fertilizer on cocoa trees does not increase cocoa output in the same year, but a year later, after which the output-increase resulting from the initial fertilizer use begins to decrease unless fertilizer is applied continuously.

The most significant factor that determines the annual output from cocoa trees is the short-term output response. This is obtained by multiplying the ratio between the prevailing producer price and the normal expected price (assumed to be the exponential average of the past ten years' producer prices), by the exponential value of the harvest response elasticity. In this study, the harvest elasticity of cocoa is assumed to be 0.05. If the prevailing producer price (the numerator of the ratio), is higher than the normal price (the denominator of the ratio), the price ratio will be greater than one. Hence, the short-term output response, which is obtained by multiplying the exponential value of the harvest elasticity, is positive. If the prevailing producer price is much higher than the normal price, the price ratio is also larger. The consequent short-term response for that year is likewise higher. However, if subsequent producer prices continue to remain high, the value of the normal producer price in the denominator also increases, which in turn, decreases the price ratio. The decrease in the price ratio results in a relative cutback of the short-term output response even though the producer price may still be increasing, as farmers regard the higher price as "normal."

Food and Cocoa Production

In computing food production, the component first calculates the food land necessary to meet the subsistence demand of the agricultural population. The remaining food land goes for cash food production. Total annual food production is the sum of the product of the annual average food yield per acre and the subsistence and cash food acreages, and the amount of staple food intercropped between gestating cocoa trees. Total cocoa production is the sum of the product of the average yield of the various productive charts of the four cocoa substreams, and their respective acreages.

Food and Cocoa Marketing

The amount of food sold in the cash food market is obtained by subtracting the subsistence amount consumed on farms from the total food output (after accounting for the food loss due to spoilage and waste). In this study, we shall assume the market loss factor for food to be 5 percent, and cocoa to be 20 percent. Since the domestic consumption of cocoa is very low, we assume that all the cocoa produced (after accounting for the field loss) is sold. We further assume that all cocoa sold is also exported within the same year, with no government inventory.

Input Accounting

The component also computes and accounts for all the input requirements--land, labor, and material, and their respective costs for food and cocoa production and marketing. In this study, we assume that the supply functions of all the purchased inputs are perfectly elastic and the inputs are available at an average constant per unit cost, with no constraints. This may not necessarily be true in reality. The derived supply functions of the various inputs may vary according to the amount produced and, with a time lag, the demand's interaction. The supply functions of the inputs may even be discontinuous if there are any institutional constraints or market barriers.

Output Accounting

Finally, the component computes the total annual income generated from food and cocoa, and the capital formation accrued to the agricultural land.

The total income from food is obtained by adding the income in kind for the food produced and consumed on the farm, and the income from the food sold at the farm-gate level in the cash food market. Since all the cocoa output is marketed, the total income from cocoa is obtained from multiplying output by the producer price in the prevailing year.

The capitalized value of agricultural land is obtained by dividing the annual average returns in an acre of land by the prevailing interest rate, which we assume to be 6 percent throughout the planning horizon. The total capitalized value in the ecological zone is the sum of the values of the total acreages. The approach used to obtain the capitalized value may be an oversimplification, since it does not take into explicit account the differential income-generating capacity of the cocoa trees of varying productive stages. Nevertheless, it provides a very useful quantitative basis to account for the capital formation in agricultural land which may result from the expansion of cocoa and food acreages. In turn, the increase in the capitalized value of agricultural land not only increases the 'wealth level' of farmers but also the collateral value of their assets, enabling them to borrow more capital should they need it for further agricultural expansion. It should also be mentioned that the capitalized value of an acre of agricultural land can be increased by the increase in output, output price and decrease in the cost of production. Furthermore, the change in the interest rate in the economy affects the capitalized land value.

4. Price Generation Component

This component calculates (1) cocoa producer prices from world prices which are specified externally at the beginning of the policy experiment, and (2) the food producer and market prices which are determined endogenously throughout the simulated time period of the planning horizon.

Cocoa Prices

The three relevant price functions in this study of the cocoa industry are (1) the world price which the economy gets for its exports, (2) the market price which the marketing board gets after accounting for the export duties and produce sales tax, and (3) the producers' price which the farmers get after accounting for the marketing board trading surplus and the administrative and handling costs from the marketing price.

In this study, the world price function of cocoa is specified exogenously at the onset. Ideally, the world price function that Nigeria faces should include the dynamic interactions of Nigeria's output in the world market because a relative increase in that output may create an excess supply, thus decreasing the long-term world price. The annual foreign exchange generated from cocoa exports is obtained by multiplying the annual export by the annual cocoa world price.

To simplify the analysis, we combine the export duties and producer sales tax as government revenue, and further assume that the revenue, marketing board trading surplus and the handling charges are predetermined proportions of the world price and market price of cocoa. According to the government revenue and marketing board stabilization policies, these proportions could also vary in rates and time duration.

Food Prices

The market price of food in the cocoa sector is conceptualized to depend on the total supply and demand of the cash food market in South Nigeria. It is calculated by using the price elasticity (assumed to be -0.3) for the demand of food in all of the region. On the other hand, the producer price of food is obtained by subtracting the 70 percent assumed to be detained by the various market intermediaries from the market price of food. We have not attempted to model in detail a sector-specific food price determination mechanism.

5. Policy Entries Component

The model is built to provide a quantitative basis for projecting the likely consequences of (1) the government production campaigns to encourage cocoa farmers to replant their relatively low-yielding trees with higher-yielding trees, and newly plant the higher-yielding trees in land now in food or bush; and (2) changing the government revenue and marketing board producer pricing policies.

Production Campaigns

The three basic analytical features in the production campaign executive routine are (1) a time profile to show when the program is first initiated, begins to reach its maximum, phases out, and terminates; (2) a budget profile to show the annual budget and total budget appropriations; and (3) an intra-budget allocation for administrative overhead and technical assistance and personnel, subsidy for inputs, and direct cash grant to the farmers in the production campaign package.

Government Revenue and Marketing Board Pricing Policies

As previously discussed, the total taxes the government and marketing board collect from the cocoa producers are the export duties and producer sales tax and marketing board trading surpluses. These we assume are predetermined proportions of the respective prevailing world price and market price. The annual government revenue and marketing board trading surplus are then accumulated for comparison. These proportions, however, may be varied, phased out, or cut off according to the government fiscal policies.

In this study, we introduce a rudimentary guaranteed producer floor price feature (recommended by CSNRD), in which cocoa farmers are paid at least the floor price should the producer price (after accounting for the revenue tax and the accumulated trading surpluses) go below that level. The guaranteed producer price of cocoa is supported by previously accumulated trading surpluses. As we shall see, this guaranteed price is especially relevant if future world prices of cocoa are expected to be low and fluctuating. The producer price guarantee operating from the accumulated marketing surpluses may thus stabilize the farmers' annual income from the fluctuations of the world price of cocoa, and increase their income in the years when the world price of cocoa is low.

6. Aggregative Sector Accounting Component

This component determines the total receipts, costs of production, disposable income, consumption, savings, investment and credit of the cocoa-food sector. In our description, we shall concentrate primarily on arriving at the annual agricultural disposable income per capita of the sector. This performance index is used to evaluate the outcome of the cocoa policy experiments.

Total Receipts and Expenditures

The annual total receipts in the zone are obtained by adding the income from the production of cocoa, the income in kind and cash from food, and the investment in the form of loans coming from outside the sector. The total expenditure by the sector includes the total cost of production for the use of chemicals, biological materials, and the amortized cost of equipment, debt services and interest payments as well as cash food expenditures.

Agricultural Disposable Income per Capita in Cocoa Sector

Total disposable income is obtained by subtracting total receipts from total expenditures. Disposable income is further constrained to cover at least the other major nonfood expenditures such as housing, poll tax, children's school fees and festivals. Any shortage of income is made up by external borrowing. Finally, sectorial per capita disposable income is obtained by dividing the total disposable income by the population which is assumed to increase by 2.2 percent per annum.[3] It is obvious that per capita income would be affected directly by the change in the rate of the population increase. In this study, we are more interested in the relative changes of the projected outcome under alternative government cocoa policies than in the absolute values of the projected outcome. Thus, a different rate of population increase would not appreciably affect the relative order and values of the projected outcome unless the actual population rate increase is drastically different from the assumed rate. Such a drastic increase would affect the fundamental, underlying conceptual framework of the model and analysis.

Model Validation and Testing

Before we present the cocoa policy experiments and their simulated results in the following chapter, we shall discuss briefly the validation tests conducted by the Nigerian Agricultural Simulation Team. These tests determine how well the system model simulated the relevant behavior of the real system. In addition, we should view the present phase of policy experiments conducted on the cocoa economy as part of the continuing process of the validation of the system model, and its usefulness as a tool of policy analysis and developmental planning. The projected results of the model (using alternative policies) can be compared in terms of the reasonableness with received economic theory, other empirical observations and the judgments of experts on the Nigerian agricultural economy.

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[3]For more information, see Chapter VI, "The Population Model," in Manetsch et al. (1971).

There are three major overlapping and reinforcing ways to validate the model. The first method (alluded to in the above discussion) compares the structure of the model and its simulated outcome using alternative assumptions about its behavior from experts on the economy and other published secondary sources. However, this process may be too personalized, judgmental, intuitive, and rather difficult to replicate.

The second approach is more rigorous and concrete. Behavior predicted by the model under various policy conditions can be compared with what actually occurs as real time passes under the same conditions. However, this approach is not very useful for policy planning, since the purpose of the model is to project the possible consequences of the proposed policy alternatives before they occur! Nevertheless, when real time passes, the model can be tuned and updated as an on-going process by comparing the simulated results with the real world data. A complementary approach is to track the simulated results with historical data from the real world which are not used in the model-building process. The model can be tuned by tracking one or more time series of past behavior by adjusting (through sensitivity tests) the values of certain system parameters, or in some instances, restructuralizing the computing mechanisms that govern the modeled behavior. Time-series tracking and sensitivity tests, as an interwoven process of model validation, require an understanding of the real system and the simulation model in order to zero-in on the meaningful parameters and/or relevant structure for adjustments. This allows the simulated behavior to conform to experienced behavior.

Four sets of time series (exports of cocoa, palm oil, rubber, and market food prices) from 1953 to 1965 were used to tune the Southern model with the goodness-of-fit measure. Goodness of fit was one of the many possible criterias used to determine the closeness between simulated and the observed real world data (see Table 3.2).

The goodness-of-fit is measured by the squared normalized deviations between the observed real world data and the simulated value in each year of the four time series. Hence, the closer to zero the squared deviations, the better the fit between the observed real world data and the simulated data.

In addition, the author also compared the model's projected total cocoa acreages from 1966 to 1995, using the values of the model reported in Manetsch et al. (1971) with the projected acreages contained in the FAO study of the Nigerian cocoa economy. It was discovered that the simulated projection of the total acreages (assuming the same level of government expenditure on the production campaigns) was unreasonably high at 4.2 million acres in 1995. Hence, by adjusting the value of some of the model's parameters, the projected cocoa acreages in 1995 were reduced to approximately 2.7 million acres, a much more reasonable estimate. The readjustment was accomplished primarily by reducing the value of the acreage presently in bush that is available for new cocoa planting. The effect of the reduction of the value is to set an upper limit in the rate of cocoa acreage expansion.

Finally, sensitivity tests, which identify the model's parameters whose outcomes are most sensitive to their value changes,

TABLE 3.2.--Time-Series Tracking of Observed and Simulated Data of Nigerian Cocoa Exports, Palm Oil Exports, Rubber Exports, Market Food Prices (South), 1953-1965.

Year	Cocoa Exports (thous. lbs./yr.)		Palm Oil Exports (thous. lbs./yr.)		Rubber Exports (thous. lbs./yr.)		Market Food Price of South (£/lb.)	
	Data	Simulated	Data	Simulated	Data	Simulated	Data	Simulated
1953	234,463.	249,399.	451,013.	430,580.	47,622.0	57,217.3	.0100000	.0100570
1954	220,355.	258,666.	467,000.	399,597.	46,816.0	61,232.8	.0108300	.0100753
1955	198,045.	267,738.	408,000.	370,527.	68,051.0	74,560.9	.0120800	.0100857
1956	262,378.	275,423.	414,926.	342,659.	85,454.0	78,923.7	.0141700	.0100660
1957	303,072.	290,547.	372,288.	341,530.	89,582.0	87,304.2	.0120800	.0101449
1958	196,331.	309,771.	381,938.	344,892.	92,301.0	96,390.0	.00917000	.0102748
1959	319,872.	333,073.	366,670.	324,788.	119,558.	110,198.	.0104200	.0108076
1960	352,074.	355,417.	410,726.	319,494.	128,193.	123,737.	.0125000	.0108254
1961	411,964.	370,297.	368,686.	313,286.	123,574.	120,777.	.0133300	.0108882
1962	436,020.	392,714.	265,816.	262,274.	133,580.	127,519.	.0137500	.0110317
1963	392,000.	413,624.	282,240.	253,238.	141,431.	135,752.	.0108300	.0112229
1964	441,280.	434,161.	300,160.	253,072.	161,435.	139,043.	.0112500	.0114399
1965	571,200.	439,963.	336,000.	239,682.	152,038.	146,242.	.0137500	.0116414
Sum of Squares	.370560		.285964		.0985511		.336367	

Source: Abkin (1972).

can also be conducted to validate the structure of the model. Sensitivity tests, as we have indicated in our discussion in the components of the simulation model, play a very important role in model building and validation. Since the validation procedure would generally indicate some of the major weaknesses of the model requiring further development and refinement, these two processes are intimately and iteratively linked. Sensitivity tests on an individual or combination of parameters enable us to check the internal consistency of the model against the theoretical and empirical knowledge we have on the economy. This is exemplified in the preceding discussion on the effects of the reduction of bush land available for cocoa expansion in future projected cocoa acreages. Based on the model validation tests conducted by Manetsch et al. (1971), Abkin (1972), and the author, the basic features of the Nigerian Agricultural Simulation Model for policy experiments appear to be reasonably valid. Nevertheless, we recognize that the general process of model validation is still judgmental and should be viewed as an iterative and ongoing process of the model's development and application.

CHAPTER IV

POLICY EXPERIMENTS ON THE WESTERN NIGERIAN COCOA INDUSTRY: RESULTS AND INFERENCES

Introduction

The primary purpose of this chapter is to present the results of the simulation experiments used to evaluate the proposed price-income policy changes of the Western Nigerian cocoa economy. The three basic sets of assumptions tested in the policy experiments are (1) alternative world cocoa prices, (2) alternative government revenue and marketing board producer price policies, and (3) government replanting and new planting production campaigns. We shall discuss the results and the projected time paths of six of the more crucial performance indices of the cocoa industry for each policy alternative. The performance indices are (1) total output of cocoa, (2) foreign exchange generated from cocoa exports, (3) disposable agricultural income per capita in the sector, (4) total and compositional (modern and traditional) acreages of cocoa trees, (5) capitalized agricultural land value of the sector, and (6) accumulated government revenue and marketing board trading surpluses. After describing the time paths, limited policy conclusions will be drawn.

Since we are interested in the long-term developmental implications of the proposed government cocoa policies, the planning horizon of the analysis extends to 1995. A shorter planning horizon would not show the long-term effects of the production campaigns because of the relatively long gestation requirements of cocoa trees, and the communication lags in the production campaigns. To simplify the analysis, 1970 is used as a base year for the policy experiments.

Expected World Cocoa Prices

Although it is beyond the scope of this thesis to forecast world cocoa prices, the following three sets of world prices based on Bateman (1971), and the fourth (constructed by the author) were selected to illustrate their possible effects on the Nigerian cocoa economy. These are shown in Figure 4.1.

First is world price pattern "A" whose annual price per long ton of cocoa in 1970 is ₤260, rises to ₤280 in 1977, and then declines to ₤169 in 1985, and remains there until 1995. This price set represents the most likely world prices facing Nigerian cocoa exports. It assumes that the world production of cocoa will increase at 3 percent per annum up to 1975, and at 2.8 percent per annum after 1976. World consumption, on the other hand, is expected to increase at 3 percent per annum.

World price pattern "B" represents a higher price expectation than "A." It begins at ₤260 in 1970, but rises rapidly to ₤328 in 1980, remains at that relatively higher level until 1995. World production is assumed to increase at the same rates as in "A."

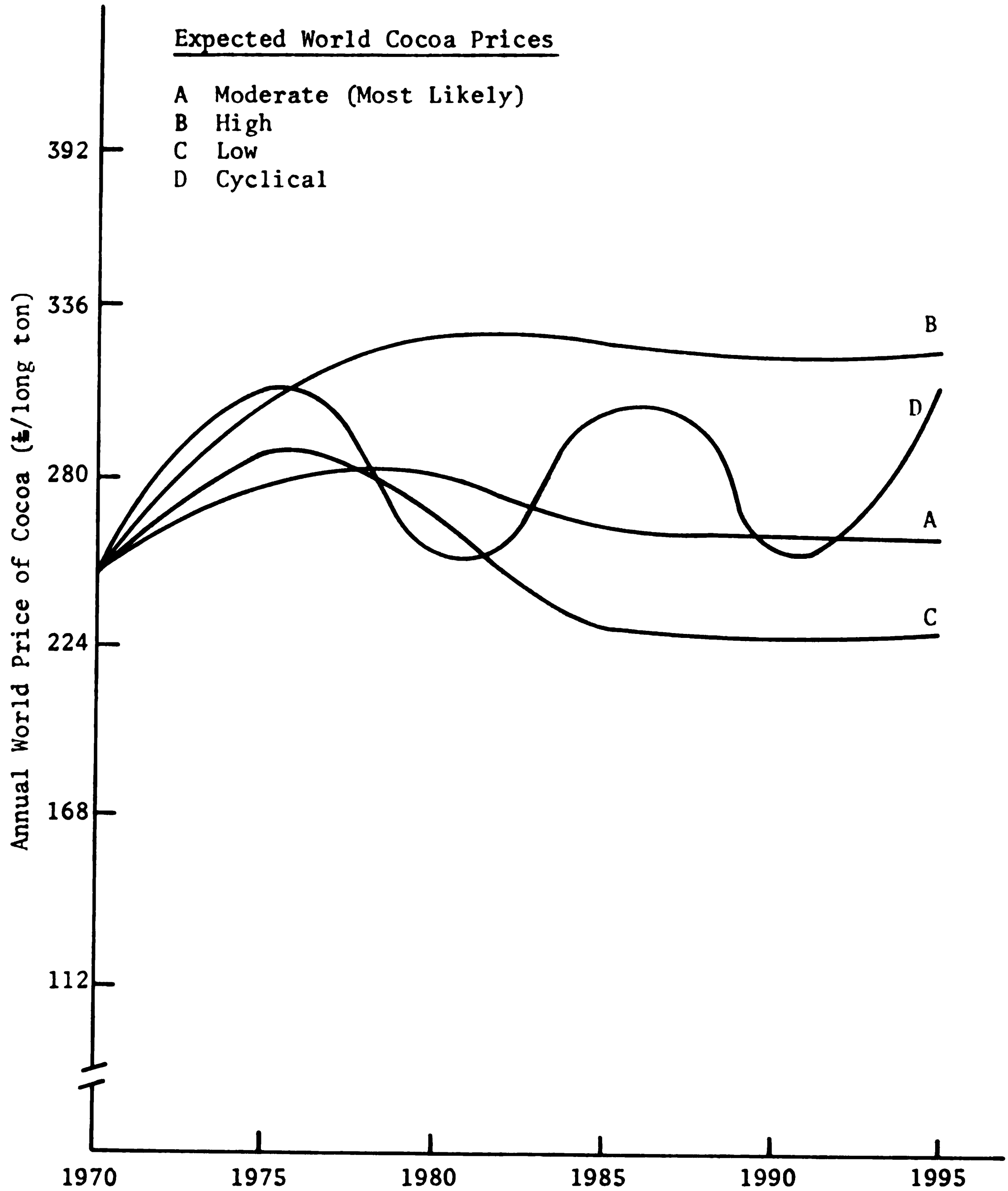

Figure 4.1.--Four Illustrative Sets of World Cocoa Prices Used in Policy Experiments on the Western Nigerian Cocoa Economy, 1970-1995.

However, increase in world consumption is higher at 3.5 percent per annum. Consequently, world cocoa prices are expected to be higher.

World price pattern "C" represents a lower world price expectation than "A." The annual price begins at ₺260 in 1970, rises to ₺288 in 1975, and then declines very rapidly to ₺230 in 1985, and remains at that level until 1995. It assumes that world production of cocoa will increase at 4.0 percent per annum to 1975, and at 4.5 percent per annum after 1976. However, world consumption will increase at a lower rate, at 3.0 percent per annum, resulting in lower world prices.

World price patterns "D," constructed by the author, represents a cyclical world price behavior which begins in 1970 at ₺260, increases to ₺310 in 1975, declines to ₺225 in 1980, and then increases again to ₺305 in 1985. The cycle repeats itself for the next ten years until 1995.

Government Revenue, Marketing Board Producer Pricing Policies and Production Campaigns

As indicated in Chapters II and III, prices farmers get for their cocoa are generally less than the world prices. Export revenue, producer sales tax, marketing board trading surplus and administrative costs account for the difference. For simplification, we have combined the first two as government revenue, and further assume the revenue tax and the marketing board trading surplus are predetermined percentages of world and market prices respectively. In this study, we have incorporated a guaranteed floor price feature (recommended by CSNRD), with farmers paid a predetermined minimum should the producer price (after accounting for the government revenue and marketing and handling costs) go below that level. The guaranteed floor price feature is especially relevant if world prices are expected to be low and fluctuating. The guarantee may thus stabilize farmers' income and the capitalized value of cocoa land.

Government Revenue and Marketing Board Producer Price Policies

The four basic sets of government revenue and marketing board alternatives used in the policy experiment are (1) a status quo policy with a relatively low tax rate based on 10 percent of world prices and 20 percent of market prices prevailing throughout the planning horizon; (2) a higher tax policy of 20 percent and 30 percent of the world and market prices at the beginning of the policy experiment, which would be phased out linearly over the following five years; (3) the same higher taxes as in alternative 2 at the base year, which would be cut off the following year; and (4) the lower tax rates as in alternative 1, with the additional producer floor price feature guaranteed at ₤168 per long ton.

Government Cocoa New Planting and Replanting Production Campaigns

As indicated earlier, the Nigerian government is encouraging cocoa producers to increase their output capacity by (1) replanting their present lower-yielding Amelonado trees with the higher-yielding Upper Amazon trees, and (2) newly planting the Upper Amazon trees on land which is now in food or bush. In this study, we shall assume that the campaign begins in 1971, and that the total budget allocated and financial assistance features for the new planting and replanting production campaigns are identical. The total government budget for each campaign is ₺25 million for the next ten years.[1] The total cash grant for each replanted and newly planted acre is ₺10; the biological materials and chemicals required for establishing the trees are subsidized at 50 percent of their market prices. The study further assumes that the higher-yielding Upper Amazon cocoa trees would be adopted by the farmers only as a result of the government production campaigns. This, however, is not necessarily true, as we shall see in our discussion on the simulated results.

The cocoa tax policies and production campaigns are now combined and grouped into five basic policy options. The first is a base run which approximates the present policy. The tax rates are relatively low with no government-initiated production campaigns. The next three runs compare the effects of the production campaigns with varying tax features. In Run 2, the government initiates the new planting and replanting production campaigns with the same tax rates as in Run 1. The tax rates of Run 3 and 4 are assumed to be higher at the onset (1971), and cut off completely the following year in Run 3, whereas in Run 4, they are phased out linearly over the next five years. The purpose of these two runs is to compare the effects of the short-term harvest and long-term output capacity

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[1]In previous studies reported in Manetsch et al. (1971), and Olayide et al. (1971), experiments using different combinations and levels of financial assistance to encourage farmers to adopt new agricultural technology were conducted. According to the simulated results, increases in the government expenditure yielded diminishing marginal returns.

expansion responses discussed in Chapter II. It is hypothesized that the output responses from the "dramatic" producer price increase of Run 3 would differ from the gradual producer price increase of Run 4. The effects of the guaranteed producer floor price (proposed by CSNRD) are tested in Run 5. The tax features and the production campaigns are similar to Run 2, except that in Run 5, future producer prices are guaranteed at ₺168 per long ton.

