Rural Development and Income Distribution: The Case of Pakistan

Khalid Saeed

B. Sc., University of Engineering and Technology, Lahore
(1968)

M. Eng., Asian Institute of Technology, Bangkok
(1975)

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Signature of Author ____________________
Alfred P. Sloan School of Management,
and Department of Urban Studies and Planning
September 1980

Certified by ____________________
Edward B. Roberts
Thesis Supervisor

Accepted by ____________________
Chairman, Departmental Graduate Committee

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RURAL DEVELOPMENT AND INCOME DISTRIBUTION:

THE CASE OF PAKISTAN

by

KHALID SAEED

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ABSTRACT

The rural parts of most developing countries are characterized by widespread poverty among the cultivating classes, with small enclaves of relative affluence in major land-owners. Over the past three decades, a number of development programs have been implemented in these countries. Most programs endeavored to increase aggregate output; some were directly intended for the poor. While these programs have helped to significantly increase land productivity and agricultural output, they have usually not helped the poor cross-sections of the rural populations. In some cases, these programs have increased income inequalities.

The issue of rural poverty has received ample attention in the economic development literature over the past decade. But most treatises on the subject are rhetorical and make no attempt to study the income distribution processes _per se_ in a holistic framework.

This thesis attempts to understand the structural mechanisms responsible for maintaining poor economic condition of the cultivators in a rural economy, and examines implications of various development policies implemented. Pakistan is used as a case study.

The analysis takes into account only the economic factors arising out of the rational decisions of the capitalists and the cultivators, each group trying to further its respective interest. Political factors, exploitative practices, and social and cultural characteristics are ignored. The economic factors are considered sufficient for creating the prevalent income inequalities.

The main instrument of analysis of the study is a System Dynamics model incorporating income generation and disbursement processes in an agrarian economy consisting of a capitalist sector and a self-employed sector. The validity of the model is argued on the basis of the soundness of its micro-structure, the logical consistency of its assumptions, and the empirical validity of its behavior. Computer simulation is used as a means of studying the model behavior and for analysing rural development policies.

The study suggests that the absence of an economic force that should encourage ownership of land by its cultivators is a key factor responsible for the poor economic condition of the cultivators. Since worker compensation is determined on the basis of the bargaining position of the cultivators, which depends on their ability to maintain a high level of consumption while being self-employed, the separation of land from cultivators also suppresses wage rate.

Other factors contributing to maintenance of the poor economic condition of the cultivators include a segmentation in the financial markets strongly linking ownership ability to saving ability, and the changes in the utility of savings for the cultivators who tend to consume more and save less for supporting investment needs of self-employment when wage-employment is available. Further, use of labor displacing modern farming implements in the commercial farms may not only limit worker demand and further depress wage rates, but may also cause relative expansion in the land holdings of the capitalist sector.

The study concludes that rural development programs striving to increase land productivity may only serve to increase the claim to income on the basis of land-ownership. If the ownership of land is concentrated outside of the cultivators, such programs may worsen the economic condition of the cultivators and suppress rural wage rate.

The study proposes a general framework for rural development incorporating simultaneously the instruments that should create economic forces encouraging transfer of land-ownership to the cultivators and the policies for increasing productivity. The suggested instruments and policies include imposition of a tax on rent income, organization of peasant cooperatives enabling them to use modern implements, provision of green revolution technologies at a wide scale, and reorganization of rural financial markets for decreasing dependency of investment on the internal savings of the households, in that order of importance.

Thesis Supervisor: Dr. Edward B. Roberts

Title: David Sarnoff Professor of Management of Technology

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CHAPTER ONE

INTRODUCTION

1.1. Purpose

This study is aimed at advancing and supporting a theory of income distribution in a developing country agrarian economy, typically rural Pakistan. The theory is developed as a systems model of the processes that underlie the disbursement of rural income to its various claimants. The model is used as basis for explaining the causes of widespread rural poverty that has persisted in Pakistan in spite of a Green Revolution which considerably increased agricultural productivity [1]. A limited exploratory analysis using the model for testing rural development policies for their impact on income distribution is also presented.

The study focuses on the dynamics of decision processes within the rural sector of a national economy. The urban-rural linkages, and the transfers of income and resources between the urban and rural sectors are treated exogenously. The model does not incorporate any of the political and cultural factors commonly suggested in most treatises on income distribution and poverty [2]. The role of the political factors in exacerbating income inequality is acknowledged, but the study is primarily concerned with identifying the economic factors underlying rural income distribution, and the way these affect rural development programs.

1.2. Pakistan's Rural Economy: An Overview

Most studies identify three modes of agricultural production in Pakistan, based on land tenure arrangements. These modes are: 1) Commercial farming, in which the landowner employs wage workers and invests in farm capital for cultivating land; 2) Peasant farming, which is carried out by small owner-cultivators using family labor and collectively owned or borrowed capital; and 3) Sharecropping, in which land is rented out by the owner to a tenant for a share of the production. Sharecroppers also use family labor and collectively owned or borrowed capital [3].

These land tenure categories are by no means mutually exclusive. Many landowners commercially farm parts of their holdings while they employ sharecroppers on the rest. Also, most cultivators who sharecrop own some land of their own [4]. Thus, with respect to the management and control of land being cultivated, there are, in effect, only two production modes: the commercial farming mode, and the peasant farming mode. The former mode entails investment and worker hiring decisions on the basis of economic efficiency. The latter mode incorporates self-employment of workers using owned or rented production factors. In the economic literature, the two categories are often referred to as the formal (or capitalist) and informal (or peasant) sectors [5].

An important feature of Pakistan's rural economy is its class structure. Cultivators, whether wage-earning or self-employed, enjoy more or less similar incomes and social status. They are often bound by family ties and share their incomes among themselves [6]. Commercial farmers and non-cultivating landlords, large and small, are different segments of a single continuum, on which they are placed according to differences in their wealth and share in political power. Albeit, they all enjoy a position of privilege and power in the rural economy [7].

The cultivators constitute an overwhelming proportion of the rural population, but claim a disproportionately small share of rural income. The commercial farmers and the noncultivating landlords, though very few as compared to the number of workers, obtain a huge share of the income. Consequently, while most cultivating households live at a subsistence level, most commercial farmers and noncultivating landowners are able to support rather affluent life styles.

Commercial farming, in fact, is a relatively new farming practice in Pakistan, that came into being after modern capital inputs were introduced over the decades of 1950s and 1960s. Before 1950s, almost all land was cultivated by self-employed peasants and sharecroppers. The chief characteristic of the rural economy at that time was an almost dichotomous separation between the land-owning and the land-cultivating parties. It is estimated that over 70 percent of the agricultural land was owned by the landlords who employed sharecroppers, the balance 30 percent represented the cumulative holdings of the cultivators [9].

1.3. History of Rural Income Distribution in Pakistan

The rural income in Pakistan is divided between its various claimants on the bases of their ownership rights and labor input to production. The main claimants to income are the landowners and the cultivators. Some income is also earned by the producers of various services. However, as these services are predominantly produced within the cultivator and land-owning households, it can be assumed that no third party accrues income from them. The exact number of noncultivating owners at various times in history is not known, but most accounts state that before modern capital inputs were introduced in the economy, anyone owning 20-25 acres or more fell in that category [10]. The published statistics about Pakistan's agriculture indicate that over the 1950s, the number of owners having holdings of 25 acres or more did not exceed 350,000 [11]. That number roughly represents less than 3 percent of the rural workforce. However, it is estimated that nearly 50 percent of the income was claimed by the noncultivating households in the form of land and farm capital rents, interest on borrowings, and gifts from the tenants. The rest was shared by the cultivating households, constituted by over 97 percent of the workforce.

The economic condition of the working classes in the rural Pakistan is reported to have further deteriorated since the 1950s, even though use of modern implements in commercial farming, and availability of new seeds, pesticides and fertilizers has allowed agricultural production to expand considerably [12].

According to historical accounts, the cultivators in the region now constituting Pakistan have not always been poor. Before colonization by the British, private land ownership rights did not exist. Thus, land was not a commodity to be bought, sold, mortgaged, or rented. Under such a land tenure system, the rights of various claimants to the product were determined on the bases of their respective contributions to production and to maintenance of socio-political conditions favorable to the cultivators [13]. The main claimants to the product were the cultivators themselves. A share of the production was collected as revenue by the emissaries of the ruler, the rest remained with the cultivator and was spent on consumption and on maintenance of farm capital.

It is often suggested that availability of abundant land played an important role in maintaining an ownership-free land tenure system [14]. However, that proposition is questionable on Malthusian grounds. The region under study has been intensively cultivated for thousands of years. If a Malthusian relationship between population and resources is accepted, it is unlikely that surplus cultivable land would continue to be in abundance at a given infrastructure level. In fact, many historians agree that if the marginal lands were not brought under cultivation by construction of extensive irrigation and transportation networks by the British, the population of the region would have been about one-fourth of what it is now [15]. Thus, it is reasonable to believe that an ownership-free land tenure system was being maintained without relative abundance of cultivable land. For the purpose of this study, both the population growth rate and the land tenure system are specified exogenously, and no causal relation is assumed between them.

A new land tenure system was introduced by the British in the early ninteenth century. Under this system, an elaborate new basis for land ownership was erected. The new system accorded rights to owners to rent out, sell or mortgage their land holdings. A new judicial system that protected the ownership rights was also introduced. Simultaneously, large grants of land were conferred upon the politically influential subjects of the crown. These subjects often resided in cities and invariably relied on sharecroppers for tilling their land [16].

Soon after the new tenure system was in place, the British undertook to construct an elaborate canal irrigation system and a railway transportation network for facilitating production and shipment of agricultural raw materials for their industry. Development of such infrastructure allowed almost all marginal lands to be brought under cultivation. This land was alloted to "peasant" and "capitalist" grantees in parcels ranging between 50 acres and 500 acres. Although these grantees were expected to engage in commercial farming, they proved to be inclined towards absentee landlordism [17].

The agricultural production of the region rose considerably as new land was brought under cultivation, but the economic condition of the cultivators appears to have eroded continuously thereafter. Land became concentrated in the hands of non-cultivating owners, while more and more of the cultivators became sharecroppers. By the mid-1920s, the majority of cultivators owned less than 7.5 acres and the tenancy pattern started being taken for granted [18].

Many historians suggest that the rapid increase in population, caused by the expansion in agricultural resources, is responsible for increasing poverty among the cultivators. However, it should be noted that even though cultivable land per capita increased considerably as marginal lands were brought under cultivation, a concomitant change in the economic condition of the cultivators did not take place. The increases in population did bring down land per capita. But in the past, the cultivators had lived in relative affluence at lower levels of per capita land.

Others attribute the increasing poverty among cultivators to the social change brought about by the new socio-economic order introduced by the British. Daniel and Alice Thorner state:

> "In retrospect, the net effect of the British rule was to change drastically the social fabric of Indian agriculture, but to leave virtually unaffected the basic process of production and level of technology. The upper strata of this agrarian society benefitted handsomely. The position of cultivators deteriorated. Capital needed for development of agriculture was siphoned off and the level of total output tended toward stagnation." [19]

The new order surely redefined the income disbursement criteria. Ownership rights entitled one to be a claimant to the production of land, while they did not bind one to till it. But in due course of time, ownership and cultivation of land became almost dichotomous activities. When Pakistan was liberated from the British colonial rule in 1947, the division between agricultural landowners and cultivators was well established. A very small cross section of rural population owned most of the land in parcels ranging between 20-25 acres to thousands of acres, but all of this land was tilled by peasant cultivators who gave up an estimated 50 percent or more of the production from land as rents and interests. Landlords became the rural elite social class. Peasant cultivators, whether tilling their own land or sharecropping, belonged to the lower strata of rural society. Friendships, marital relationships, and extended family support were common within each social class but were rare across the classes [20]. Alavi reports:

> "Until mechanized farming was introduced, all landowners who owned 20-25 acres employed sharecroppers. Owner-cultivators were those who just had enough land that could be cultivated by one or at most two pairs of bullocks, and family labor. Conventionally, $12\frac{1}{2}$ acres (half a "square") of land is taken to be the maximum area that could be cultivated by two men and a pair of bullocks. A large family might employ two pairs of bullocks, but rarely more. The feudal mode of production, therefore, is to be found not only on lands of those who own hundreds of acres, but also on lands of large numbers of landowners who own as little as 20-25 acres. A land holding of 25 acres might appear small, but it is five times as large as a subsistance holding (estimated to be 5 acres)." [21]

Modern agricultural implements introduced in Pakistan after the 1950s were accompanied by new seed varieties, synthetic fertilizers, and pesticides. Further, the country also experimented with a number of rural reforms, including community development programs, agricultural credit schemes, and "land reforms" [22]. Generally, the reformist policies were implemented on a limited scale, and had little if any impact. The community development programs were abandoned due to administrative difficulties in implementation [23]. Agricultural credit schemes tended to favor the relatively affluent landowners, who were considered better credit risks by the banks [24]. Land reforms afforded only trivial transfers of land to cultivators and did little to improve their economic condition [25].

Use of mechanical farming equipment allowed the landowners higher returns on their investment in commercial farming than was available in sharecropping. Thus, introduction of modern capital equipment led to large scale evictions of the tenants from the sharecropped land. The scarcity of rentable land pushed up land rents, while the unemployment created due to these evictions depressed rural wage rates. Thus, introduction of modern agricultural equipment increased the share of income claimed by the landlords, and further depressed income and consumption levels that were already declining due to population increases [26].

1.4. Alternative Models of Rural Income Distribution

While programs to alleviate mass poverty and inequality of income in developing countries proliferate, systematic efforts to study the processes that lead to mass poverty have been few. The economic development theories, nevertheless, embody implicit expositions of poverty, though often rhetorical and with doubtful logic [27].

Current explanations of rural poverty have one element in common: They all begin with the assumptions that the production system consists of multiple subeconomies, and that income-generating factors are unequally distributed among them. Few theories identify the processes which lead to the creation of multiple subeconomies. The failure of the theories to explain the processes underlying income distribution limits their use in the design of anti-poverty programs.

Indeed, the concept of multiple subeconomies embodied in various development theories is empirically valid. In most developing countries, a modern commercially run subeconomy and a traditional subeconomy of self-employed workers exist side by side in both urban and rural sectors. The modern subeconomy is often called the formal sector and the traditional subeconomy the informal or peasant sector. The productivity of the formal sector is usually much higher than the traditional sector, and while the formal sector appears efficient and progressive, the traditional sector appears to be the center of inefficiency and poverty.

Mass poverty among rural peasants and cultivators has been attributed to a variety of agents in various economic development theories. The neoclassical economists dismiss the problem as a temporary consequence of growth [28]. The structuralists are mystified by the inability of the resources to flow from the inefficient to the efficient sectors, and the continued existence of large informal sectors [29]. The liberals and the revisionists blame it on the disregard of economically efficient practices by the peasants [30], an urban bias in economic development decisions [31], and even to the genetic stupidity and docility of the poor [32]. The radicals recognize it as a part of the exploitative practices of the rich against the poor, which are seen as an essential ingredient of the continuing power struggle in a capitalist society [33].

The economic development policies advocated by the proponents of various theories vary according to the general diagnoses of poverty made by those theories. The traditionalist theories advocate promoting the formal sector, which should facilitate economic growth by drawing the inefficiently employed resources away from the informal sector [34]. The structuralist theories continue to expect that growth in the modern sectors will stimulate growth in the traditional sectors through the economic linkages between the two [35]. The liberal and revisionist theories suggest development programs aimed at the poor target groups [36], while the radical theories favor creation of conditions that would facilitate the socio-historic course of events believed to be imminent for a capitalist system [37].

There have been a few attempts at understanding the interaction between the capitalist and peasant modes of agriculture that should help illuminate the nature of rural poverty to some degree. Models presented by A. K. Sen [38], P. K. Bardhan [39], and K. P. Anderson [40] are particularly insightful. Nonetheless, formal models of income distribution, as attempted in this study, are virtually non-existent.

The model of rural income distribution presented in this study incorporates mechanisms underlying the disbursement of rural income between its various claimants. Ownership of resources being an important basis for claim to income, the mechanisms of allocation of resources between the capitalist and peasant sectors also form part of the model. Political and cultural factors which are held responsible for poverty in most development theories have not been included in the model.

1.5. Issues and Hypotheses

As rural poverty in Pakistan is almost exclusively associated with the economic condition of the cultivators, the key issue to be examined is how the dichotomy developed between land-owning and land-cultivating parties and how this dichotomy reduced the latter's claim to income. Also, rural development policies must be evaluated not only with respect to their roles in increasing aggregate rural production, but also with respect to their effects on division of rural income between the capitalist owners and the peasant cultivators, so that their impact on the poor cross-sections of the rural population can be assessed.

At the outset, the rural income distribution problem in Pakistan appears to arise from the economic transactions between a self-employed peasant sector that also monopolizes the labor supply, and a land-owning capitalist sector that enters into wage and rent contracts with the peasant sector by hiring workers or by renting out land for sharecropping. Both sectors strive to further their respective economic interests. However, the presence of a land tenure system which allows free separation between ownership and cultivation of land, coupled with segmented financial markets which restrict investment if internal cash balances of households are inadequate are responsible for concentration of land in the hands of parties with a high saving ability, even if these parties take no part in tilling land.

The following hypotheses are advanced in this thesis for explaining the dynamics that led to the current inequality in land ownership and the concomitant deterioration in the condition of the cultivators:

1. The introduction of a land proprietry system together with large grants of land to non-peasant parties created two classes of owners: self-employed peasants who enjoyed ownership rights over the land they cultivated, and non-peasant landlords,

who could either engage in farming on capitalist lines or could enter into sharecropping contracts with the self-employed peasants.

2. In the past, the self-employed peasants were the only cultivators in the economy and thus monopolized labor supply for farming. Farming on capitalist lines entailed hiring workers from the peasantry, who demanded a wage equal to their opportunity costs of leaving the self-employed sector. If peasants are assumed to maximize consumption, these opportunity costs are equal to the average consumption expenditure enjoyed by a worker in the self-employed sector. Wage rates based on such criteria were high as compared to the marginal revenue product of labor in capitalist farming.

3. Due to high wage rates, capitalist farming tended to be less labor intensive than peasant farming, albeit, low labor intensity decreased the productivity of their investment in land and farm capital. At the same time, labor-extensive cultivation using only a part of the resources of the economy left the peasant sector with a relatively large number of workers, who raised its productivity of land and capital. However, in the presence of ownership privileges and highly segmented financial markets, land could not be transfered from one sector to the other without a financial transaction between the two.

4. The land tenure system permitted the owners to freely sell, mortgage, or rent out land, but the segmented financial markets assured continued land ownership by households with adequate internal cash resources. Peasant cultivators presumably had less savings than the capitalist landowners, and thus their ability to maintain their land holdings or to expand them was limited. Land rents were determined by the aggregate productivity of land and the demand for rented land and, therefore, were bid up as the intensity of cultivation and land shortage in the peasant sector rose concomitantly. As such, sharecropping contracts between landlords and peasants, involving land rent payments by the latter to the former, allowed efficient utilization of surplus resources of both and were seen as mutually beneficial. Sharecropping, therefore, emerged as an efficient alternative to capitalist farming, and soon became a widespread practice.

5. The assumption of differences between savings of capitalist landlords and peasants is, at the outset, based on observer accounts. It is generally recognized that self-employed peasants save a smaller fraction of their income than the capitalist landowners [41]. Empirical studies indicate that while capitalist landowners usually save about one-third of their income, the fraction of income saved by the peasants is not only small but also widely varies [42]. Low worker productivity and rent and interest liabilities are often suggested as the causes of poor saving ability in peasant farming [43]. Thus, it can be

inferred that the fraction of income saved by the peasants would vary depending on their labor efficiency and rent and interest liabilities.

The efficiency of labor in a production sector that does not hire any wage workers can be measured only against the opportunity costs of retaining a worker in that sector. As long as alternative job opportunities offering a wage higher than the marginal contribution of a worker in self-employment are available, the labor productivity in self-employment will be deemed low, and there will be little incentive to forego consumption of income in favor of saving for meeting investment needs of the sector [44].

Thus, the job opportunities created by the introduction of a new capitalist sector in the economy presumably permitted the peasants to raise their consumption levels in the short run, but at the cost of depleting their saved cash resources and decreasing their ability to invest. In the long run, due to the rise of sharecropping practice, job opportunities in the formal sector slowly vanished. This should have increased the need to save in the peasant sector to maintain self-employed production, but the saving ability of the peasant sector was now limited by the need to maintain past consumption levels while rising rent and interest burden claimed a substantial share of its production.

6. The capitalist landowners continued to get adequate returns on their investment by charging adequate rents on the land and capital rented out by them, which not only made it economically viable for them to maintain and expand their ownership, but also afforded them continued high saving rates. Availability of adequate cash balances due to a high level of savings further enhanced their ability to invest.

7. Propositions 1 to 6 incorporate the necessary ingredients for the dichotomy between land-owning and land-cultivating parties, which developed in due course after the introduction of the new land tenure system. This dichotomy evidently determines the shares of the various claimants to production and, hence, has played an important role in realizing the current income distribution pattern. Population growth reinforced this pattern by overburdening land, thus lowering per capita income of workers, while simultaneously enabling the land rent claims of the capitalist landowners to be raised.

1.6. Method of Analysis

A scientific enquiry, whether striving to understand natural or social phenomena or for studying a policy problem, invariably entails use of a model of the phenomenon or the problem. At the outset, such models are mental images of the processes underlying the problem. Metal images are translated into descriptive, mathematical, or physical analogues for experimentation and for expository purposes. In general, the method of translation varies depending on the purpose of the enquiry, the analytical tools available to the analyst, and the considerations of time and budget.

Forrester distinguishes between two categories of models: the observer's models, and the operator's models. The former attempt to show reasons for past behavior, but such explanations may not guide the future. The latter are used for making decisions to control action and emphasize the ability to articulate implications of the decision [45]. The methodologies for the observer models are selected on the basis of their theoretical rigor, even though their scope may be limited. The methodologies for the operator models depend largely on practical considerations such as time, information and resources available for investigation before a decision has to be made.

The methodological approaches for the two types of models may overlap despite their different underlying considerations. However, while the observers may focus only on inferences of the model, the operators must use the model as a decision tool in addition to other instruments, such as intuition and knowledge of the environment outside the model boundary [46]. The enquiry of this study is aimed at understanding the underlying causes of widespread rural income inequality in Pakistan, but with a view to studying implications of various rural development policies.

Thus, this eqnuiry clearly entails policy-oriented or operator-type modelling.

Greenberger identifies nine methodologies for policy-oriented modelling. These methodologies are Input-Output Analysis, Linear Programming, Two-Person Zero-Sum Games, Probabilistic Methods, Algebric Methods, Econometric Modelling, Micro-Analysis, and System Dynamics. This list is not exhaustive, but includes the methodologies particularly germane to policy problems [47].

While all methodologies mentioned above have their weaknesses and strengths, given similar time and budgetary constraints, the advantage of a specific methodology over the others for an enquiry depends, to some degree, on the analyst's dexterity in using it. System Dynamics is selected as the method of analysis in this study. While it is conceded that this choice incorporates the author's concentration in that field, the System Dynamics method seems to offer several advantages over the other methods.

First, System Dynamics is one of the latest modelling innovations and provides a flexible framework within which to view the internal operations of systems in a coherent and orderly manner. The method also lends itself easily for application in a wide range of problems requiring social experimentation [48]. Of course, it is not possible to analyse these problems in a universally holistic framework, because of the degree of complexity involved, but a clear boundary has to be established between the subsystem being analysed and the rest of the universe acting as its environment. The elements inside the boundary are structured into feedback loops that cause internal elements to interact, while the cause and effect relationships between the subsystem and its environment are assumed to be uni-directional.

Second, as the System Dynamics modelling process requires explicit representation of the micro-components of the system, it encourages delineation of the cause and effect relationships connecting various elements of the system instead of using statistically derived correlations that assume a random universe. Thus, instead of offering the model as a policy panacea, the System Dynamics method helps to increase knowledge about how the system works, and thus allows the model to be used together with the intuitive knowledge about the system and its environment.

Third, the modelling methodology permits a high degree of communication between the mental model of the problem which is based on empirical experience, and a mathematical model which is based on the mental model. The high degree of communication between the two is possible due to their structural similarity. The mathematical model acts as an instrument for testing the logical consistency of the mental model. The ease of communication between the two facilitates iterative reformulation and refinement of both, which helps to zero in on the roots of the problem relatively quickly.

Finally, as System Dynamics models are largely internally driven by forces generated by the feedbacks they embody, these models are relatively insensitive to the numerical values of their parameters. Thus the need for a high degree of accuracy in determining the model parameters is eliminated. This is valuable in addressing social problems where data are scarce and inaccurate, but qualitative information about the way the components of the system interact can be obtained.

The System Dynamics method, however, has its limitations. As the components lying outside the model boundary are unknown, their behavior is unpredictable. Therefore, those components are a source of randomness and uncertainty. A model may be sound and logically consistent in terms of its internal structure, but its ability to predict a reality will depend upon the relative importance to the reality of the structure outside the model. Thus, it is extremely important to be aware of the context of the model and its limitations. The limitation of this analysis are discussed in Chapters Five and Six. It suffices here to say that the boundary of the model, rather than the quality and the quantity of the numerical data used in this study, limits the model's use as a decision-making tool.

1.7. Summary of Analysis and Organization of Thesis

A dynamic simulation model of the rural income distribution system is the main analysis instrument of this study. The logical consistency of the propositions stated in section 1.5 is examined with the help of simulation experiments with this model. The model also serves as a vehicle for testing several technology and community related rural development programs, and reformist, financial and fiscal policy instruments commonly suggested for alleviating poverty. Finally, a critical set of policies expected to afford growth in rural income as well as an improvement in its distribution is identified.

The model's validity is evaluated in regard to historical evidence drawn from Pakistan. The model validity issue is addressed in several parts over the succeeding chapters. First, the micro-relationships of the model are examined for their plausibility and their relevance to the theoretical and empirical evidence in Chapters Two and Three. The equation by equation description of the model given in Appendix A further elaborates those relationships. Second, the internal tendency of the model to realize a unique income distribution pattern similar to that of Pakistan is evaluated in Chapter Four. Third, the implications of various policy interventions into the model is compared to the impact of the relevant rural development programs in Pakistan in Chapter Five. Finally, the discussion of model parameters and their sensitivity in Appendix B provides an empirical basis for model validity.

Each of the above steps contributes towards increasing confidence in the model.

The study reveals that in the absence of any frictional factors that may prevent separation of parties owning and cultivating land, most development programs striving to increase the productivity of land will not raise median income, although these programs may considerably enhance incomes of the capitalist landowners, thus reinforcing their ability to acquire more land from the peasants. The content of the succeeding chapters of this thesis is arranged as follows.

Chapter Two describes the general structure of the model and gives its substantive assumptions. (The detailed technical description of the model is placed in Appendix A, while the estimation of model parameters is discussed in Appendix B.)

Chapter Three discusses the feedback structure of the model and identifies the forces governing income distribution in an agrarian economy consisting of peasants and capitalist landlords. These forces represent the internal tendencies of Pakistan's rural income distribution system.

Chapter Four describes the simulation experiments for testing and validating the model and for examining the hypotheses advanced in the section 1.5. The simulation experiments are performed in a sequence that helps isolate a set of modifying assumptions which must be added to the model of a perfect market economy for portraying Pakistan's rural income distribution system. The relevance of these assumptions to Pakistan is argued, and the historical developments in the country's rural income distribution are explained in the context of the model behavior.

Chapter Five describes a second set of simulation experiments aimed at testing rural development policies. The specific policies tested include increasing supplies of labor-saving modern capital equipment, land reforms, organization of financial markets for decreasing dependence of investment on household cash balances, injection of inputs for causing a "green revolution", organization of cooperatives allowing self-employed farmers to take advantage of modern capital equipment, increasing outmigration from rural areas for reducing the burden on land, and fiscal measures to affect income redistribution. These policies are tested separately and in groups for formulating the general framework of a rural reform for overcoming poverty.

Chapter Six sums up conclusions of the study and identifies issues for extension of the research.

NOTES AND REFERENCES

1. The primary inputs to the "green revolution" in Pakistan over the 1960s were high yielding varieties of seeds, synthetic fertilizers and pesticides. The use of these inputs has been relatively widespread, and covered both mechanized and labor intensive farms. But the impact of the "green revolution" on the social and economic structure of the rural society has been disturbing. Widespread tenant eviction resulting from resumption of land by the owners for capitalist farming have not only increased poverty among the cultivators but have also nourished militancy between land-owning and peasant classes. See GOTSCH, Carl H., "The Green Revolution and Future Development of Pakistan's Agriculture", in STEVENS, et al., Rural Development In Bangladesh and Pakistan, The University Press of Hawaii, 1976.

2. Most studies of income distribution emphasize political and cultural factors responsible for the poverty of the poor. See, for example, GALBRAITH, John Kenneth, The Nature of Mass Poverty, Harvard University Press, 1979; LIPTON, Michael M., Why Poor People Stay Poor, Harvard University Press, 1976; and PAPANEK, Gustav F., "Economic Development Theory, The Earnest Search for a Mirage", in NASH, M., (ed.), Essays in Economic Development and Cultural Change in Honor of Bert F. Hoselitz, The University of Chicago Press, 1977.

3. Commercial farming is only a recently introduced practice. Before the 1950s only peasants farmed owned or sharecropped land. See ALAVI, Hamza, "The Rural Elite and Agricultural Development in Pakistan", in STEVENS et al., op. cit.

4. Ibid. Also see CALVERT, H., The Size Distribution of Agricultural Holdings in Punjab, Rural Section Publication # 4, India Board of Economic Enquiry, Lahore, 1925.

5. This terminology has been introduced by the "dualist" economists. A good explanation of the terms formal and peasant sectors can be found in McGEE, T. G., "Rural Urban Mobility in South and Southeast Asia" in ABU LUGHOD and HAY JR. (eds), Third World Urbanization, Maaroufa Press, Chicago, 1977.

6. Pakistan's rural life styles are portrayed with reasonable accuracy in the report of PENN SCHOOL STUDY COUNCIL, Patterns of Village Life in South and Eastern Asia, Interstate Printers and Publishers, 1965.

7. ALAVI, 1976, op. cit.

8. These estimates are based on land size distribution before 1958 (Report of the Land Reform Commission for West Pakistan, Lahore 1959); and the land tenure pattern suggested in a number of studies (ALAVI, 1976, op. cit.).

9. Ibid.

10. Figures based on the report of the Land Reform Commission for West Pakistan, op. cit.

11. The owners usually claimed 50 percent or more of the production, depending on the quality of land and their contribution to farm capital. In addition, they expected seasonal gifts and free labor from the tenants. Although charging interest on loans is frowned upon, the peasants borrowing money from landowners are obligated to compensate the latter in some form. Thus, the sharecroppers may end up remitting almost two thirds of the production of land as rent and interest on borrowings to the landowners. With 70 percent of the land being sharecropped, the landowners should receive about 50 percent of the rural income.

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28. See, for example, ALONSO, William, "Urban and Regional Imbalances in Economic Development", in FRIEDMAN and ALONSO (eds.), Regional Policy: Readings in Theory and Applications, MIT Press, 1975.

29. The most prominent theories in the structuralist class are the "dualist" theories. Suggested readings are FEI, John C., and RANIS, Gustav, "Agrarianism, Dualism, and Economic Development", in ADLEMAN and THORBECKE (eds.), The Theory and Design of Economic Development, Johns Hopkins Press, Baltimore, 1966; and HOSELITZ, Bert F., "Interaction Between Industrial and Preindustrial Stratification Systems", in SMELSER and LIPSET, (eds.) Social Structure and Mobility in Economic Development, Aldine Publishing Co., Chicago, 1966.

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CHAPTER TWO

MODELLING PAKISTAN'S RURAL INCOME DISTRIBUTION SYSTEM

This chapter describes the broad structure of a System Dynamics model of Pakistan's rural income distribution system. The key assumptions of the model are stated and the resource and income flows incorporated in the model are described. Theoretical and empirical evidence supporting the model assumptions is also related. The causal mechanisms embodied in the model are further analysed in Chapter Three while the validity of the hypotheses advanced in the model is argued in Chapter Four.

2.1. The Model Building PROCESS

Models, whether mental, physical, rhetorical or mathematical are based on historical experience and knowledge of the system being modeled. Models serve as explanatory tools and as bases for designing and controlling complex systems. The various modelling practices and their validity are prolifically discussed and debated in the literature and the reader is referred to the writings by Forrester [1], Bell [2] , and Greenberger [3] for interesting treatises on the subject. This thesis does not delve into the controversial aspects of modelling issues. Instead, the model in this study was developed using as guidelines the steps entailed in a scientific enquiry. Figure 2.1 illustrates the logical sequence of those steps.

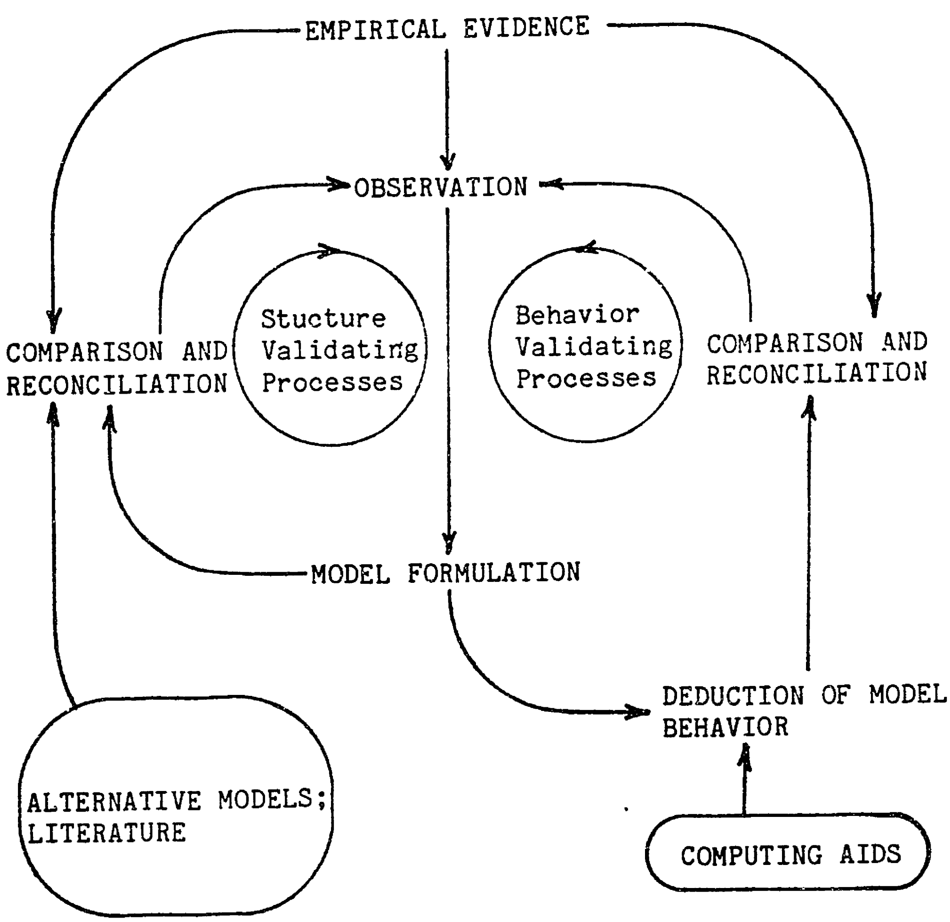

Figure 2.1: Model Building and Validation Processes Entailed in a Scientific Enquiry

At the outset, a model is formulated on the basis of observed evidence about how various elements in the system interact. The structure of the formulated model is then compared and reconciled with the alternative theories on the subject. Identification of points of agreement and discord with the alternative theories help clarify ambiguities in the model and allow the initial formulations to be revised and refined.

Once a satisfactory correspondance between the empirical evidence, the alternative theories, and the model has been achieved, the model is subjected to behavior tests. Computer simulation is used for deducing behavior of the model from its structural elements. The behavior of the model is compared and reconciled with the empirical evidence about the behavior of the system. If a discrepancy is observed between the model behavior and the evidenced behavior of the system, the model structure is modified. The behavior tests, therefore, provide a framework for testing hypotheses incorporated in the model. A particular hypothesis is accepted or rejected on the basis of its ability to contribute towards producing empirically valid behavior.

The steps in model building embody continuous processes for validating the structural elements of the model and their behavior, with the help of empirical evidence, alternative theories, and deduction. When a functional correspondence between the model structure, the model behavior, the alternative theories, and the empirical evidence is achieved, the model is accepted as a valid representation of the system, and can be used as a basis for policy analysis [4].

The succeeding sections of this chapter give an overview of the structure of a model of Pakisan's rural income distribution system and describe the broad assumptions embodied in it.

2.2. The Model Boundary

The model boundary is selected on the basis of the issues to be addressed by the model. The model in this study is concerned with understanding the nature of economic forces which determine the distribution of income and resources between the capitalist and peasant sectors of a dualist agrarian economy. The political, social, and cultural forces are not the focus of this study and are not explicitly represented in the model [5]. The model also does not incorporate origins of the rural development policies, which are exogenously specified. Further, although the model incorporates interaction of the rural economy with the urban economy, the behavior of the latter economy is exogenously specified.

Figure 2.2 shows how the model boundary separates the processes internal to the model from those lying outside it. While potential feedbacks may exist between the processes inside the model boundary and those outside (shown by broken arrows), these feedbacks are disregarded in this study as the effects of outside processes are exogeneously specified.

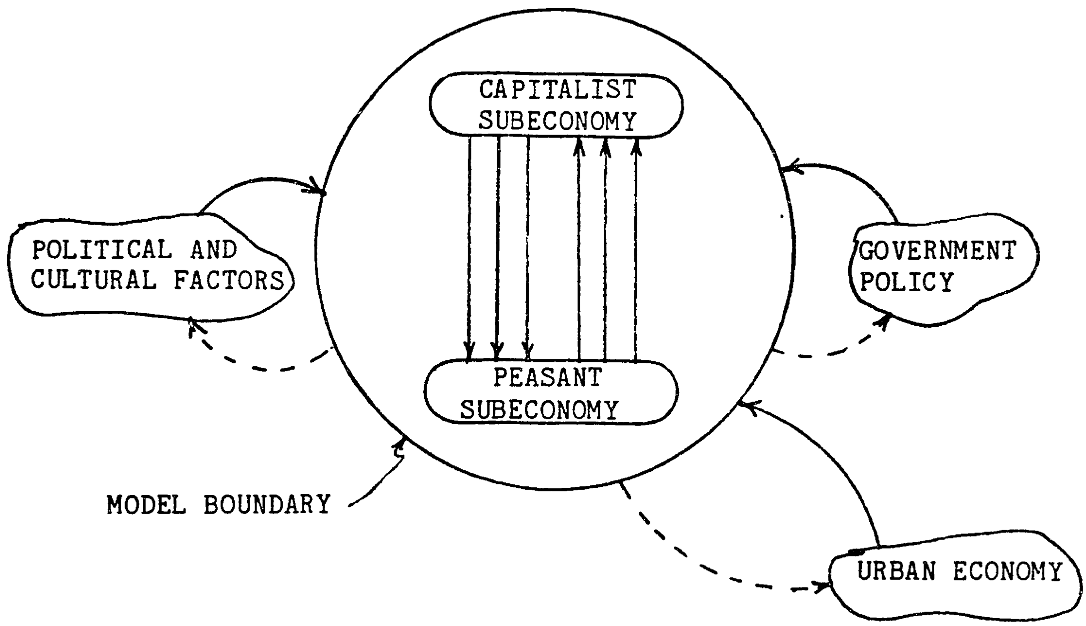

Figure 2.2: The Model Boundary

The model has two sectors: the capitalist or the formal sector, and the peasant or the self-employed sector. The variables of the model consist of accumulations (levels) and flows (rates of change) associated with allocation of resources between those sectors and disbursement of income in each sector. Thus, land and capital owned in each sector, and land, capital and workers employed in each sector are the variables associated with allocation of resources, while production and value of production in each sector, wage and rent payments between the sectors, and savings, investment and consumption of saved cash balances are the variables associated with income disbursement.

2.3. A Broad Overview of the Processes being Modeled

Production in a rural economy is carried out by employing land, physical capital, and workers. In Pakistan, most land and capital resources are privately owned. Therefore, income distribution depends on who owns the resources and how total revenue of the economy is divided between owners of resources and workers.

The owner and worker categories, however, are not exclusive. Workers may own or rent some of the resources and be self employed. Non-working owners may either hire wage labor for employing their resources or rent them out to workers. The workers' income consists of the value of production of their output and the wage payments received by them for providing labor to the non-working owners, less the rent payments made by them for rented resources. The non-working owners' income consists of the value of production of their output and the rent payments received by them for renting out their resources, less wage payments for labor hired by them for engaging in farming on capitalist lines.

Land ownership changes through transactions between various parties as they bid on each other's land holdings. The land bids are based on profitability criteria as well as on the financial ability of the bidding parties. The profitability criteria incorporate comparison of the income accrued from a production factor with its opportunity costs; the financial ability of a party depends on its saved cash balances, which in turn are determined by the rates of saving, investment, and consumption of savings [6].

Physical capital includes farm buildings, structures, draught animals, plows, agricultural implements, tractors, and machinery. Other capital inputs such as fertilizers, seeds, and pesticides are assumed to be of uniform quality and available in desired quantities, unless exogenously changed. As in the case of land, ownership of physical capital depends upon its profitability and the financial ability of the owning party. Physical capital has a limited life and has to be replenished constantly. In a traditional rural economy, physical capital is often produced indigenously by allocating a part of the production capacity to producing capital inputs needed by the economy. Modernizing efforts in many developing countries, however, have entailed substitution of indigenously produced capital inputs by modern capital inputs supplied from outside the rural economy [7].

The prices and rents of the production factors depend upon their respective productivities and availabilities. The wage rate depends upon average consumption level of all workers, including self-employed as well as wage workers. The wage rate, therefore, represents the opportunity cost of providing labor to the non-working owners by workers assumed as a homogeneous socio-economic group [8].

The dual economic structure manifested in production by self employed workers as well as by hired labor is widely recognized in the economic development literature. The self employed subeconomy is often referred to as the "informal" or "peasant" sector, while the labor hiring subeconomy is called the "capitalist" or the "formal" sector. These terms, however, have been used loosely as synonymous with urban and rural subeconomies as well as for the dual sectors within those subeconomies [9]. In this study, the terms "capitalist" or "formal" sector are used for the labor hiring subeconomy, while the terms "peasant sector", "peasants", or "self-employed cultivators" are used for the self employed subeconomy. The terms "workers" and "cultivators" are used interchangeably for agricultural workers, self-employed as well as wage employed.

2.4. The Substantive Assumptions

The assumptions of logic are explicitly represented in the model equations given in Appendix A. Implicit in the model structure are a number of substantive assumptions. These assumptions are stated below:

2.4.1. Socio-economic Grouping

All workers, whether self-employed in tilling their own or rented land or employed as wage-workers belong to a homogeneous socio-economic group, namely, the peasant sector. This group has a common economic interest and is the sole supplier of labor in the economy. The wage rate is determined by the opportunity cost of labor to the peasant sector. All land and capital owners, who either rent out property or hire wage labor to carry out production form a second socio-economic group, namely, the formal or the capitalist sector. Both groups compete for the resources of the economy in an effort to maximize their respective interests.

The assumption of socio-economic grouping is implicit in most dual economic theories, while it is somewhat rhetorically presented in the radical theories [9]. In the case of Pakistan, rural classes have often been identified as landlords, peasants, and landless farm workers [10] although the distinction between the landless workers and the peasants is artificial. Often, land-owning peasants rent additional land and capital from bigger landlords, who prefer not to engage in farming. Peasant farmers also act as wage workers at sowing and harvesting times, while unemployed workers often become part of the extended families of the self-employed relatives. Marital bonds are common among peasants and farm workers, though rare between the landlord and the working classes [11]. Thus, all workers in fact belong to the same socio-economic class.

Until the 1960s, over 70% of the land in Pakistan was sharecropped by tenants, less than 30% was owned by self-employed peasants [12]. After modern capital inputs were introduced in the 1960s, farming on capitalist lines flourished, while sharecropping and peasant farming declined [13]. The absolute number of capitalist land-owners, however, has remained quite small as compared to the number of peasants and workers [14]. The capitalist sector contribution to the workforce, therefore, is negligible.

2.4.2. Homogeneous output

Production is carried out by employing land, labor, and capital in proportions depending on the production technology used. The output produced by the economy is of homogeneous quality. The output meets demands for agricultural products, capital services, and consumption services. The production technology is not affected by changes in the shares of various goods and services in the output. The composition of output is adjusted according to the demand for each type of goods and services.

The latter assumption is made for the purpose of simplification. In fact, groups of farmers may be engaged in producing various crops, livestock, and services, using different proportions of production factors. The distinctions of product and technology, however, are outside the scope of this study. At the level of aggregation assumed in the model, the assumption of homogeneous output is considered reasonable.

2.4.3. Inventories of Output

No inventories are maintained for agricultural and consumption goods. Capital goods production is accumulated in an inventory until acquired by a sector. The inventory condition, together with the average demand for capital goods, determine the fraction of the rural production capacity assigned to capital goods production.

In view of the urban demand for agricultural production, and the government policy to purchase, store, and distribute food crops, private inventories of agricultural output in the rural areas are negligible. Further, most consumption goods and services have short production cycles and are produced at a small scale to meet requirements of small fragments of the market. Consumption goods inventories are, therefore, also negligible.

Capital goods entail relatively longer production cycles and a larger scale of production. Therefore, regulating their supply necessitates maintenance of an inventory, albeit, this inventory is distributed all over the economy in small quantities. The single inventory for capital goods and services assumed in the model is for simplification.

2.4.4. Income Disbursement

Total income of the rural economy equals the total value of its production. Prices are determined by supply and demand pressures. The value of production accrues to the respective producing sectors and is either disbursed as wages and rents or is retained by the producer. A part of the revenue is saved by each sector and accumulated. Accumulated savings are used for financing investment and for meeting lumpy consumption expenditure needs.

The income of Pakistan's rural economy is disbursed on the bases of claims of ownership and labor input [15]. The value of production is divided between the capitalist and peasant sectors depending on their respective claims. Thus, the capitalist sector makes wage payments to the peasant sector for hired labor, while the peasant sector makes rent and interest payments to the capitalist sector for rented land and rented or borrowed capital.

A part of the net revenue of each sector is saved. The rest is consumed. In the absence of any formal financial institutions, investments in physical capital or land entail equivalent transfers of liquid assets to and from the accumulated savings portfolio of the respective sector. Further, a number of lumpy consumption expenditures on ceremonies and feasts associated with births, marriages, and deaths etc., are also met out of the accumulated savings. Financial transactions accompanying exchanges of land between the sectors allow savings of the buying sector to be transfered to the selling sector. Further, as the value of physical capital produced by a sector is assumed to accrue to the sector at the time of production, acquisition of capital for ownership by a sector is accompanied by dissolution of an equivalent amount of its savings.

2.4.5. Modern and Traditional Farm Capital

Traditional farm capital includes bullocks, plows and hoes, farm structures, and low technology implements produced within the rural sector. Modern farm capital includes tractors, mechanical plows, thrashers, harvesters, and high technology equipment supplied from outside the rural economy. Due to the higher productivity of the modern capital goods, they are ,if available, preferred over traditional goods by the investors. The volume of production of traditional goods is adjusted according to their demand. The volume of supply of modern goods is determined by government policy. If the supply of modern goods is limited, they are rationed to the capitalist and peasant sectors on the basis of their respective demands.

Modern capital goods are assumed to be less divisible than the traditional capital goods as is pointed out in many studies [16]. The lumpiness of modern capital goods limits their use in small scale farming in the peasant sector where the farms are divided and subdivided into smaller tracts as the number of persons working in the sector increases [17]. Modern capital is also assumed to be labor displacing. Thus, use of modern capital would affect relative output elasticities of labor and capital. The use of modern capital is assumed not to change the elasticity of output of land, as is evidenced in many empirical studies [18]. However, modern capital permits a reduction in farming time requirements and thus allows increases in annual production.

2.4.6. Land Ownership and Cultivation

All land is assumed to be privately owned. Increases in total available land depend upon government policy to develop new land for allotment to private owners. Thus, total privately owned land remains fixed unless changed by government policy. Changes in land ownership of the peasant and capitalist sectors depend upon land transactions between them.

Capitalist owners may either farm their land by hiring wage labor, or rent it out to the peasant sector for sharecropping. Peasants cultivate all land owned by them or rented out to them by the capitalist land-owners.

Out of about 49.2 million hectares of farmland in Pakistan, over 49 million hectares are privately owned [19]. Government farms include experimental and model farms. Government participation in rural production has been insignificant and can be ignored.

The assumption of fixed land is reasonable for the time frame of this study. Over the past three decades, the amount of total cultivatable land reported has stayed practically constant [20]. Development of marginal lands entails huge costs. Such development is not a continuous process and depends on the political and economic decisions of the government. Land can be bought, sold, mortgaged or rented freely by its owners. Land holdings of the capitalist and peasant sectors, therefore, change as they buy and sell land between them, but land cultivated by each sector is independent of how much land is owned by it, as sharecropping contracts allow land owned by the capitalists to be cultivated by the self-employed peasants.

2.4.7. Employment of Production Resources

It is assumed that all land, capital and labor resources of the economy are employed. A production factor, however, may be intensively or extensively employed in a given sector depending upon relative factor proportions.

About 80% of the private farmland in Pakistan is cultivated. The fraction of land left idle each year increases with the farm size [21]. Physical capital, being a scarce resource with an elastic supply, is invariably fully employed, while disguised unemployment of labor is more pervasive than unemployment per se [22]. Therefore, a full employment assumption permitting variation in factor intensities adequately represents factor employment conditions in the economy.

2.4.8. Saving Attitudes of Capitalists and Peasants

The saving attitudes of the capitalists and the peasants differ. While capitalists are assumed to save a constant fraction of their net income, the saving rate of the peasants is assumed to depend on their utility of investment for in the self-employed production activity and their rent and interest burden. If the wage rate in the capitalist sector is comparable to the level of consumption in self-employment, the utility of investment in self-employment production is low and the saving propensity of the peasants declines [23]. Also, when a large part of the peasant sector income is paid as rents and interest, the net income available to the workers decreases while consumption demand does not decrease proportionately. Thus, excessive rent and interest payments also diminish saving propensity of the peasant sector [24].

2.4.9. Fragmented Financial Markets

Each sector finances its investment out of its own financial resources. Savings of one sector are not available for acquisition of resources in the other because of the absence of financial institutions common to the two sectors.

Developing country financial markets incorporating informal lending and borrowing mechanisms are a subject of many studies, notable among them, by McKinnon [25] and by Shaw [26]. The fragmented nature of these markets is widely recognized. Informal lendings and borrowings for investment are more common within the capitalist and informal sectors than between them. However, the capitalist land owners often lend money to their tenants at heavy interest rates and in exchange for holding the borrower's property as mortgage [27]. Such practices are assumed to be a part of the capital renting transactions between the capitalist land-owners and their sharecropping tenants.

2.5. Resource and Income Streams in the Model

The model incorporates decision mechanisms underlying the allocation of resources and disbursement of income between the capitalist and the peasant sectors. The streams between the sectors through which the flows of resources and income take place represent the key change processes in the economy. The resource allocation structure of the model incorporating these streams is described below.

2.5.1. Allocation of Land Between Sectors and Income Generating Activities

Figure 2.3 shows how land is allocated between the capitalist and peasant sectors, and within the capitalist sector, between farming and renting activities. Single arrows connect the total quantities to their respective components; double arrows represent flows of resources between sectors and between income generating activities.

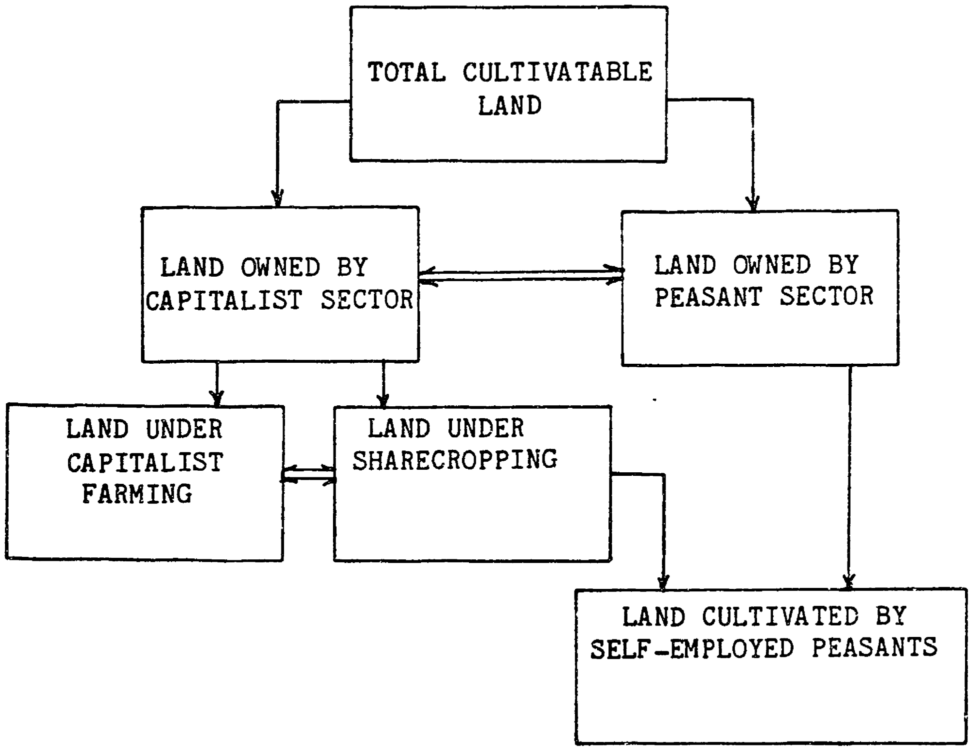

Figure 2.3: Allocation of Land Between Sectors and Income Generating activities

Total land available for cultivation is divided between capitalist and peasant sectors. Land owned by each sector changes as the two sectors buy and sell land between them. Land in the capitalist sector is divided between cultivation and renting activities, on the basis of their relative profitabilities. Land cultivated in the peasant sector consists of land owned by the peasants as well as land rented out by the capitalist sector to the peasants. Thus, cultivation of land can be easily transferred to the more profitable farming mode without separating its ownership from the capitalist sector.

2.5.2. Acquisition of Physical Capital by Sectors and its Allocation Between Income-Generating Activities

Figure 2.4 illustrates how physical capital other than land is accumulated in the capitalist and peasant sectors and how it is allocated between cultivation and renting activities. Each sector acquires physical capital out of the inventories of modern and traditional capital goods. The traditional capital inventory is built up as capital goods are produced in the economy; the modern capital goods inventory is built up from supplies from outside. The capital inventories are depleted as capital goods are acquired by the two sectors. Capital accumulations in each sector are built up by capital acquisitions, and are depleted by the respective capital deterioration rates.

The capitalist sector divides the physical capital accumulated by it between commercial farming and renting activities depending on which activity is more profitable. Physical capital employed in the peasant sector comprises capital accumulations within the peasant sector as well as capital rented out by the capitalist sector. As in case of land, capital can also be employed in an efficient sector without requiring its ownership in that sector.

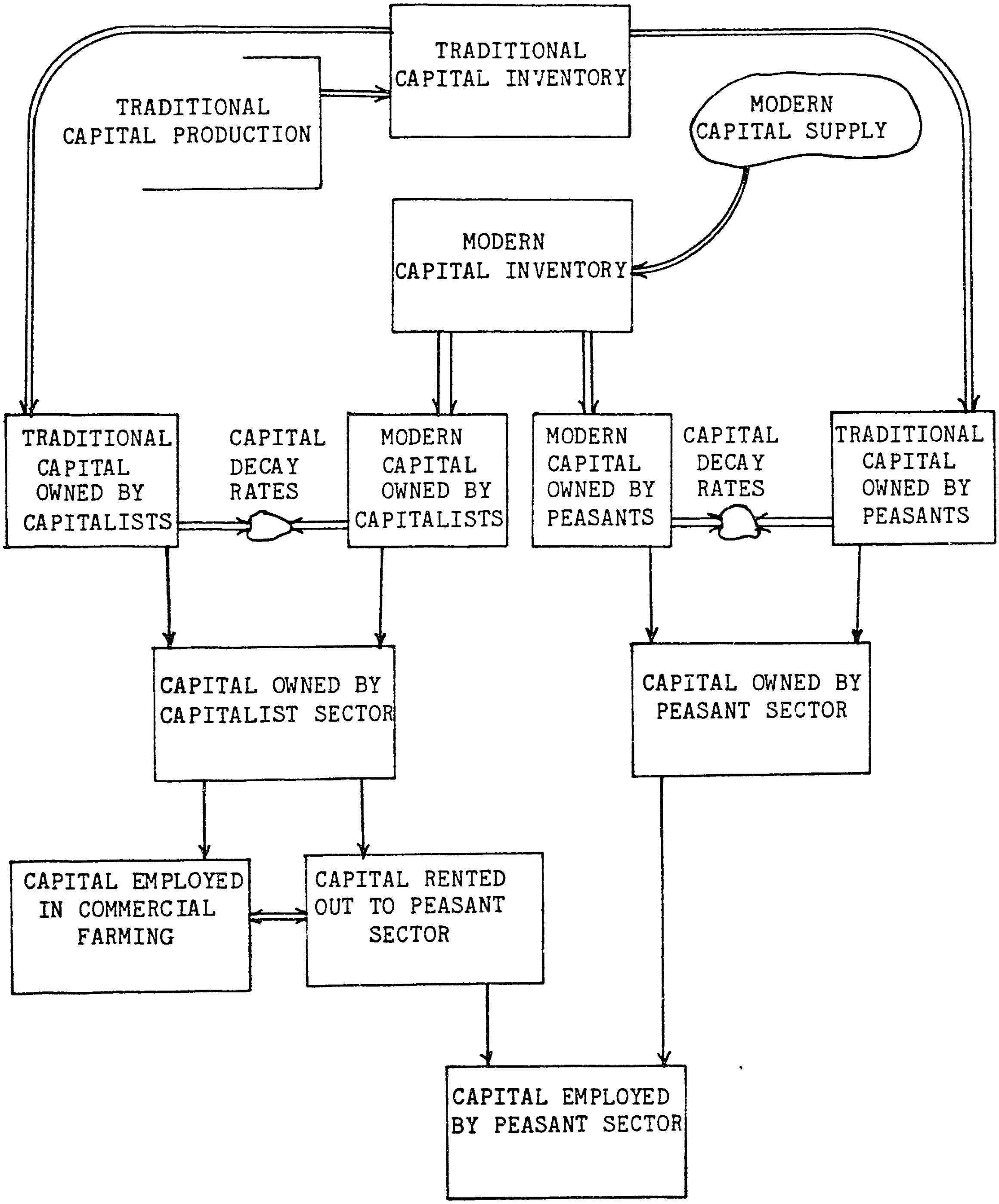

Figure 2.4: Acquisition of Capital by Sectors and its Allocation Between Income Generating Activities.

2.5.3. Allocation of Workers

Figure 2.5 shows how workers are allocated between the capitalist and peasant sectors. The rural workforce is changed through a natural growth rate and urban rural migration. Rural

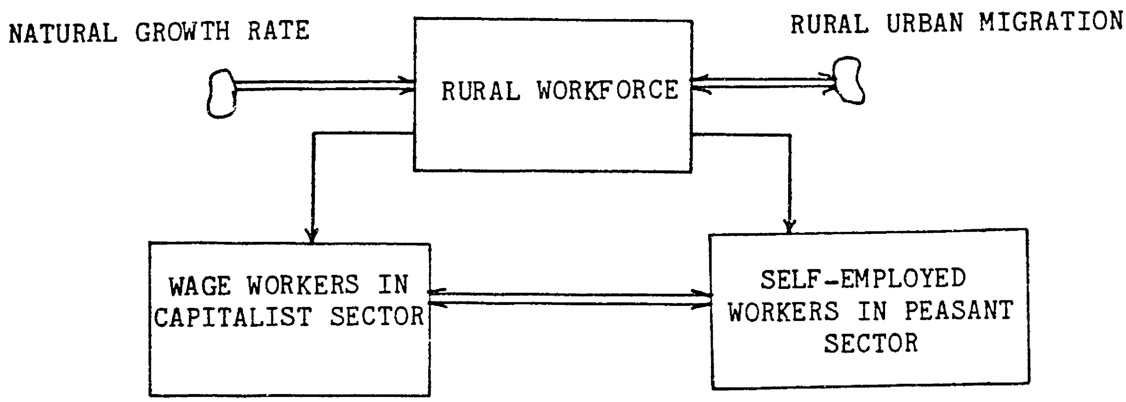

Figure 2.5. Allocation of Workers Between Sectors

workers are distributed between the capitalist and the peasant sectors, depending on the demand for labor in the formal sector, and the self-employed income of the peasants. The capitalist sector hires as many workers as it needs at a wage rate comparable to self-employed income of workers. All workers not hired by the capitalist sector are accommodated in the peasant sector.

2.5.4. Disbursement of Income

Figure 2.6 shows how income of the rural economy is divided between the capitalist and peasant sectors. A part of the value of production of the capitalist sector is disbursed as wages, the rest is added to the revenue of the sector. Other components of the revenue of the capitalist sector are land and capital rent payments received from the peasant sector for production factors rented out to them. A part of the value of production in the peasant sector is disbursed as rent paymants. The rest is added to the revenue of the sector. Wage payments received from the capitalist sector also add to the revenue of the peasants.

A part of the income in both sectors is consumed. The unconsumed parts of the incomes are saved and flow in to the respective accumulated savings. Accumulated savings are spent by each sector on acquisition of land and capital, or are consumed. When any assets are liquidated by a sector, funds equal to the money value of the liquidated assets flow into accumulated savings. Thus, as land is bought and sold between the sectors, savings representing money value of the transacted assets are concommitantly transfered between them.

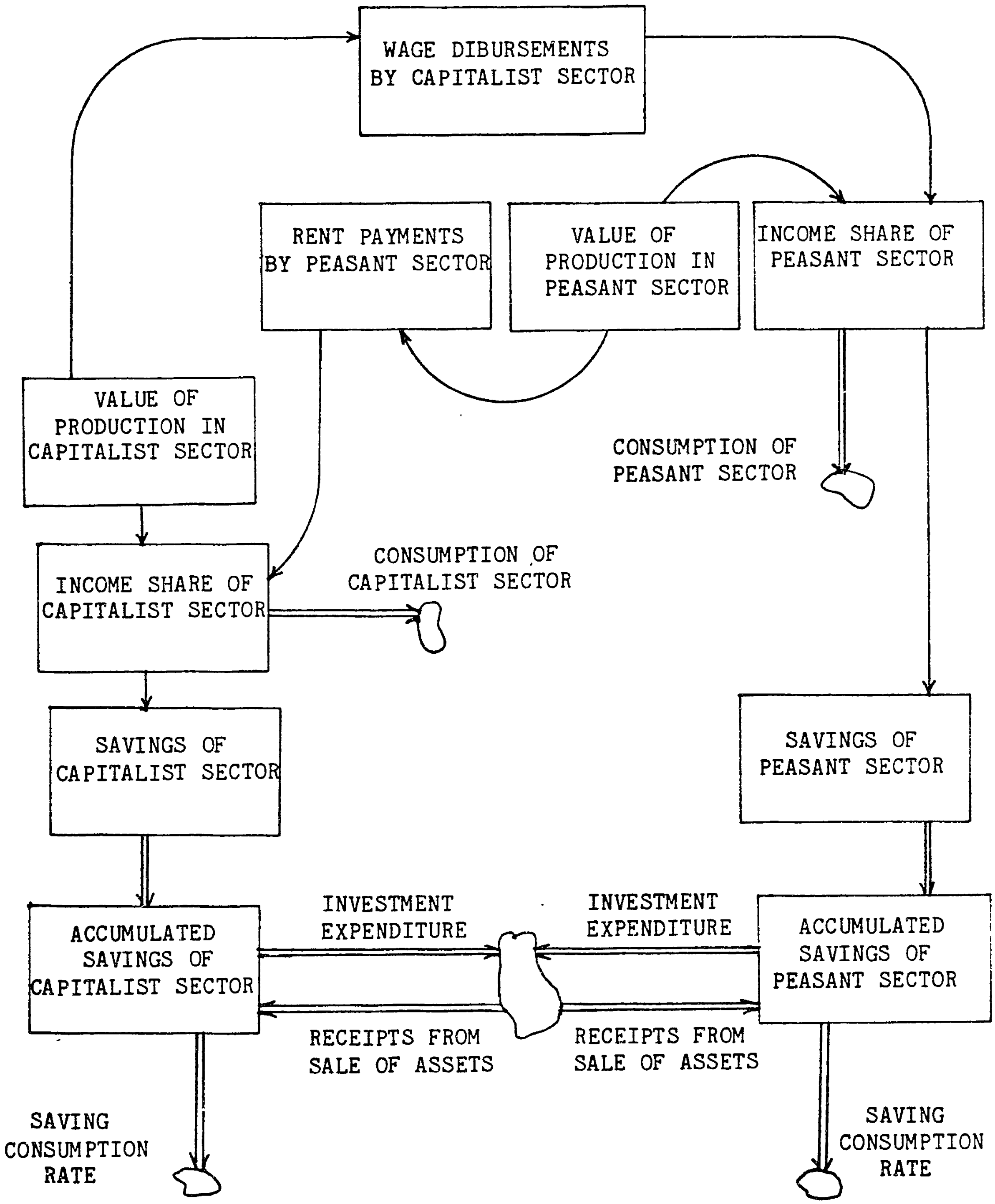

Figure 2.6: Disbursement of Income in a Rural Economy Consisting of Capitalist and Peasant Sectors.

2.6. Forces Governing the Resource and Income Streams

The resource and income streams discussed in section 2.5 are governed by a set of forces arising out of the economic decisions of the two sectors. These forces are incorporated in the model logic and are responsible for a tendency of the income distribution system to move towards an internally determined goal.

Key relationships impinging upon the resource and income streams in the economy and their role in ascertaining an internal income distribution goal are discussed in Chapter Three.

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CHAPTER THREE

KEY RELATIONSHIPS GOVERNING RURAL INCOME DISTRIBUTION IN PAKISTAN

This chapter describes the causal relationships that are hypothesized to underlie the rural income distribution system of Pakistan. The relationships are formalized into a system dynamics model which embodies a theory of income distribution and serves as a basis of policy analysis.

When several causal relationships acting in series create an information path leading back to the original cause, feedback loops are formed. These feedback loops constitute building blocks of the model. The validity of the micro-structure of the model is partly judged from the plausibility of its feedback structure. The feedback loops generate a set of forces that are responsible for the tendency of the system to move towards an internally determined goal. The logical structure of the mathematical relationships constituting the feedbacks is discussed in detail in Appendix A. Model parameters and the details of their estimation are given in Appendix B. Those appendices should be read for understanding the technical aspects of the model while this chapter provides a description of the overall structure of the model.

3.1. Types of Feedback Processes and Their Functions

A feedback process can be self-reinforcing or goal seeking depending on the causal relationships constituting it. Feedback processes are called positive or negative according to the nature of forces they generate.

A positive feedback loop is a reinforcing spiral. When a positive feedback loop influences distribution of a fixed resource between the two sectors of the economy, it may tend to make all resources accumulate in one of the sectors. A positive feedback loop affecting incomes and ownership of resources in both sectors may also cause growth in one sector to stimulate growth in the other. A negative feedback loop generates a re-equilibrating force [1].

Positive feedbacks acting in isolation from negative feedbacks can cause independent growth in both sectors, make one sector grow at the cost of the other, or allow growth in one sector to trickle down to the other. The presence of both positive and negative feedback loops allows dual economies to exist side by side in a state of dynamic equilibrium.

Indeed, the various theories of economic growth discussed in Chapter One suggest the presence of the various feedback forces as well as their possible roles in fostering growth. Albeit, these theories disagree about the nature of the dominating forces.