Results of Policy Experiment Assuming Moderate (Most Likely) World Cocoa Prices

The world market and producer prices (after accounting for the various tax, trading surplus, handling costs), and the guaranteed producer price are shown in Figure 4.A1.

There are two interesting observations concerning the projected outputs of the five policy options as seen in Figure 4.A2. First, the projected outputs of Runs 2 to 5 (with the production campaigns) are in all cases greater than Run 1 (without the production campaigns). However, we should interpret the simulated results with caution. The projected cocoa output of Run 1 (without the production campaigns) may in reality be higher had we allowed farmers to adopt the higher-yielding Upper Amazon cocoa trees in the absence of the government-initiated production campaigns. Consequently, the present conceptualization may have also created a downward bias in the values of the subsequent performance indices of Run 1, when compared to the other runs which assumed the government-initiated production campaigns. The obvious research implication for future policy experiments is to allow cocoa farmers to grow the

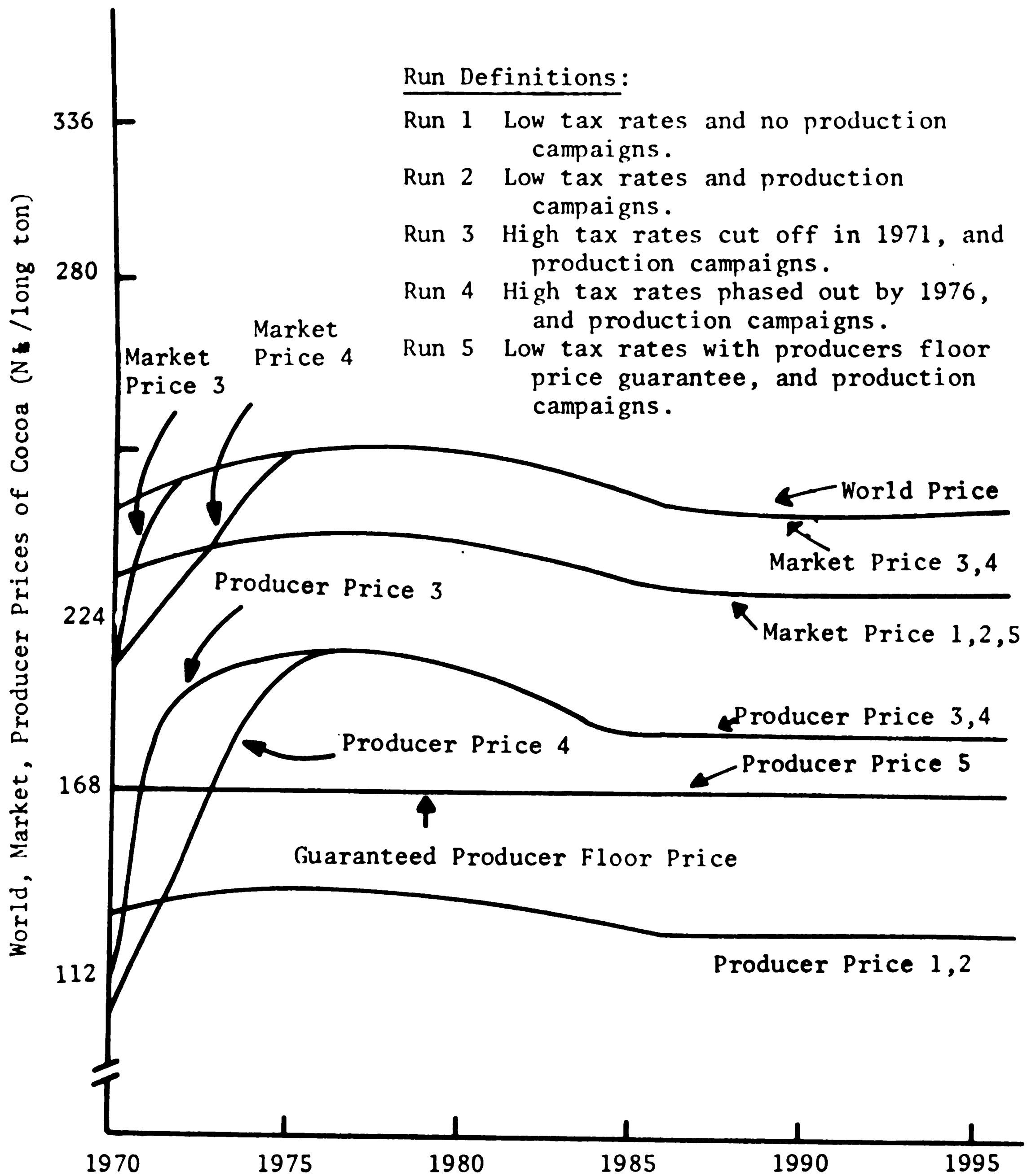

Figure 4.A1.--Market and Producer Prices of Nigerian Cocoa under Indicated Policy Alternatives Assuming Moderate (Most Likely) World Prices, 1970-1995.

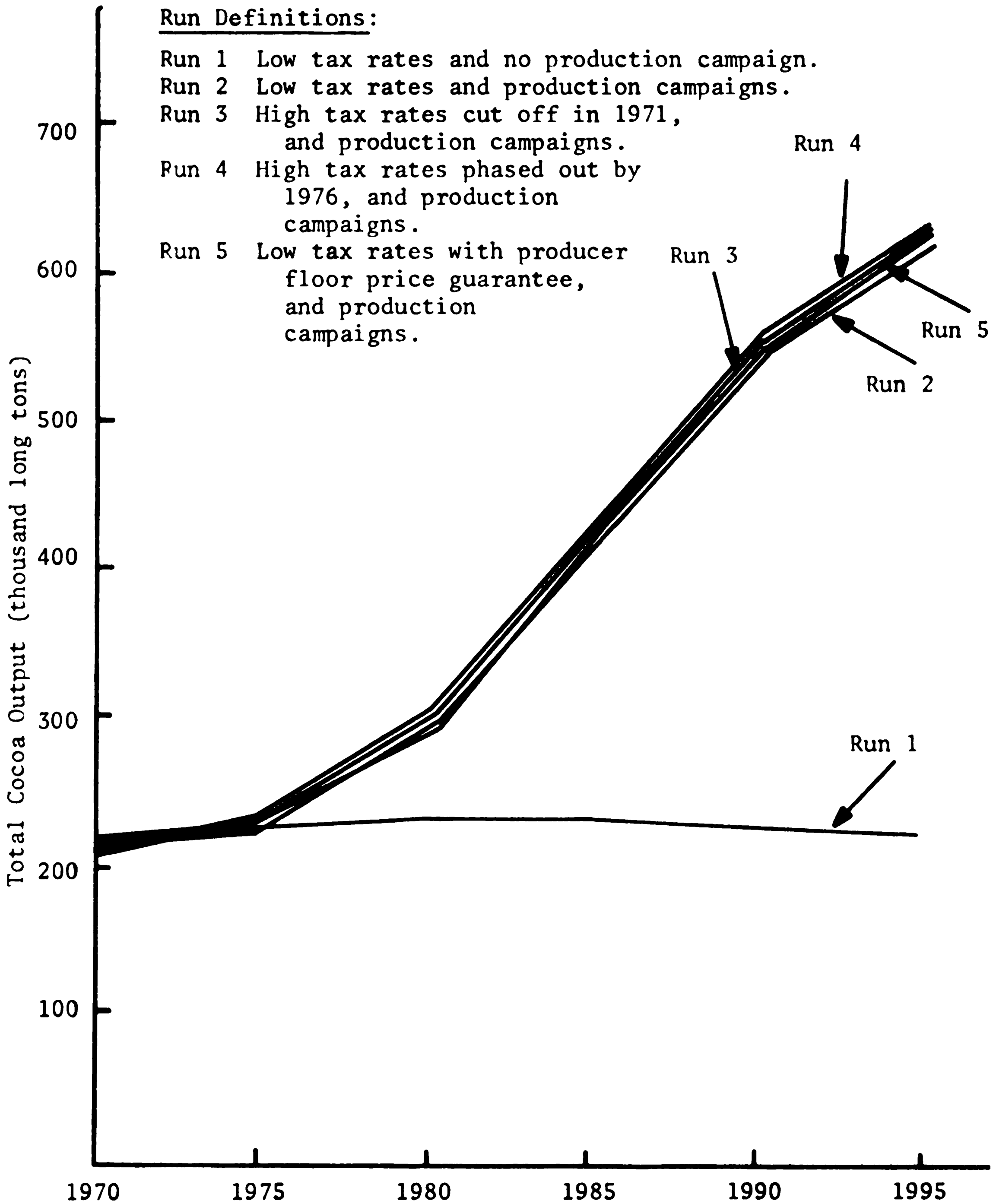

Figure 4.A2.--Total Projected Nigerian Cocoa Output under Indicated Policy Alternatives Assuming Moderate (Most Likely) World Cocoa Prices, 1970-1995.

higher-yielding Upper Amazon trees outside the purview of the production campaign mechanisms.

Second, the projected annual cocoa outputs differ among the four runs because of the farmers differential short-term and long-term output responses, which result from the varying tax, trading surplus and producer guaranteed floor price features of each run. However, despite the different producer pricing policies of Runs 2, 3, 4, and 5, their projected outputs are very close. The apparent cluster can be explained by recalling (1) the farmers' allocative decision mechanism for long-run output capacity expansion responses, and (2) farmers' short-term harvest response to price changes--that determine the annual projected output of each run.

While it is true that the average producer price of Run 3, for example, averages about £20 (per long ton) higher than Run 5 throughout the planning horizon, their discounted values to the base period (and therefore differences) are much smaller. Since we have conceptualized (1) the farmers' decision to expand their cocoa acreages to be based on the relative profitabilities of their net present value, and (2) the final cocoa land expansion to depend on the threshold and response rate parameters, the resultant differences of the projected cocoa acreages among the four pricing options are very small. Recalling the land allocative mechanisms in the model, we see that the effects of the producer price differences among the price alternatives are minimized by the time preference discount rates, and further reduced by the threshold and response rate parameters. As a result, the values of the threshold and response rate parameters become the dominant factors in determining the final projected cocoa acreages.

Because the annual cocoa outputs of the various runs depend on their projected total and compositional cocoa acreages, their projected time paths do not differ very much on an absolute basis. Moreover as we shall see, the initial differences in the short-term annual harvest responses resulting from the different producer pricing policies are soon dissipated as the farmers begin to regard their respective prices as "normal." Although the differences in the various produce prices persist throughout the planning horizon, the differences in the projected output from the cocoa acreages (resulting from their short-term harvest responses) under alternative pricing policies are comparatively small. Nevertheless, the relative differences and ranking of the projected output are noteworthy.

In general, the annual output of Run 4 with the tax phase-out feature is highest, followed very closely by Run 3 with the tax cut-off feature. Superficially, we would have expected the output of Run 3 to be always higher than Run 4, since the producer prices of Run 3 between 1972 and 1975 are higher than in Run 4. This paradox can be explained by examining the dynamic nature of the farmers short-term and long-term output responses to price changes. Given the higher producer prices of Run 3 with the tax cut-off, the projected annual output of Run 3 in the first four years, is higher than in Run 4. However, the short-term output effects of the higher producer prices are soon dissipated as the farmers begin to regard the relatively higher prices as normal. As we recall in our discussion on the model's agricultural production and marketing component in Chapter III, the farmers' short-term harvest response with price changes depends on the ratio between the prevailing producer price, and the exponentially averaged "normal" price of the preceding years. Thus, with the dramatic producer price increase in Run 3, the exponential average price also increases, with the net effect of decreasing the price response differential, and thus, the farmers' short-term output responses.

The higher producer prices of Run 3 in the initial years also stimulated the cocoa farmers' long-term output responses by expanding their cocoa acreages. Due to the time-lag nature of the promotion and diffusion effects of the production campaigns, the peak effects of the campaigns initiated in 1971 would not occur until the late '70s. Hence, as seen in Figure 4.A4, many of the new trees in the early 1970s are of the traditional lower-yielding Amelonado variety. On the other hand, the long-term output responses of Run 4, with the tax phase-out feature, is such that the producer price increase occurs concurrently with the full effects of the production campaigns. Consequently, more new cocoa acreages in Run 4 consist of the higher-yielding Upper Amazon trees recommended by the production campaigns.

The compositional differences of the long-term output responses between Runs 3 and 4 manifest themselves in the projected output of the 1980s when all these new trees come into production. The higher projected output in Run 4 is maintained since the output from the modern trees is much higher than that of the traditional varieties. Hence, with the exception of the first four years, the projected output of Run 4 throughout the planning horizon is consistently higher than in Run 3. The output of Run 5 (with the guaranteed producer price of £168 per long ton) is higher than that of any other run at first, since the producer prices of all the other runs are below that price. However, the projected outputs of Runs 3 and 4, surpass Run 5 after 1976. On the other hand, the projected output of Run 5 (with the guaranteed floor price) is generally higher than Run 2 (without the guarantee).

At this juncture it may be helpful to examine the reasonableness of the simulated cocoa outputs based on the system model with the econometrics approach, a procedure used frequently to estimate (and project) output responses with proposed price and technological changes. As we have indicated earlier, because of data limitations, the estimating equations in past econometric studies on cocoa production were formulated (and eventually estimated) in simple, causal, linear and additive terms. No formal attempt was made to incorporate explicitly the interactions, and the positive and negative feedbacks that must exist among *current* output, output capacity, price and *anticipated* technological changes. Since the econometric approach was empirically-based, it was methodologically difficult to establish or validate statistically such complex interactions and processes postulated in the system model of the present study. Hence, we shall make the case that it is only within a dynamic system simulation and cybernetic framework[2] that these postulated interactions and feedbacks can be investigated. Furthermore, it is only within the system framework that the close cluster and resultant steady-state equilibrium (homeostasis) of the various output projections, despite the varying pricing policies of Runs 2, 3, 4 and 5 (with the production campaigns), would appear logical and internally consistent. Because of the negative, price-output feedback mechanisms[3] in the system model, the annual short-term harvest, output responses resulting from the producer price differences of the various policies alternatives are eventually dissipated, reaching--in time--steady-state equilibrium (Boulding, 1972).

Nevertheless a fundamental question remains concerning the realism of the model's projected cocoa output for the various price policy alternatives (with the production campaigns). Under the model's conceptualization, despite the producer price differences among the policy alternatives, the projected cocoa acreages do not differ considerably. Furthermore, because of the projected closeness of the cocoa acreages (based on the model's land allocation

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[2]For more explication of the system view-of-the-world (Weltanschauvung), see Boulding (1972), Forrester (1972), Laszlo (1972), and Von Bertalanffy (1972).

[3]An example of a controlled positive feedback (established in Manetsch et al. (1971) where the outcome combining the producer price increases and government production campaigns was synergistically greater than the sum of each of the program if they were promulgated independently. An example of an uncontrolled positive feedback effect would be if the projected cocoa outcome resulting from high producer prices was unstable and "explosive." Hence, to ensure that such an "explosive" outcome would not occur, the projected output derived from the model also depended on the availability of other resources (e.g., suitable agricultural land and credit).

mechanism), and the postulated short-term harvest response mechanisms, the projected annual cocoa outputs do not differ appreciably.[4] On the other hand, received economic theory (and common sense) would suggest a wider divergence among the runs (rather than the present cluster) for the projected cocoa acreages and cocoa output. As such, the present mechanisms for determining the short-term and long-term output responses may be limited in capturing the farmers actual output response behavior. Specifically, the land allocation mechanisms may have to be modified such that the expansion rate of cocoa acreages would be more sensitive to the differences and changes in producer prices. Based on the present model, the effects of the producer price differences on the long-term output responses are obscured by the dominating influence of the threshold and response rate parameters.

Likewise, the present short-term harvest response mechanism (which assumed that the initial output increase resulting from a price increase would diminish with time) may have to be modified. An alternative formulation may show that while the initial output increase resulting from the price increase may eventually decline, the final equilibrium level would be higher than the initial level. The final equilibrium level of the short-term harvest increase should therefore depend as well on the absolute level of the producer price increase. By the same token, there is an upper limit (bounded by the biological yield capacity and compositional acreages of the trees)

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[4]For example, in 1990, the projected annual output difference between Runs 2 and 4 is approximately 20,000 long tons (or 3 percent of the average value of the projected outputs), and the difference in their producer prices are ₵58 (or about 33 percent value of the average value for the two prices). Hence, the crude composite output elasticity is 0.01.

in the short-term harvest response with producer price increases. Thus, no matter how high the producer price increase may be in any one year, there is an upper limit to its output increase. Consequently we should interpret the projected results of the four runs with the production campaigns with caution. The differences in their projected output and output capacity may in fact be greater.

The annual foreign exchange generated from cocoa exports is obtained from the annual output multiplied by the annual world cocoa price. Thus, the relative order of the foreign exchange projections under the five policy runs, shown in Figure 4.A3, depends on the relative order of the projected output. Likewise, since the projected value of the annual agricultural disposable income per capita in each run depends primarily on the total annual sectoral income (obtained principally by multiplying annual projected output by producer prices), the relative order of the five runs also corresponds to the order of theoutput. The rapid decline of the agricultural income per capita of Run 1 after 1980 is caused by the increase in population without the commensurate increase in agricultural production (see Figure 4.A4).

From Figure 4.A5, we see that projected total cocoa acreages in Run 3 are highest in 1995, even though projected output that year is slightly lower than in Run 4. Since the higher acreages in Run 3 are due primarily to a higher proportion of the lower yielding traditional trees, the projected output in the latter years is lower. Because of the generally lower producer prices of Runs 2 and 5, their projected cocoa acreages are also lower.

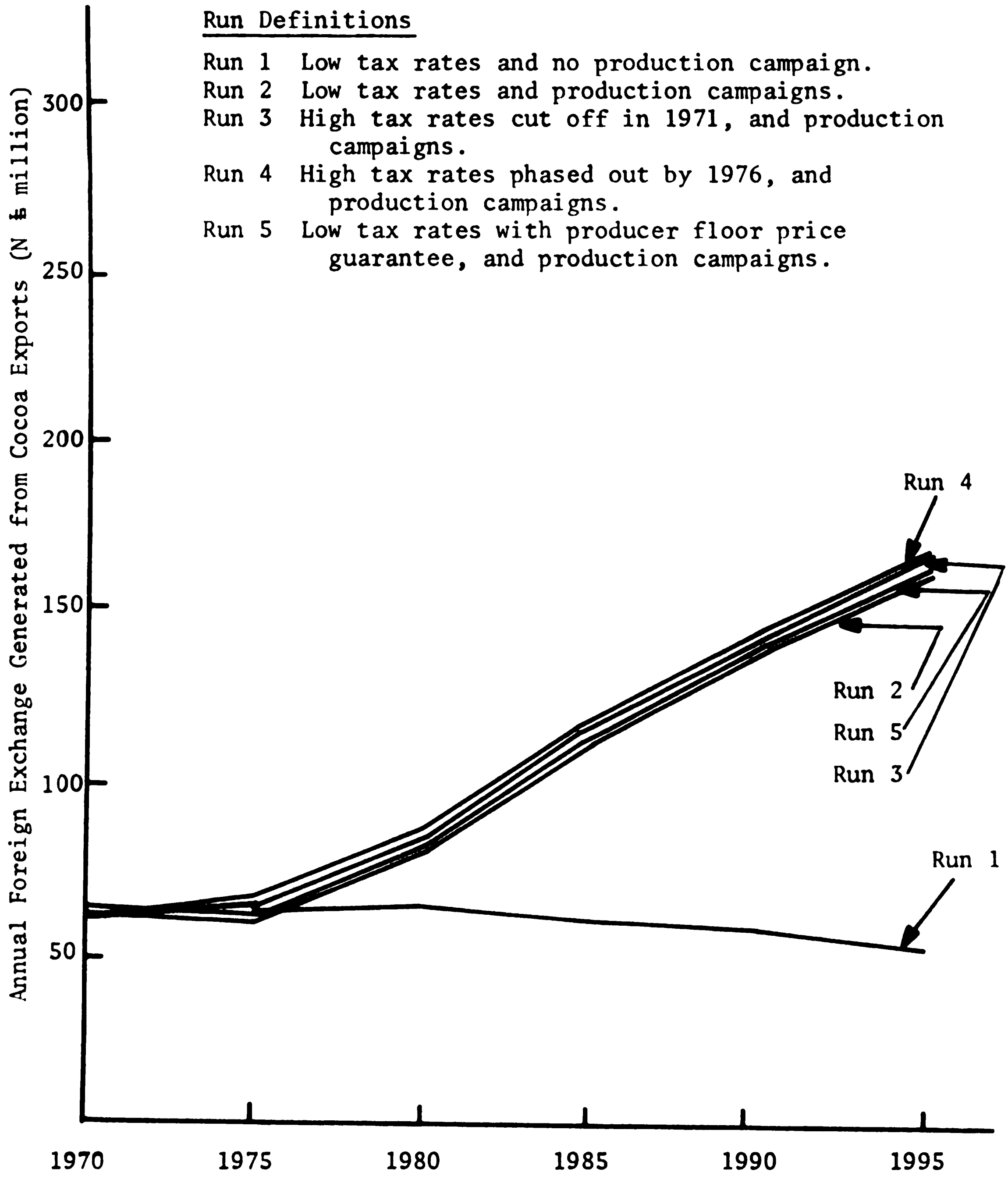

Figure 4.A3.--Foreign Exchange Generated from Nigerian Cocoa Exports under Indicated Policy Alternatives Assuming Moderate (Most Likely) World Cocoa Prices, 1970-1995.