Figure 3.1 illustrates the range of growth and control forces suggested in the various theories. The neo-classical theories manifest presence of growth and control forces leading towards a perfect market equilibrium; the diffusionist and structural growth theories suggest that growth in "leading" sectors can stimulate growth in "lagging" sectors; the revisionist theories describe mechanisms of unbalanced sectoral growth; and the radical neo-Marxist theories focus on how "leading" sectors grow at the expense of "lagging" sectors [2].

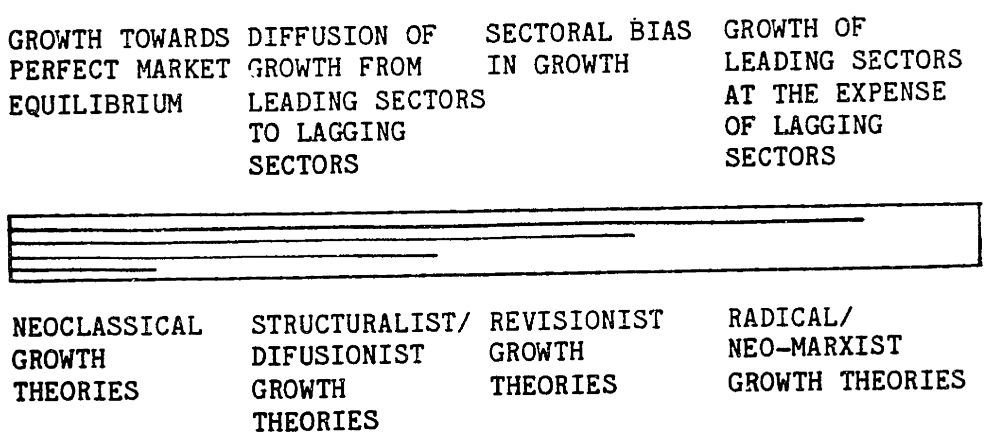


Figure 3.1: Growth Tendencies Suggested in Various Growth Theories.

The model logic does not explicitly incorporate any of the economic growth theories. But the model abstracts the economic behavior of the various actors in the system which the theories strive to explain with their respective ideological biases. The following discussion will reveal that the model incorporates in its micro-structure a whole range of growth and control forces delineated in a wide spectrum of economic growth theories ranging from conservative neo-classical to the radical neo-marxist [3].

The structural similarity between the feedback mechanisms of the model and those incorporated in the various theories, however, is only a partial proof of the model's validity unless the behavior of the model also corresponds to what is suggested by the empirical evidence. The behavior tests of the model focussing on how its internal tendency compares with the historical tendency of the rural income distribution system in Pakistan are presented in Chapter Four. Additional tests comparing the impact of various rural development policies on rural income distribution in Pakistan to the changes in the model behaviour in response to similar policies are discussed in Chapter Five.

To facilitate understanding, the major feedbacks in the model are divided into groups affecting designated resource allocation and income disbursement processes. The forces embodied in these feedbacks are discussed in isolation from one another to illustrate the anatomy of the model's decision structure. The discussion is illustrated by diagrams containing all feedback loops impinging upon a process, but with the specific loops discussed shown in heavy lines. The implications of all forces acting simultaneously to affect decisions are discussed in the succeeding chapters.

3.2. Feedbacks Affecting Allocation of Land Between Sectors and Income-Generating Activities

Land is divided between capitalist and peasant sectors through transactions resulting from competitive bidding by the sectors for total land resources. The bids for land from each sector depend on profit considerations and financial resources. Within the capitalist sector, land is transferred between cultivation and renting activities, until the two are equally profitable. Within the peasant sector, owned and rented land is self-cultivated. The following feedback forces determine how land is distributed between sectors and activities:

3.2.1. The Growth Forces

Positive feedbacks implicit in economic decisions of the sectors and affecting distribution of land between them are capable of accumulating all land in a single sector. Distribution of land is directed in favor of a particular sector depending on the trend of change in the distributive forces.

Figure 3.2 shows positive feedbacks affecting competitive bids for land by the two sectors. An increase in production of either sector raises its marginal productivity of land which increases profitability of investment in land, thus making it desirable to expand land ownership. Indicated land in the sector rises, and as land is redistributed between sectors on the basis of their respective demands for land, the sector with higher productivity receives a greater share of land, which allows it to further expand its output. The spiraling effect of these feedbacks will lead to accumulation of all land in the sector with higher land productivity.

Land renting practices are a source of additional positive feedback forces affecting the distribution of land. The peasant sector rents land from the capitalist sector if such land is available. Land rent is determined by the demand and supply conditions of rented land and by the aggregate marginal productivity of land. Because an increase in land holdings of the capitalist sector entails a corresponding decrease in land holdings of the peasant sector, such an increase is accompanied by an increase in the demand for rented land, which bids up land rent and raises income from land rented out by the capitalist sector. This further increases demand for land in the capitalist sector, and gives an added impetus to expansion in its land holdings.

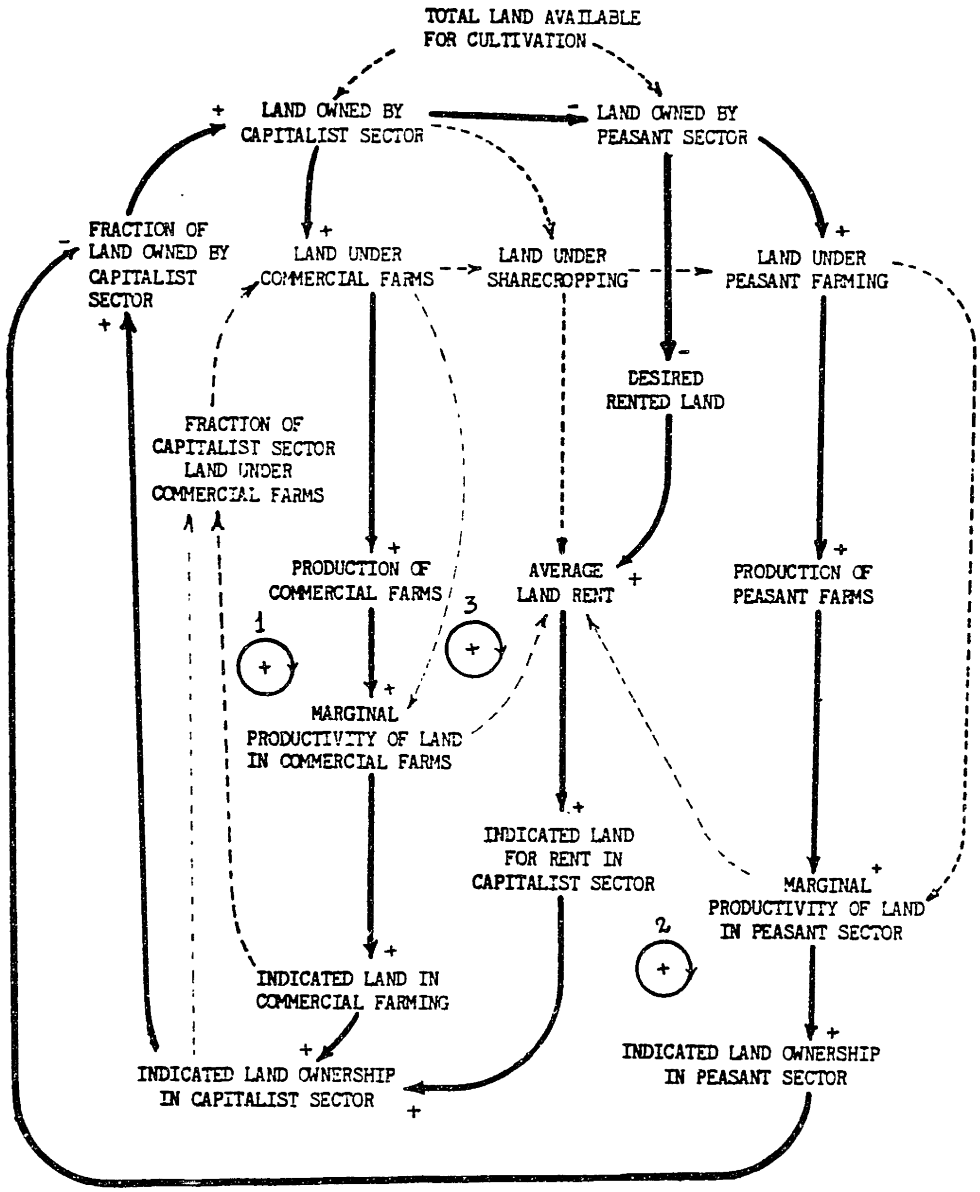


Figure 3.2: Positive Feedbacks from Competition for Land Ownership Affecting Distribution of Land between Sectors.

Figure 3.3 shows positive feedbacks arising out of sharecropping practices and affecting distribution of land between sectors. An increase in land ownership in the capitalist sector causes a proportionate increase in land rented out by it. Rented land increases total land at the disposal of the peasants, the intensity of land cultivation in the peasant sector falls and productivity of land declines. Consequently, land bids in the peasant sector decline and the share of capitalist sector in total land further rises. An increase in the marginal productivity of land in commercial farming also raises aggregate productivity of land, thus raising claims to income on the basis of ownership. This bids up land rent, which further enhances land bids by the capitalist sector.

Figure 3.4 shows yet another positive feedback loop affecting distribution of land between sectors. If the productivity of land in the peasant sector rises, the peasants will be willing to pay higher land rents, which will increase the profitability of land in the renting activity. Consequently, capitalist sector bids for land rise, and capitalist sector land holdings expand. Land holdings of peasants decrease, intensity of cultivation in the peasant sector rises, and their productivity of land further increases.

Fragmentation in the financial markets establishes a high degree of dependence between the saved cash balances of a sector and its investment ability. This dependence generates additional

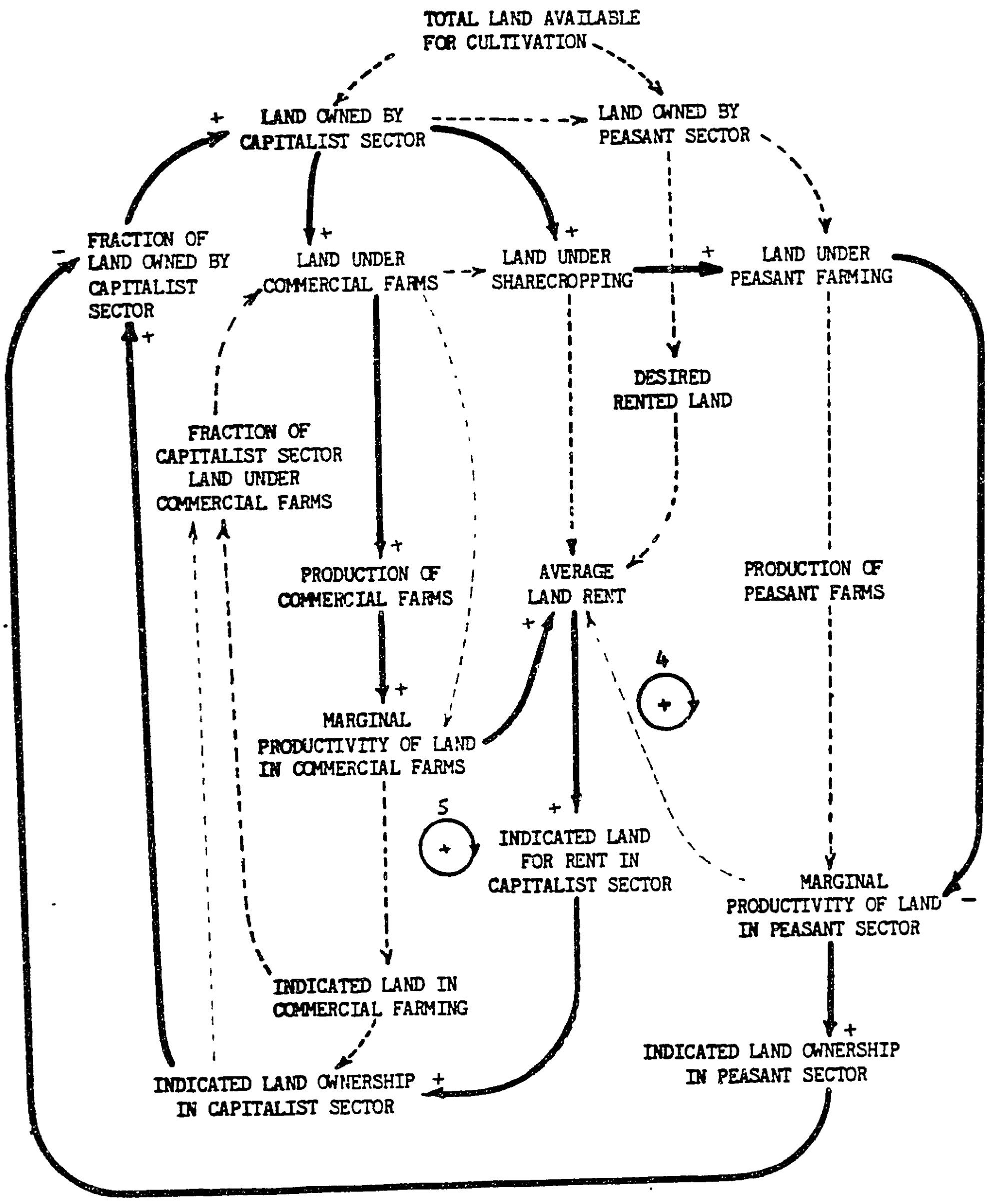


Figure 3.3: Additional Positive Feedback Forces from Competition for Land Ownership Affecting Distribution of Land Between Sectors.

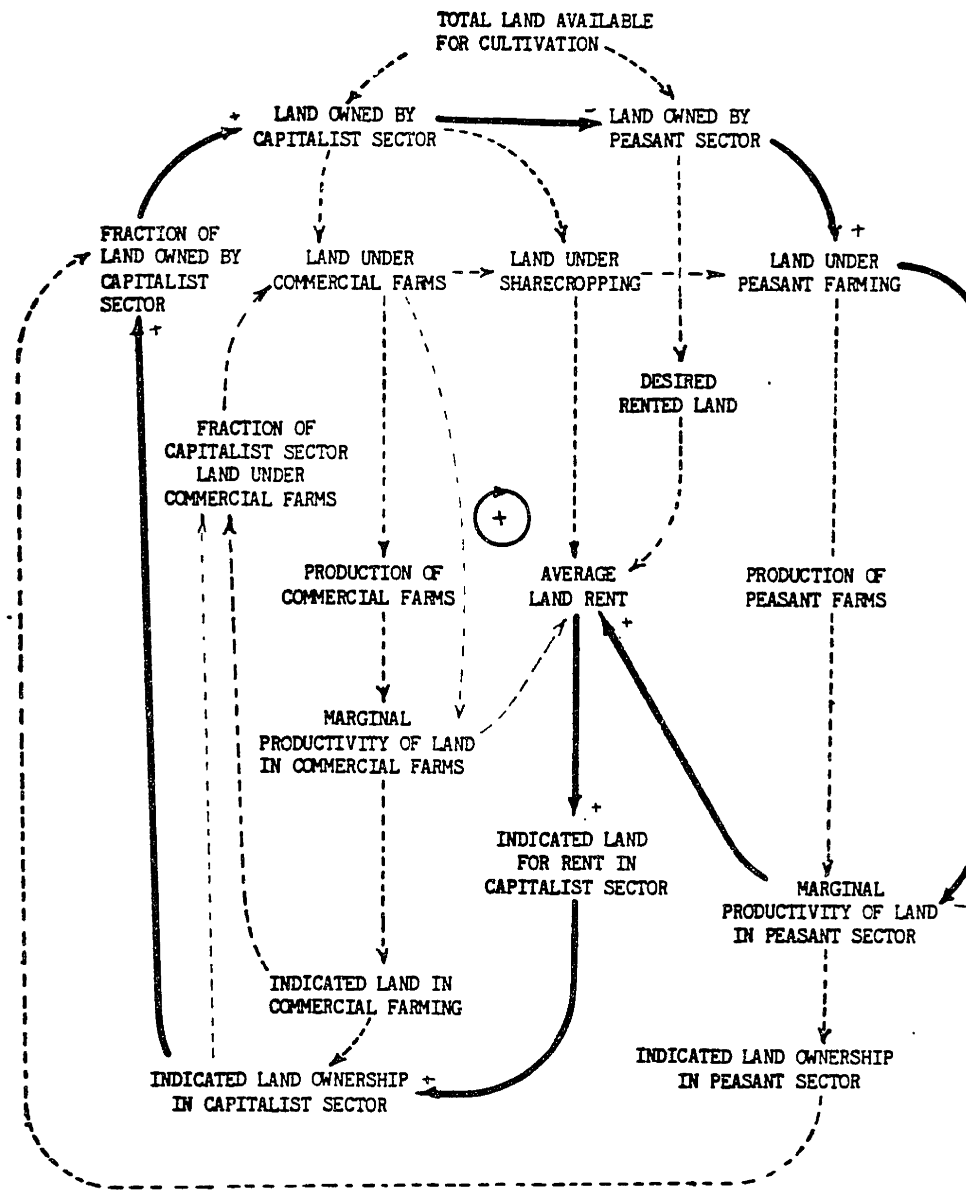


Figure 3.4: Positive Feedbacks from Renting Processes Affecting Distribution of Land.

positive feedbacks which further reinforce the growth forces affecting distribution of land, as illustrated in Figure 3.5. An increase in the financial resources of a sector allows it to raise its bids for land ownership. As more land is allocated to the sector, the income from additional land further increases its financial resources.

3.2.2. The Control Forces

Control forces embodied in the economic decisions affecting distribution of land between sectors arise out of negative feedbacks which regulate the demand for land in each sector. These forces check spiralling growth in land ownership of one of the sectors at the cost of the other, and thus allow both sectors to maintain some ownership of land.

Figure 3.6 shows the major negative feedback loops affecting distribution of land between the two sectors. Indicated land in each sector is determined by the productivity of land engaged by the sector in production and renting activities. As land in each activity increases, its incremental productivity falls, which brings down the demand for acquiring additional land. When the marginal revenue from land becomes equal to the opportunity cost of the investment in land in a sector, the sector tends not to change the amount of land employed by it.

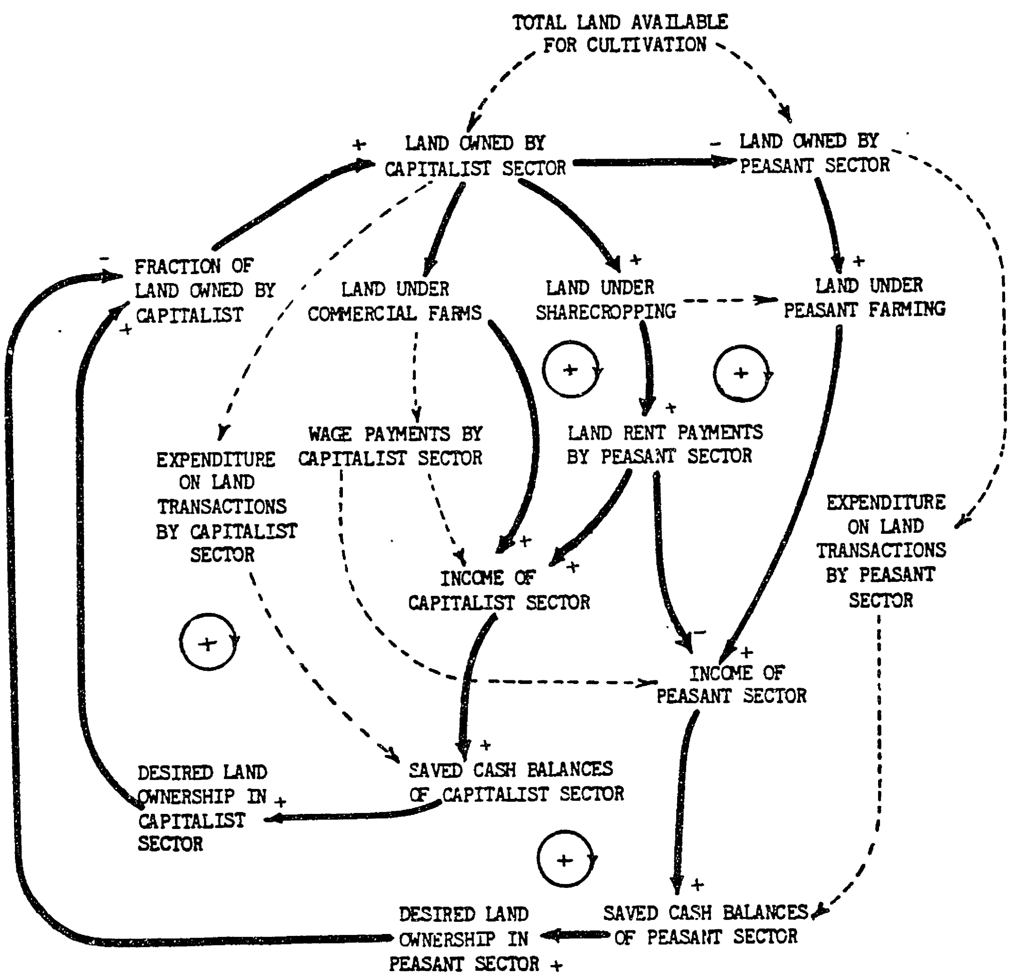


Figure 3.5: Growth Forces due to Fragmented Financial Markets Affecting Distribution of Land.

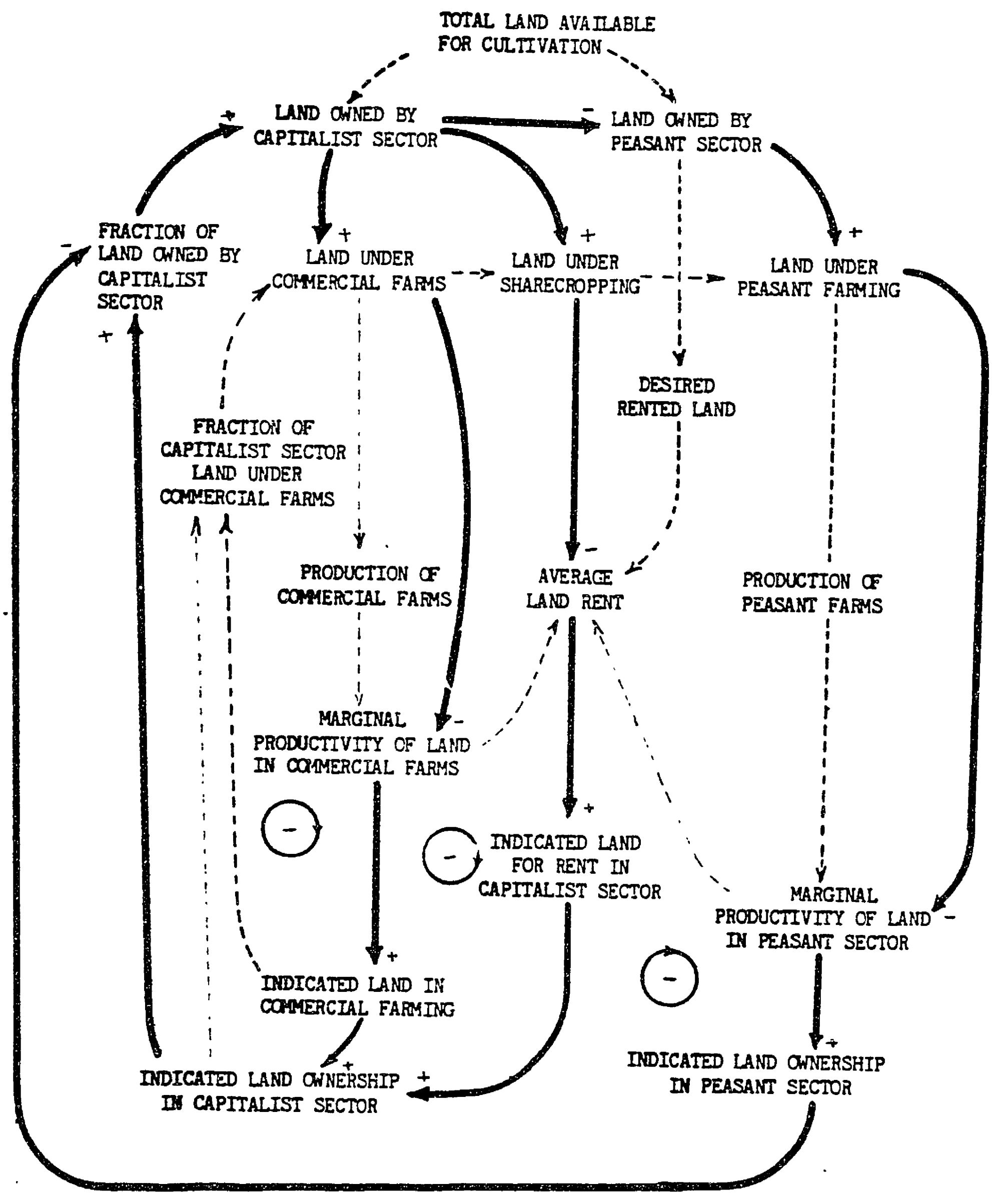


Figure 3.6: Negative Feedbacks from Competition for Land Ownership Affecting Distribution of Land between Sectors.

Within the capitalist sector, land is allocated between commercial farming and renting activities on the basis of the marginal revenue accrued from land in each activity. Figure 3.7 shows the feedbacks governing this allocation. Land is tranferred from one activity to the other until the incremental revenue from land in each activity is the same.

An additional controlling force arising out of land renting practices in the economy is illustrated in Figure 3.8. If the production of the peasant sector rises, the increased productivity of land causes the demand for land ownership in the sector to grow. Consequently, as more land is acquired by the peasant sector, land ownership in the capitalist sector declines. Land rented out by the capitalist sector decreases proportionately, which reduces the amount of land cultivated by the peasants and hence limits further growth in their production.

In view of the negative feedbacks described above, land is transfered between the capitalist and the peasant sectors, and within the capitalist sector between cultivation and renting activities, until the incremental productivity of land in each sector and in each activity is the same. Such a condition corresponds to a unique distribution of land between the sectors and between various activities, which serves as an internal goal of the system.

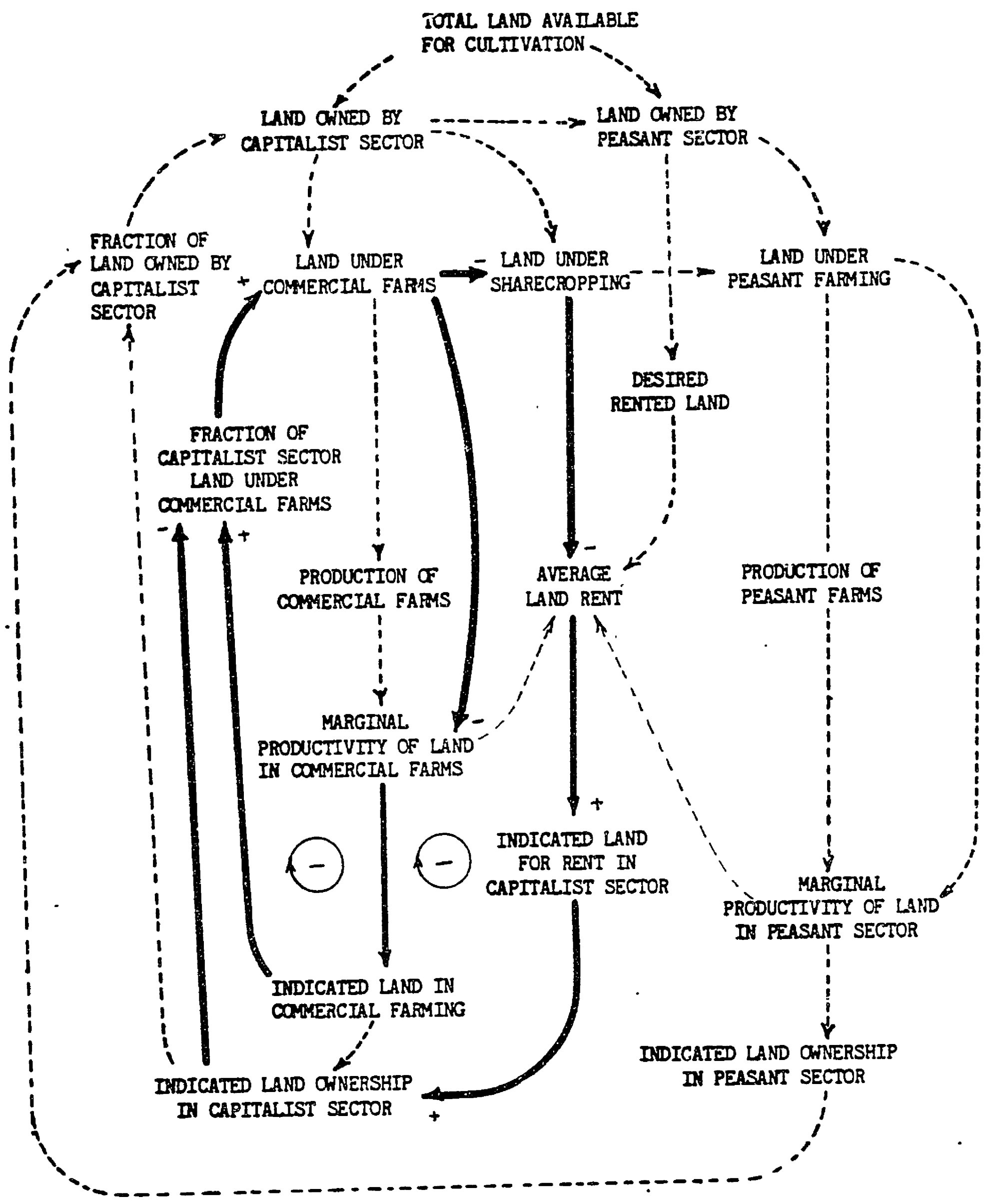


Figure 3.7: Negative Feedbacks Affecting Allocation of Land to Commercial Farming and Renting Activities in the Formal Sector.

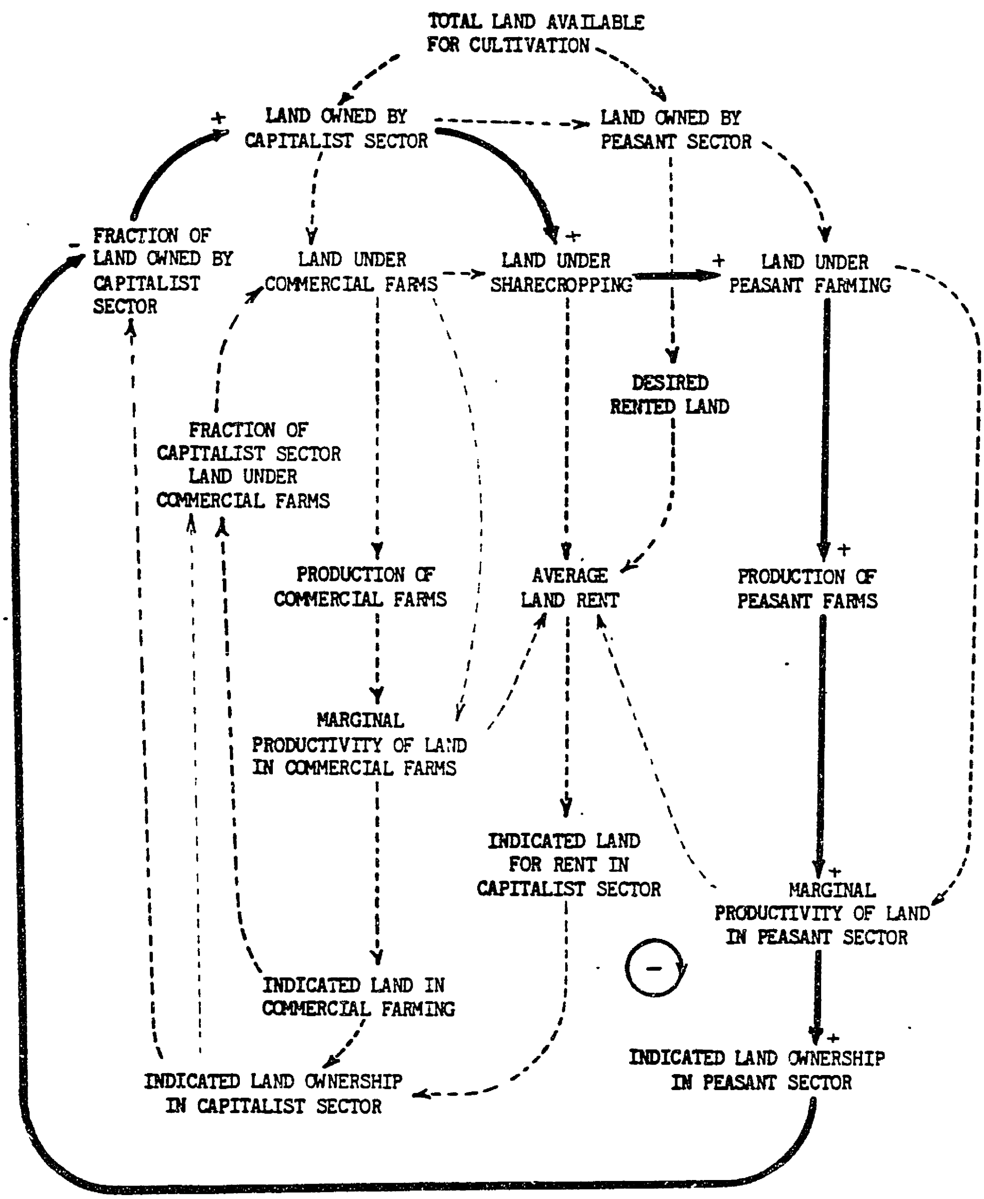


Figure 3.8: Negative Feedbacks from Land Renting Practices Affecting Distribution of Land.

The fragmented financial markets and the ensuing dependence of competitive bids for land on internal financial resources of a sector generate additional control forces in the system. Figure 3.9 illustrates some of these forces. An increase in land holdings of a sector also entails payment of price of the additional land acquired. Such payments deplete the financial resources of the sector and limit its ability to bid for land in the subsequent rounds. Similarly, liquidation of land by a sector and receipt of its price builds up the sector's financial resources, which enables the sector to increase its bids for land in the subsequent rounds. The negative feedback loops representing these relationships are labeled 1 and 2 in Figure 3.9.

As land cultivation by the capitalist sector requires wage labor, an increase in commercial farming necessitates a larger share of the revenue to be disbursed as wages, which limits growth in its financial resources. Therefore, capitalist sector ability to acquire more land and further expand cultivation activity is limited (see feedback loop labeled 3 in Figure 3.9).

Two additional negative feedback loops arising out of the fragmented financial market conditions are shown in Figure 3.10. Wage payments by the capitalist sector add to the revenue of the peasants. The subsequent increase in the peasants' financial resources allows them to raise their bids for land. As more land is acquired by the peasants, land ownership in the capitalist

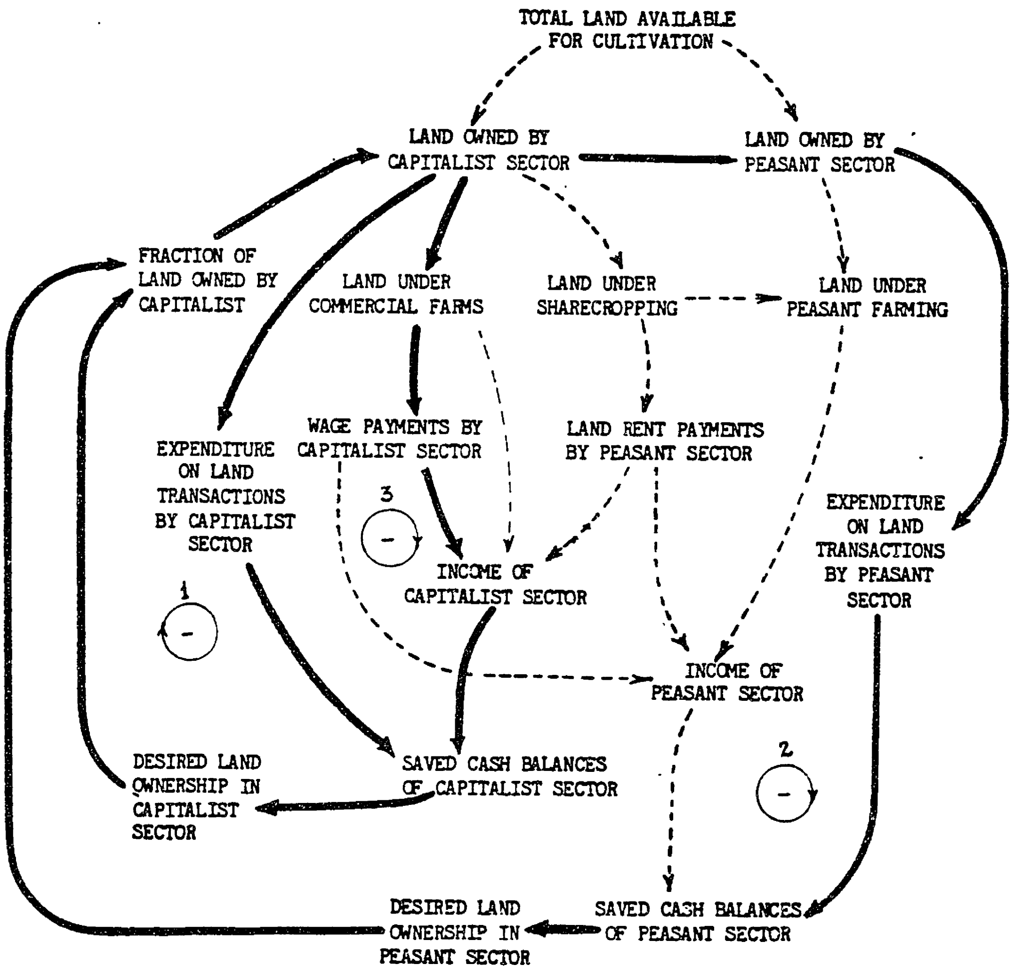


Figure 3.9: Negative Feedbacks due to Fragmented Financial Markets Affecting Distribution of Land.

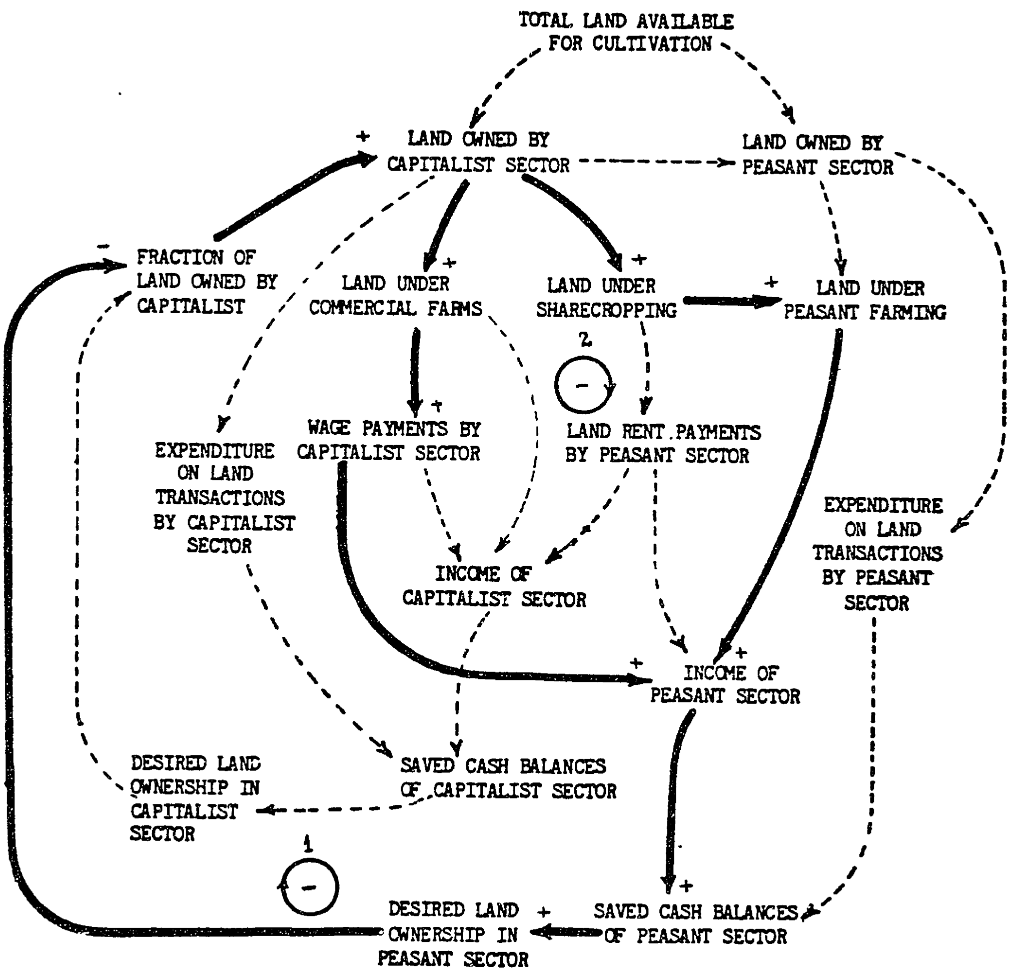


Figure 3.10: Additional Negative Feedbacks Due to Financial Market Condition Affecting Distribution of Land.

sector falls. Commercial farming declines proportionately. The number of workers employed by the capitalist sector goes down and wage disbursements to the peasant sector decrease. Thus, the growth in revenue of the peasant sector is limited.

Finally, as growing financial resources of the peasant sector allow it to acquire more land, land holdings of the capitalist sector decrease. Land rented out to the peasants decreases proportionately. Consequently, growth in the total land cultivation by the peasants is constrained, and further growth in its revenue is limited.

3.3. Allocation of Physical Capital

Physical capital in a rural economy is either produced on the farm or imported from the urban sector. The amount of physical capital produced in the economy is adjusted to be in line with the demand for it. Physical capital is indigenously produced by allocating a part of the production capacity of the economy to produce capital goods and services. The amount of physical capital imported from outside is exogenously determined. The quantity of physical capital in the capitalist and peasant sectors is governed by the growth and control forces discussed below:

3.3.1. Growth Forces Affecting Capital Formation

Figure 3.11 illustrates the major positive feedback loops embodied in economic decisions that affect growth of physical capital in the capitalist and peasant sectors. Feedback loops labeled 1 and 2 represent basic capital formation processes. An increase in the production of a sector raises productivity of capital in the sector, thus making it desirable to acquire more capital. Expansion in capital ownership of the sector causes a proportionate increase in capital employment, which allows the sector to further expand its production.

Feedback loop labeled 3 in Figure 3.11 represents an auxiliary growth force in the capitalist sector. As the capitalist sector rents out part of the capital owned by it to the peasant sector, an increase in production of the peasant sector increases productivity of capital, which also increases the amount of rent the peasants are willing to pay for rented capital. The increase in capital rent raises the revenue from capital in the capitalist sector, which stimulates expansion in its capital assets. Subsequently, capital renting is stepped up, which further contributes to expansion of production in the peasant sector.

Finally, feedback loops labeled 5 and 6 cause capital acquisitions in each sector to be proportional to the amount of capital owned by each, because the volume of replacement capital

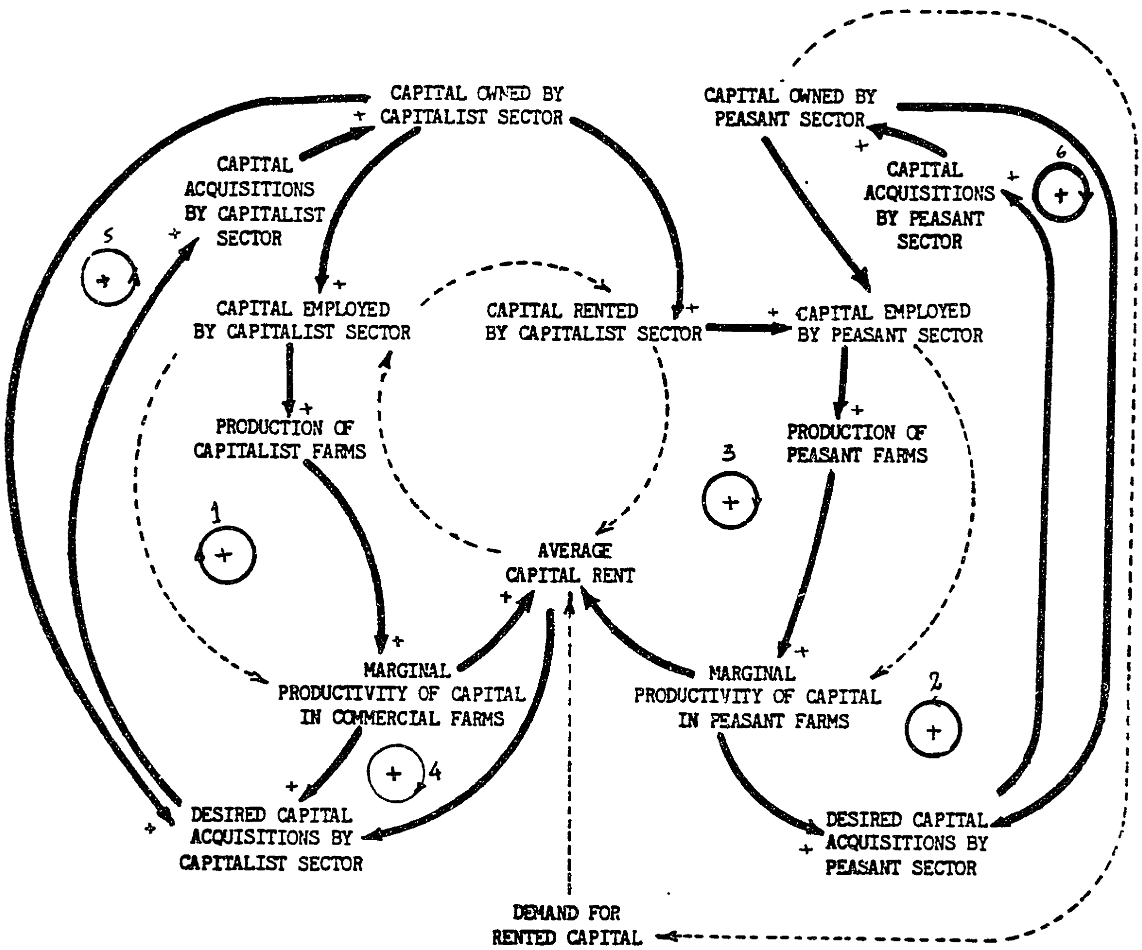


Figure 3.11: Major Positive Feedback Loops Affecting Growth of Capital.

and new purchazes are linked with the scale of operation.

Other growth forces generated due to capital renting practices are shown in Figure 3.12. Feedback loop labeled 1 manifests that an increase in capital ownership in the peasant sector decreases demand for rented capital. Capital rent is bid down, income from renting out capital in the capitalist sector declines, and this decreases desired capital ownership in the sector. The subsequent decrease in capital ownership and capital rented out by the capitalist sector reduces the amount of capital employed by the peasants, the marginal productivity of capital in the peasant sector rises, and this stimulates further investment in capital.

Feedback loop labeled 2 stimulates growth in capital ownership in the peasant sector as capital employment in the capitalist sector expands. When capital employment in the capitalist sector increases, less capital is available for renting out to the peasants. Hence, capital employment in the peasant sector falls. Incremental revenue from a unit of capital in the peasant sector rises, which draws more investment in capital by the peasants. Increased capital ownership by peasants, however, bids down capital rent, in response to which the capitalist sector transfers more capital from renting activity to commercial farming activity.

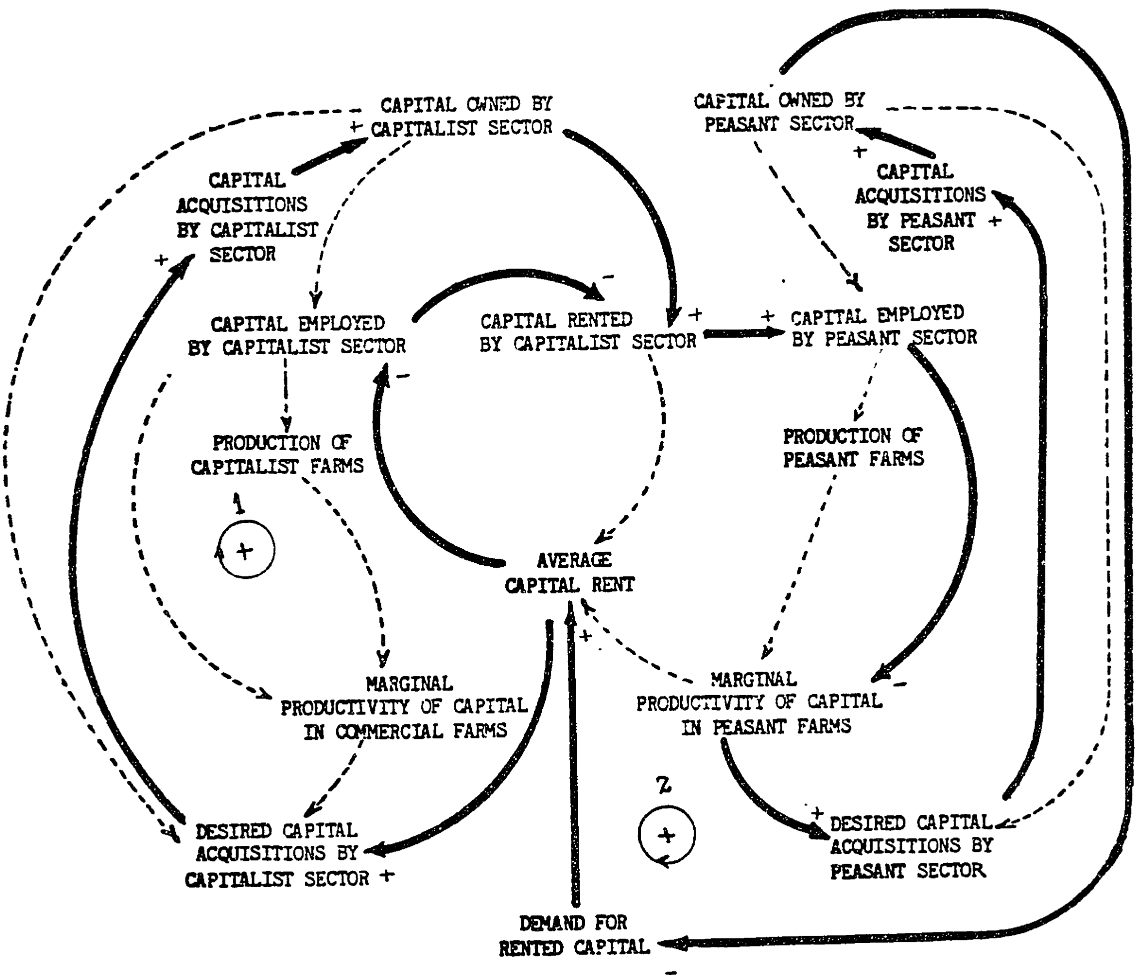


Figure 3.12: Additional Growth Forces Affecting Capital Formation.

Financial mechanisms shown in Figure 3.13 reinforce the capital growth forces. Each sector receives the income from the capital it owns. An increase in capital owned by a sector, therefore, expands the sector's revenue which also raises its financial ability. Expansion in financial resources stimulates investment and raises demand for capital in the sector; capital acquisitions are increased and capital accumulation in the sector further expands.

3.3.2. Control Forces Affecting Growth of Physical Capital

The growth forces described in section 3.2.1 are undermined by several negative feedback mechanisms implicit in economic decisions. The main negative feedbacks affecting growth in physical capital are illustrated in Figure 3.14. First, capital acquisitions in each sector vary according to the marginal productivity of capital in each sector which decreases as the intensity of capital employed in a sector rises. Therefore, the desired capital is changed in a such a way that the incremental revenue from capital becomes equal to the opportunity cost of investment in capital. Second, capital rented out by the capitalist sector is governed by the capital rent which is partly determined by the aggregate productivity of capital in the economy. Finally, capital rent determines how the capitalist sector will divide its capital assets between employment in commercial farming and renting out, but the changes in the supply of rentable capital will effect capital rent.

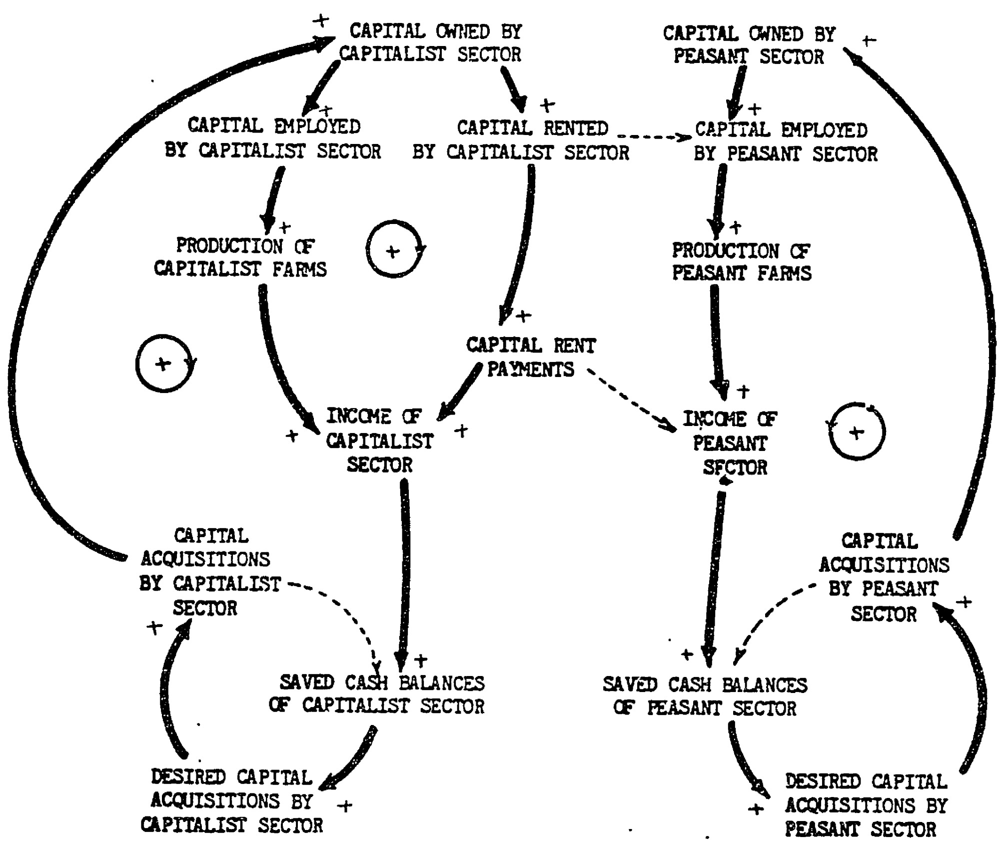


Figure 3.13: Positive Feedbacks from Financial Decisions Affecting Capital Formation.

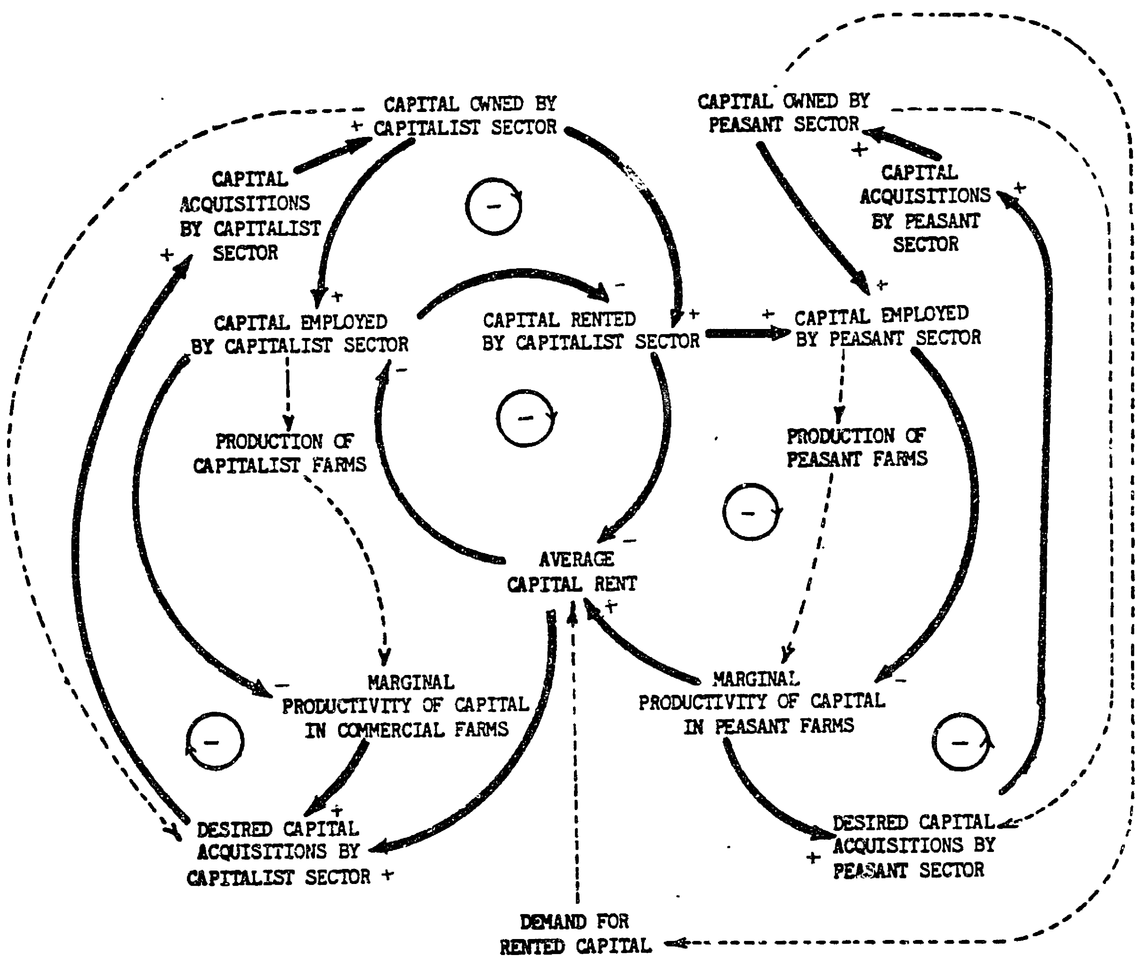


Figure 3.14: Main Negative Feedback Loops Controlling Capital Formation.

As renting out or lending capital is an easy alternative to directly employing it in the capitalist sector, an increase in capital rent also raises the demand for capital ownership in the capitalist sector. The incremental productivity of capital in the renting (peasant) sector falls as capital intensity, which is partly due to rented capital, rises. Thus, two negative feedback loops are created. These loops strive to allocate capital to commercial farming and renting activities in such a way that the marginal revenue product of capital, capital rent, and opportunity costs of capital are the same.

Financial mechanisms shown in Figure 3.15 provide additional control on growth of each sector. An expansion in the financial resources of a sector stimulates investment in capital, but the expenditure on capital acquisitions depletes financial resources and thus limits further investment in capital.

3.3.3. Policy Related Growth Forces

These forces arise out of the modern capital supply policy and are illustrated in Figures 3.16(a) and 3.16(b). Physical capital owned in each sector consists of both traditional capital and modern capital. The proportion of modern capital in total accumulated capital is determined by the volume and frequency of modern capital acquisitions, which depend on modern capital supply and the sector's ability to employ modern capital. Due to

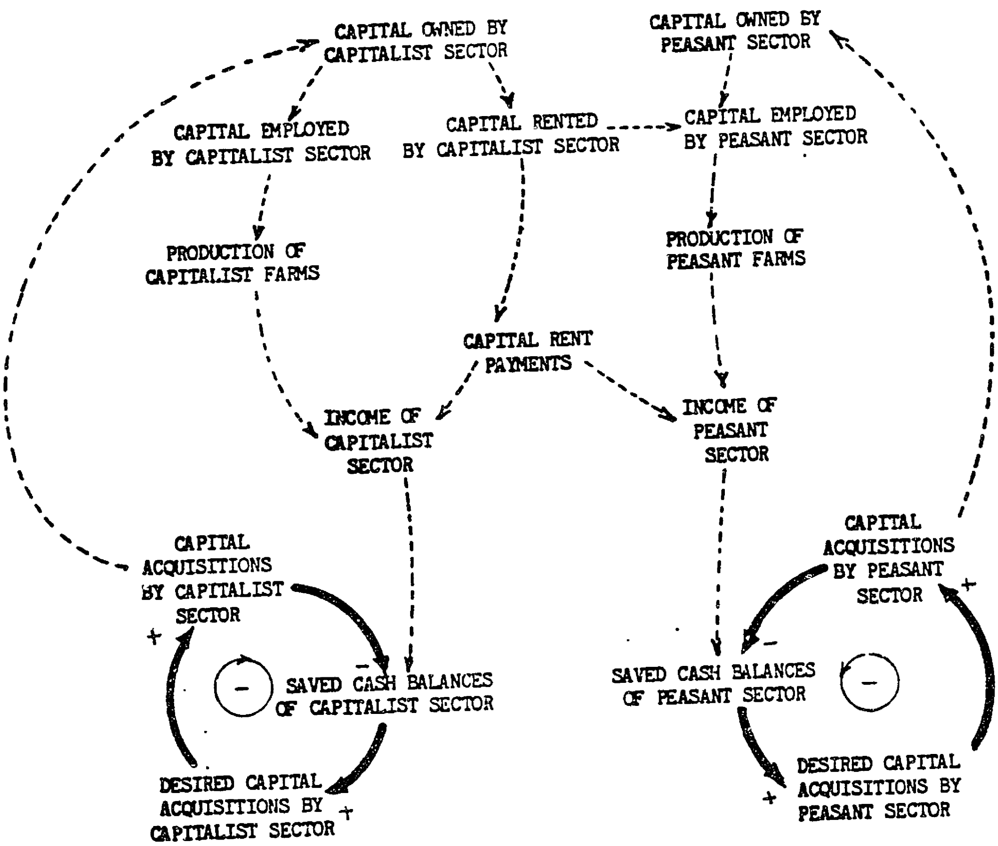
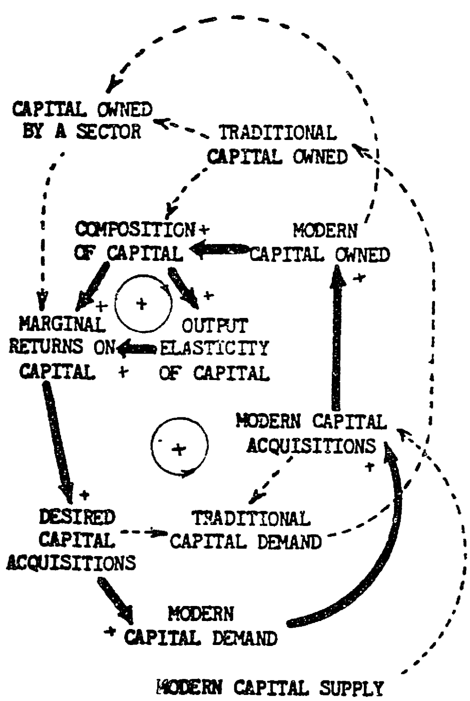


Figure 3.15: Negative Feedbacks From Financial Mechanisms Affecting Capital Formation.



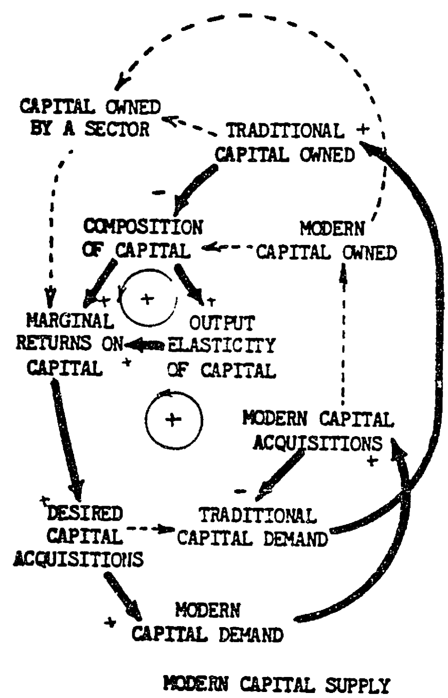


Figure 3.16(a) Figure 3.16(b)
Policy Related Growth Forces Affecting Capital Formation.

a preference for more productive modern capital, availability of modern capital also decreases traditional capital demand. The decrease in the volume and frequency of traditional capital acquisitions further increases the proportion of modern capital in the sector. Modern capital is labor displacing and has a higher output elasticity than the traditional capital. Modern capital also allows an increase in the frequency of cropping which raises annual output. Thus, as the proportion of modern capital in a sector rises, marginal productivity of capital rises concomitantly. This increases demand for capital and stimulates more modern capital acquisitions, which further raises the productivity of capital.

3.4. Allocation of Workers, Wage Determination, and Distribution of Resources

Workers are either self-employed in the peasant sector, or hired as wage laborers in the capitalist sector. The capitalist sector expands its workforce if marginal revenue product of a worker exceeds the wage rate, and vice versa. The peasant sector does not have any hiring or firing ability, but absorbs all workers not hired by the capitalist sector. The wage rate is determined by the overall average consumption level affordable by the workers (including wage and self-employed workers). The distribution of workers between the peasant and capitalist sectors, therefore, depends on the amount of resources employed in commercial farming by the capitalist sector (determining the need for wage workers), and the share of total income claimed by the peasant sector (determining the wage rate). The following growth and control forces affect wage determination and the allocation of workers and resources between sectors.

3.4.1. The Growth Forces

Figure 3.17 illustrates the positive feedbacks affecting the wage rate and the demand for workers in the capitalist sector. The innermost feedback loop labeled 1 represents an expectation spiral. An increase in the wage rate increases total wage disbursements, which raise the revenue of the peasant sector. An increase in the revenue of the peasant sector allows peasants and wage workers to expand their consumption levels. Subsequently, wage demanded by the workers for providing labor to the capitalist sector is determined on the basis of the expanded consumption level.

The feedback loop labeled 2 reinforces the expectation spiral. An increase in the wage rate raises the marginal factor cost of workers in the capitalist sector. Consequently, the number of workers in the capitalist sector decreases. The surplus workers forced into the peasant sector help increase intensity of cultivation, and hence the production of the peasant sector rises. Increased intensity of cultivation raises production of the peasant sector and hence its revenue. This further raises wage expectations of the workers.

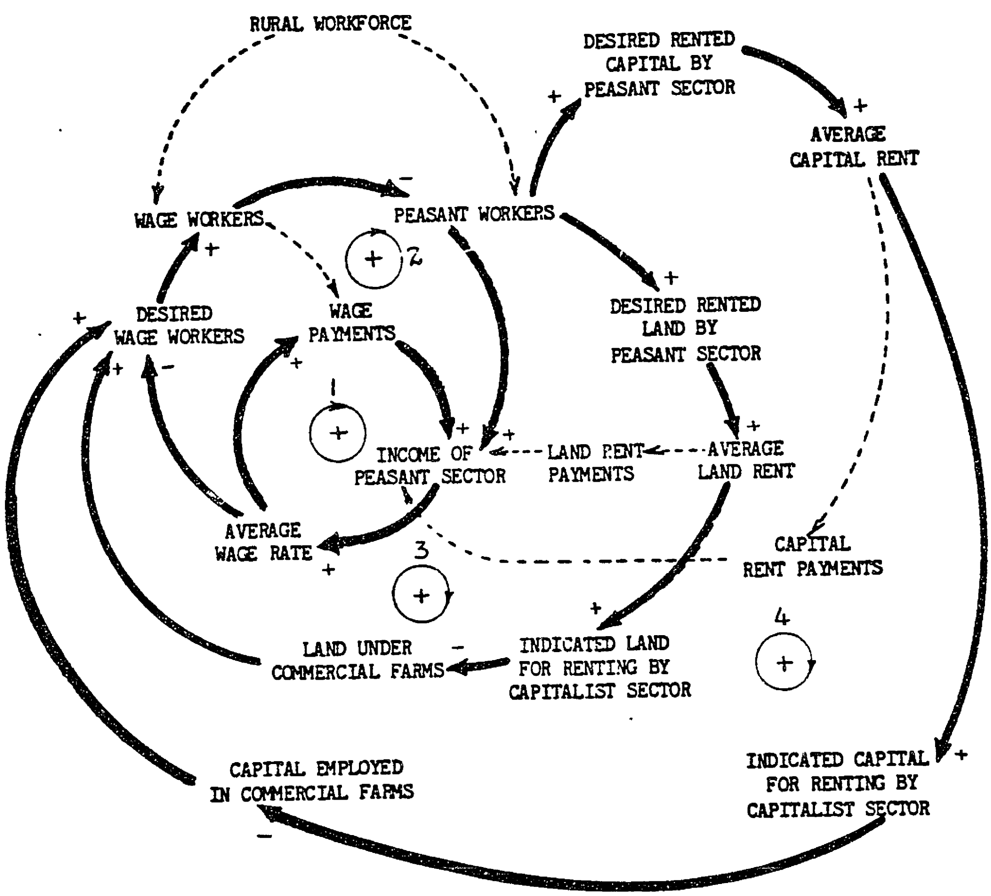


Figure 3.17: Main Positive Feedbacks Affecting Distribution of Workers and Wage Determination.