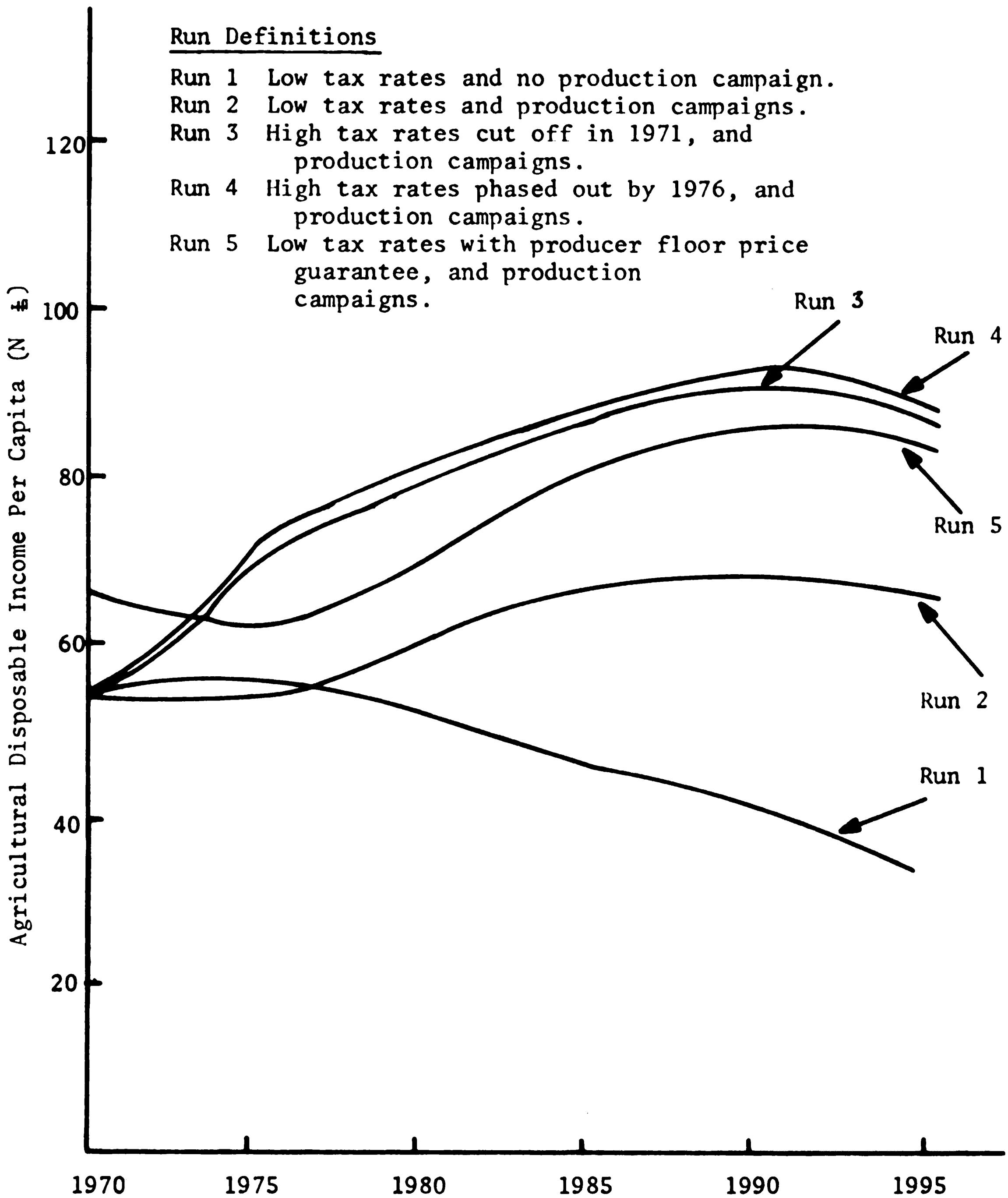

Figure 4.A4.--Agricultural Disposable Income Per Capita in Nigerian Cocoa Sector under Indicated Policy Alternatives Assuming Moderate (Most Likely) World Cocoa Prices, 1970-1995.

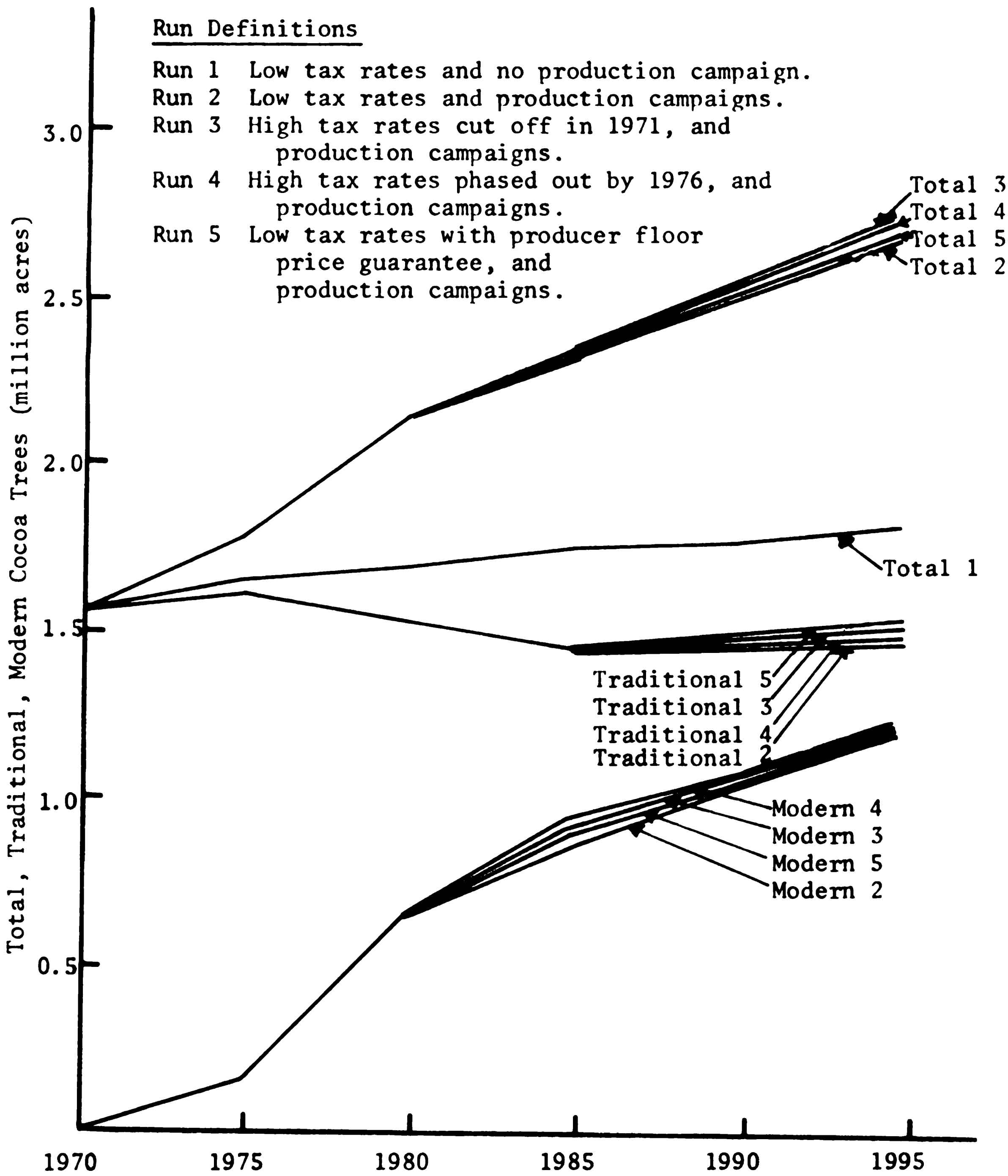

Figure 4.A5.--Total, Traditional and Modern Nigerian Cocoa Acreages under Indicated Policy Alternatives Assuming Moderate (Most Likely) World Cocoa Prices, 1970-1995.

The order of the projected capitalized land value in the ecological zone in Figure 4.A6 follows very closely the order of the total and compositional acreages of cocoa land. The land value of an acre of cocoa land (based on its amortized annual average returns) is much higher than an acre of food land, so if the relative composition of food land in the total agricultural land changes, it would not appreciably affect the capitalized land value of the zone. Although the total cocoa acreages are higher in Run 3 than in Run 4, the total capitalized land value of Run 4 is always higher than Run 3, because of Run 4's relatively higher proportion of modern trees. The exception is in the initial years where the capitalized land value of Run 3 is highest because of the effects of the dramatic producer price increase when the producer taxes were removed.

Since what is generally the farmers' income gain is the government revenue and marketing board loss, the rankings of the accumulated government revenue and the marketing board trading surpluses of Runs 2 to 5 in Figure 4.A7 are in the reverse of the projected disposable agricultural income ranking in Figure 4.A5. Hence, Run 2 (without the tax reduction) also has the highest accumulated revenue and trading surpluses. The accumulated funds are very low in Run 4 (with the tax phase off) and close to zero in Run 3 (with the tax cut-off). The relative loss in the accumulated trading surpluses of Run 5 (with the guaranteed floor price) is compensated for by the increase in output, foreign exchange, and disposable agricultural income per capita when comrared to Run 2 (without the guaranteed floor price). The accumulated government revenue of

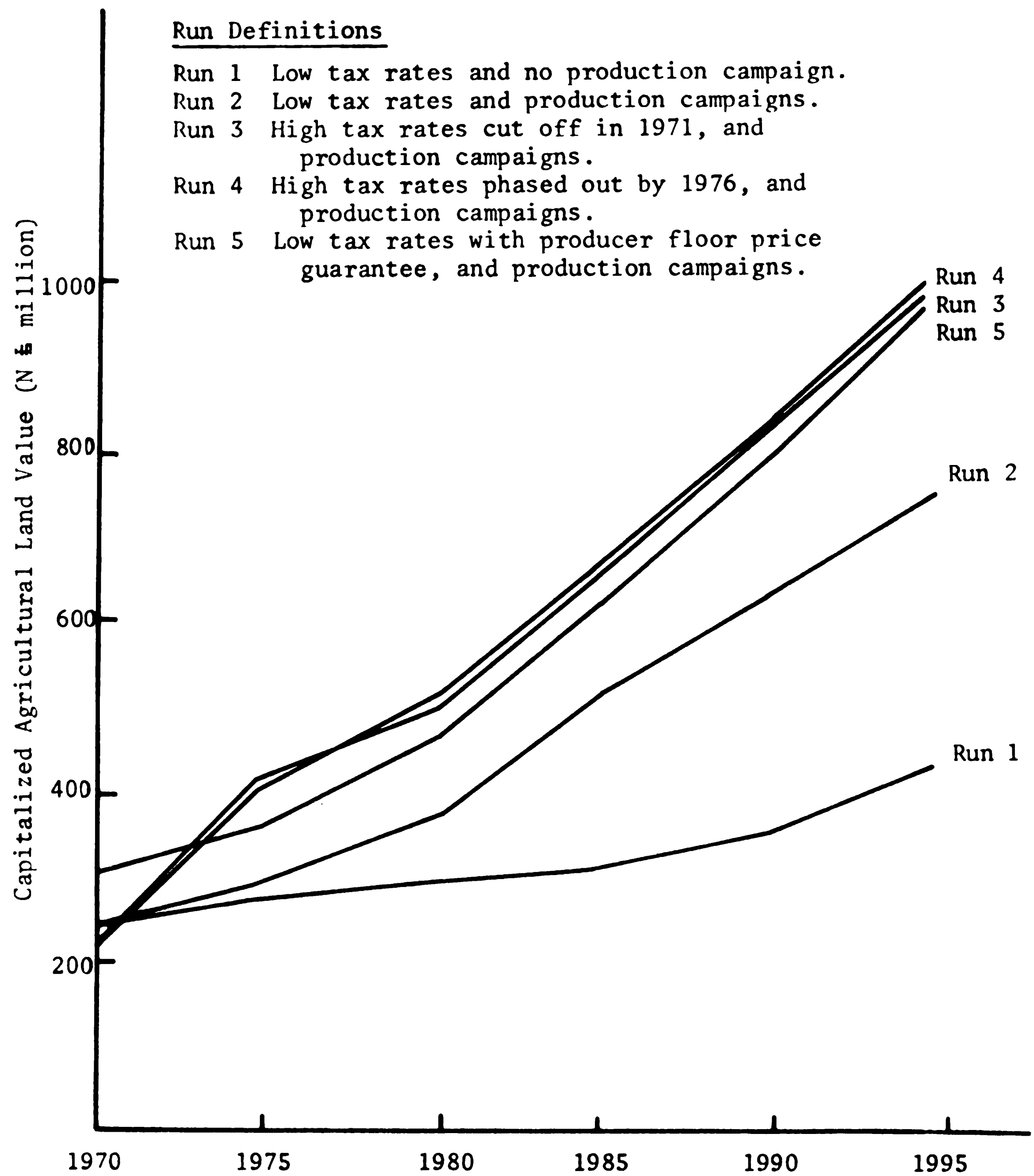

Figure 4.A6.--Capitalized Agricultural Land Value in Nigerian Cocoa-Food Ecological Zone under Indicated Policy Alternatives Assuming Moderate (Most Likely) World Cocoa Prices, 1970-1995.

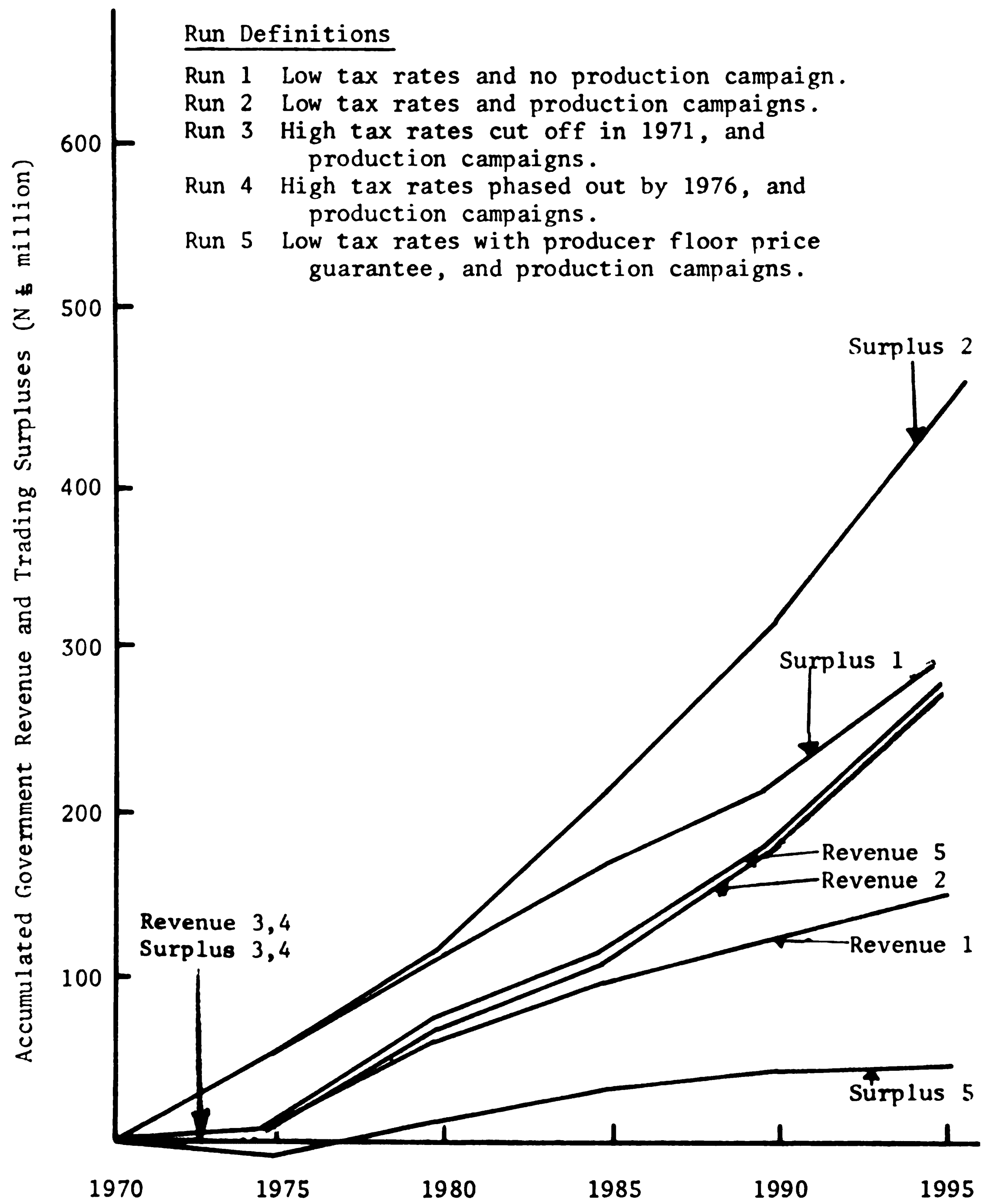

Figure 4.A7.--Accumulated Government Revenue and Marketing Board Trading Surpluses from Nigerian Cocoa Production under Indicated Policy Alternatives Assuming Moderate (Most Likely) World Cocoa Prices, 1970-1995.

Runs 2 and 5, on the other hand, are relatively close since their projected outputs are very close and their government revenue rates are the same.

However, we should interpret the results of the projected agricultural income per capita, and government accumulated revenue and trading surpluses with caution. Government revenue and trading surpluses under the various policy runs in the simulation experiment are simply accumulated. No attempt is made to show the dynamic, multiplier effects on the total economy that may result from the government's reinvestment of the accumulated funds. In reality, the government would probably invest the accumulated funds on projects that may directly, or indirectly affect the welfare of the farmers. For example, the government could invest the accumulated funds generated from Runs 1, 2, and 5, in public service projects, such as health and education, which could increase the welfare of the farmers, without necessarily increasing their income level. However, the present model is not able to show the nonmonetary benefits that may result from these investments. Hence, there is an upward income bias in the projected income of Runs 3 and 4, when compared to the projected income of Runs 1, 2, and 5, where producer taxes prevailed throughout the planning horizon.

Although it is not within the scope of the thesis to discuss the merits of alternative agricultural taxes, it should be pointed out that the loss in government revenue from the producer tax cut-off or phase-out can be compensated by imposing alternative forms of taxes on the farmers. For example, the government can also collect taxes from the farmers increased income, asset land value, or from their increased purchase of producer and consumer goods that result from the increased income which has, in turn, resulted from the increase in producer prices augmented by the subsequent increases in production and productive capacity. However, because of the distributional differences and inter-temporal trade-offs, such revenue compensations are not equivalent to one another (Hicks, 1969).

Results of Policy Experiment Assuming High World Cocoa Prices

In this set of runs, future world cocoa prices are assumed to be higher than in the previous set. The price increase is more rapid and it remains at a higher level than under the moderate price assumption. As a result, the absolute producer prices under the five pricing policy options are also higher (see Figure 4.B1). Consequently, the farmers' short-term and long-term output responses differ from the responses under the moderate world cocoa price assumption. In general, because of the higher producer prices, the increase in the annual amortized returns the farmers expect to get by growing more cocoa trees is greater than the increase in the annual amortized returns they expect to get from their existing trees. Hence, the effects of the higher producer prices on the long-term output response are potentially greater than the short-term output response. Subject to meeting the other production requirements, cocoa farmers would allocate more of their resources for cocoa acreages expansion rather than increasing their short-term harvest output.

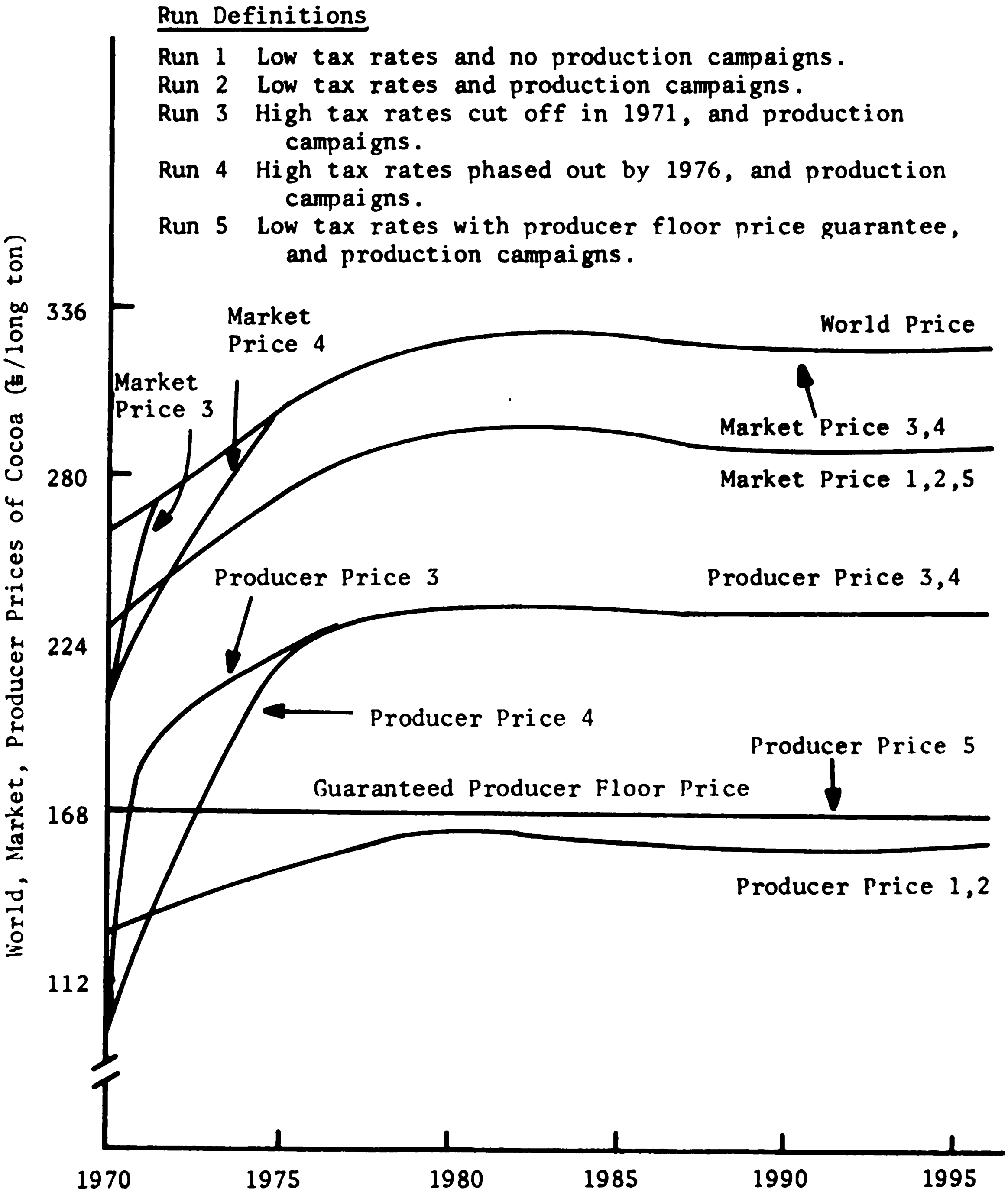

Figure 4.B1.--Market and Producer Prices of Nigerian Cocoa Under Indicated Policy Alternatives Assuming High World Cocoa Prices, 1970-1995.

Specifically, the long-term response of Run 3 where the producer price was increased dramatically with the tax cut-off is greater than Run 4 where the taxes were gradually phased out. Consequently, the projected annual output of Run 4 between 1970 to 1983 is greater than in Run 3 because farmers in Run 3 are allocating more of their resources to grow more cocoa trees rather than to further increase their output from the existing lower-yielding trees. However, by 1983 when the trees that are grown in the 1970s come into production, the projected output of Run 3 (which also has the highest total cocoa acreages) surpasses Run 4. Thus we see that the effects of the greater long-term output responses in Run 3 are lagged and do not manifest themselves until many years later when the new cocoa trees come into production. In the intervening years, the total annual output is lower than what it would be if the farmers had not responded to the higher producer prices by expanding their output capacity. Because of the guaranteed producer floor price of Run 5, its projected output is higher than in Run 2. For the same reasons discussed previously, the relative ranking of the other performance indices correspond to the ranking of the projected output (see Figures 4.B2 to 4.B7.