It should, however, be borne in mind that wage income lost when workers are laid off by the formal sector may exceed the gains in production of the peasant sector because of an increase in its worker intensity. The feedback resulting from the former action is discussed later.

If the number of total workers in the economy is fixed, an increase of workers in one sector manifests a corresponding decrease of workers in the other. The positive feedback causing growth in the number of workers in one of the sectors will tend to accumulate all workers in that sector.

Other positive feedbacks affecting distribution of workers between sectors are represented in feedback loops labeled 3 and 4. As more workers are forced into the peasant sector, complementary land and capital in the sector become scarce and demand for renting them increases. Thus, land and capital rents are bid up, which makes it profitable for the capitalist sector to allocate more land and capital to the renting activity. As more assets are rented out, the volume of production in commercial farming declines, which also reduces the demand for wage workers, thus forcing more workers into the peasant sector.

Fragmented financial markets and the dependence of asset acquisition ability on a sector's internal financial resources also create positive feedbacks affecting distribution of workers. These feedbacks are illustrated in Figure 3.18. An increase in

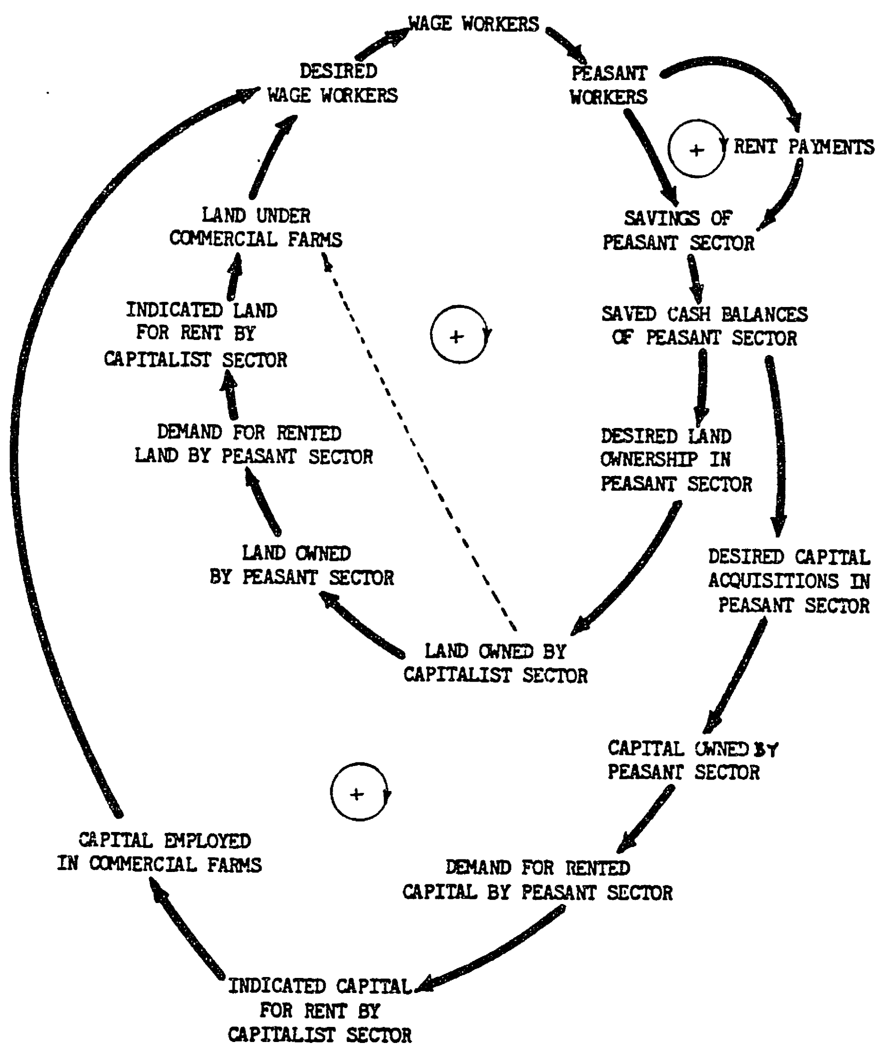


Figure 3.18: Financial Mechanisms Affecting Distribution of Workers Between Sectors.

workers in the peasant sector is accompanied by a loss of wage income which is less than offset by the the concomitant increase in the output of the peasant sector. Thus, in the face of continuing consumption pressures, the fraction of income saved shrinks.

An increase in workers in the peasant sector also creates relative scarcity of land and capital and, therefore, bids up rents. As rent payments have to be made at the time of each harvest, they decrease the net revenue of the peasant sector and the consumption pressures further force down the fraction of income saved.

A decrease in the savings of the peasant sector depletes its financial resources and hence its ability to acquire more land and capital declines. Because saved income supports lumpy consumption expenditure as well as investment, a large reduction in saved cash balances may not only limit capital ownership, but may also result in liquidation of some of the land by the peasant sector for meeting lumpy consumption needs. As resource ownership by peasants declines, their demand for renting land and capital rises, bidding up land and capital rents. Subsequently, the capitalist sector steps up renting activity, while the volume of commercial farming declines. Therefore the demand for workers in the capitalist sector decreases, and more workers are forced into the peasant sector.

3.4.2. Control Mechanisms Affecting Wage Rate and Allocation of Workers between Sectors

Figure 3.19 illustrates the important negative feedbacks which regulate the wage rate and the number of workers in each sector. The innermost feedback loop labeled 1 incorporates the adjustment of workforce in the capitalist sector on the basis of the marginal factor cost of workers. If wage disbursements by the capitalist sector continue to increase the revenue of the peasant sector, the consumption level of workers and wage expectations rise. The rising cost of labor in the capitalist sector will necessitate a decrease in its workforce. The ensuing decrease in wage disbursements lowers revenue of the peasant sector, which forces the workers to contract their consumption levels. Consequently, wage expectations fall and the wage rate decreases.

The outer feedback loops labeled 2 and 3 represent additional control mechanisms for distributing workers between the sectors. An increase in the number of workers in the peasant sector increases the amount of land and capital desired to be rented by the peasants. Land and capital rents are bid up, and rent payments by peasants start increasingly limiting their revenue. A decrease in the revenue of the peasants brings down the opportunity costs of workers in the peasant sector. Wage rates fall, in response to which, the desired number of workers in the capitalist sector rises. Subsequently, more workers are

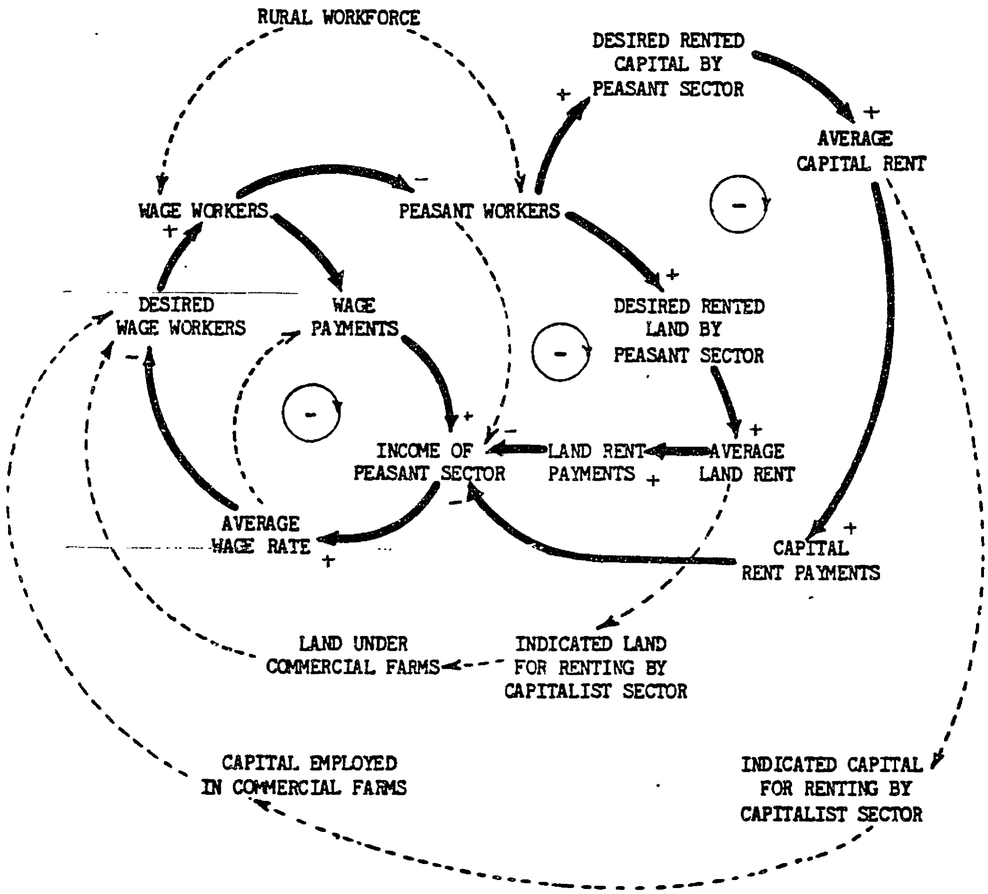


Figure 3.19: Negative Feedbacks Controlling Distribution of Workers Between Sectors.

absorbed in the capitalist sector while the number of workers in the peasant sector decreases.

The fragmented financial markets are also a source of control in distribution of workers, as illustrated in Figure 3.20. An increase in the saving rate of the peasant sector raises its internal cash balances and its ability to expand ownership of land and capital. An increase in the ownership of peasants allows an increase in the share of production claimed by them, which raises their net income, and consequently, their consumption. Higher worker consumption pushes up the wage rate in the commercial sector. But the availability of wage employment offering a high wage reduces the number of workers desired to be supported in self-employment; the utility of savings for supporting self-employment in the peasant sector diminishes, and the peasant sector saving rate declines. (See feedback loops labeled 1 and 2 in Figure 3.20).

Also, as the pressure to consume continues while wage workers are decreased in response to high labor costs and crowd the peasant sector without adding adequately to its output, saving rate of the peasants is further limited. Finally, when peasants try to expand self-employment activities by renting more land and capital, the rent payments shrink their net income but the number of workers to be supported by that income does not decrease which again taxes their saving ability. The capitalist sector, on the other hand, with more financial resources bids the

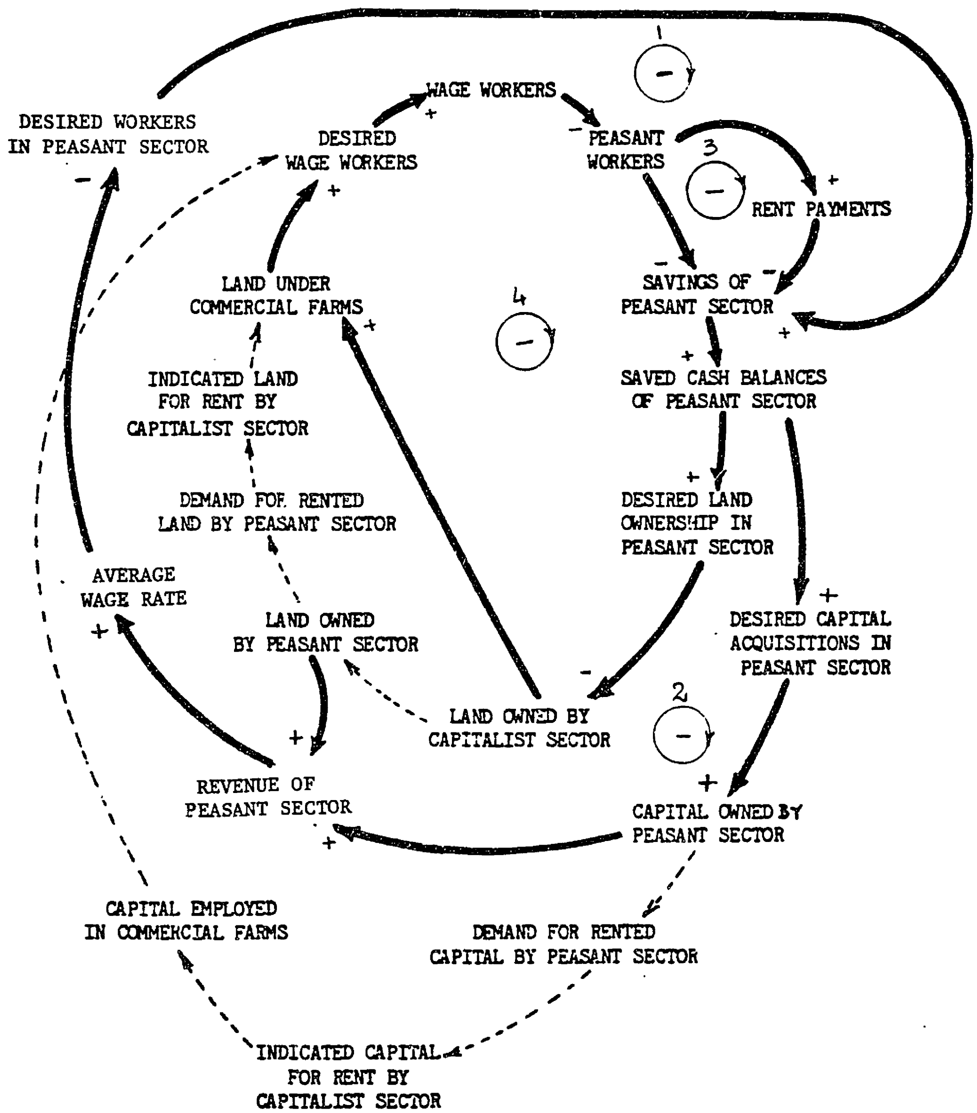


Figure 3.20: Negative Feedback from Financial Mechanisms Affecting Allocation of Workers.

peasants out of their land. As land ownership in the capitalist sector rises, land cultivated by it also increases. The demand for workers in the capitalist sector increases. The number of wage workers rises, while the number of self-employed workers falls. (See feedback loops labeled 3 and 4 in Figure 3.20.)

3.5. Implications of the Multiple Feedbacks in the Rural Income Distribution System

The identification of individual feedbacks in the rural income distribution processes brings out several interesting insights.

First, since the feedbacks represent the building blocks of the model, their explicit representation helps evaluate their plausibility and contributes to confidence in the model structure.

Second, the variety of positive feedbacks suggests that while certain forces allow incomes of the capitalist and peasant sectors to grow independently, other forces cause one sector to grow at the cost of the other, or even allow growth in one sector to stimulate growth in the other.

Third, the presence of a variety of negative feedbacks manifests an internal tendency of the system to be in a dynamic equilibrium. This tendency resists forces of change, whether internal or external to the system. The presence of negative feedbacks allows the dual economies to exist side by side.

Finally, the presence of both positive and negative feedbacks that generate conflicting internal forces as well as resist policy changes demonstrates that little confidence can be placed in the success of rural development and income equalizing policies without understanding the nature of those feedbacks. Looking at individual feedbacks in isolation, as has been done in this chapter, allows identification of various forces, and is the first step toward understanding the system.

However, in view of the complex interaction of the growth and control forces, it is often difficult to extrapolate the behavior of the system from the knowledge of individual feedbacks alone. First, it is necessary to assure that the stated feedbacks indeed underlie the income distribution behavior being investigated. Second, even if it is established that these feedbacks are a valid representation of the decision structure of the rural economy, it is still difficult to know the precise implications of specific rural development and income equalizing policies, without fully understanding how these policies are transmitted through the system.

Traditionally, historical analysis and experimentation in a controlled environment have been used to advance and substantiate hypotheses about physical and social phenomena and to design policies with specific objectives. However, historical information is often limited, imprecise, or irrelevent for addressing certain problems. Experiments with the real system, particularly in a social environment, are difficult to control while also being immensely expensive and time consuming. These experiments may also have some irreversible effects which are not desirable. Experiments with the model of a system have been used extensively for designing physical systems. Such experiments also provide an easy alternative for understanding socio-economic phenomena and for designing related policies with specific goals.

The succeeding chapters in this thesis discuss the results of the simulation experiments with the model of the rural income distribution system incorporating the feedbacks discussed in this chapter. Chapter Four attempts to validate and elaborate the theory embodied in the model; Chapter Five analyzes a limited set of rural development policies using the model.

NOTES

1. See FORRESTER, J. W., Principles of Systems, Wright Allen Press, 1968, and FORRESTER, J. W., Industrial Dynamics, MIT Press, 1961, for detailed discussion of the characteristics of positive and negative feedbacks.

2. For a comparison of various economic theories, see CONROY, Michael E., "Towards a Policy Oriented Theory of Economy in Latin America", in Portes and Browning, (eds.), Current Perspectives in Latin American Urban Research, 1976.

3. Ibid.

CHAPTER FOUR

TESTING MODEL ASSUMPTIONS

The confidence in a model depends on the consistency of the model's logic, the empirical validity of the theory embodied in the model, and the model's usefulness for the purpose for which it has been constructed [1]. The model presented in Chapter Two and Appendix A describes a theory of income distribution in Pakistan's rural economy and is intended for serving as an instrument for analysing rural development policies. The validity of this model will be judged on the basis of the soundness of its causal structure, its ability to explain the prevalent inequalities in the distribution of rural income, and its usefulness as a framework for policy analysis.

The causal structure of the model has been discussed in Chapter Three. The causal mechanisms of the model are based on generally recognized theoretical premises and empirical facts/observations. Although an explicit causal structure that can be related to the real world gives the model a functional validity, it is necessary to test the causal assumptions for their ability to generate the problem behavior in the framework of the whole system. This is done in this chapter by performing a set of simulation experiments aimed at testing the key assumptions of the model. These experiments entail varying assumptions embodied in the model and comparing its behavior each time to a "reference mode", representing a historical tendency of the system.

"Historical tendency" is used as a reference condition instead of "historical behavior" because of the lack of data providing a substantive basis for measuring a historical behavior. The historical tendency serving as reference mode is abstracted from the various bits and pieces of the historical evidence.

A second set of experiments comparing implications of the various development policies for the model to the experience in the real world are described in Chapter Five. Those experiments also contribute to the model validation process as they test the robustness of the model in the face of exogenous intervention.

4.1. The Reference Mode

The reference mode for testing the model assumptions represents a hypothetical time-dependent behavior displaying the internal tendency of the rural income distribution system. Empirical evidence suggests that there is a tendency for the ownership of resources to separate from the cultivators and be concentrated in the capitalist sector. As ownership is an important basis for claiming income, the separation of resources from the cultivators allows a large fraction of the rural income to be obtained by the capitalist sector, leaving the balance to be shared by the cultivators. Also, in spite of some effort on the part of the British colonial government, commercial farming has been difficult to sustain, until recently.

Thus, the abstracted reference mode must show that irrespective of the initial distribution of land between the capitalist and the peasant sectors, the system will tend toward an equilibrium where most of the land is owned by the capitalist sector. Further, almost all capitalist owned land is expected to be sharecropped by self-employed workers, even if it is commercially farmed initially. All workers are expected to be self-employed, tilling own or rented land, while a large share of output claimed on the basis of ownership is accrued to the capitalist sector. Also, because the intended state of the system manifests a dynamic equilibrium, it must incorporate a clear market in which the marginal returns on the factors are equal to their respective marginal costs and the factor proportions are optimal.

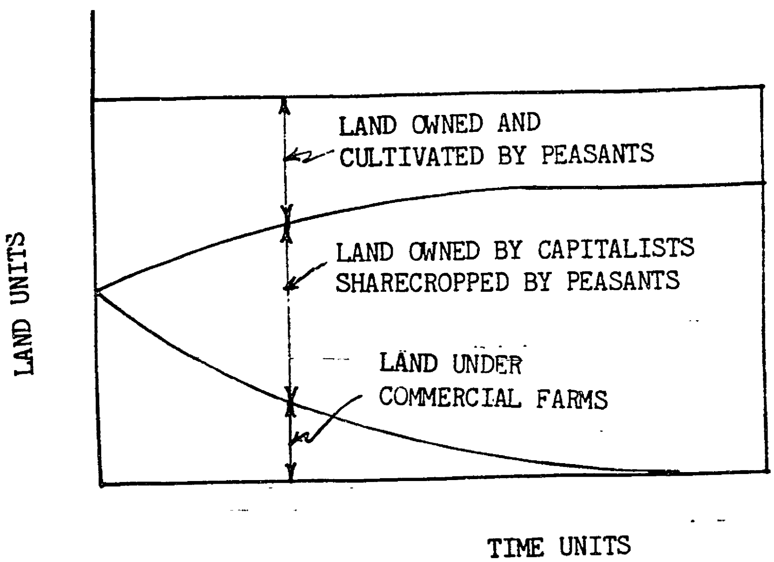
Indeed, the end equilibrium manifested in the above description of the reference mode was amply visible in Pakistan's stagnant rural economy over the early 1950s. Table 4.1 illustrates the characteristics of this equilibrium; population growth is ignored.

	Capitalist sector	Peasant sector
Land-ownership [2]	> 70%	< 30%
Worker Distribution [3]	-	almost 100%
Income Shares [4]	> 40%	< 60%

Table 4.1. Land and Income distribution in Pakistan's Rural Economy over the 1950s.

Yet, only a century earlier, claim to income on basis of ownership alone was unknown, and except for land revenue payments, all income was accrued to the cultivator. The distribution of land between the capitalist and peasant sectors at the time of introduction of a land-ownership system is not known. However, if the current distribution represents the internal goal of the system, any initial distribution should lead to that goal.

The reference mode, therefore, can be graphically represented as shown in Figure 4.1. It is arbitrarily assumed that, initially, half the land was under capitalist farming while the balance was self-cultivated; none was sharecropped. Albeit, the sensitivity of the model to a change in the initial distribution will be tested later.



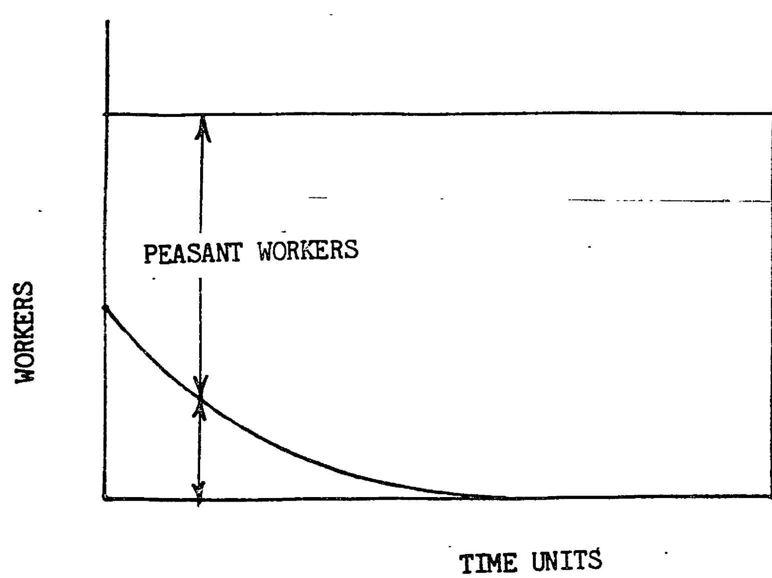


Figure 4.1: Reference Mode Representing the Internal Tendency of the System.

The simulation experiments described in the succeeding sections of this chapter test various model assumptions for their contribution to the internal tendency of the system represented in the reference mode. These experiments were a part of the model building process. The presented results pertain to the final version of the model, as the model underwent a number of revisions during the course of its development.

4.2. Simulation Experiments for Testing Model Assumptions

These experiments entail varying assumptions of the model and studying the resulting changes in its behavior. All experiments but one described in this section were performed with the "fixed economy" assumption, wherein, the workforce, the total land resources, and the demand for agricultural production were kept fixed. In each experiment, it was assumed that a perfect market equilibrium existed in the economy before the modifying assumptions being tested were introduced. Such equilibrium requires that the marginal revenue products of the factors be the same in both capitalist and peasant sectors and substitution of one factor by another in either sector may not yield higher returns. Further, the demand for factors and the output exactly equal their respective supplies and the economy is closed. To maintain perfect market equilibrium, the model assumed perfect financial markets, determination of factor costs on the basis of their respective marginal revenue products, and transfer of resources to the sector with higher returns.

Only one feature distinguished between the resource allocation processes in the two sectors in the perfect market model: while the capitalist sector was allowed to adjust the number of workers employed by it on the basis of their cost relative to their benefit, the peasant sector absorbed all residual workers after the capitalist sector met its worker needs. Additional assumptions were incorporated into the model in steps and the corresponding changes in the behavior of the model from its initial equilibrium studied. The initial resource distribution shown in the reference mode was used as an initial condition in all experiments except the one testing sensitivity of the model to changes in the initial conditions.

4.2.1. Experiment 1: Testing Perfect Market Assumptions of the Model

In this experiment, mechanisms responsible for a perfect market equilibrium at the begining of each simulation are tested. The initial equilibrium of the model is disturbed by taking away a fraction of the workers from the capitalist sector and accommodating them in the peasant sector. This transfer raises the marginal productivity of workers in the capitalist sector, which immediately proceeds to increase its workforce. The transfer also increases the intensity of cultivation in the peasant sector, as a result of which, the marginal productivity of land and capital in that sector rises. Hence, the peasant

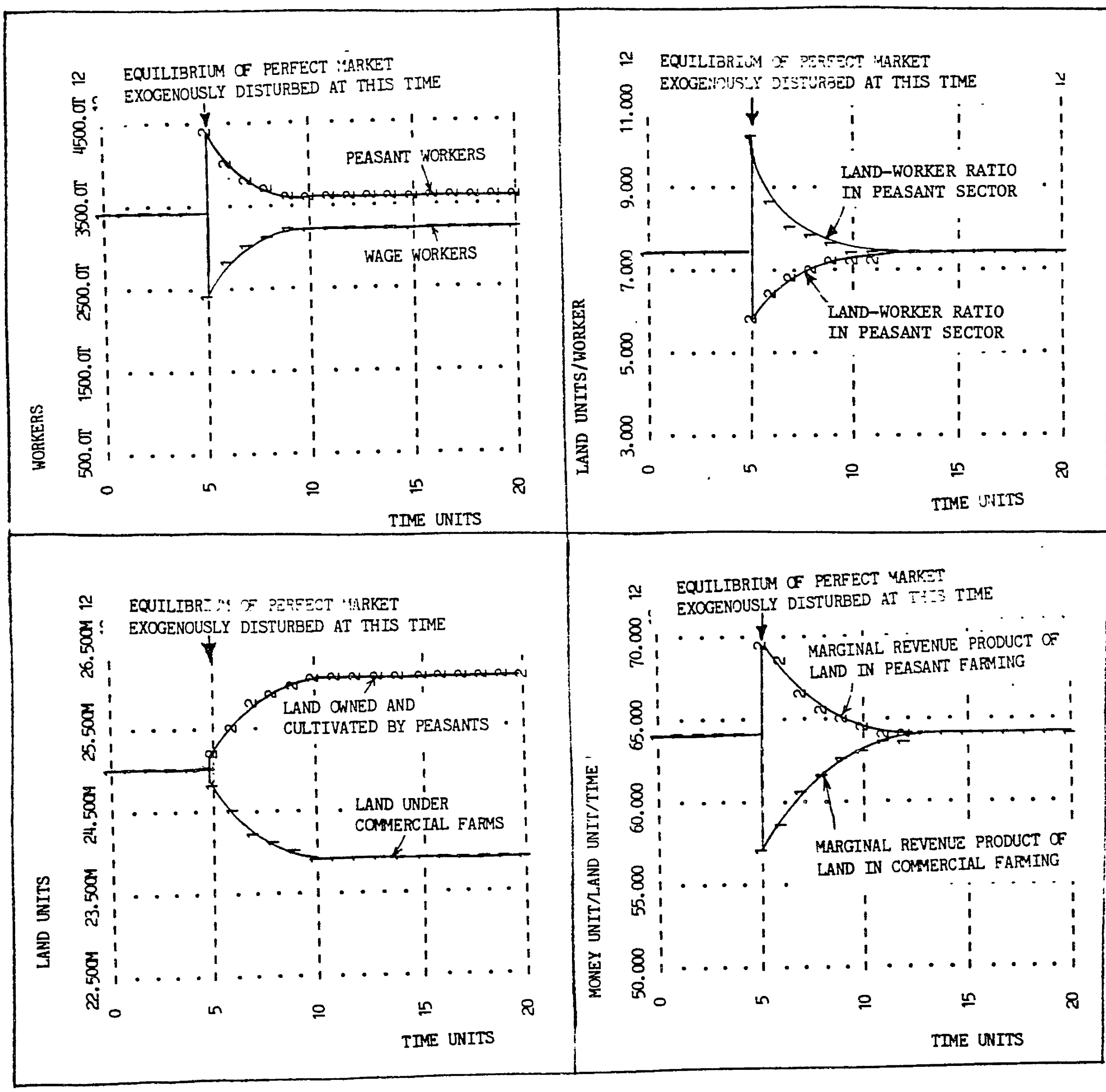


Figure 4.2: Experiment 1: Recovery from Disequilibium in a Perfect Market Economy.

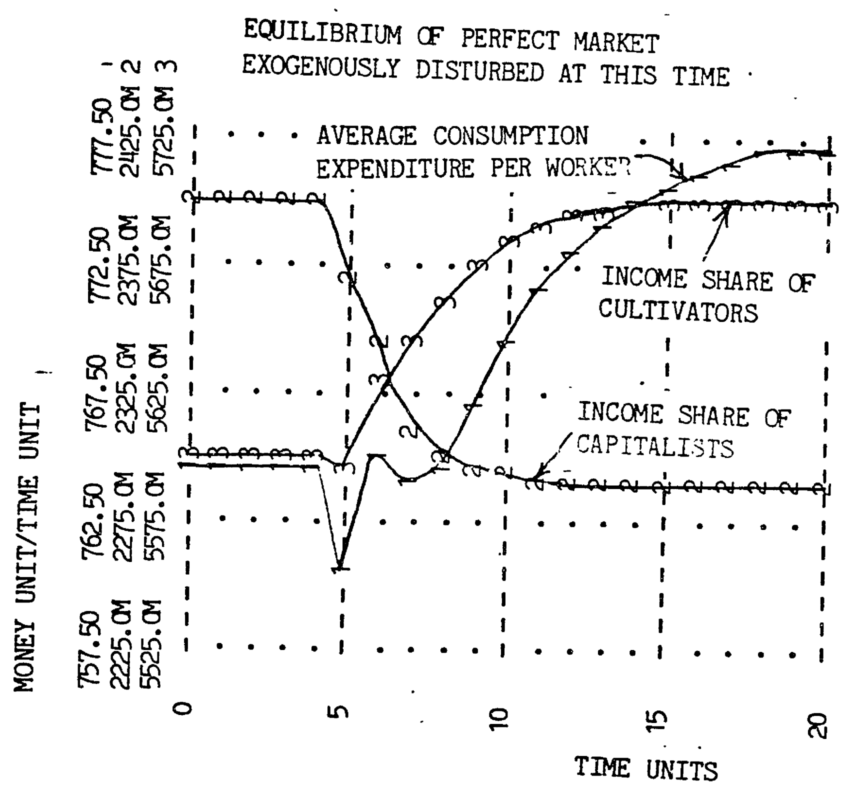


Figure 4.3: Experiment 1: Changes in Income Distribution Concomitant with Recovery from Disequiliberium in a Perfect Market Economy.

consumption per worker suffers when wage income is lost, but recovers to a higher level as the peasant sector starts receiving additional income from the newly acquired resources.

The behavior of the model in experiment 1 satisfies the premises of a perfect market, and is logically consistent, albeit empirically invalid. The market equilibrium tendency of the kind suggested in the simulation is nonexistent. At the outset, factor proportions in the two sectors have been reported to differ considerably. The peasant sector is labor intensive, while ownership of resources is concentrated in the capitalist sector [5].

The dualist literature often suggests that the crowding of workers in the peasant sector is due to a distortion in the labor market that works against the capitalist sector. As labor is provided by the peasant sector, the wage rate is not determined by the marginal revenue product of workers, but represents opportunity costs seen by a worker for being employed in the capitalist sector [6]. The dualist literature also suggests the peasant leaving his family to work in the capitalist sector loses his average product on the family farm. Thus, the capitalist sector must pay him a wage rate that compensates him for the loss [7].

Although such wage determining assumptions appear plausible, they embody several anomalies. First, even though the wage worker is assumed not to sell out his interest in the family farm, he neither gets a share of the family farm income, nor does he share his wage income with the family farm. Second, while the workers are implicitly assumed to be maximizing consumption, the costs of maintaining family farms are not excluded from the average product which form the basis of the wage rate [8].