Results of Policy Experiment Assuming Low World Cocoa Prices

In contrast with the previous world price situation, a set of lower world prices is assumed. Consequently the values of other performance indices are also reduced. As seen in Figure 4.C1, the producer prices in Runs 3 and 4, after 1985, are slightly below the

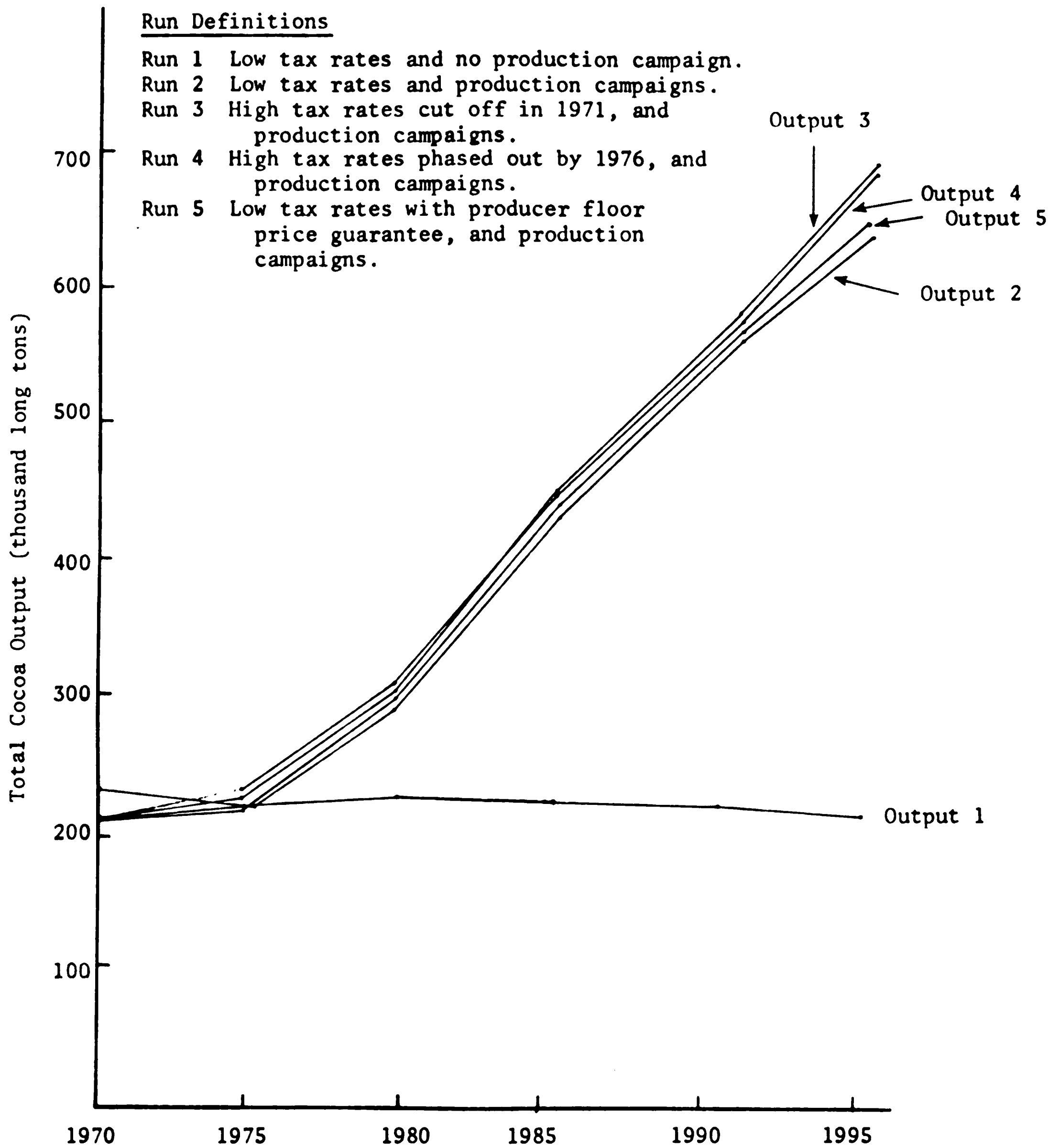

Figure 4.B2.--Total Projected Nigerian Cocoa Output Under Indicated Policy Alternatives Assuming High World Cocoa Prices, 1970-1995.

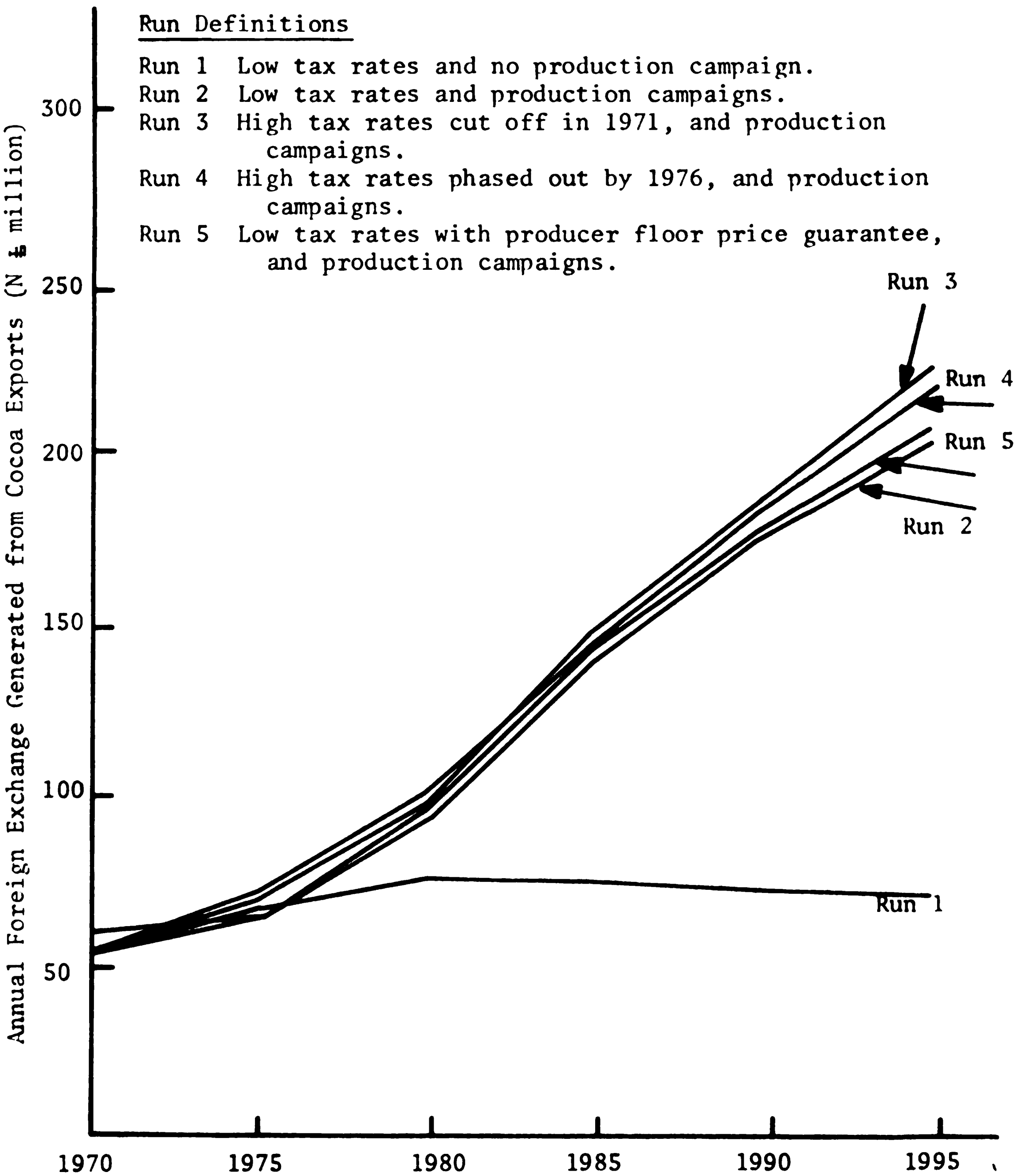

Figure 4.B3.--Foreign Exchange Generated from Nigerian Cocoa Exports Under Indicated Policy Alternatives Assuming High World Cocoa Prices, 1970-1995.

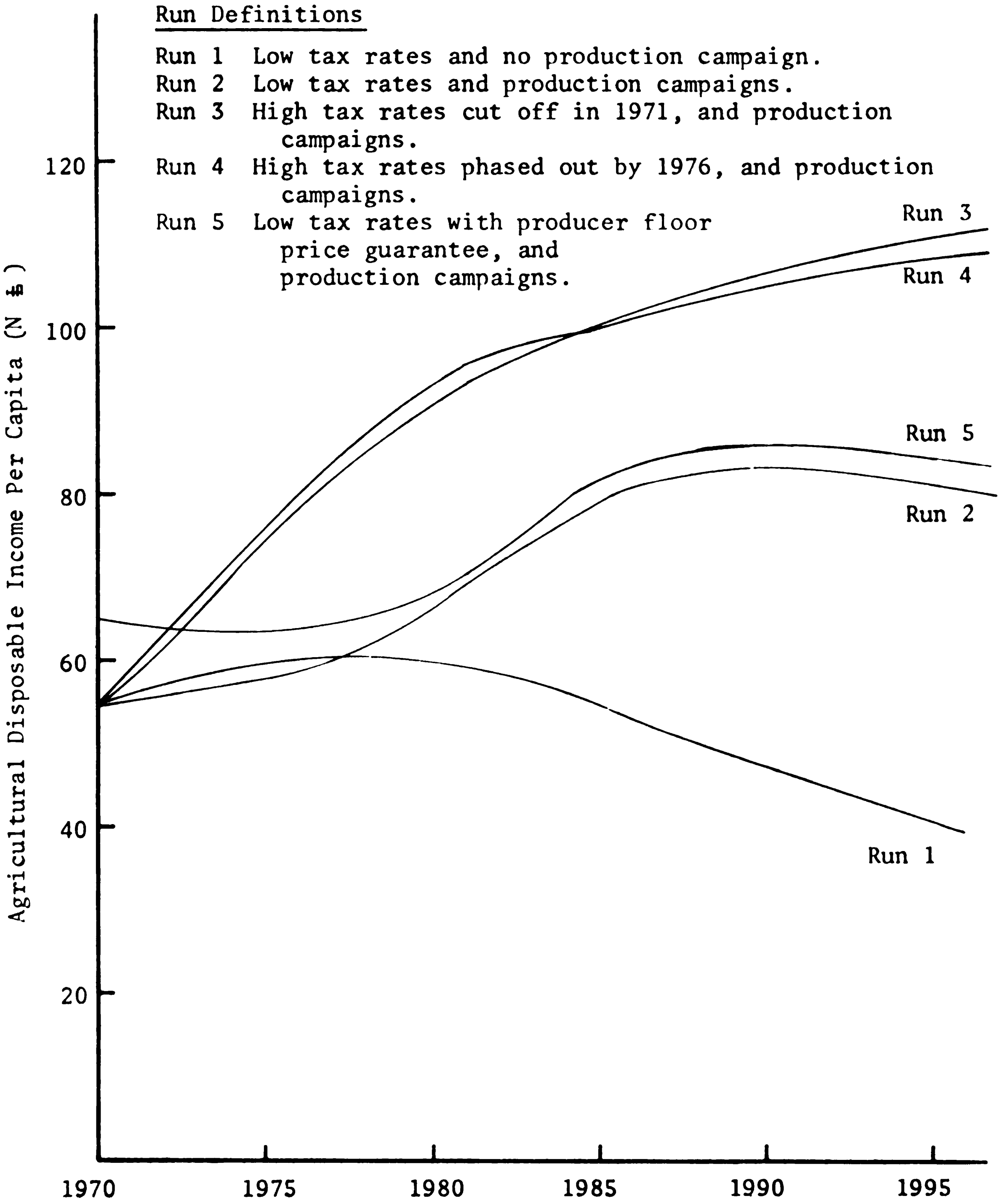

Figure 4.B4.--Agricultural Disposable Income Per Capita in Nigerian Cocoa Sector Under Indicated Policy Alternatives Assuming High World Cocoa Prices, 1970-1995.

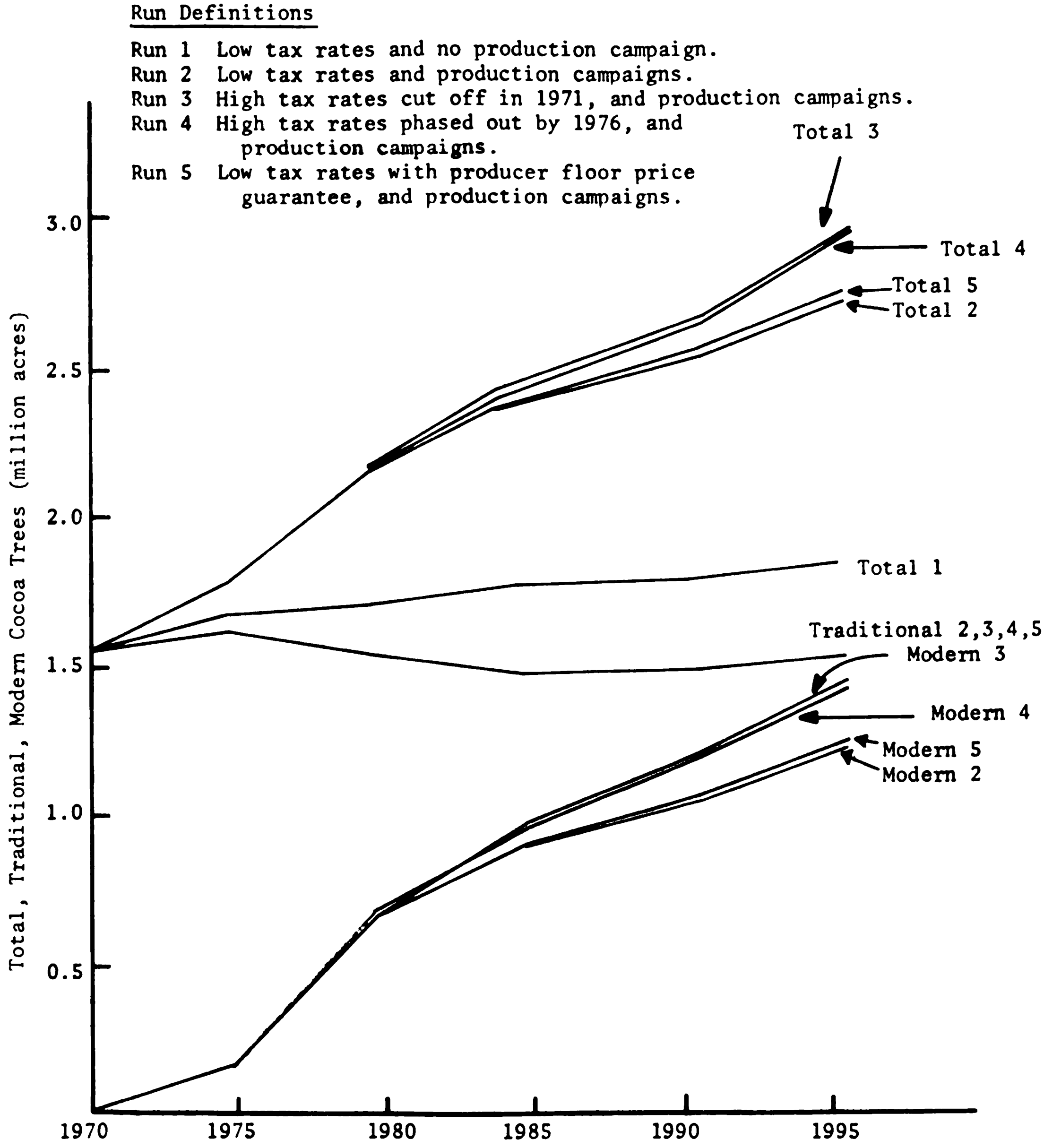

Figure 4.B5.--Total, Traditional and Modern Nigerian Cocoa Acreages Under Indicated Policy Alternatives Assuming High World Cocoa Prices, 1970-1995.

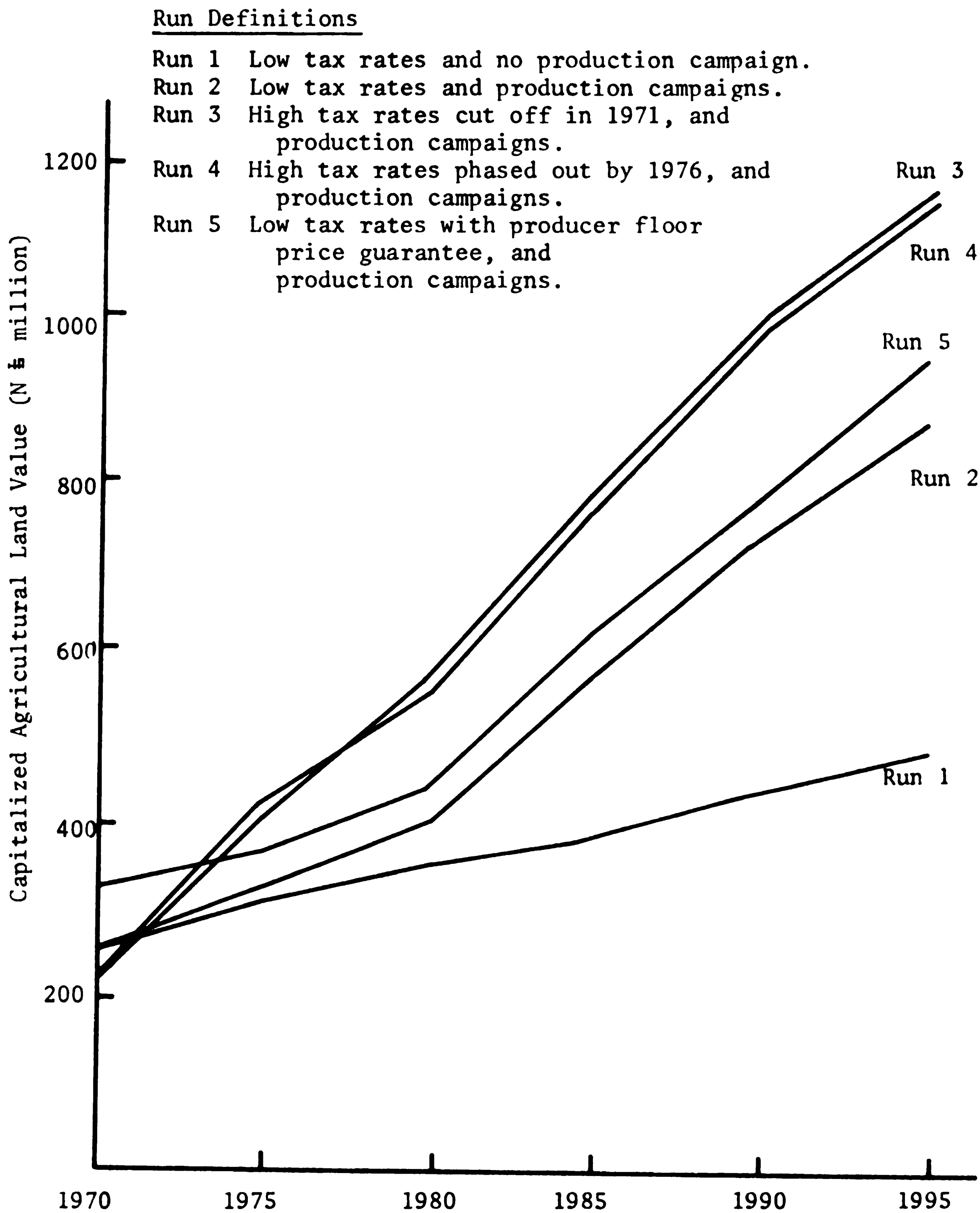

Figure 4.B6.--Capitalized Agricultural Land Value in Nigerian Cocoa-Food Ecological Zone Under Indicated Policy Alternatives Assuming High World Cocoa Prices, 1970-1995.

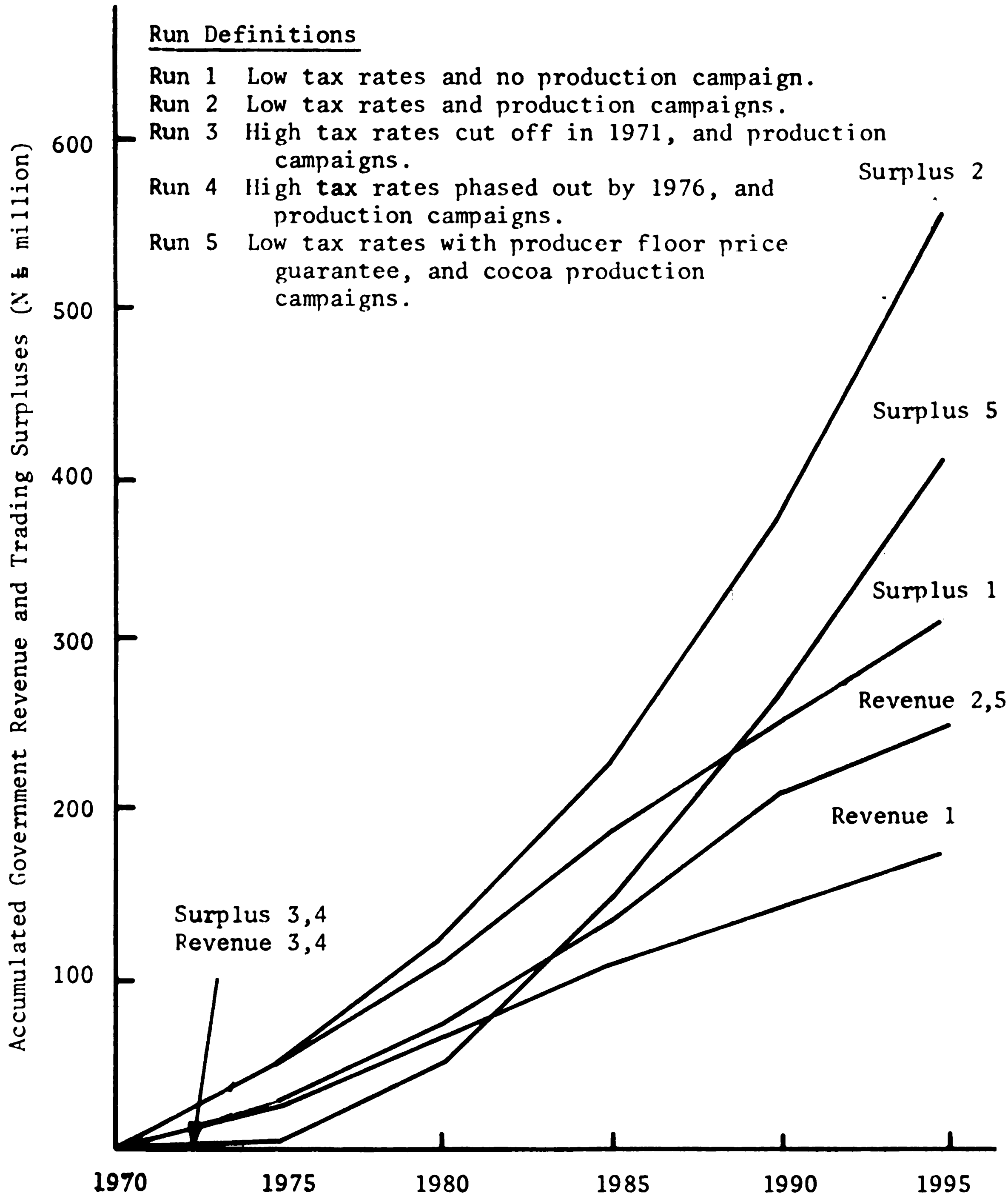

Figure 4.B7.--Accumulated Government Revenue and Marketing Board Trading Surpluses from Nigerian Cocoa Production under Indicated Policy Alternatives Assuming High World Cocoa Prices of 1970-1995.