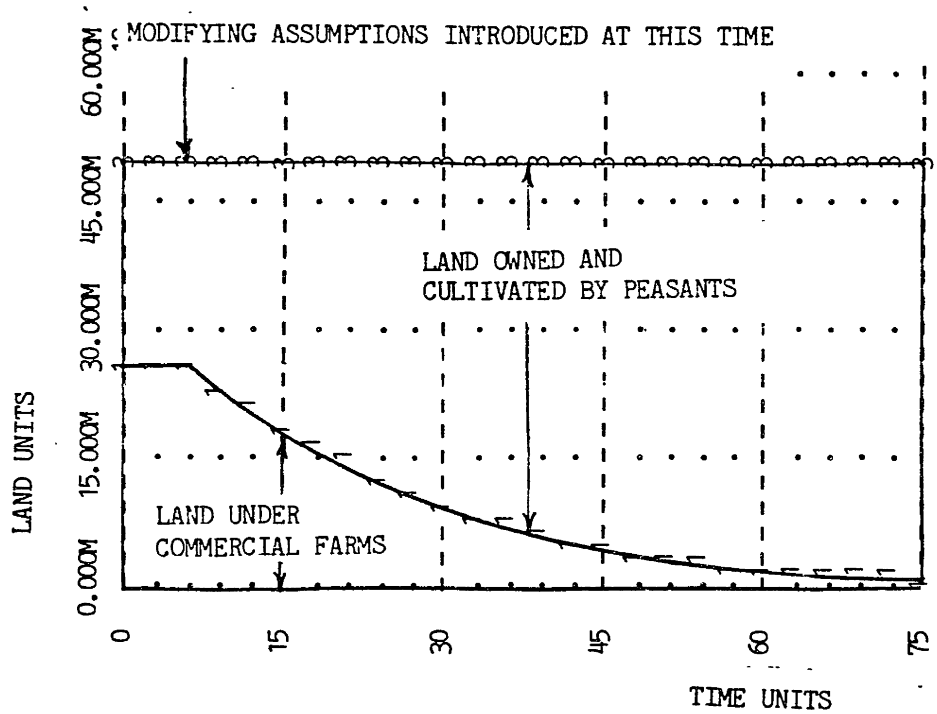
The alternative assumption that the wage rate is determined on the basis of average consumption expenditure per worker, taking into account both wage income and self employed income of workers, more consistently represents opportunity costs of workers. The wage determination structure of the model is revised in the following experiments to incorporate these considerations.

4.2.2. Experiment 2: Modifying Wage Determining Assumptions of the Model

The total income of the workers consists of the value of production of the peasant sector and the wage disbursements by the capitalist sector. A part of this revenue is set aside as savings, which are allowed to accumulate and are later spent on farm maintenance and future consumption. Disposable income of the peasant sector, therefore, comprises its total income, plus the rate at which savings are consumed, less the rate of saving. Average consumption per worker is given by dividing the disposable income of workers by the total rural workforce.

Figure 4.4 shows the changes in land and workforce distribution between the capitalist and peasant sectors when the wage determining mechanisms of the model are modified. As the wage rate now exceeds the marginal revenue product of workers in the capitalist sector, wage workers are laid off. The laid off workers are accommodated in the peasant sector. However, as the number of workers in the peasant sector rises, it becomes possible to cultivate land more intensively. The marginal revenue product of land in the peasant sector increases, and its bids for land rise. On the other hand, the decrease in workforce in the capitalist sector lowers its land cultivation intensity, and hence its land productivity. Falling productivity increases the opportunity costs of investment in land, and the capitalist sector is forced to sell out its holdings to the peasants.

If the peasant sector increases its land and capital holdings, its production rises. When increases in production of the peasant sector exceed the wage income lost due to decreasing wage disbursements from the capitalist sector, the net revenue of the peasants rises and allows average consumption expenditure of the workers to be increased. The wage rate, therefore, is pushed further up, which necessitates further decreases in wage workers. The spiraling action of these processes allows gradual transfer of all resources to the peasant sector.



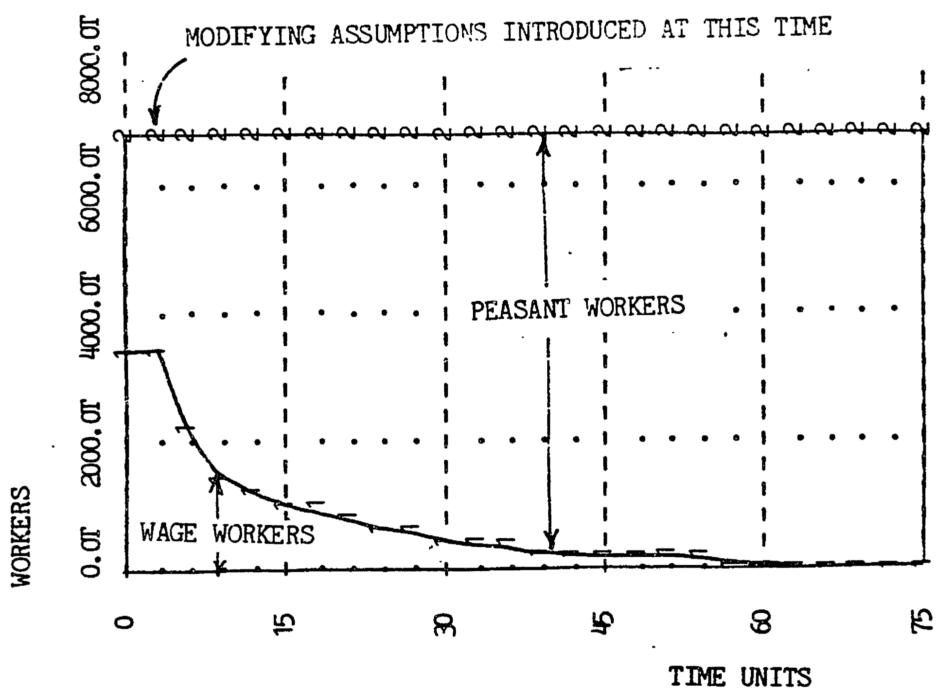


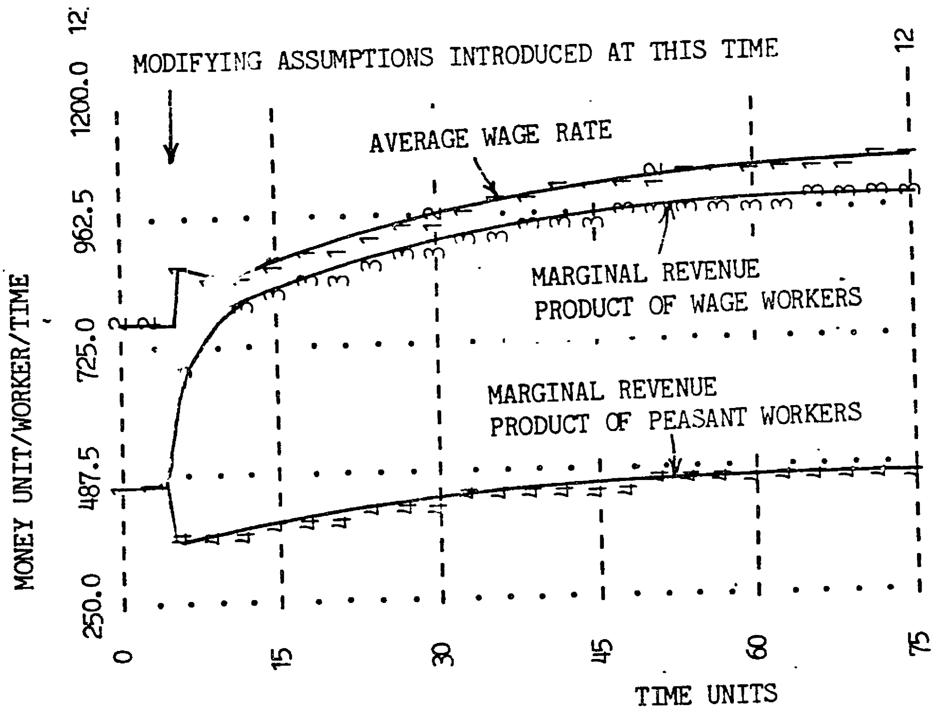
Figure 4.4: Experiment 2: Changes in Land and Worker Distribution when Wage Assumptions are Modified.

The behavior of wages and the marginal revenue products of land and labor in the two sectors is shown in Figure 4.5. When the capitalist sector reduces its workforce due to increase in wage costs, and is subsequently bid out of land and capital, the wage rate rises faster than the marginal revenue product of workers in the capitalist sector. Due to a longer adjustment time for land than for workers, the capitalist sector always has excess land as compared to its workforce. Therefore, the marginal revenue product of land in the capitalist sector tends to be higher than in the peasant sector, albeit, the capitalist sector hardly employs any land towards the end of the simulation.

The income distribution in this experiment tends to become perfectly egalitarian in the long run, as shown in Figure 4.6. As all resources are transferred to the self-employed peasants, the total revenue of the economy is exclusively controlled by its workers.

The behavior of the model in this simulation is also logically consistent but is still far from reality. The factor proportions in the two sectors tend to be different, as evidenced, but the distribution of resources and income between capitalists and workers is nowhere near reality.

An important element missing in the model so far is the tenure system which permits the renting of land and capital and thus allows the amount of resources owned and employed by a



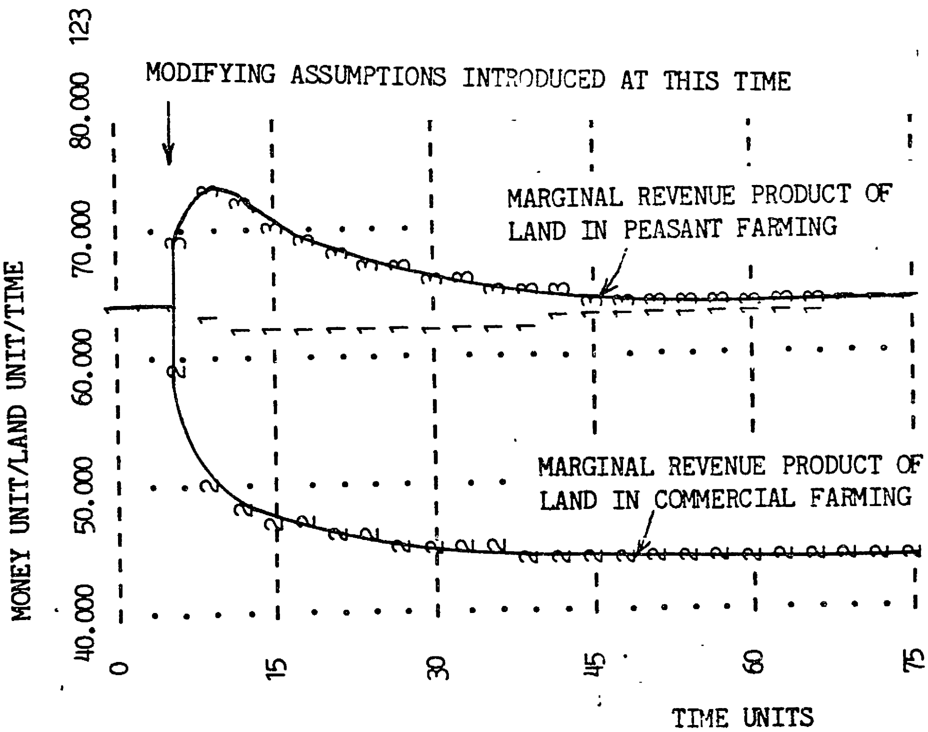


Figure 4.5: Experiment 2: Changes in Wage Rate and Marginal Revenues of Land and Workers when Wage Assumptions are Modified.

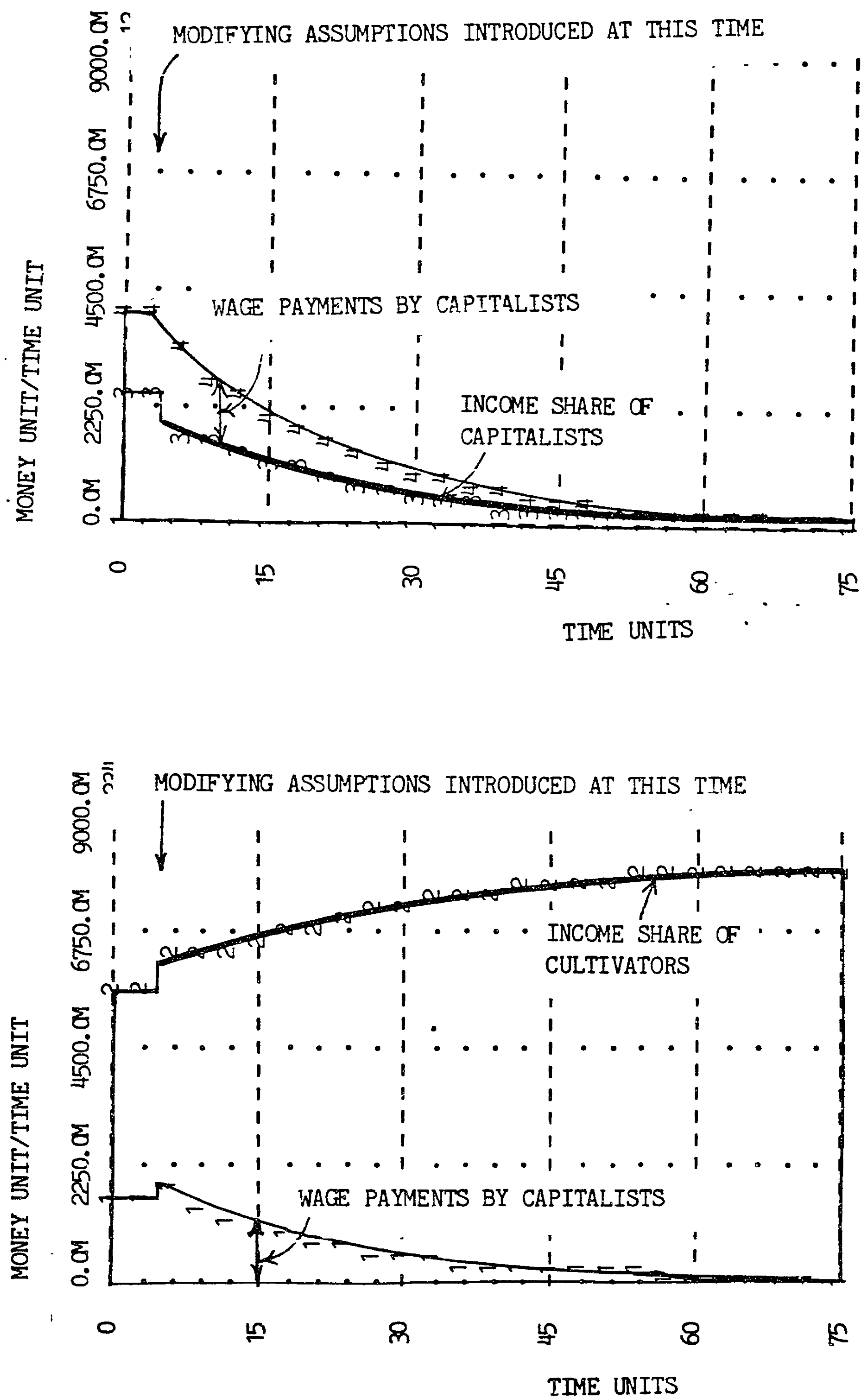


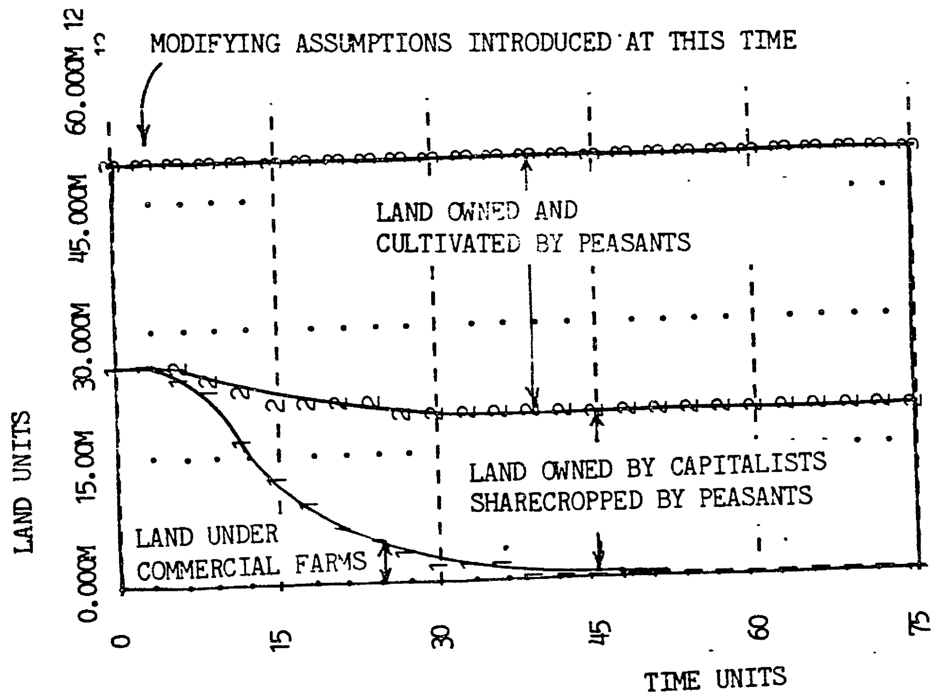
Figure 4.6: Experiment 2: Changes in Income Distribution when Wage Assumptions are Modified.

sector to be different. The tenure system used in the model so far is simplistic and assumes concomitant changes in employment of resources and their ownership in the two sectors. Indeed, sharecropping has been the dominant mode of production in Pakistan's rural economy in the past although its volume has been decreasing after modern capital inputs were introduced in agriculture. Sharecropping represents a method of renting out land and sometimes farm capital to peasant cultivators in return for a share of the production. Until mechanized farming was introduced in Pakistan, all land-owners having more than 20 or 25 acres employed share croppers. Owner cultivators were those who had just enough land that could be cultivated by family labor [9]. The tenure assumptions of the model will be modified in the following experiments to include renting options.

4.2.3. Experiment 3: Modifying Tenure Assumptions of the Model

In this experiment, the capitalist sector is allowed to divide its resources between farming and renting activities on the basis of profits available in each activity. Rents are determined by the aggregate marginal revenue product of the rented resources and their supply relative to their demand. The modified wage determination mechanisms of experiment 1 are also retained.

Figure 4.7 shows the changes in the distribution of land and workers in the model resulting from introducing the modified



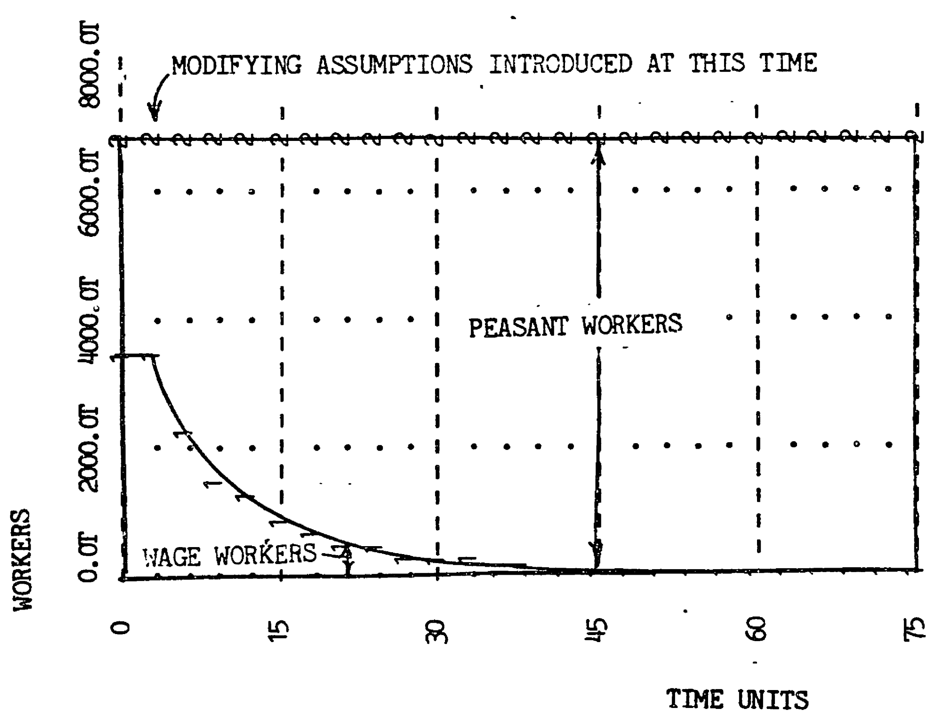


Figure 4.7: Experiment 3: Changes in Land and Worker Distribution when Wage and Tenure Assumptions are Modified.

tenure assumptions in the model. Towards the end of the simulation, all land is still cultivated by the peasants, but a substantial share of land is owned by the capitalist sector. There are only peasant workers in the economy who either cultivate their own land or rent land from the capitalist sector.

The land and worker distribution displayed in Figure 4.7 develops due to the combined effect of the modified wage and tenure assumptions. When workers are laid off by the capitalist sector in response to high wage rates, the productivity of land cultivated in the capitalist sector falls. However, as the laid off workers are accommodated in the peasant sector, its demand for land as well as its intensity of cultivation increase. Therefore, land rents are pushed up and the capitalist sector is able to get enough returns from renting land to justify retaining its investment in land [10].

The behavior of the wage rate, land rent and the marginal revenue products of workers and land in the two sectors is shown in Figure 4.8. Again, the marginal revenue products of factors in the capitalist sector towards the end of the run are only hypothetical, as the volume of farming in the capitalist sector is negligible. Thus, the wage rate shown represents only a shadow wage as there are no wage workers. While the wage rate equilibrates at a much higher level than the marginal revenue

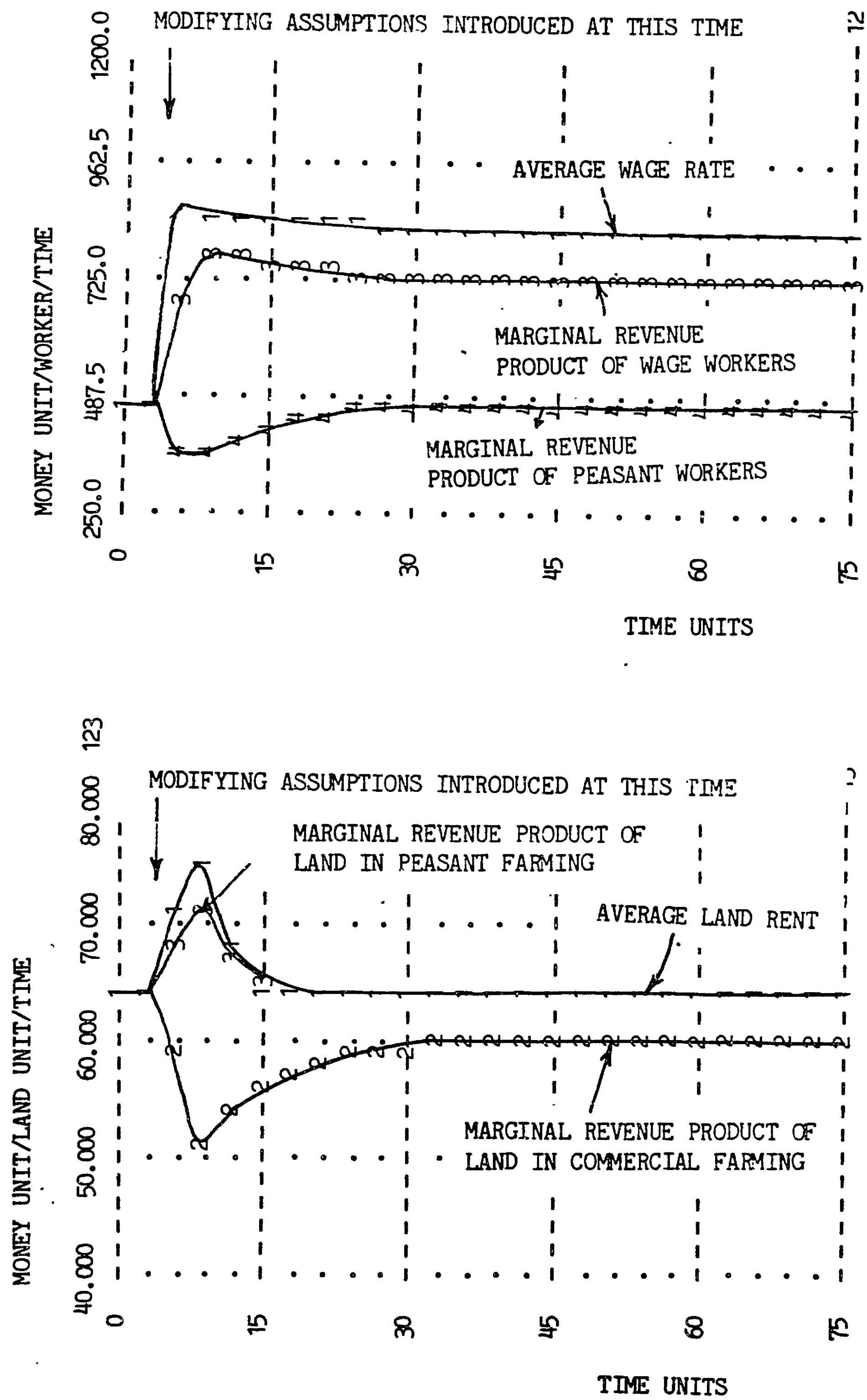


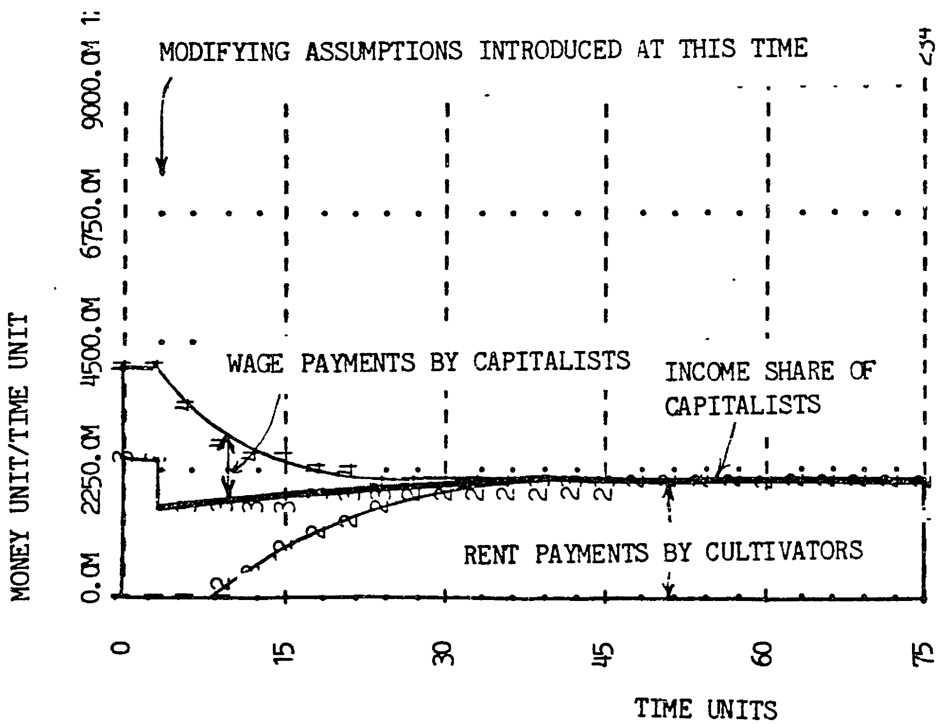
Figure 4.8: Experiment 3: Changes in Wage Rate, Land Rent, and Marginal Revenues of Land and Workers when Wage and Tenure Assumptions are Modified.

product of workers in the peasant sector, the land rent tends to coincide with the marginal revenue product of land in the peasant sector.

Land renting allows the peasant sector to adjust its factor proportions quickly when it is faced with accommodation of a large number of workers. When the economy reaches an equilibrium, the marginal rates of returns on factors in the peasant sector are the same as those at the beginning of the simulation. The wage rate equilibrates at a relatively high level as the peasant sector still owns a substantial share of the resources.

The changes in income distribution in this experiment are shown in Figure 4.9. Income distribution towards the end of the run is less egalitarian than in Experiment 2. The worker share of income is decreased by rent payments, even though all production is still carried out by self employed peasants.

The final equilibrium in this experiment bears a functional resemblance to Pakistan's rural economy before modern capital inputs were introduced in it, but it does not correctly portray the distribution of resources and income. The model behavior manifests ownership of most of the resources by peasants, whereas, peasant holdings in the case of Pakistan are considerably smaller than holdings of the noncultivating landlords [11].



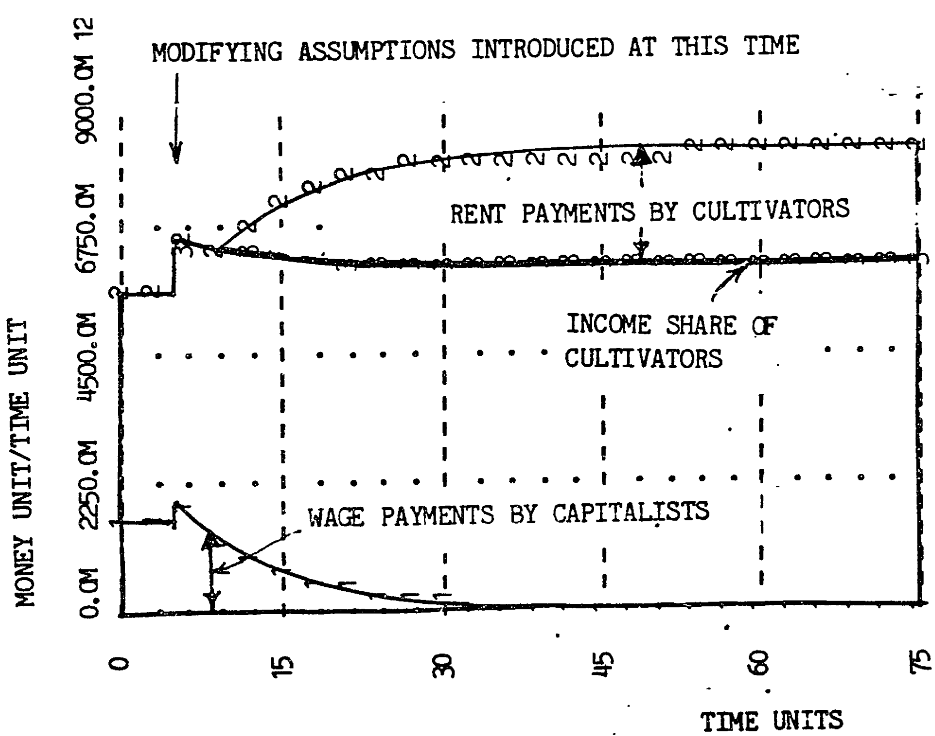


Figure 4.9: Experiment 3: Changes in Income Distribution When Wage and Tenure Assumptions are Modified.

The model developed so far assumes the existence of perfect financial markets in which internal cash balances of the sectors have no effect on investment decisions. In reality, the financial markets in the developing country economies are highly segmented. Some models of the developing country financial markets available in the literature assume that all economic units are confined to self-finance and that these units (called firm-households) do not borrow from or lend to each other. Thus, the desired rates of investment are highly dependent upon the availability of cash balances within the economic units [12]. While such models portray some of the characteristics of Pakistan's rural financial markets, their definition of an economic unit is rather narrow. In fact, substantial informal lending and borrowing facilities are available to the peasant sector, while bigger landlords have access to on another and to institutional credit sources [13].

According to a World Bank study conducted in 1960, all farming households in rural Pakistan had access to some form of credit, although only 5% of the households, largely affluent, enjoyed institutional credit. In terms of the value of credit, only about 14% of the loans are institutional; the rest come from informal sources [14]. The bulk of the credit is provided by relatives and friends, while some credit also comes from small money lenders, cooperatives, and government [15], as shown in Table 4.2:

SOURCE	% OF RURAL BORROWINGS
Friends and Relatives	63.2%
Rural Money Lenders	20.7%
Cooperatives	13.2%
Government	2.9%
Banks	-

Table 4.2: Sources of Agricultural Credit in Pakistan, 1960
Source: Lowdermilk(1972)

Informal lendings to and borrowings from relatives and small money lenders allow the financial resources of a social class to be available to its members, while savings of one social group are rarely available to another social group for investment.

Some writings also argue that big landlords in Pakistan act as the primary money lenders for the peasantry [16]. Such perceptions are usually based on the money-lending practices evidenced in India [17]. Such money-lending practices are limited in Pakistan due to a religious bias against usury. Big landlords do extend credits to their tenants, though mostly for meeting lumpy consumption needs [18]. Such credit transactions also require mortgage of the borrower's property, and the failure to pay back loans in time often results in forfeiture of the mortgaged property. These credit transactions, therefore, tend to exacerbate segmentation in the financial markets.

In view of the possibility of mobilizing savings within each sector at the same time as there are restrictions on the transfer of savings between the sectors, Pakistan's rural financial markets may be said to be segmented by sectors rather than being fragmented by households. The amount of savings available in a sector greatly influences its investment decisions. The amount of savings available for investment, in turn, depends upon cash balances left after meeting past investment expenditure and after providing for the anticipated rate of consumption of savings [19].

4.3.4. Experiment 4: Modifying Financial Market Assumptions

In this experiment, the availabilities of saved cash balances in each sector are allowed to affect the desired rates of investment. The wage and tenure assumptions of the last experiment are retained. Cash balance availability is determined by subtracting the average investment expenditure from the average saving rate and dividing the difference by the rate of consumption of accumulated savings. Thus, cash balance availability depends on the rate of saving, the past expenditure of saving on investment, and a rate of consumption of savings based on the saving consumption tradition. A cash balance availability of unity allows desired investment to be determined entirely on the basis of profitability criteria. A cash balance availability of >1 stimulates investment while a cash balance availability of <1 depresses investment below that indicated by the profitability criteria. In the extreme case, a very low cash balance availability may prompt liquidation of some of the assets of the sector. A constant fraction of net revenue is assumed to be saved in each sector.

Figure 4.10 shows the distribution of land and worker in this experiment. This distribution differs only slightly from what was displayed in Experiment 3. All land is still cultivated by the peasants towards the end of the simulation, while the ownership of land is divided between the capitalist and the peasant sectors. However, the proportion of land owned by the peasants is slightly higher than in Experiment 3.

The behavior of the model in Experiment 4, though still unrealistic, can be explained in terms of the model logic. Segmentation of the financial markets entails complementary increases in assets and cash balances. When both sectors are saving a constant fraction of their income, the expanding sector will have a higher cash balance. As peasant sector productivity increases after it absorbs workers laid off by the capitalist sector while capitalist sector productivity falls, the peasant sector expands both in terms of the land it owns and the volume of its production. Increases in ownership of the peasant sector also reduces its rent burden to some degree, thus further enhancing its financial ability.

Figure 4.11 shows the income distribution behavior in Experiment 4. The peasant sector share of income is slightly higher than what was observed in Experiment 3. This is realized

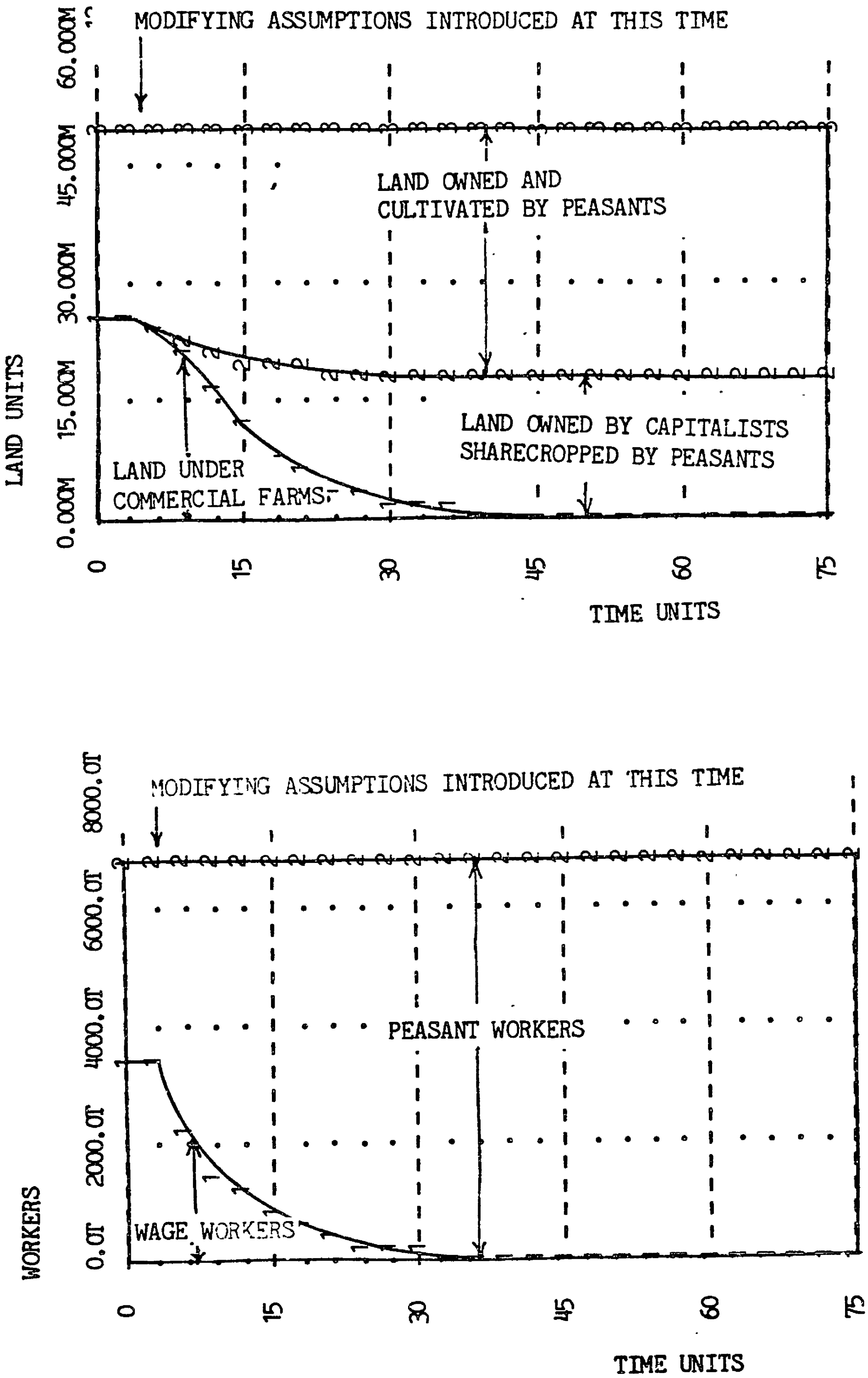


Figure 4.10: Experiment 4: Changes in Land and Worker Distribution When Wage, Tenure, and Financial Market Assumptions are Modified.

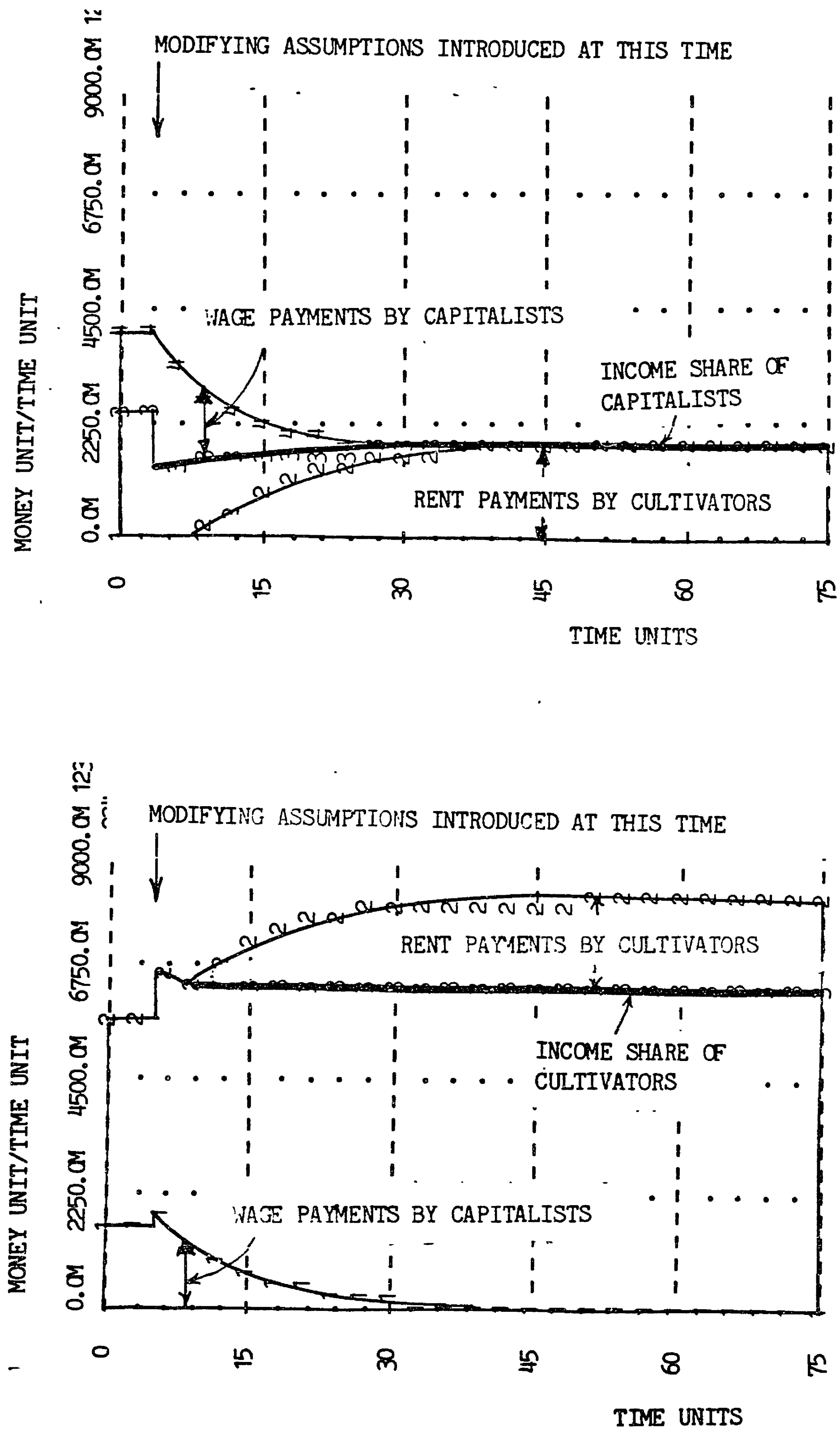


Figure 4.11: Experiment 4: Changes in Income Distribution when Wage, Tenure, and Financial Market Assumptions are Modified.

because of a reduction in the rent burden of the peasants.

The model evolved so far incorporates analogous saving behavior for the capitalist and the peasant sectors. Similar proportions of net income are saved in each sector for investment and deferred consumption. A number of models in the literature have suggested that while landlords save a substantial part of their income, the workers do not save any although some contrary evidence about the incidence of saving amongst peasants and workers is now also becoming increasingly available [20,21].

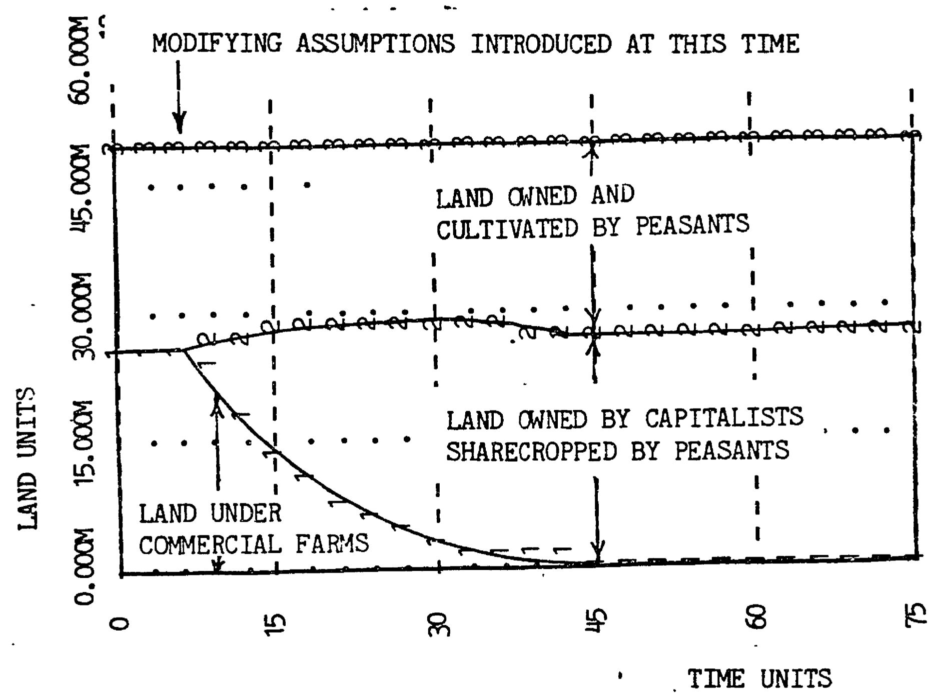
In context of the model, savings also include deferred consumption. Therefore, savings are an important part of income disbursement process in both sectors. The absence of differentiation between the saving behavior of the capitalist and the peasant sectors, however, is unrealistic. Landlords, in general, appear to have a higher propensity to save than the peasants [22], possibly because their income is much above subsistence. Further, while the saving propensity of landlords may remain constant, the saving propensity of peasants is considerably affected by the utility of saving for maximizing the consumption of the peasant sector. Thus, the peasant sector will tend to save less when wage employment offering compensation comparable to that in self-employment is available. The saving assumptions of the model are modified in the following experiments.

4.2.5. Experiment 5: Modifying Assumptions for the Utility of Savings to the Peasant Sector

In this experiment, the model is further modified by allowing the fraction of resources saved in the peasant sector to be influenced by a measure of the utility of savings to the workers. When wage employment offering compensation comparable to the opportunity cost of workers is available, the peasant sector would tend to increase its consumption by letting some of its workers seek wage employment and consuming some of the income that was being saved for supporting self-employment production facilities for those workers. This to say that as wage employment opportunities decrease and wage rate falls, the utility of saving for self-employment rises.

Figure 4.12 shows how land and workers are redistributed between the capitalist and peasant sectors when the modifying assumptions of Experiment 5 are activated. While the farming pattern is still dominated by the feudal (implying ownership and cultivation by different groups) and peasant (implying self-cultivation of peasant owned land) modes, a larger share of land is under the feudal mode than in the previous experiments.

As long as wage employment offering wages comparable to self-employed earnings is available, the peasant sector saving rate will be depressed, causing its saved cash balances to deteriorate and its ability to bid for income generating factors to decline. Thus, over the period while the capitalist sector is



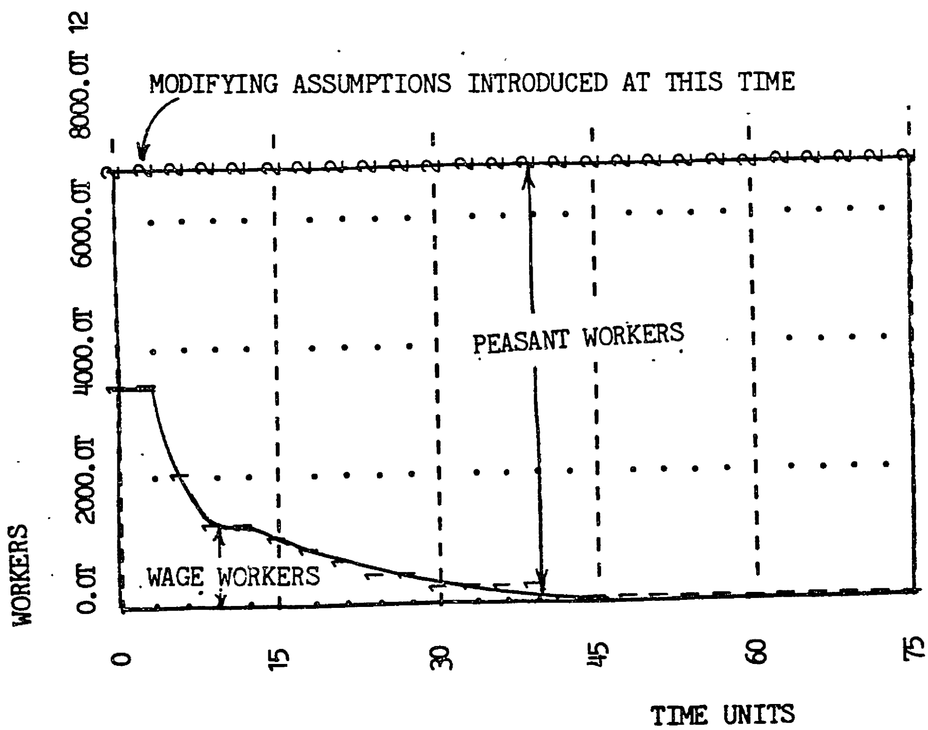


Figure 4.12: Experiment 5: Changes in Land and Worker Distribution When Wage, Tenure, Financial Market, and Peasant Saving Utility Assumptions are Modified.

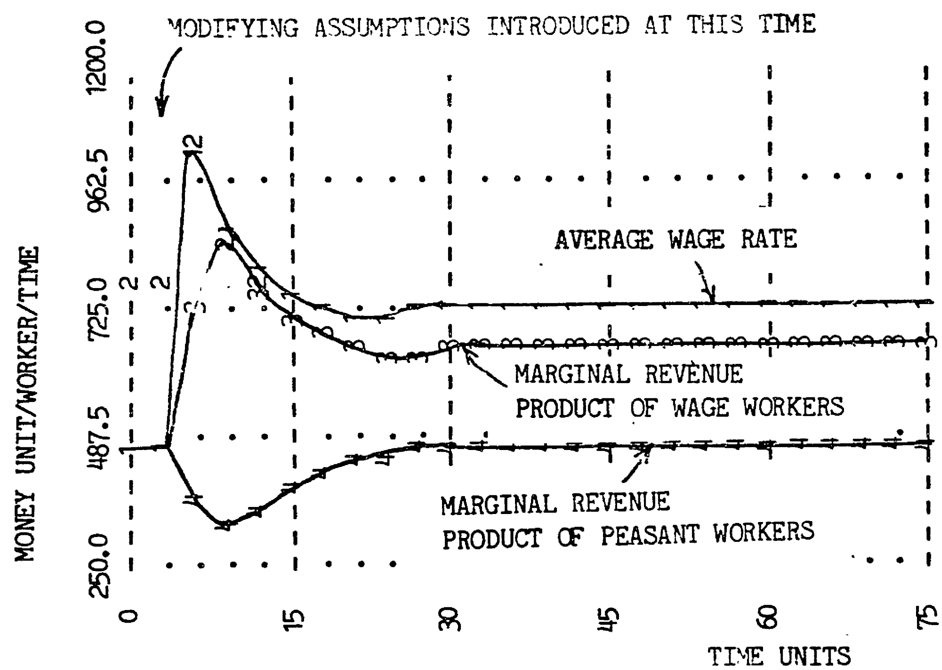
shifting its resources from commercial farming to sharecropping, the peasant sector is bid out of a large share of its land and becomes addicted more and more to sharecropping.

The capitalist sector is able to rent out more and more of its land and capital as rents are bid up due to the shortage of owned resources in the peasant sector. At the same time, the capitalist sector has adequate and rising cash balances for investing in more land and capital for the now profitable renting activity. The ownership of land in the capitalist sector, therefore, rises.

The peasant sector recovers from its spending spree (in the model) as wage employment opportunities decline. Nevertheless, the urge to increase consumption leads the peasant sector to lose ownership of its assets at a time when it has surplus workers and is able to raise its land productivity by increasing the intensity of cultivation. The benefit of higher productivity in the peasant sector, therefore, mostly accrues to the capitalist sector which is able to charge higher rents and to use its revenues for bidding land away from the peasants. By the time the peasant sector recovers from the spending spree, a substantial part of its land has been transferred to the capitalist sector.

The behavior of the wage rate, land rent, and the marginal revenue products of workers and land for this experiment is illustrated in Figure 4.13. The equilibrium wage rate is even lower than the wage rate in Experiment 3 which so far has exhibited the lowest wage rate. The decline in the wage rate is due to an increase in the rent burden of the peasant sector because of which the workers' net revenue and, hence, the average consumption per worker declines. As a cropping pattern similar to the last experiment develops, the equilibrium land rent and marginal revenue products of factors in the peasant sector are the same as in that experiment. Changes in income distribution are shown in Figure 4.14, which indicates an increase in the rent burden of the peasants and a decrease in the share of their income.

Although the end of the simulated distribution of land and workers in this experiment bears a closer resemblence to Pakistan' rural economy than the earlier experiments, deviations between the model behavior and the empirical evidence persist. First, the land ownership in the peasant sector is still much higher than is true for Pakistan. Second, contrary to continuing financial inability of the peasants to increase their land ownership, the peasant sector in the model is able to recover towards the end of the simulation (see Figure 3.12), when wage employment opportunities vanish and pressure to save for investment in self-employment infrastructure rises. Sharecropping provides additional self-employment opportunities and thus further raises the need for saving by the peasants.



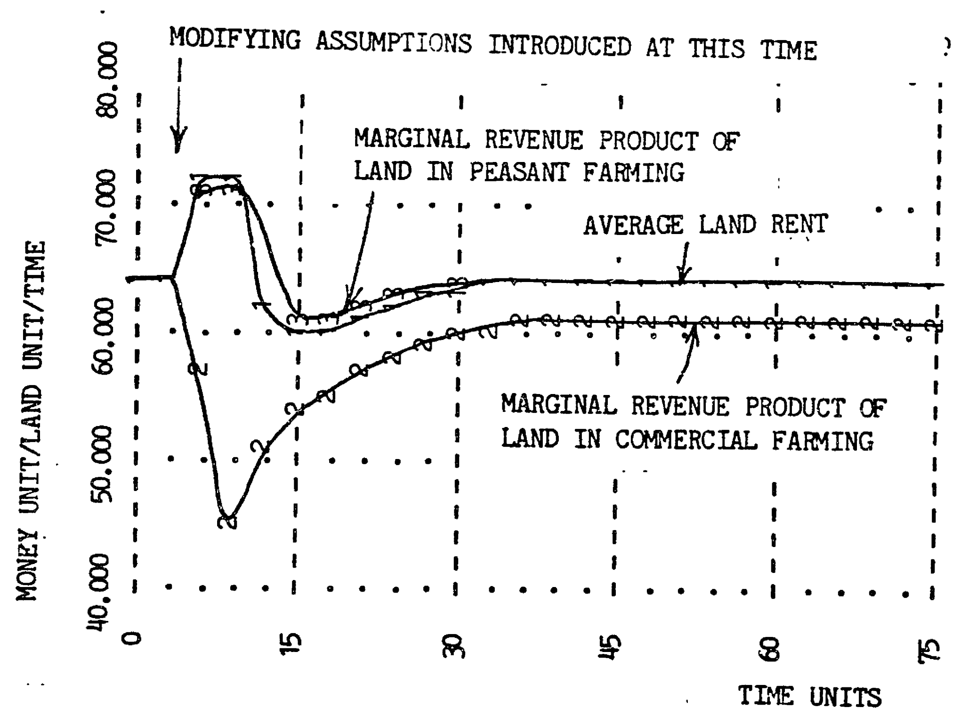
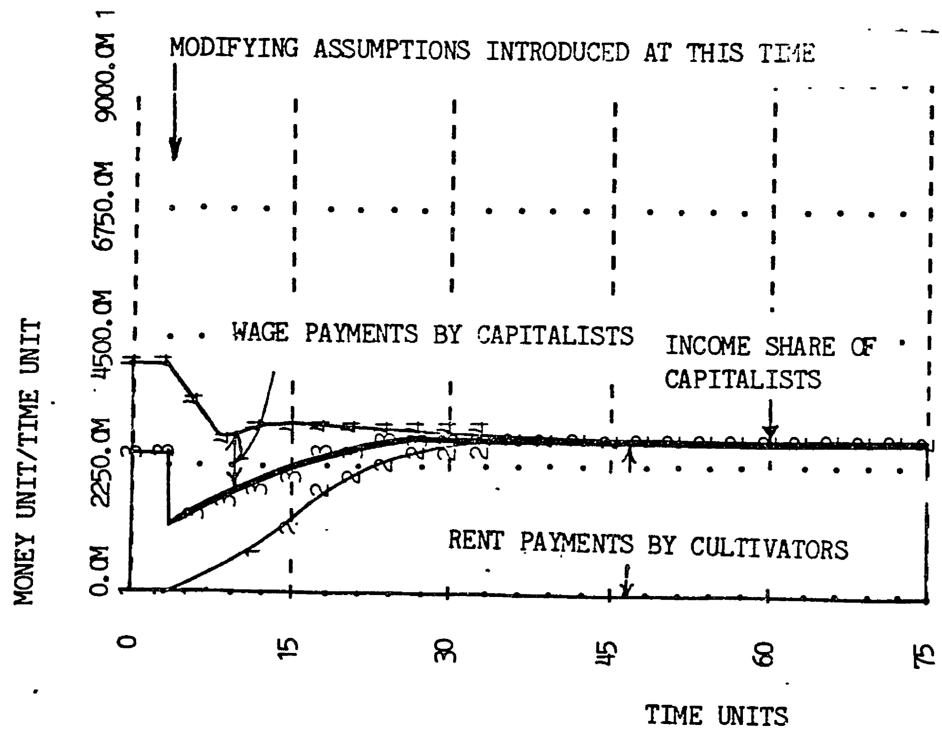


Figure 4.13: Experiment 5: Changes in Wage Rate, Land Rent, and Marginal Revenues of Land and Workers when Wage, Tenure, Financial Market, and Peasant Saving Utility Assumptions are Modified.



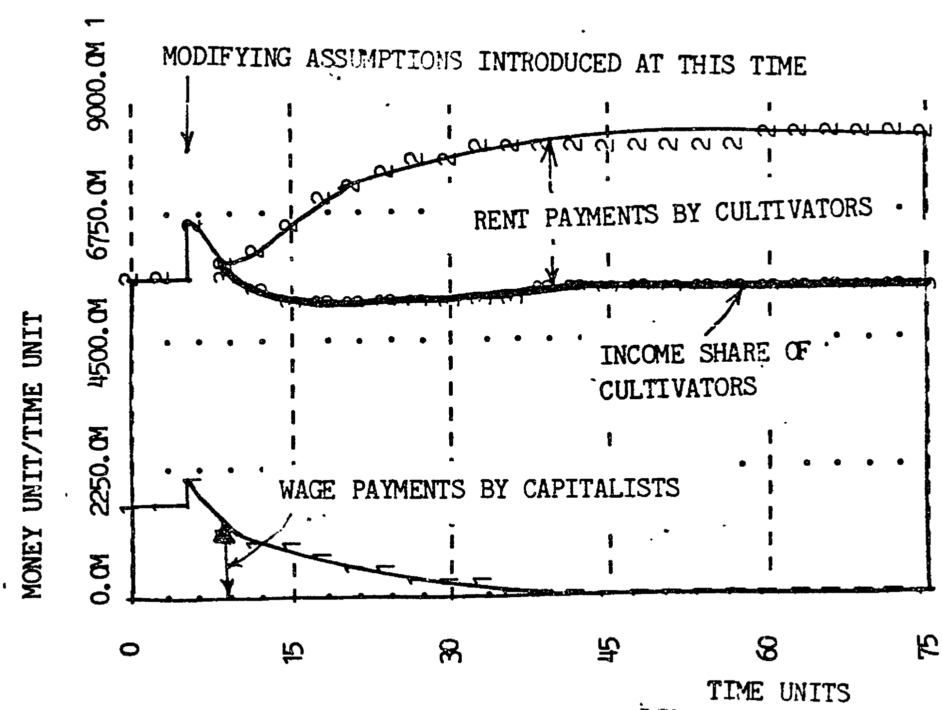


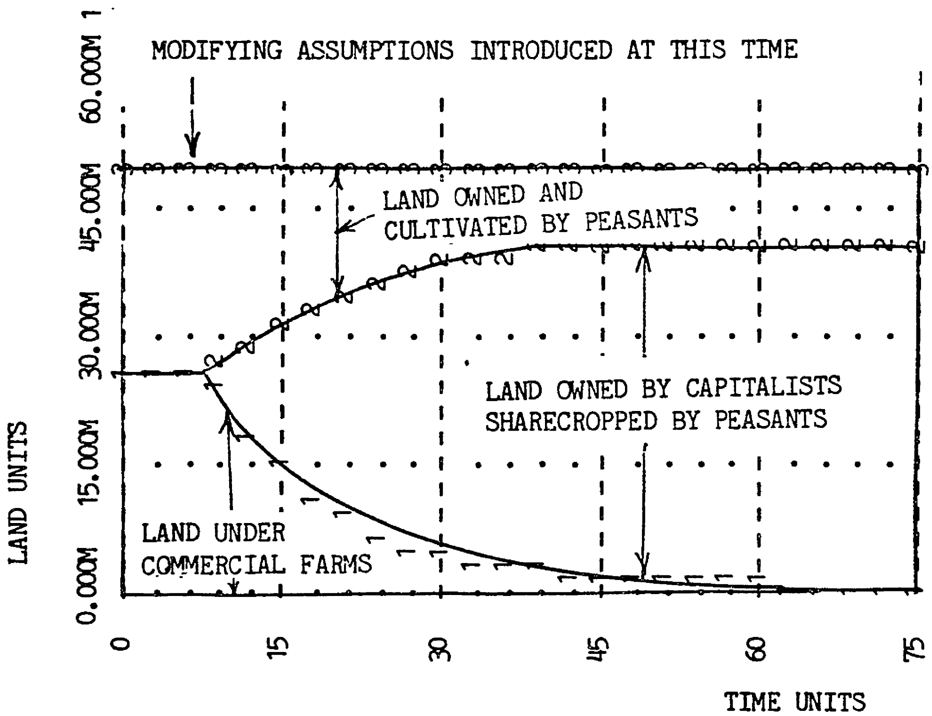
Figure 4.14: Experiment 5: Changes in Income Distribution when Wage, Tenure, Financial Market, and Peasant Saving Utility Assumptions are Modified.

However, even though an absence of wage employment opportunities and an increase in self-employment possibilities (due to an increase in sharecropping) may raise the utility of savings for the peasant sector, increasing rent burden of the sharecropping peasants, in the face of the pressure to maintain past consumption levels, begins to limit the saving ability of the peasant sector [23]. The assumptions of peasant saving behavior in the model, therefore, need to be further modified.

4.2.6. Experiment 6: Effect of Rent Payment Pressures on Peasant Sector Savings

In this experiment, in addition to the modifying assumptions introduced into the model so far, the savings of the peasant sector are also influenced by the fraction of peasant sector gross receipts from employing land and capital paid out as rents. The gross receipts from land and capital are calculated by subtracting the contribution of labor from the total value of production. As the ratio between the total rent and interest payments and the gross receipts from employing land and capital rises, the fraction of net income saved declines.

The changes in the distribution of land and capital after modifying assumptions are introduced are shown in Figure 4.15. The simulation displays a cropping pattern similar to that in Experiment 5, albeit the distribution of land between the sectors is more realistic. Land ownersip in the peasant sector declines to a low level and shows no signs of recovery, and the capitalist



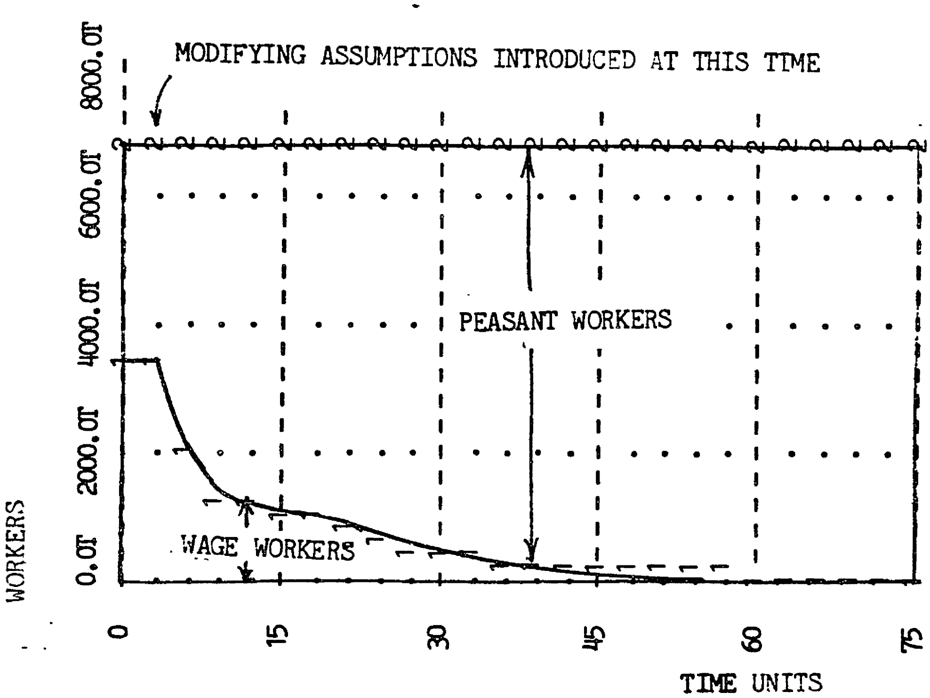


Figure 4.15: Experiment 6: Changes in Land and Worker Distribution when Wage, Tenure, Financial Market, Peasant Saving Utility and Rent Pressure Assumptions are Modified.

sector emerges as the major land owner, but all farming is carried out by the self-employed cultivators.

When the peasant sector faces a land shortage and is unable to buy land to alleviate it, land rents are bid up. Consequently, the capitalist sector is not only able to get enough returns in renting its land to justify maintaining and even expanding its holdings, but its cash balances also expand. On the other hand, an increasing rent burden on the peasant sector decreases its savings and causes its cash balance to decline. The economic viability of expanding ownership together with the superior financial ability of the capitalist sector allow it to bid the peasants out of their land. As a result, the shortage of land in the peasant sector heightens, and the peasants are forced to seek more rented land which further increases its rent burden. Thus, the peasant sector never recovers its financial ability to expand its land ownership.

The behavior of wage rate, land rent, and the marginal revenue products of workers and land in Experiment 6 are shown in Figure 4.16. While the marginal revenue products of factors in the peasant sector and land rent are comparable to those in the last experiment, the wage rate is lower. The increased rent burden on the peasants reduces their net revenue and decreases their consumption level.