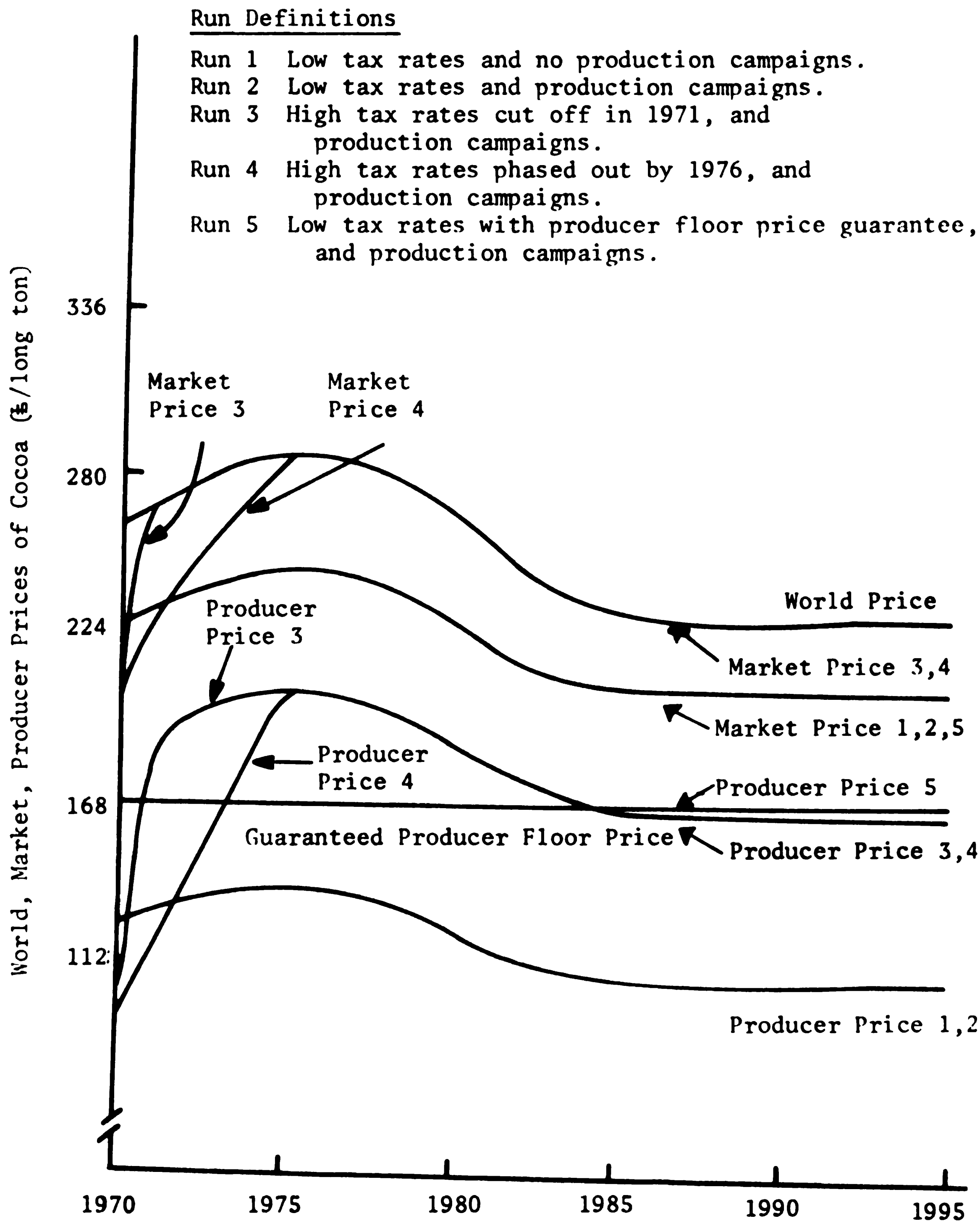

Figure 4.C1.--Market and Producer Prices of Nigerian Cocoa Under Indicated Policy Alternatives Assuming Low World Cocoa Prices, 1970-1995.

guaranteed floor price of ₤168. Since the relative ranking of the performance indices in this set of runs is basically similar to the ranking derived from the moderate world price set, we shall highlight the more interesting simulation results.

From Figure 4.C2, we see that because of the higher initial producer price of Run 5 (with the producer price guarantee) in 1970, the short-term output response is such that the projected output of Run 5 in that year is also the highest. However, in subsequent years when the producer prices of Runs 3 and 4 (with the tax cut-off and phase-out features) are higher, the projected output of Run 5 is lower than in Runs 3 and 4. As in previous situations the long term responses in capacity expansion of the various runs, interacting with the government production campaigns, depend on their respective producer prices. For example, because the producer price of Run 5 is highest in the initial years, most of the trees planted are of the traditional variety. Likewise, since the producer price increase in Run 3 also occurs in the initial years, the expanded output capacity consists more of the Amelonado trees. On the other hand, because the peak of the production campaigns coincide with the gradual producer price increases of Run 4, most of the new acreages consist of the Upper Amazon trees (see Figure 4.C5). The differences in the compositional acreages in turn manifest themselves in subsequent years with the relative ranking of the projected output of the various policy runs. Hence, despite the slightly higher producer prices of Run 5 from 1985 upwards, its projected annual cocoa output is lower than in Runs 3 and 4.

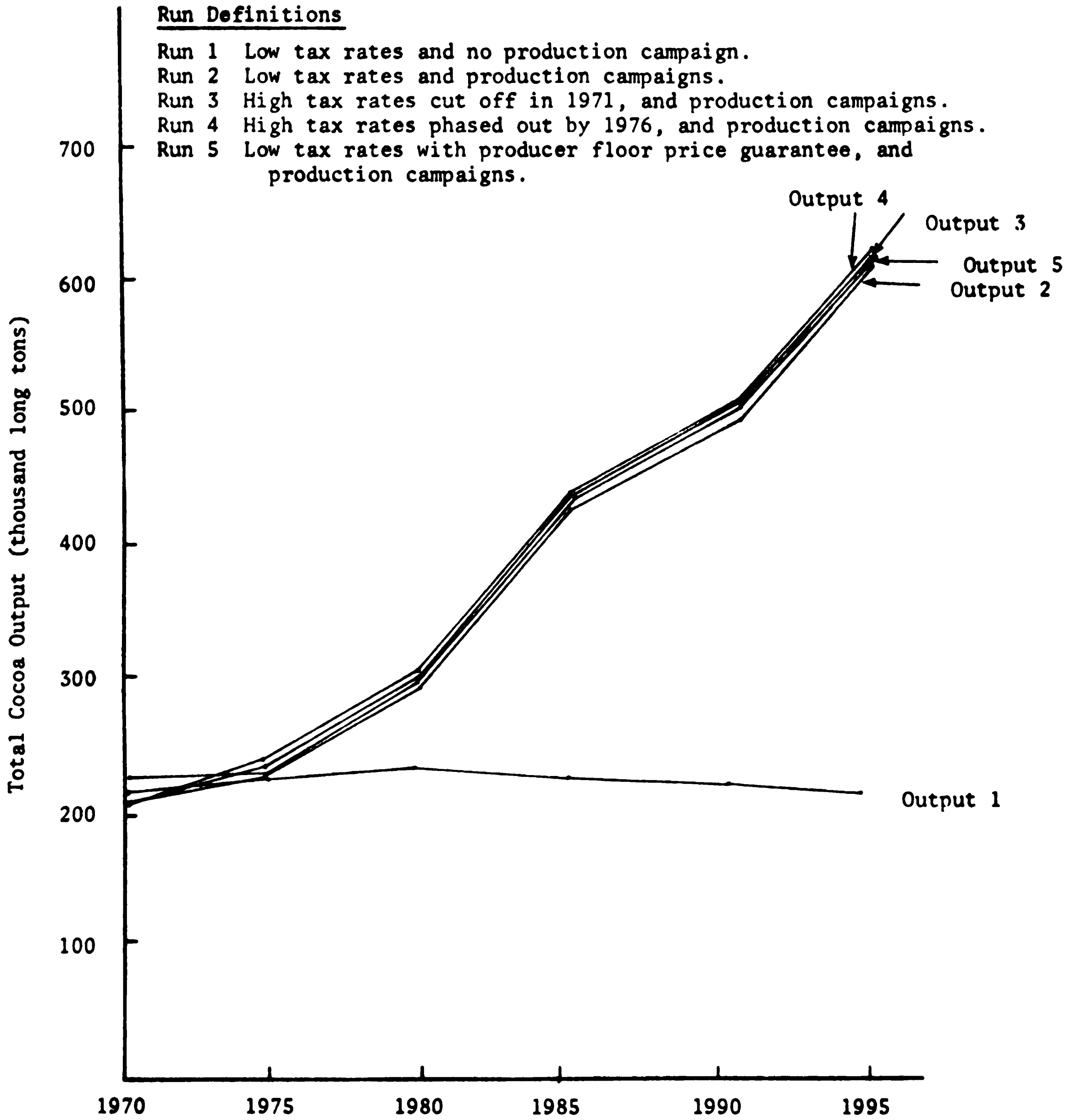

Figure 4.C2.--Total Projected Nigerian Cocoa Output Under Indicated Policy Alternatives Assuming Low World Cocoa Prices, 1970-1995.

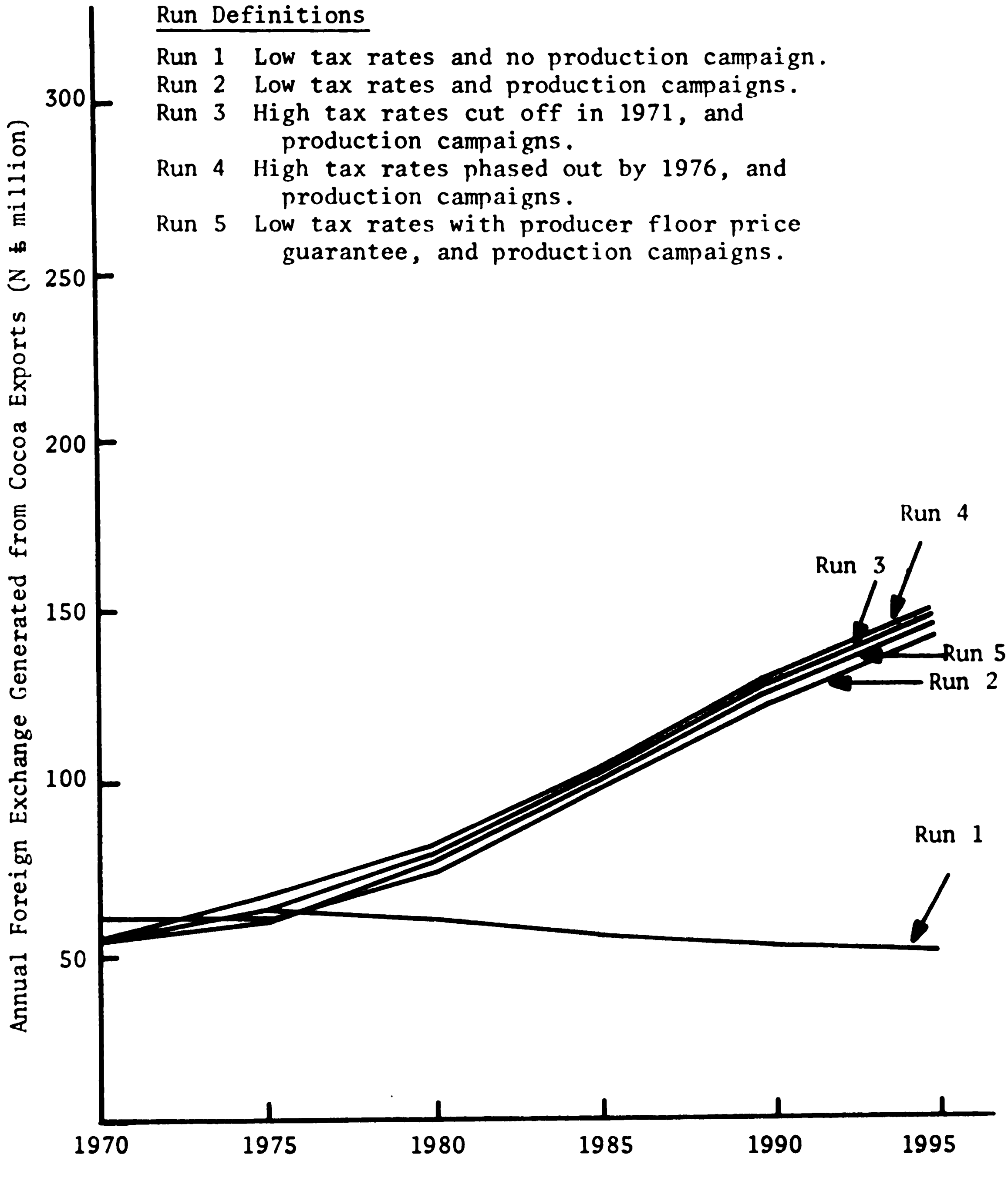

Figure 4.C3.--Foreign Exchange Generated from Nigerian Cocoa Exports Under Indicated Policy Alternatives Assuming Low World Cocoa Prices, 1970-1995.

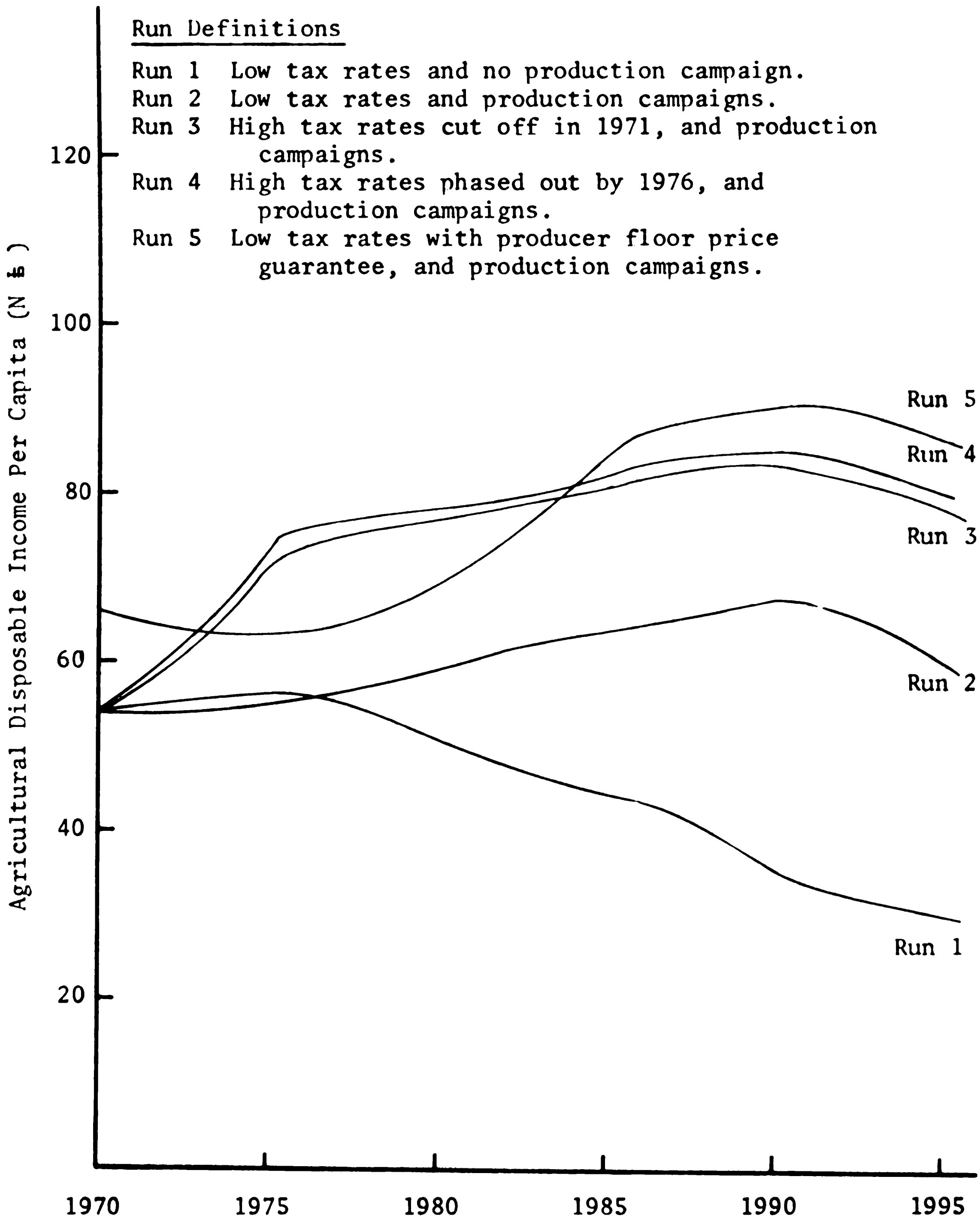

Figure 4.C4.--Agricultural Disposable Income Per Capita in Nigerian Cocoa Sector Under Indicated Policy Alternatives Assuming Low World Cocoa Prices, 1970-1995.

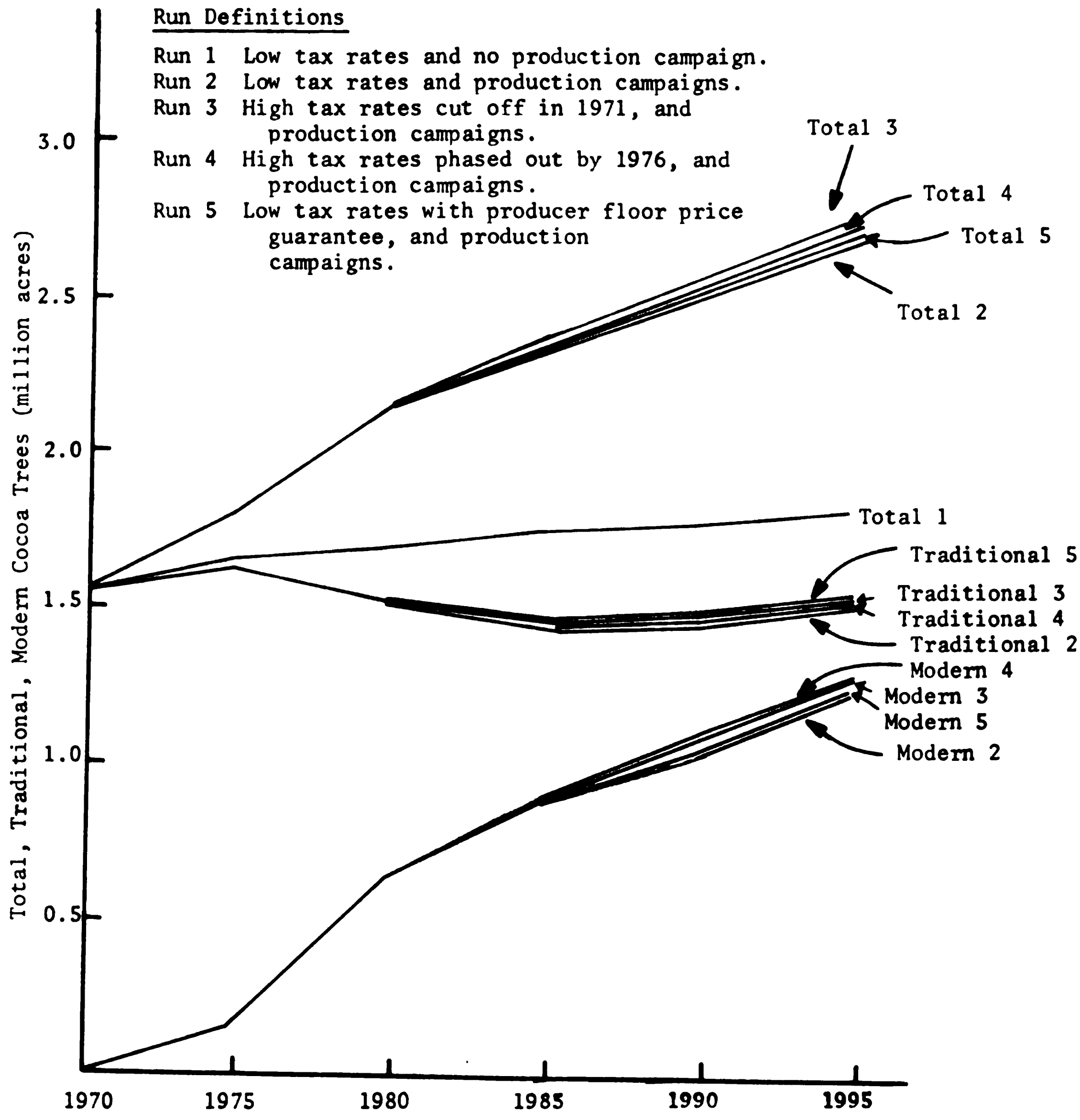

Figure 4.C5.--Total, Traditional and Modern Nigerian Cocoa Acreages Under Indicated Policy Alternatives Assuming Low World Cocoa Prices, 1970-1995.

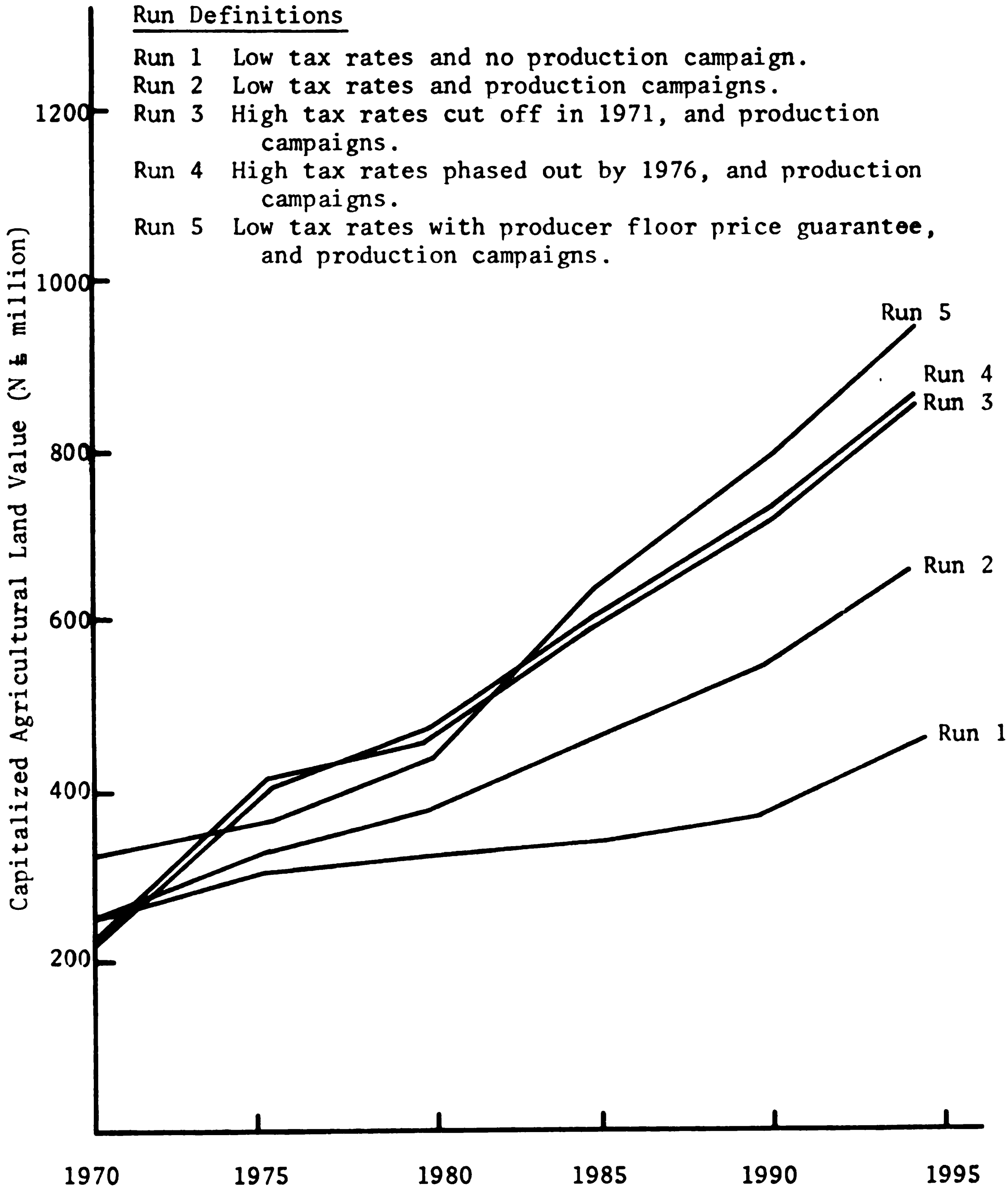

Figure 4.C6.--Capitalized Agricultural Land Value in Nigerian Cocoa-Food Ecological Zone Under Indicated Policy Alternatives Assuming Low World Cocoa Prices, 1970-1995.

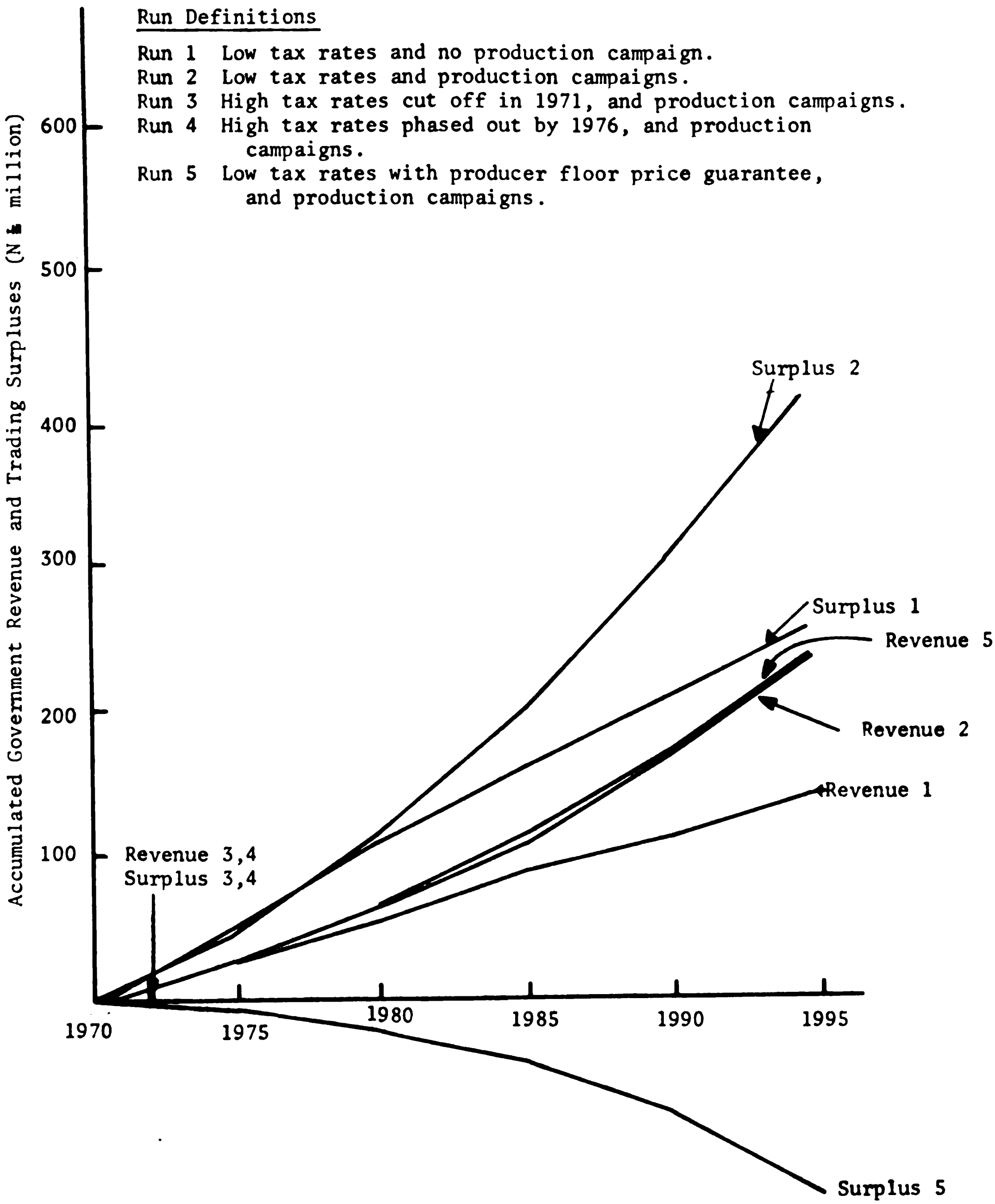

Figure 4.C7.--Accumulated Government Revenue and Marketing Board Trading Surpluses from Nigerian Cocoa Production Under Indicated Policy Alternatives Assuming Low World Cocoa Prices, 1970-1995.

The ranking of the accumulated government revenue and marketing board trading surpluses for the various runs depends on their tax rates and projected annual output. Although the government revenue rates of Runs 2 and 5 are the same, the accumulated revenue of Run 5 is higher than in Run 2, because of the latter's higher projected output. Due to the low world price assumption used in this set of policy experiments, the producer price of all the five runs are also very low. Consequently, the trading surpluses of Run 5 (with the price guarantee) are negative, and the deficit increases with time because of the continuing subsidy necessary to maintain the guarantee. As in the preceding experiments, the values of the other performance indices of Run 5 are higher than in Run 2, which does not have the producer price guarantee.

D. Results of Policy Experiment Assuming Cyclical World Cocoa Prices

Finally, the effects of a set of cyclical world cocoa prices on the economy are discussed in terms of the simulated time paths of the six performance indices presented from Figures 4.D2 to 4.D7. The world, market and producer prices in this policy experiment are shown in Figure 4.D1. The relative ranking of the projected curve output can be best explained by recalling the major factors that determine the projected annual output. They are (1) total and compositional (traditional and modern) cocoa acreages of producing trees, (2) the past producer price trend which determine the exponentially-averaged "normal" price, and (3) prevailing producer prices. The ratio of the last two factors multiplied by the farmers' short-term exponential

<u>Run Definitions</u>

Run 1 Low tax rates and no production campaign.
Run 2 Low tax rates and production campaigns.
Run 3 High tax rates cut off in 1971, and production campaigns.
Run 4 High tax rates phased out by 1976, and production campaigns.
Run 5 Low tax rates with producer floor price guarantee, and production campaigns.

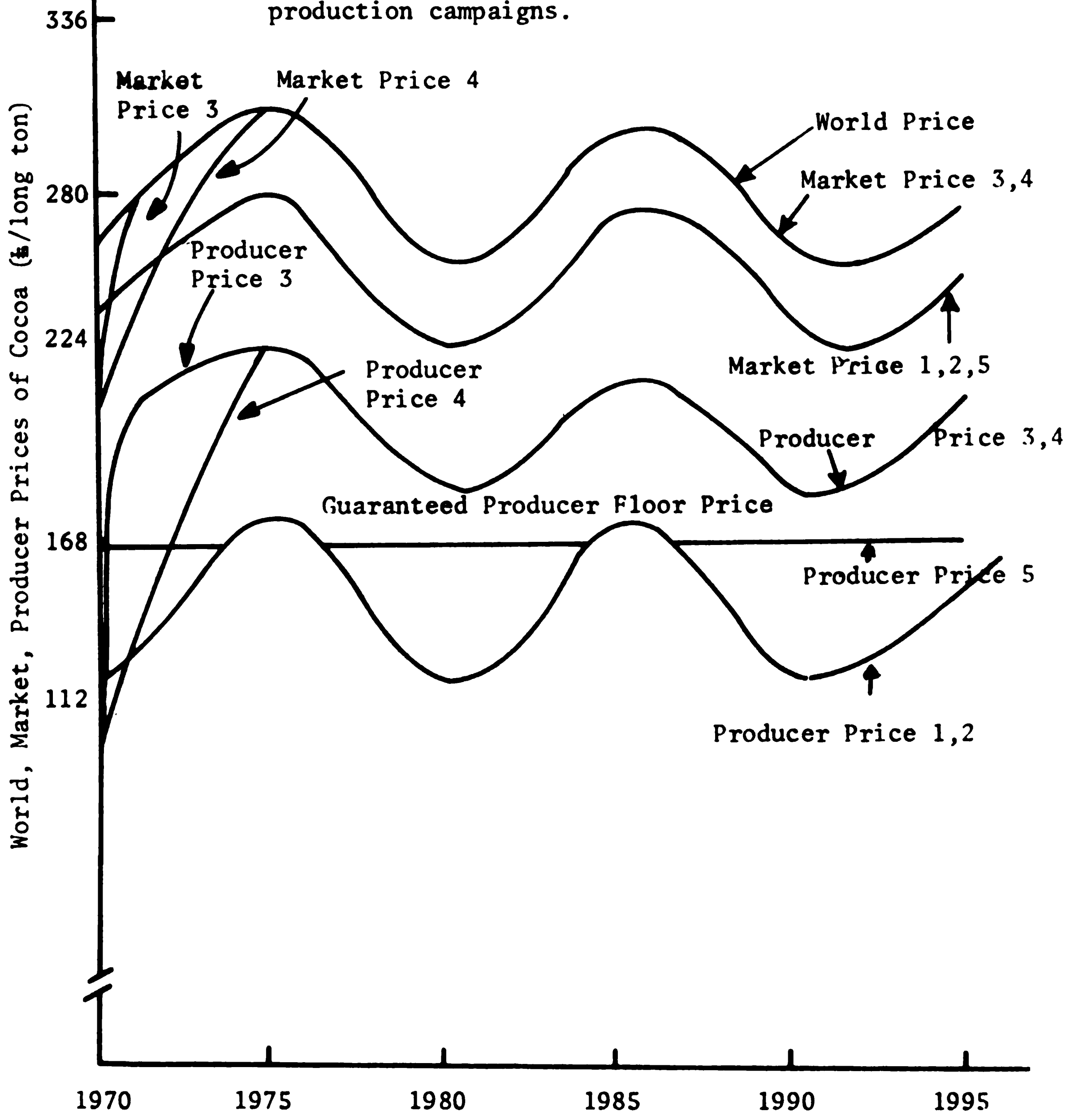

Figure 4.D1.--Market and Producer Prices of Nigerian Cocoa Under Indicated Policy Alternatives Assuming World Cyclical Prices, 1970-1995.

harvest elasticity determine the annual output from the producing cocoa trees. On the other hand, the long-term responses in output capacity expansion (which determine the total and compositional acreages) depend on (1) the prevailing producer prices, (2) expected producer prices and output (which determine the relative profitability of cocoa production), and (3) program features of the production campaign. Because of the cyclical nature of this set of world prices, the total output effects depend crucially on the interactions between the short-term harvest responses and the long-term, expansion responses.

As evident in Figure 4.D2, the outputs of Runs 2 to 5 (with the production campaigns) are in all cases higher than Run 1 (without the production campaign). However, the order of their projected output depends on their respective producer prices, which in turn determine their annual short-term and long-term output responses. Because of the high initial producer price guarantee feature, the short-term response in Run 5 causes its projected output to be the highest. However, the projected outputs of Runs 3 and 4 with the higher producer prices (and therefore higher short-term output responses) soon surpass Run 5. As in the other policy experiments, the effects of the long-term output capacity responses depend on the respective producer pricing policies, and their interactions with the production campaigns. The interactions result in the differences in the total and compositional acreages of the cocoa trees among the runs (see Figure 4.D5). Since the ranking of the projected time paths of the other performance indices are similar to the ranking

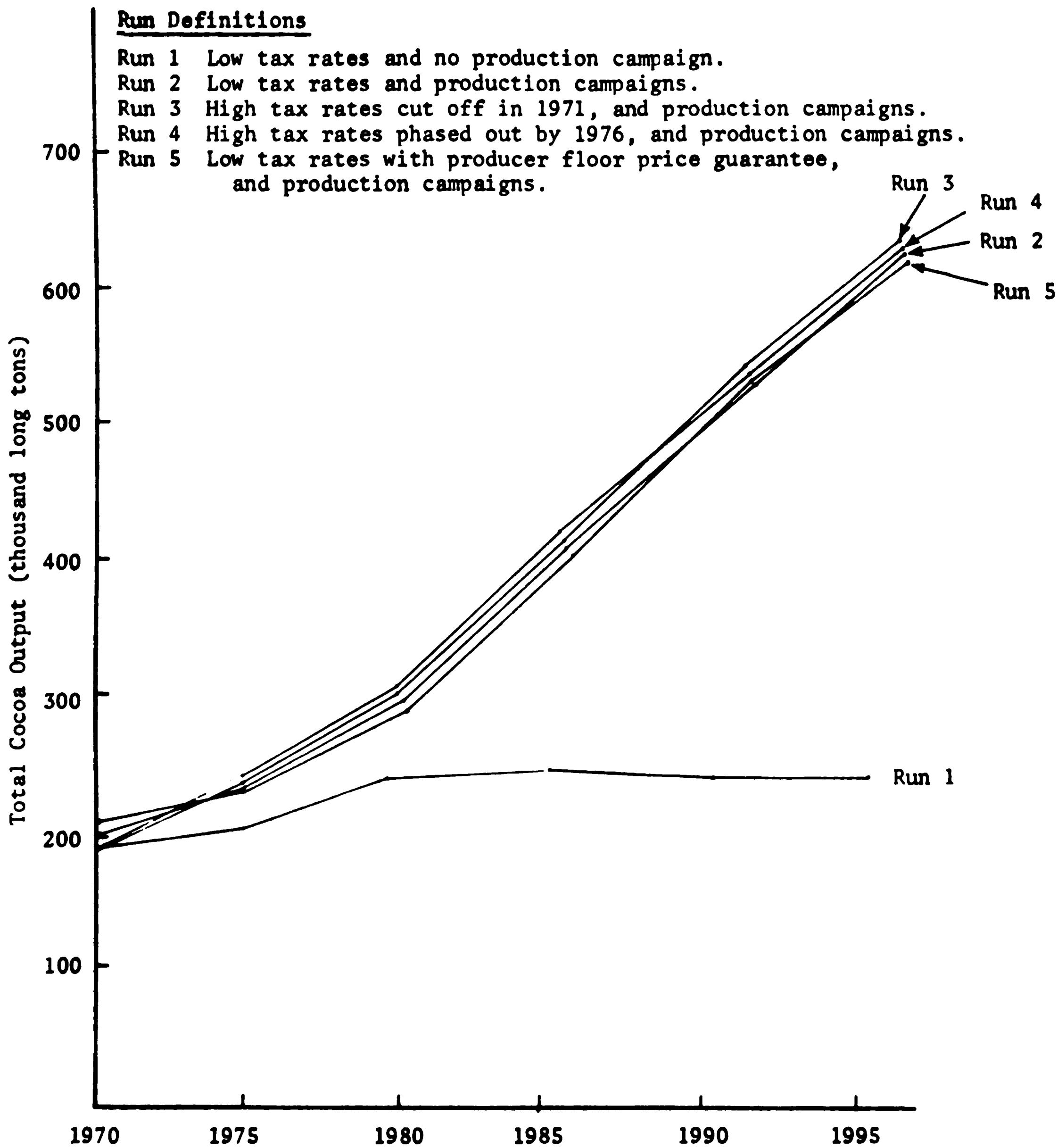

Figure 4.D2.--Total Projected Nigerian Cocoa Output Under Indicated Policy Alternatives Assuming Cyclical World Cocoa Prices, 1970-1995.

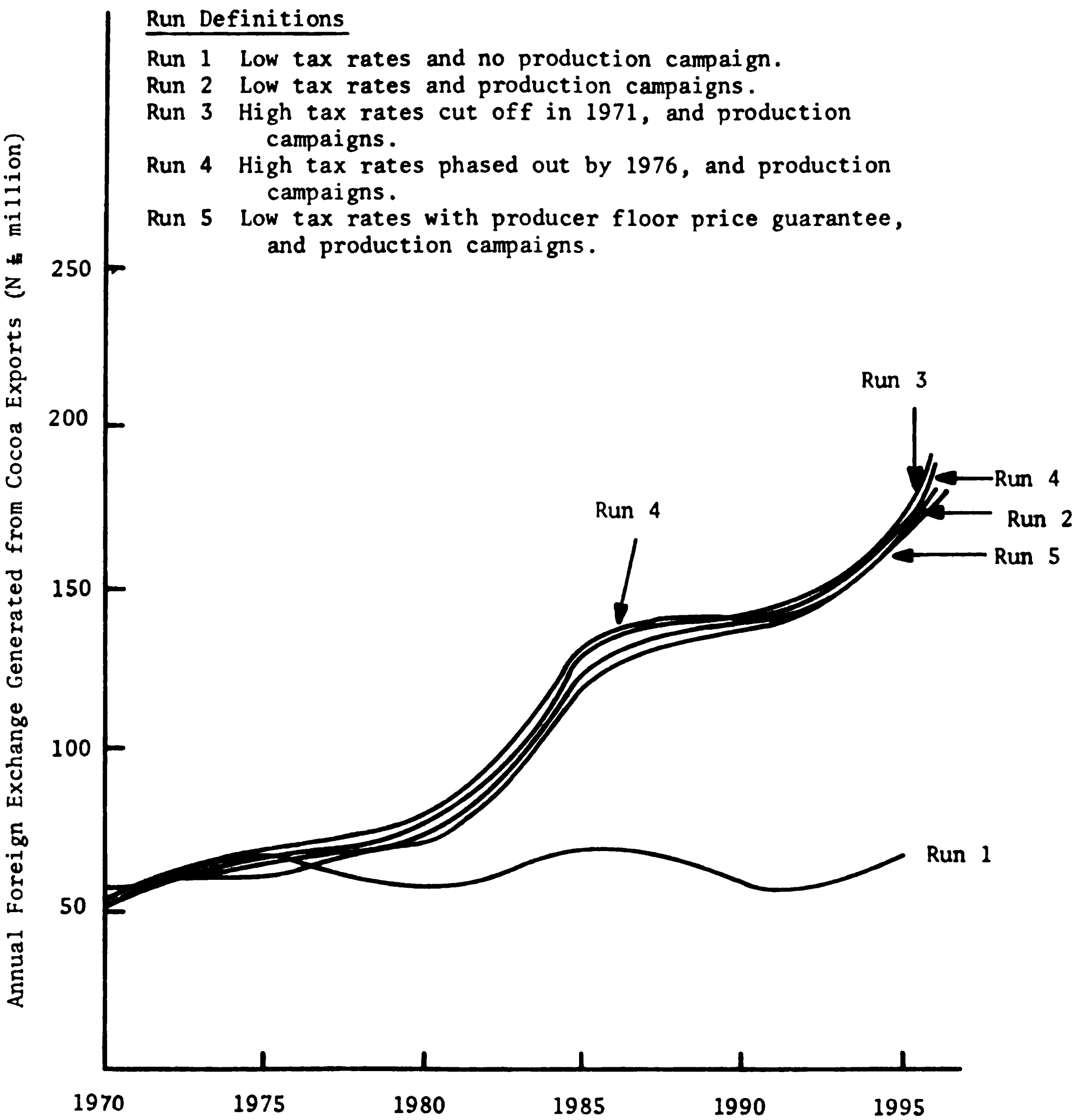

Figure 4.D3.--Foreign Exchange Generated from Nigerian Cocoa Exports Under Indicated Policy Alternatives Assuming Cyclical World Cocoa Prices, 1970-1995.

under the moderate world cocoa price assumption, they will not be discussed.

Under the cyclical world price assumption, the stabilization role of the rudimentary producer floor price guarantee of Run 5 is illustrated most dramatically in Figure 4.D4. The annual projected agricultural income per capita of Run 5 increases very smoothly. The projected income is determined primarily by the increase in output with the fluctuations in producer prices minimized. In contrast, the increases in income of the other runs fluctuate according to their prevailing producer prices. However, the higher and more stabilized income of Run 5, compared to Run 2 (which does not have the floor price guaranteed) is offset by its lower accumulated trading surpluses as shown in Figure 4.D7.

Discussion of Simulation Results from Cocoa Policy Experiments

There are five major inferences to be drawn from the results of the cocoa policy experiments we have conducted. First, the values of the performance indices depend crucially on the world cocoa price assumptions. For example, in Figure 4.2, which shows the projected outputs of Run 2 under the four world prices, it is clear that the output under the high world price assumption is greater than the output under the moderate and low world price assumptions. Since the average price of the cyclical world prices is also greater than the average price of the low world prices, its projected output is thus higher.

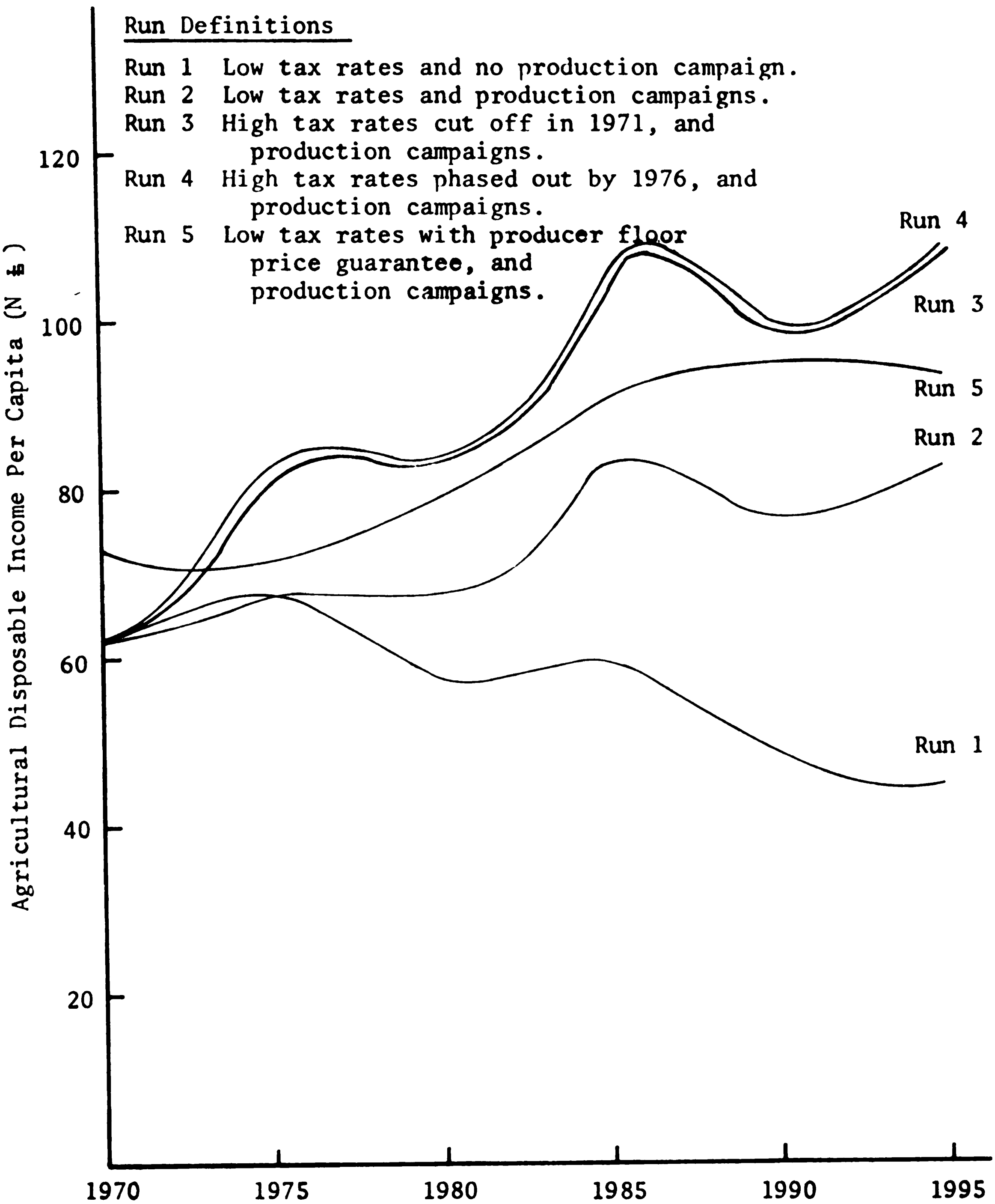

Figure 4.D4.--Agricultural Disposable Income Per Capita in Nigerian Cocoa Sector Under Indicated Policy Alternatives Assuming Cyclical World Cocoa Prices, 1970-1995.

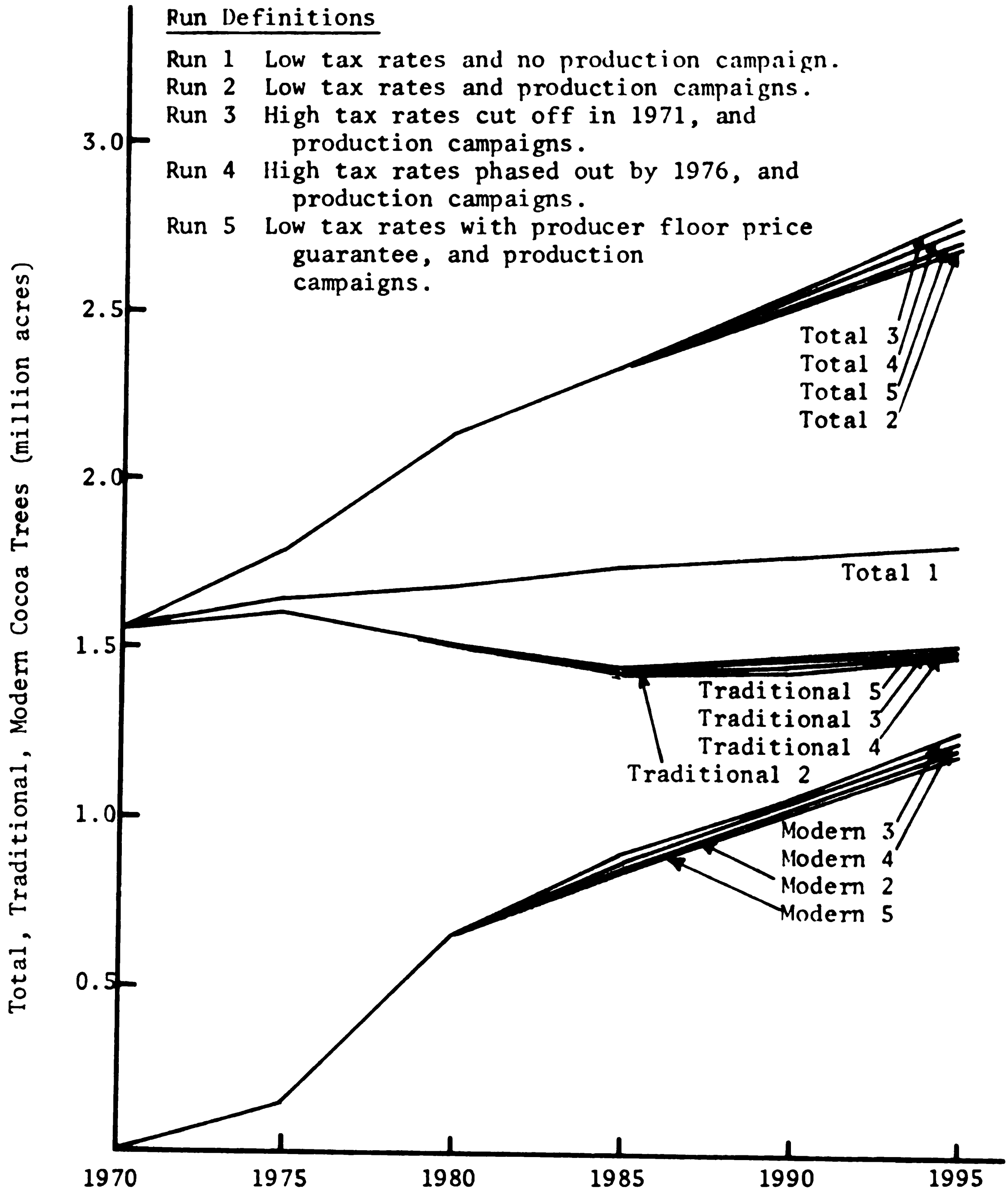

Figure 4.D5.--Total, Traditional and Modern Nigerian Cocoa Acreages Under Indicated Policy Alternatives Assuming Low World Cocoa Prices, 1970-1995.

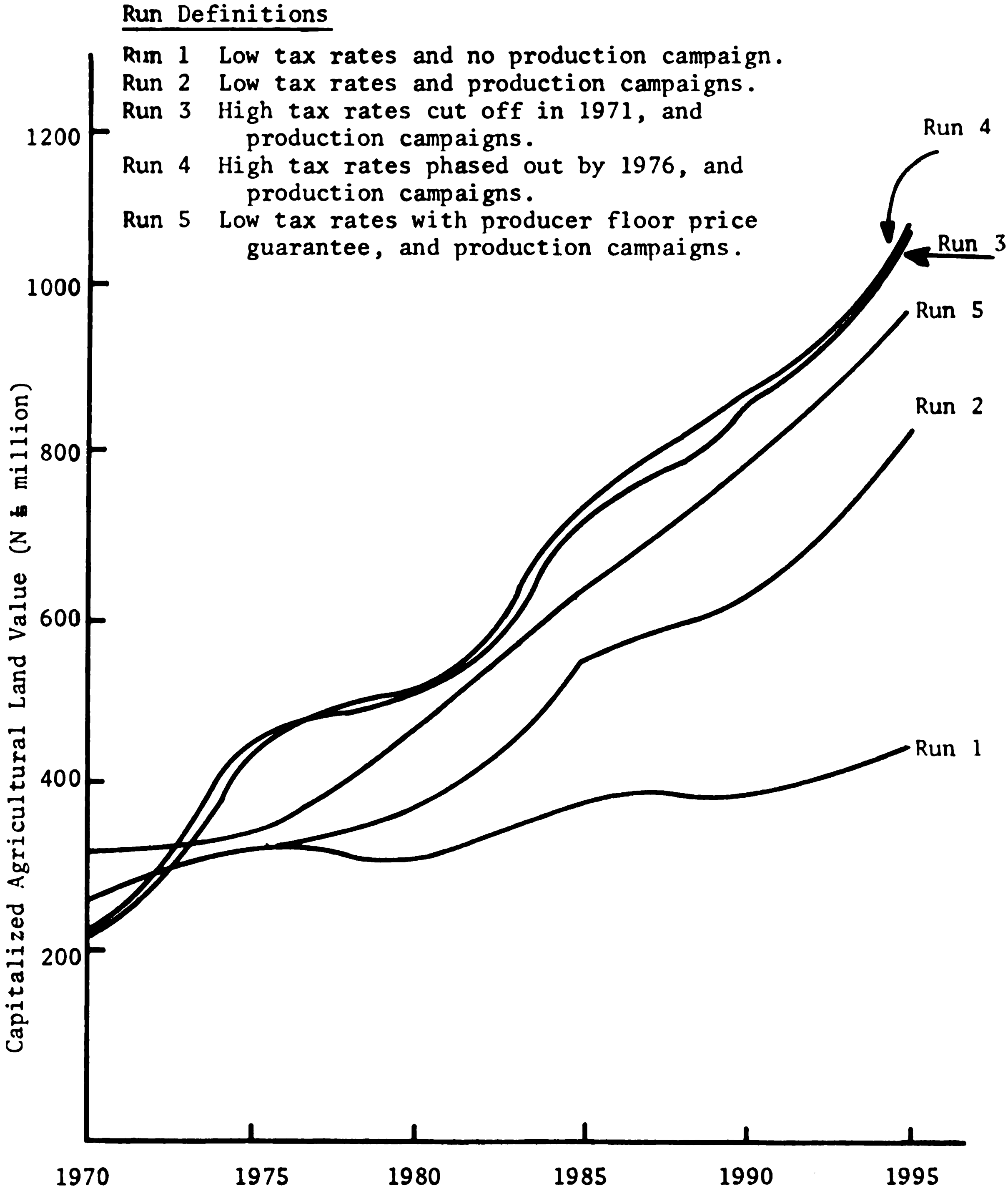

Figure 4.D6.--Capitalized Agricultural Land Value in Nigerian Cocoa-Food Ecological Zone Under Indicated Policy Alternatives Assuming Cyclical World Cocoa Price Functions, 1970-1995.

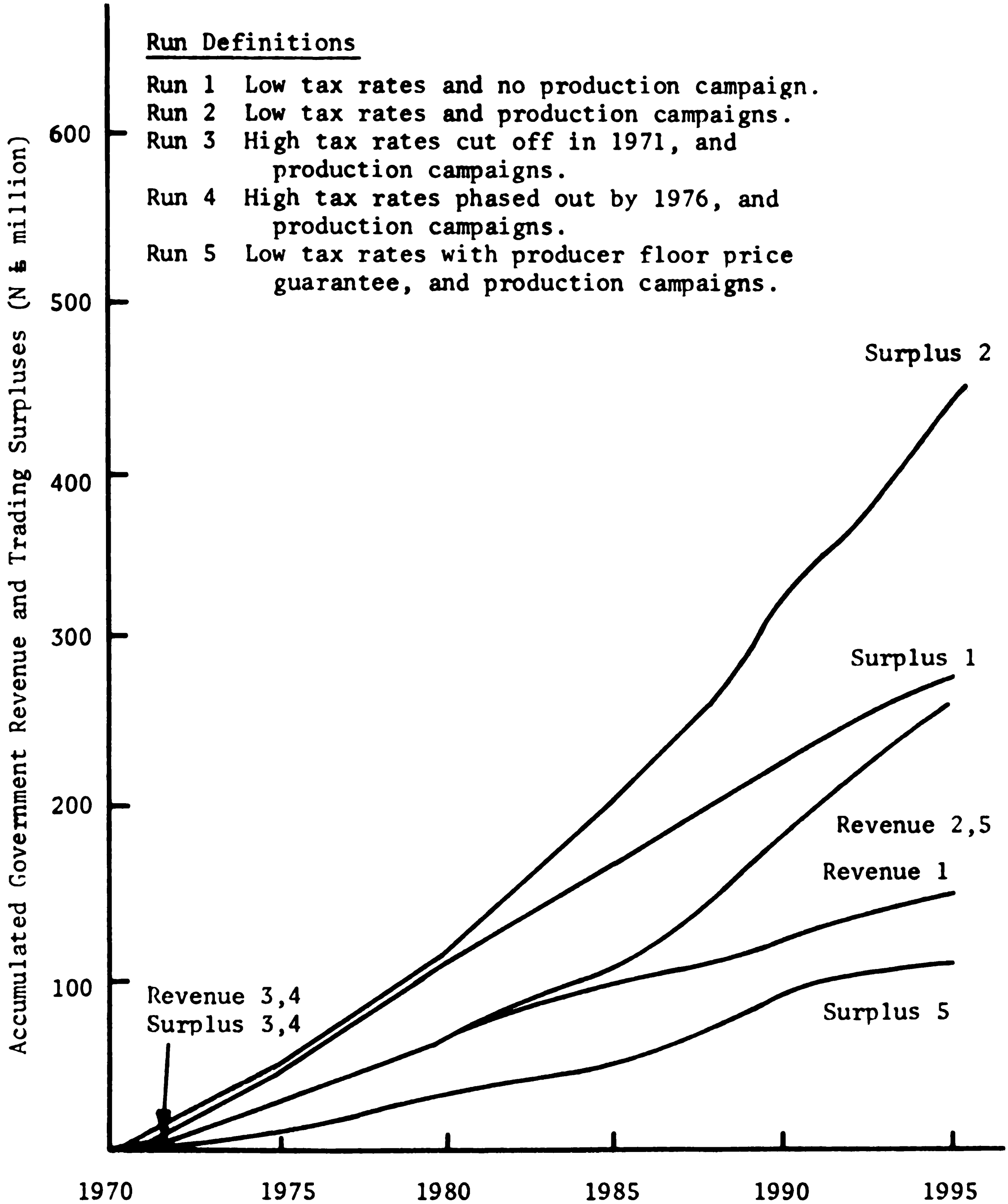

Figure 4.D7.--Accumulated Government Revenue and Marketing Board Trading Surpluses from Nigerian Cocoa Production Under Indicated Policy Alternatives Assuming Cyclical World Cocoa Prices, 1970-1995.

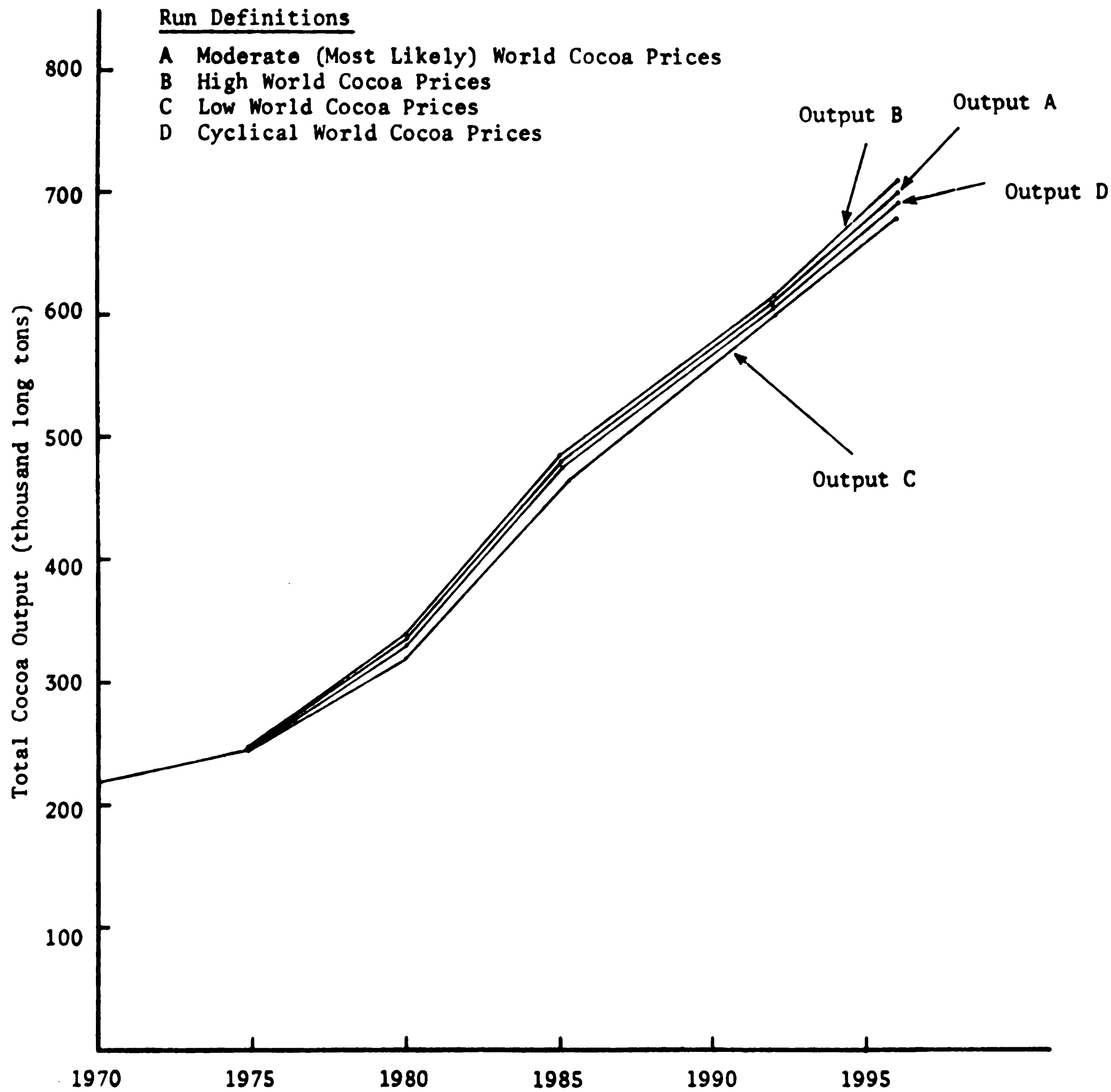

Figure 4.2.--Total Projected Nigerian Cocoa Output Under Indicated Alternative World Cocoa Prices Assuming Low Tax Rates and Production Campaigns, 1970-1995.

Second, the ranking of the projected cocoa output also depends on world prices over the planning horizon. For example, because of the higher world prices of "B," which remain continuously high, the output of Run 3 with the tax cut-off feature remains higher than Run 4 where the taxes are phased out (see Figure 4.B2). On the other hand, in the low world price situation of "C" where the prices after 1985 remain relatively lower than their initial level, the projected output of Run 4 is higher than Run 3 (see Figure 4.C2).

Third, given the assumptions of the model's mechanisms, the influences of short-term output responses from a dramatic producer price increase are dissipated very quickly, as the farmers begin to regard the higher producer prices as "normal." Hence, the short-term output effect of a gradual producer price increase is cumulatively greater than that of the dramatic price increase. The projected annual output of Run 4 with the tax phase-off feature is generally higher than in Run 3 even though producer prices after 1976 are the same.

Fourth, the benefits of long-term output responses in cocoa acreage expansion can be further reinforced if they also coincide with the peak of the production campaigns. Otherwise, the farmers given the higher producer prices may prematurely expand their cocoa acreages without taking full advantage of the communication effects of the production campaigns. If the producer price increases coincide with the peak of the production campaigns, more of the new acreages would consist of the higher-yielding Upper Amazon trees promoted by the campaigns. Or conversely, if the full effects of the production campaigns were to occur concurrently with a favorable producer price increase, an even greater proportion of the acreage expansion in both new planting and replanting would consist of the higher-yielding variety. Thus, the effects of the producer price increase and the production campaigns are highly complementary in encouraging the farmers to cultivate the higher-yielding Upper Amazon cocoa trees as they expand their cocoa acreages.

Finally, each of the five policy runs have projected different outcomes at different time-phases of the planning horizon. Their projected differences can in turn provide policymakers with a basis for selecting the preferred policy option with its tradeoffs according to their perceived objectives of the economy. For example, if the perceived overriding objective for the cocoa sector for the next twenty-five years is to maximize farmers' income and the foreign exchange generated from cocoa exports, Run 4 (which has the tax phase-out and production campaign features) may be the preferred option. On the other hand, if the perceived paramount objective is to maximize government revenue and marketing board trading surpluses, Run 2, which gives the highest accumulated funds is the logical policy option over Runs 3, 4, and 5, even though the consequent projected output, foreign exchange, and farmers income of Run 2 are lower. However, if the objective is to ensure the cocoa farmers a steady and stable income increase, Run 5 (with the guaranteed producer floor price feature) is recommended, especially if the world price is expected to behave cyclically as we have seen in Figure 4.D4. Hence, in this particular situation, the tradeoff is between a loss in the accumulated government revenue and marketing board surpluses, and an increase in output, foreign exchange generated from cocoa exports, and personal income of the farmers in the cocoa economy.

Effects of Cocoa Policy Experiments on Food Production

A secondary objective of the study is to explore the impact on food production in Western Nigeria which may result from the proposed cocoa producer price changes and the government production campaigns to expand cocoa output capacity. Given the model's present structure and its underlying assumptions, the study is not able to show convincingly the cocoa policy effects on food production in Western Nigeria. Figures 4.3 and 4.4 show the total subsistence and cash food acreages of the sector, and the market and the producer prices of food composite for all of Southern Nigeria under Runs 1, 2, and 4, from 1970 to 1995 (assuming the cyclical world price function of cocoa).

As discussed in Chapter III, the total demand for staple food in the region (expressed generically in caloric value) is met by subsistence and cash food production. The general increase in the total food land in all three runs is caused by the increase in the rural population. In Run 1, while the total food acreages increase, cash food land remains relatively constant. Although total food land acreage in Run 2 is similar to that in Run 1, Run 2's increase in cash food land after 1980 is offset by the decrease in the subsistence food land. Hence, we may infer that the expansion of the cocoa acreages resulting from the production campaigns did

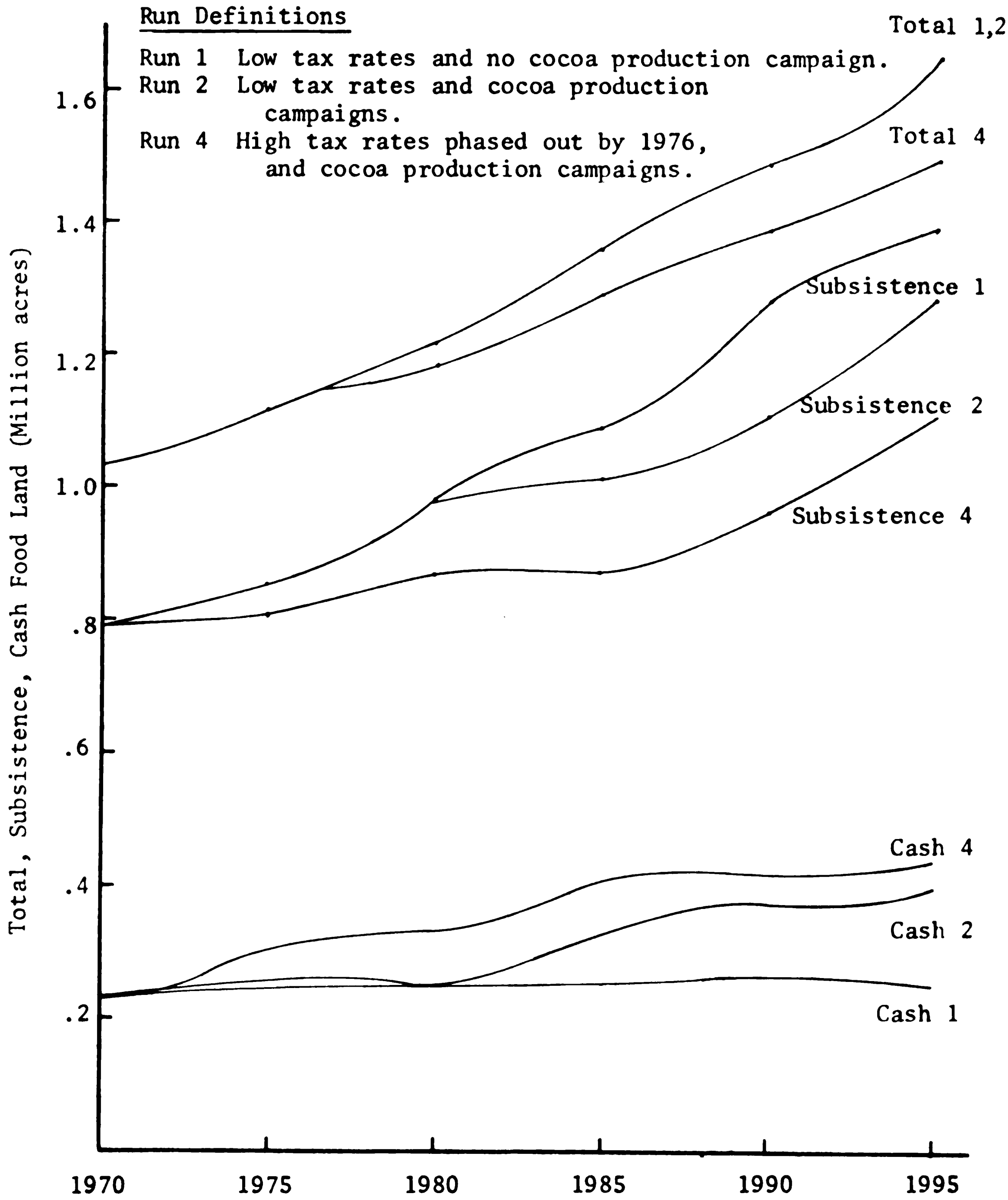

Figure 4.3.--Total, Subsistence, Cash Food Land in Nigerian Cocoa Ecological Zone Under Indicated Cocoa Policy Alternatives Assuming Cyclical World Cocoa Prices, 1970-1995.

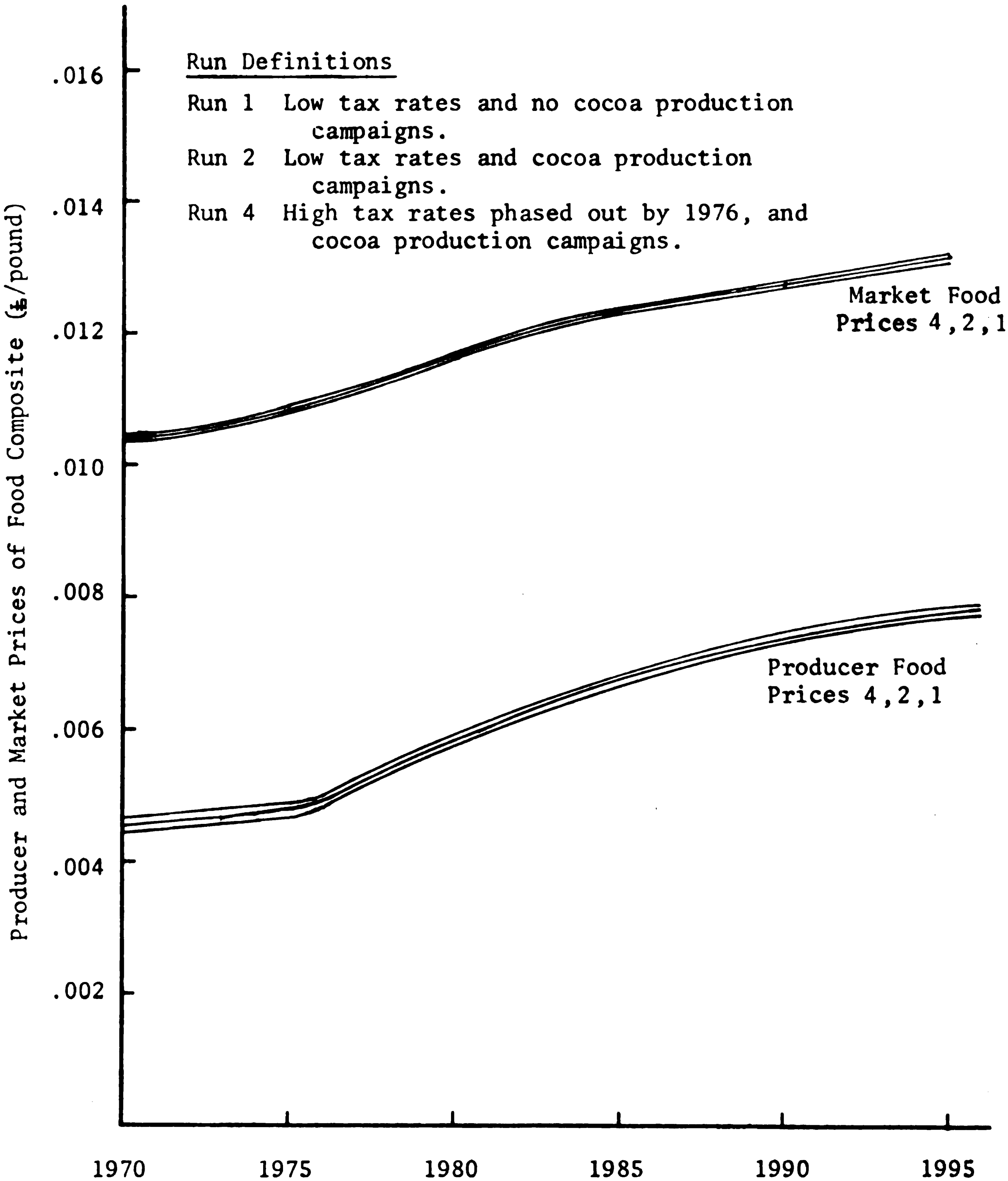

Figure 4.4.--Market and Producer Prices of Food Composite in Nigerian Cocoa Ecological Zone Under Indicated Cocoa Policy Alternatives Assuming Cyclical World Cocoa Prices, 1970-1995.

not increase appreciably the expansion rate of total food land. Instead, a greater proportion of the staple food consumed by the farmers is now obtained from the cash food market. The increased dependence on the cash food market of Run 2 (with the cocoa production campaigns) results from the increased income generated from the greater cocoa output. In Run 4 (which has the highest projected cocoa output and acreages), total food land increases at a lower rate after 1978 than in Runs 1 and 2. The projected cash food land of Run 4 throughout the planning horizon is also highest and subsistence food land the lowest.

From Figure 4.4, we see that the annual producer and market prices of the staple food composite in the sector are very small among the three policy runs. According to the model, the market price of food depends on the total supply and demand of food in all of South Nigeria. Hence, policy experiments focusing on one particular sector in the region does not appreciably affect the food pricing mechanisms. (In contrast, when policy experiments were conducted on the total region, the projected market food prices under alternative policies were markedly different [Manetsch *et al.*, 1971]).

The increasing food prices in all three runs are caused by the increasing population in the sector. Although the behavior of food prices is consistent with the model's assumptions, we must interpret the results with caution. Let us recall the assumptions we built into the food price determination mechanisms: (1) food prices are adjusted annual averages without considering explicitly the considerable intra-year or seasonal fluctuations; (2) the difference between the producer food price at the farm gate and the market food price is a constant markdown from the market price of food; and (3) consumer preferences and the cultivational technology of the food composite are assumed to be constant throughout the planning horizon.

The last assumption is tenuous in reality. Obviously, within the 25-year planning horizon, the population's preferences for staple food along with their relative prices would change. The changes in consumer preference would probably affect the production of the food crops. Likewise, the production functions of the various staple foods would change. For example, although Western Nigerians prefer yam over cassava, the lower labor requirement and higher output for cassava, and hence, its higher caloric value per unit cost would certainly increase its production. This, in turn, would increase the use of cassava as a food staple. In addition, future increases in income from increased cocoa production may also affect the farmers' total and compositional demand for staple foods, just as it would probably raise their demand for nonstaple foods and consumer durables and nondurables.

Nevertheless, we can conclude from the policy experiments that the expansion of cocoa acreages would dampen the expansion of total food land in the region. Since we have also assumed that cocoa farmers would always feed themselves first from their food production, the relative decline in total food land in the cocoa-food zone would therefore affect primarily the nonagricultural population. Hence, unless the relative decline in production is met by increased food production from the Oyo Province in the West, or food shipment from

Midwestern and Northern Nigeria, annual staple food consumption by the lower income segments of the nonagricultural population would probably decline in the future.

CHAPTER V

SUMMARY AND CONCLUSIONS

Introduction

Since cocoa is the major source of Western Nigeria's income, employment, revenue, and foreign exchange, the industry is very important to the regional economy. Over 95 percent of Nigerian cocoa production, covering a total area of approximately 1.6 million acres--cultivated by over 400,000 households, is located in the Western State. Nigerian cocoa production, which is relatively labor-intensive, is almost exclusively a smallholder enterprise. The typical landholding consists of about three acres of cocoa providing a cash income, and two acres of food cultivated primarily for household consumption (Okurume, 1970).

All the cocoa produced is sold to the Nigerian Cocoa Marketing Board, a statutory monopsonist. However, the producer prices farmers receive are generally less than the world prices. Between the world prices and producer prices, the government collects export duties, producer sales tax, and the marketing board collects a trading surplus tax. Additionally, farmers also pay for the operational and handling costs involved in the sale of their output. The total differences in some years may amount to as much as 50 percent of the world price. Hence, most economists recommended the increase in the cocoa producer prices. Moreover, since the cocoa farmers have been responsive in their output to producer price changes, any increase in their prices would further increase their output and output capacity. The loss in government revenue due to the initial commodity tax decrease may be offset by the increased tax base from (1) increased cocoa production and productive capacity, and (2) indirectly by the increase in the producers' income, and the asset value of cocoa land. Thus, taxing the increased tax base may recuperate the initial tax loss.

Furthermore, since the yield of many of the existing Amelonado cocoa trees is relatively low when compared to the recommended higher-yielding Upper Amazon species, the Western Nigerian government is encouraging farmers to grow more of the latter (Johnson *et al.*, 1969). In addition, the government is encouraging farmers to grow the higher-yielding Upper Amazon cocoa trees in land presently in bush or food.

The primary purpose of this study was to adapt components of the Nigerian Agricultural Simulation Model developed at Michigan State University in order to analyze the proposed revamping of the Nigerian cocoa producer pricing policy, and the government-initiated cocoa production campaigns. The study can also be viewed as part of the continuing process to further validate and improve the operational usefulness of the system simulation approach and the model for agricultural planning. To accomplish these objectives, the study focused specifically on the Nigerian cocoa sector, one of the four ecological zones in Southern Nigeria.

In addition, more realistic alternative world cocoa prices were used. (In previous studies [Manetsch et al., 1970; Olayide, Abkin, and Johnson, 1971; and Abkin, 1972], for the purpose of model testing, future world commodity prices were assumed to be constant.) The study also introduced and tested the usefulness of a guaranteed producers' floor price, whereby farmers would be paid a predetermined minimum, should their prices (after accounting for the various taxes and handling costs) go below the level. The price support program would be financed from previously accumulated trading surpluses, and if necessary, from outside sources.

The Western Nigerian Cocoa System Simulation Model

To explore the ramifications of the proposed government cocoa price-income strategy and production campaigns and their resultant interactions and feedback effects, the study adapted components of the Michigan State University Nigerian Agricultural Simulation Model to analyze their impact on the Western Nigerian cocoa economy. The cocoa simulation model has four major components which (1) allocated land use according to the farmers' perceived profitabilities of cocoa and food subject to the land, labor, and capital constraints, (2) calculated the yield and output of cocoa and food, and their respective producer and market prices, (3) provided the instrumental linkages for the government revenue, marketing board trading surplus, and production campaign policies, and (4) generated the performance criteria to evaluate the impact of alternative programs on the cocoa economy through time.

Cocoa Simulation Policy Experiments Conducted

The three major sets of assumptions investigated were (1) alternative world cocoa prices, (2) alternative revenue and marketing board producer pricing policies and, (3) proposed government cocoa planting and replanting production campaigns. The four world price functions used in the study represented the moderate (most likely), high, low, and cyclical price projections that would be relevant to the analysis of the Nigerian cocoa economy.

The first of the five policy options (which combined alternative producer pricing features and the proposed production campaigns) is Run 1, the base run which approximated the status quo policy. It assumed a relatively low government revenue tax of 10 percent of the prevailing world cocoa price, and a 20 percent marketing board trading surplus tax on the market price, and no government production campaign. Run 2 (which assumed the tax features of the base run and government replanting and new planting production campaigns) examined the effects of the campaign on the economy. Runs 3, 4, and 5 compared the effects of the production campaigns with varying tax features. The tax rates of Runs 3 and 4 were assumed to be 20 and 30 percent of the world and market prices. However, the taxes of Run 3 were cut off in the following year, whereas in Run 4, the taxes were phased out linearly over the following five years. Run 5 (with the same tax features and production campaigns as in Run 2) compared the effects of a guaranteed floor price feature supported by previously accumulated marketing board trading surpluses.

The results of the cocoa policy experiments were discussed in terms of the projected time paths (from 1970 to 1995) of six of the more important performance indices incorporated in the model. They were (1) total annual output of cocoa, (2) total and compositional (traditional and modern) acreages of cocoa trees, (3) foreign exchange generated from cocoa exports, (4) capitalized agricultural land value of the cocoa-food ecological zone, (5) disposable agricultural income per capita, and (6) accumulated government revenue and marketing board trading surpluses.

Policy Implications from the Simulation Experiments on the Western Nigerian Cocoa Economy

There are five major policy implications from the simulation experiments which agree substantially with the findings of CSNRD's study of the Nigerian cocoa industry. First, the total benefits to the Nigerian cocoa economy depend importantly on the world price Nigeria receives for her export. Obviously, the higher the world price of cocoa, the more it benefits the economy. It is therefore very important for the government to secure the highest world price for her exports.

Second, investments in government production campaigns which encourage cocoa farmers to cultivate higher-yielding Upper Amazon trees are justifiable since the projected output, foreign exchange, farmers' income, and accumulated government revenue and marketing board trading surpluses functions were in all cases (regardless of their tax features) higher than Run 1 (without the production campaigns). The modernization of the Nigerian cocoa economy is defensible, even if world cocoa prices should decline subsequently--either resulting directly from an excess capacity because of the slower growth rates of demand, or from other factors outside the direct control of Nigeria and other producing countries.

Third, based on the farmers' positive supply responses, increases in cocoa producer prices raise both the short-term harvest output and the long-term output capacity responses and hence, farmers' disposable income as well as the foreign exchange earnings from additional cocoa exports. In turn, increases in cocoa exports and farmers' income would most probably have their spill-over benefits in the other sectors of the economy. Increases in foreign exchange earnings increase Nigeria's capacity to import. Increases in output and output capacity would also increase the demand for agricultural productive goods and services, viz., more fertilizer, seedlings, tools, and machinery. Similarly, increases in farmers' income also increase their effective demand for other durable and nondurable consumer goods, in addition to the productive goods mentioned earlier. Hence, the increase in the profitability of cocoa production resulting from higher producer prices, and the decrease in the farmers' cost of production campaigns reinforced the expansion of the agricultural land. The expansion of the cocoa land and food land by the farmers is thus a very important means of private capital formation.

Any increased loss in government revenue that might occur from the producer tax decrease could be compensated by taxing the farmers' increased income and the asset value of their cocoa land, or indirectly by taxing the increased purchase of their producer and consumer goods. However, the effects of alternative taxes on the economy do not necessarily correspond to one another. Besides the administrative problems of enforcement, costs of collection, distribution and equity impact, there is also the intertemporal problem and trade-off between present revenue and future revenue of the alternative methods. Although it may be argued that the future tax base resulting from the proposed tax decrease may be greater, the increased taxes from the increased output would not be collected until the trees come into production. Hence, if government revenue is needed for other development programs, it is highly unlikely that the government would reduce cocoa producer taxes unless the revenue loss is replaced by other sources outside of the cocoa sector, such as royalties from the petroleum industry.

Fourth, the introduction of an annual guaranteed producer floor price would stabilize the farmers' income, especially if world cocoa prices are expected to behave cyclically. The producer price support also increases farmers' income, cocoa acreages, capitalized agricultural land value as well as the foreign exchange generated from cocoa exports in the years when cocoa prices are expected to be relatively low.

Finally, based on the policy experiments, the projected time paths of the various performance indices under alternative cocoa pricing policies (with their varying tax features) differed discernibly. Their projected differences, in turn, can provide a more comprehensive basis for policymakers to select the most efficacious cocoa pricing strategy. The choice of the strategy depends on the policymakers' perceived objective of the pricing policy. Hence, if the perceived overriding objective for the cocoa pricing policy is to maximize farmers' income and the foreign exchange generated from cocoa exports, then the policy which phased out all taxes would be preferred. On the other hand, if the perceived objective of the pricing policy is to maximize government revenue and marketing board trading surpluses, the status quo policy (which was projected to accumulate the highest revenue and trading surpluses) would be the choice. Finally, if the objective is to ensure the cocoa farmers a steady increase in their income from cocoa production, the proposed producers' floor price feature discussed above can be incorporated, as part of the cocoa pricing strategy.

Conclusion from the Use of the System Simulation Approach for Cocoa Development Planning

In using the system simulation approach, we were interested in providing an analytical framework in which researchers and policymakers could interact while formulating alternative cocoa policies. Hence, we were guided more by the nature of the problem we attempted to solve rather than by the availability of relevant data to estimate statistically the coefficients of the postulated economic phenomena, or by the constraints imposed by a computing algorithm. In this study, we were specifically interested in evaluating the long-term economic impact of the proposed revamping of the cocoa producer price policy, and the government production campaigns to expand the Western Nigerian cocoa industry.

To this end, the computerized Nigerian Agricultural Simulation Model provided a very useful and convenient "laboratory" whereby the outcomes of various combinations of cocoa programs and policies were compared and analyzed. Based on the projected time paths of the various performance indicies of the cocoa sector, the merits of various policy alternatives were discussed. This particular computing advantage of the computerized system simulation model (with its relative low cost and quick computation turn-around time) should not be minimized, especially when compared to the tedious and time-consuming conventional pen and pencil projections used in CSNRD. However, the prolific ability of the computerized model to generate results under alternative assumptions, like the opening of Pandora's box, still does not negate the researcher's responsibility to interpret the simulated results to policymakers in light of the model's limitations and underlying assumptions.

At a more subtle epistemological level, a major characteristic of the approach used in the study is simulation. Simulation is a formalized process of thinking through some of the interactions, feedbacks, effects and related policy implications. The fundamental methodological problem, therefore, was to determine what were the essential variables, interrelationships, processes, and boundary conditions of the Nigerian cocoa system--recognizing that the essence of scientific inquiry is to simplify complexity without being overly simplistic. On the other hand, the cocoa system simulation model would have been very cumbersome, if all the thought-of-linkages and processes were included, without the investigators first discerning which were the most important or significant. Moreover, since it is very difficult to validate (or refute) the postulated interrelationships if they became too complex, it was methodologically more defensible to build and validate the simpler relationships. On the other hand, we could have been too parsimonious, by selecting out a priori most of these interrelationships, or by consigning the developmental process to occur at a predetermined rate, thereby assuming the research problem away. Hence, the research was motivated toward the middle-ground between these two extreme positions.

The process of developing a system simulation model of the Nigerian cocoa economy had led us to consider variables and interrelationships which were less amenable for analysis by the more conventional techniques. Past cocoa econometric studies (constrained by data availability) were concerned primarily with establishing statistically past empirical relations of a handful of variables in order to forecast what might happen to the industry under proposed intervening policies. Such linear extrapolations, however, might not be valid for policy prognostication, since the underlying economic conditions in the future would have changed. Moreover, the very purpose of development is to set in motion forces that are not self-equilibrating, but interactive. Following the system concepts expounded by Forrester (1972) and Von Bertalanffy (1972), the model explored the implications of the interactions and positive and negative feedback effects that might modify the final outcome.

As a general conclusion, it is hoped that the computerized, system simulation model of the Nigerian cocoa economy has captured some of the more important dynamic and interactive relationships, under alternative government policies and data and behavioral assumptions. In addition, the model's projected time-paths of the various performance indices, may better assist policymakers in cocoa planning and policy analysis with the display of the composite outcome of each proposed policy.

Further Research on the Nigerian Agricultural Simulation Model for Policy Analysis

There are six additional ways in which the Nigerian Agricultural Simulation Model can be extended for policy analysis.[1] First, it should provide a more comprehensive basis for analyzing government revenue and investment policies of the cocoa sector. The present model was not able, nor built to, compare the efficacy of cocoa producer tax as a means of generating government revenue, vis-a-vis alternative income, consumption, import, capital gain and land taxes. Likewise, the present model did not provide a comprehensive basis to evaluate the impact and effectiveness of the government overall investment program, including the reinvestment of the revenue generated from the cocoa industry. In the present model, we have attempted to capture the benefits that might accrue to the cocoa producers in the private sector by showing their increase in the income (flow) and the increase in their capitalized land value (stock). However, in the policy options where producer taxes prevailed, the government revenue and marketing board trading surpluses

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[1]See also Abkin (1972) for possible improvements and extensions of the Nigerian Agricultural Simulation Model for policy analysis.

that resulted from the various tax policies were merely accumulated. No attempt was made to show how the returns to the economy might have been greater if the accumulated revenue and trading surpluses had been "ploughed-back" either directly or indirectly to the cocoa sector. Obviously, the benefits derived from the government reinvestment of the revenue and trading surpluses would depend on the nature of the activity invested.

The central unresolved analytical issue is: How do we determine who is the more efficient and effective allocator of the reinvestable surpluses that result from the government tax and investment policies? Is it the public sector and its agencies who, with the collected revenue may attempt to increase public and private capital formation through various means? These could include equity, participation in quasi-government corporations; financial grants to colleges, extension services, and research institutes; and directly to the agricultural producer sector, through cash, subsidy and low interest loans to the farmers. Or is it the cocoa producers in the private sector, who with the increase in income resulting from the increase in producer price, may invest further in their present agricultural production, or other alternative ventures either within agriculture or outside of agriculture?

Secondly, to discuss meaningfully the impact and distributional costs and benefits of government investment, including the proposed production campaigns and the revamping of the producer pricing policy, the cocoa sector may have to be disaggregated by its geo-political divisions. Since the trees in each division have their own genetic, cultivational, and age cohort characteristics, such disaggregation may indeed be helpful. For example, the trees in the Ibadan Division are generally older than those in the Ife Division. Because of the present rather intensive land utilization pattern, Ibadan cocoa farmers would probably have to replant their existing trees in order to increase their output capacity, whereas the Ife cocoa farmers could still annex neighboring bush land for cocoa cultivation.

Since we are also interested in the differential output and consumption responses under the proposed producer price and resultant income changes, and the distributional impact of government investment policies in the sector, it may be useful to further subcategorize the cocoa industry in each geopolitical division by farm size. Although there are other attributes by which we can divide the industry, farm size seems to be the best proxy variable especially since the model's present unit of analysis is an acre of agricultural land, and not the individual agricultural decision maker. If the unit were the latter, then it might be more useful to subcategorize the industry by the income levels or social characteristics of the farmers.

The third model extension is to provide new policy entry points in future simulated time-periods of the experiment. The present policy experiments on the cocoa economy were conducted with the government revenue and marketing board producer pricing policies throughout the planning horizon, specified at the base year. The time paths of the various performance indicies were then projected through simulated time. However, the present approach did not allow policymakers who (upon the assessment of the performance indices at the future time period) may want to introduce another policy in a future time period to counter or augment the consequences of the prevailing policy alternative. For example, a policymaker may find the market price of food in 1980, resulting from a crash cocoa production campiagn in 1972 intolerably high. He can then experiment with alternative food production campaigns, initiated at different time periods between 1972 and 1980, that might reduce the high market price of food in 1980.

Fourth, closely related with the above, is the inclusion of a semi-automatic decision-making interphase whereby the government tax policy in any one year depends on the interaction between the prevailing world price of cocoa and a predetermined tax rate schedule. Although the general trend of world cocoa prices can be specified, the actual price in any one year would probably occur randomly within a predetermined variance from that trend. Hence, to model the phenomena, cocoa world prices can be specified stochastically with a random component to simulate the uncertainty of the price in any one year. Should the simulated world price in any one year go below a predetermined low level, the government tax rates for that year could be reduced accordingly. Likewise, should the simulated world price in another year exceed a predetermined upper level, the tax rates for that year could be increased. The major benefit of the model extension is to help determine a more flexible governmental tax policy which

would stabilize farmers' income as well as the government revenue, given the fluctuations of world prices.

Fifth, as part of the continuing process to update and improve the substantive and informational base of the model, more field and empirical research must be conducted to verify some of the projected outcome anticipated in the present series of simulation experiments. Specifically, more concrete evidence is necessary to substantiate (or refute) (1) the postulated effects and interrelations of the cocoa farmers' short-term harvest responses and their long-term output capacity expansion responses, given producer price changes; (2) the communicational effects of the government production campaigns; and (3) the constraining effects of inputs (such as labor and credit) on the cocoa farmers' agricultural land allocative decisions.

Finally, alternative formulation of the model's present land allocation and the annual harvest response mechanisms may have to be made and tested to conform to the farmers' actual output response behavior. The projected annual cocoa outputs (assuming government-initiated production campaigns) under alternative producer price policies tend to cluster. On the other hand, economy theory suggests a wider divergence among the projected time paths. Specifically, the land allocation mechanism (which models the farmers' long-term output capacity expansion) may have to be modified such that the expansion rate of cocoa acreages would be more sensitive to producer price changes. Likewise, the short-term harvest response may have to be modified such that the output increase resulting from producer price increase would also depend on the farmers' past experience on price changes as well as their anticipated changes--given the biological yield capacity and composition of the cocoa trees.

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