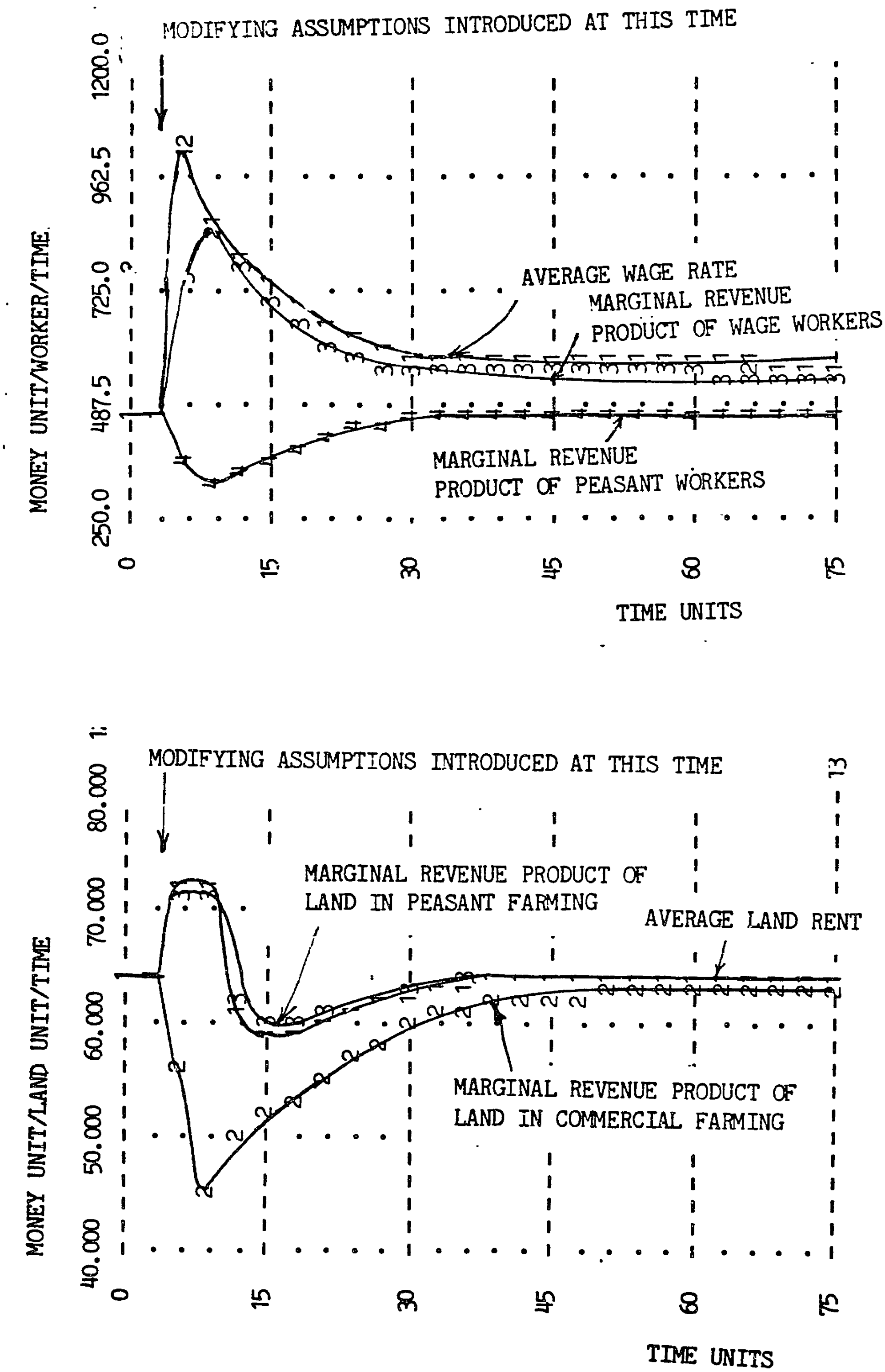


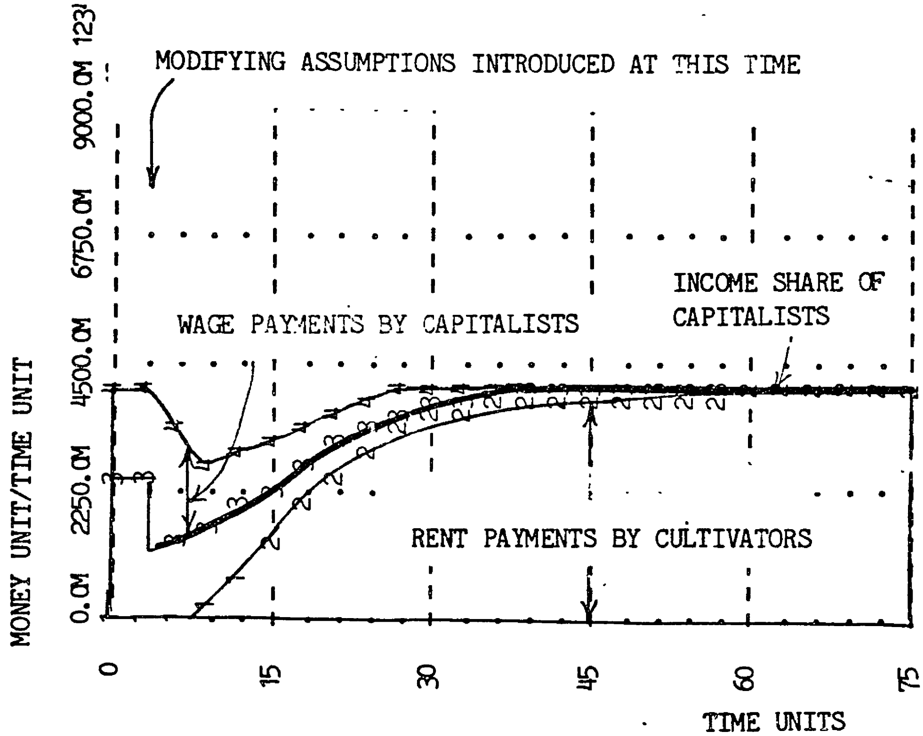
Figure 4.16: Experiment 6: Changes in Wage Rate, Land Rent, and Marginal Revenues of Land and Workers when Wage, Tenure, Financial Market, Peasant Saving Utility and Rent Pressure Assumptions are Modified.

As in earlier experiments, the marginal revenue products of factors in the capitalist sector towards the end of the run are only hypothetical, as all production is carried out by the self-employed cultivators.

Figure 4.17 shows the changes in income distribution when the assumptions of this last experiment are introduced. Due to an increase in rent payments by the peasants, the income share of the capitalist sector rises to a higher level than the past experiments, but at the expense of the peasant sector.

The resource and income distribution, and the cropping pattern that appear in Experiment 6 closely resemble those in Pakistan's rural economy before modern capital inputs were introduced in it. Capitalist farms run on commercial lines were non-existent. Most of the land was owned by landlords who almost exclusively depended on sharecropping tenants for cultivating their land. Peasant holdings were small, and often the peasants cultivated a combination of owned and rented land. A large part of the rural income was claimed by the landlords, while average consumption of workers was maintained at a low level [24].

Population growth in such an economy worsens income distribution even though the concomitant increase in workforce raises intensity of cultivation and total output. Figure 4.18 shows the behavior of the wage rate and land rent when population was allowed to grow at a constant rate in the model. The



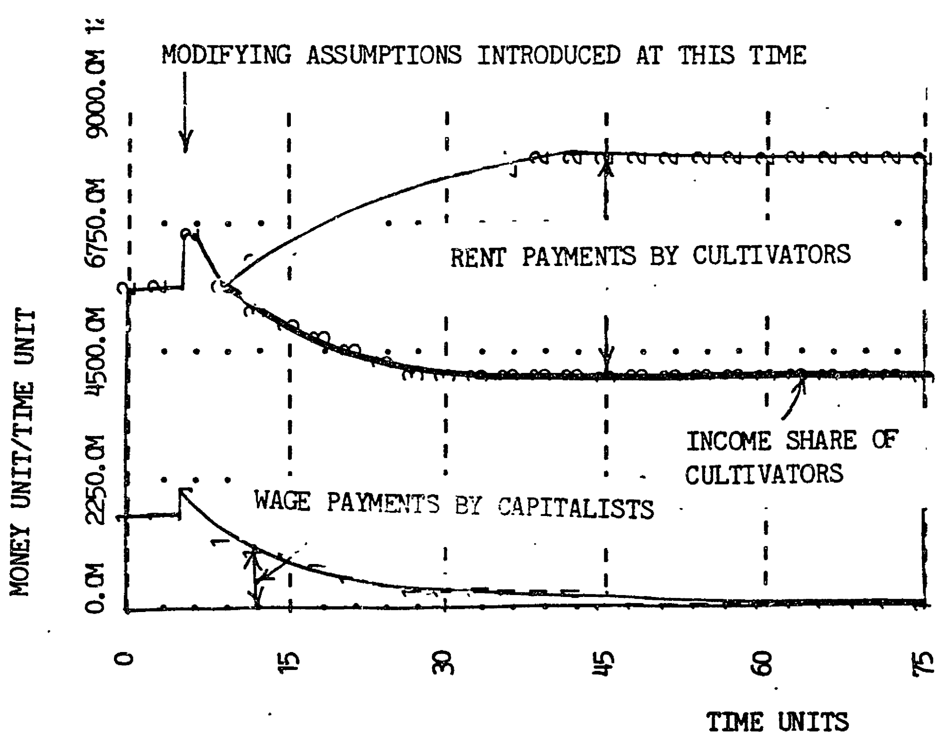


Figure 4.17: Experiment 6: Changes in Income Distribution when Wage, Tenure, Financial Market, Peasant Saving Utility and Rent Pressure Assumptions are Modified.

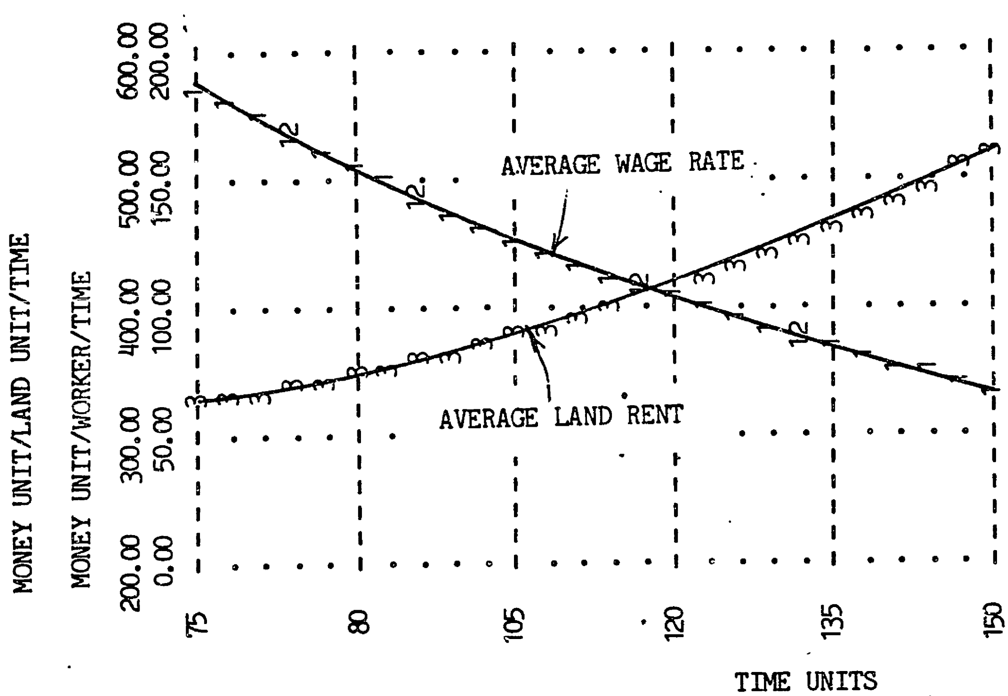


Figure 4.18: Experiment 6(a): Changes in Land Rent and Wage Rate When Population Growth Mechanisms are activated.

population growth mechanisms were introduced after the end of the scenario in the previous simulations of this experiment had been reached. As increased intensity of cultivation increases productivities of land and capital, rents are bid up. Consequently, the capitalist sector share of the total rural income absorbs a substantial part of the increase in output, while the slowly increasing output has to be shared by an ever-increasing number of workers. Therefore the average consumption level of workers and the wage rate decline.

Indeed, a significant observation in rural Pakistan is the worsening financial condition of the cultivators and their increasing indebtedness to land owners even though the aggregate agricultural production has been increasing [25]. In fact, the rate of deterioration in the financial condition of the cultivators has been observed to be higher in the districts with a faster rate of growth in agricultural output [26].

At this point, it is expedient to test the model for its sensitivity to changes in the initial distribution of resources between the two sectors to see whether the arbitrary initial distribution assumed in the foregoing experiments is justified. Figure 4.19 compares two simulation runs with different initial distributions of land. The two simulations illustrate that irrespective of the initial distribution, the land distribution goal of the system is the same. This supports the premise that the current income distribution is a result of an internal

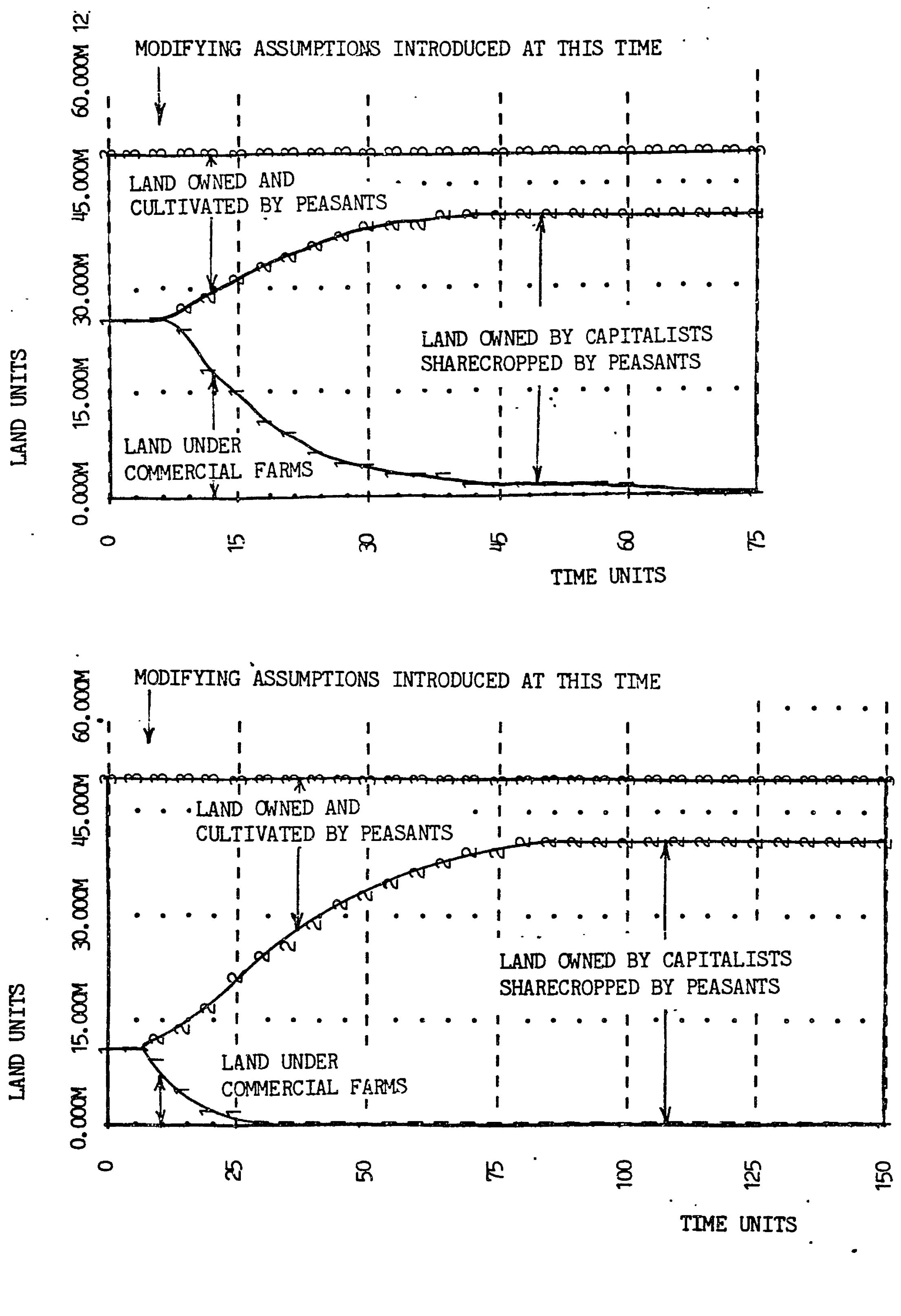


Figure 4.19: Experiment 6: Sensitivity of the Model to Changes in Initial Distribution of Resources.

tendency of the system and that resource distribution at the time of introduction of the ownership system would not affect its tendency to reach the shown end condition. Thus, the knowledge of initial conditions is unimportant for testing model assumptions.

The model behavior in Experiment 6 compares favorably with the tendency displayed in the reference mode delineated in section 4.1. The characteristics of Pakistan's economy in the 1950s and those realized in the final state of equilibrium achieved by the model are compared in Table 4.3.

CHARACTERISTIC COMPARED		PAKISTAN 1950s		MODEL FINAL STATE OF EQUILIBRIUM
Workforce Distribution	Wage Workers	almost	0%	almost 0%
	Peasant Workers	almost	100%	almost 100%
Land Distribution	Commercial Farms	almost	0%	almost 0%
	Peasant-owned Farms	<	30%	25%
	Share-cropped Farms	>	70%	75%
Income Shares	Capitalists	>	40%	50%
	Cultivators	<	60%	50%

Table 4.3: A Comparison of the Stagnant Rural Economy Pakistan in the 1950s and the Model Final Equilibrium.

The model is able to replicate the tendency manifested in the reference mode only when the modifying assumptions about wage determination, tenure, segmented financial markets, saving utility of the peasants, and squeeze in peasant sector savings due to rent burden are incorporated in the model. The step-by-step addition of these assumption to the model allows identification of the role of each in realizing the goal of the system.

It can be argued that an alternative set of assumptions may also produce the same results as the set presented in Experiments 1 to 6. However, as mentioned earlier, the presented model was arrived at after considerable experimentation in which several alternative mechanisms were considered. Also, since the reference behavior incorporates several aspects of the rural economy, the probability of an alternative set of assumptions leading to an exactly similar scenario is small.

4.3. Model Relevence to the Post 1950 Emergence of a Commercial Sector in Rural Pakistan

The introduction of modern capital inputs into Pakistan's agriculture beginning in the 1960s allowed substantial growth in agricultural output while over the same period the economic condition of the peasant cultivators and farm workers further worsened. Modern capital inputs were, during this period, available in limited quantities. They were neither easily accessible to the peasant cultivators, nor were they very useful for the peasant cropping pattern due to the problems of scale.

On the other hand, use of these inputs afforded the bigger landlords an opportunity to get a higher rate of return on their investment in land than was available from sharecropping. Therefore, sharecropping tenants were freely evicted in favor of commercial farming activity.

Use of modern capital inputs also reduced the number of workers required per unit of land when compared to the number needed using conventional methods. So, the employment generation in the commercial farms was inadequate to absorb all evicted tenants. Further, high rates of return in commercial farming allowed the bigger landlords to bid small cultivators out of their owned land. Thus, unemployment and underemployment in the rural sector rose as evidenced by massive outmigration of rural surplus labor into the urban areas [27,28].

An interesting aspect of agricultural modernization in Pakistan is that it did not lead to 100% conversion of the sharecropped farms to commercial farms. Big landlords converted only a part of their holdings to commercial farms, the rest were left with the sharecropping peasants. Alavi(1976) observed:

> ".....Only part of total land owned by persons who have tractors is under mechanized cultivation; land not cultivated by them is in the hands of sharecroppers who employ bullocks." [29]

Simultaneous engagement of big landlords in sharecropping and commercial farming practices manifests yet another aspect of interdependence of the capitalist and peasant sectors, which is examined in Experiment 7.

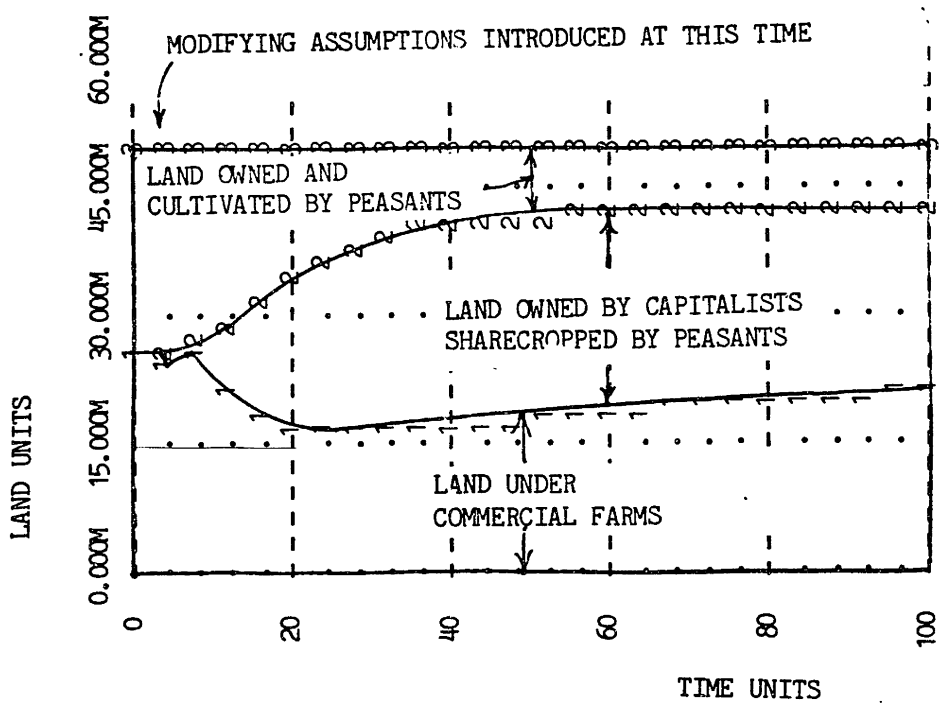
4.3.1. Experiment 7: Introduction of Capital Differentiation in the Rural Economy

In this experiment, a fixed amount of modern capital inputs are exogenously made available to the economy, along with the modifying assumptions of Experiment 6. The output elasticity of modern capital is assumed to be higher that of the traditional capital while the former's use is also assumed to permit an increase in the frequency of cropping. The output elasticity of land is assumed to be same when using either type of capital. The elasticity of output of workers is assumed to decrease when modern capital is used. The assumption of uniform returns to scale is maintained. These assumptions serve to represent the high productivity and labor displacing characteristics of modern capital.

To amplify the possible effects of capital differentiation between the sectors, it is assumed that the peasant sector is unable to employ any modern capital. Capital differentiation between the sectors develops as the capitalist sector starts meeting its additional and replacement capital needs by acquiring a mixture of modern and traditional capital inputs. Capital demand is met by modern capital as much as the fixed supply permits. The balance of the demand is met by acquiring traditional capital.

Figure 4.20 shows the changes in the distribution of land and workers in Experiment 7. At the beginning of the simulation, there is no capital differentiation between the sectors. Thus, as wage determination assumptions become active, the capitalist sector lays off workers while simultaneously transferring land into renting activity. As the proportion of modern capital in the capitalist sector rises, the productivity in the sector increases, which makes it profitable to transfer back land into production activity and hire back workers at the going wage rate. The increased productivity and income derived from it make it both economically and financially viable for the capitalist sector to increase its bids for land. Thus, the capitalist sector share of land rises faster than in the last experiment and equilibrates at a higher level.

The increasing use of modern capital in the capitalist sector also reduces the marginal revenue product of workers as worker elasticity of production falls with the increase in the fraction of modern capital. Therefore, while the capitalist sector acquires additional land from the peasants, it does not hire a proportionate number of workers. When workers expelled by the capitalist sector join the peasant sector, the demand for rented land is increased and land rents are bid up. Thus, it again becomes profitable for the capitalist sector to allocate land to renting activity. Eventually, the economy comes to equilibrium in a state where the marginal productivities of land



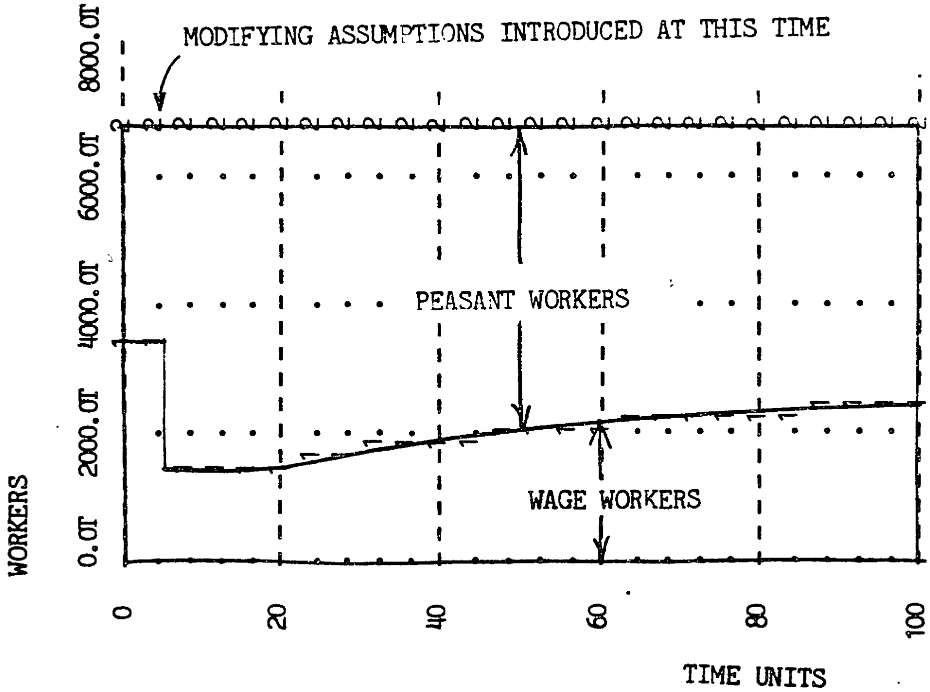


Figure 4.20: Experiment 7: Changes in Distribution of Land and and Workers when Capital Differentiation is introduced.

in the two sectors are the same, and peasant farming, capitalist farming, and feudal farming activities exist side by side.

Figure 4.21 shows the wage rate, the land rent, and the marginal productivities of workers and land in Experiment 7. While the wage rate equilibrates at a level lower than in Experiment 6, land rent equilibrates at a higher level. Higher land rents are made possible due to the increase in aggregate productivity of land from employment of modern capital in the capitalist sector and increase in the number of workers per unit of land in the peasant sector. Indeed, the marginal revenue product of workers in the peasant sector is lower than in Experiment 6, due to an increase in its worker intensity.

Capital differentiation between the capitalist and peasant sectors makes it expedient for the two sectors to employ factors in different proportions as is shown in Figure 4.22. Such differences of technology between the sectors are quite common in a number of developing countries and arise out of the interdependences of the sectors discussed in this chapter.

Changes in income distribution in Experiment 7 are shown in Figure 4.23. The capitalist sector share of income is higher than the last experiment, while the peasant sector share is lower. The ensuing decrease in the average consumption of workers lowers the wage rate demanded by the workers, as displayed. Thus, while the peasant sector now also receives

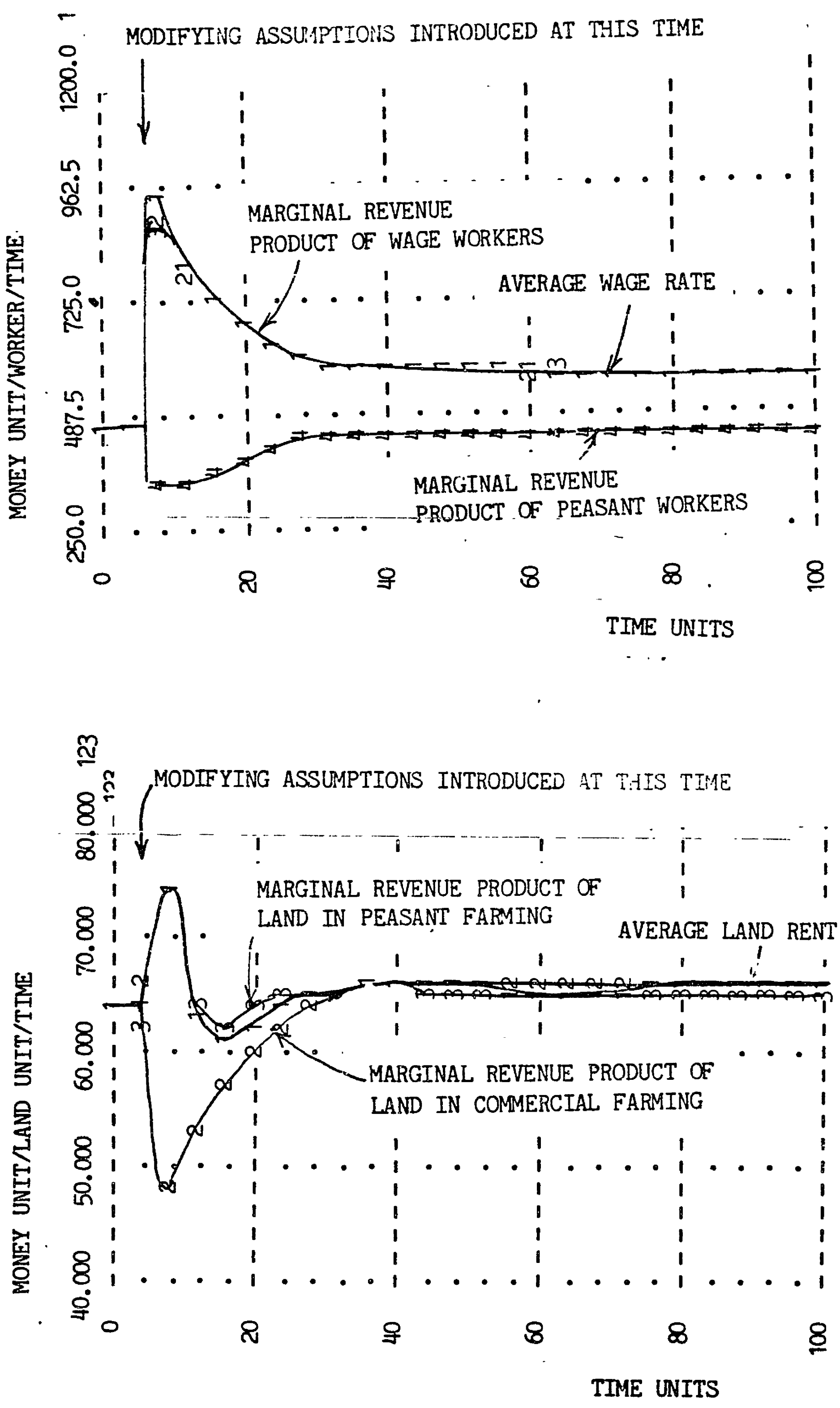


Figure 4.21: Experiment 7: Changes in Wage Rate, Land Rent, and Marginal Revenues of Land and Capital when Capital Differentiation is Introduced.

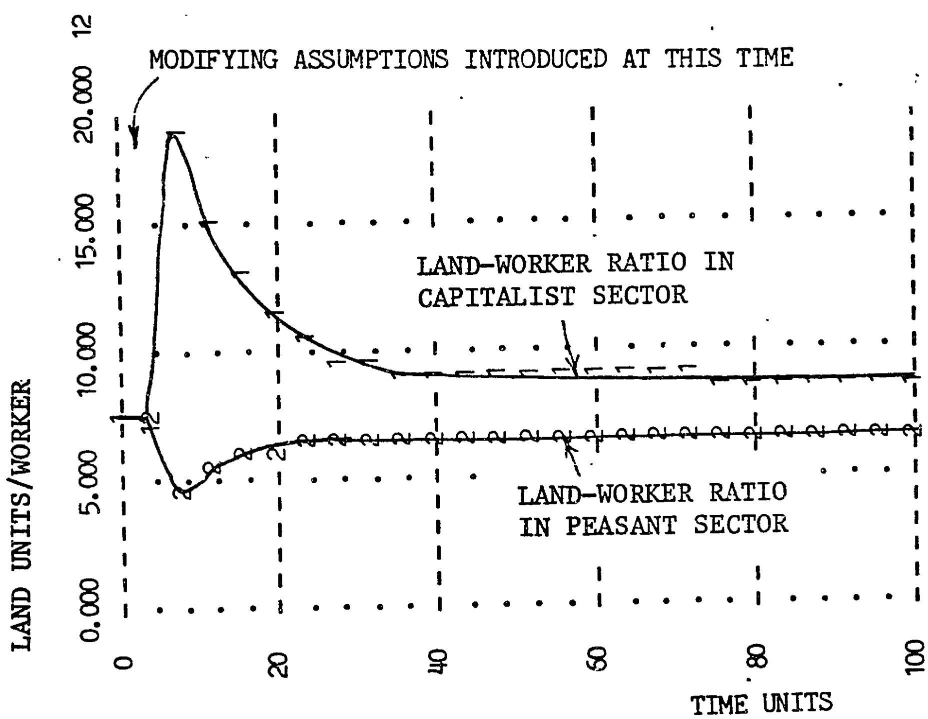
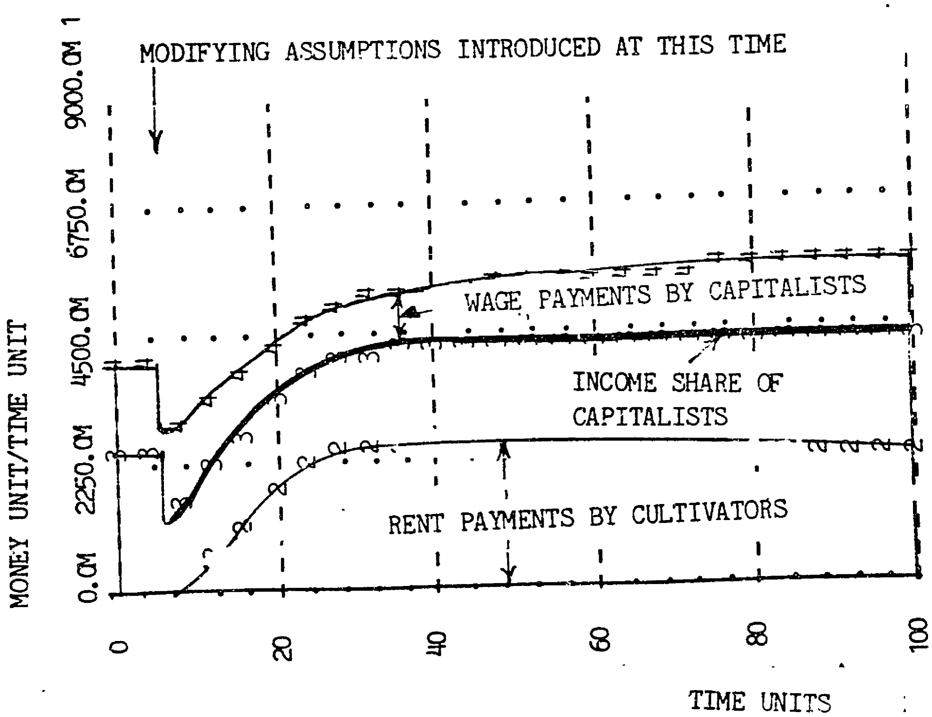


Figure 4.22: Experiment 7: Changes in Factor Proportions when Capital Differentiation is Introduced.



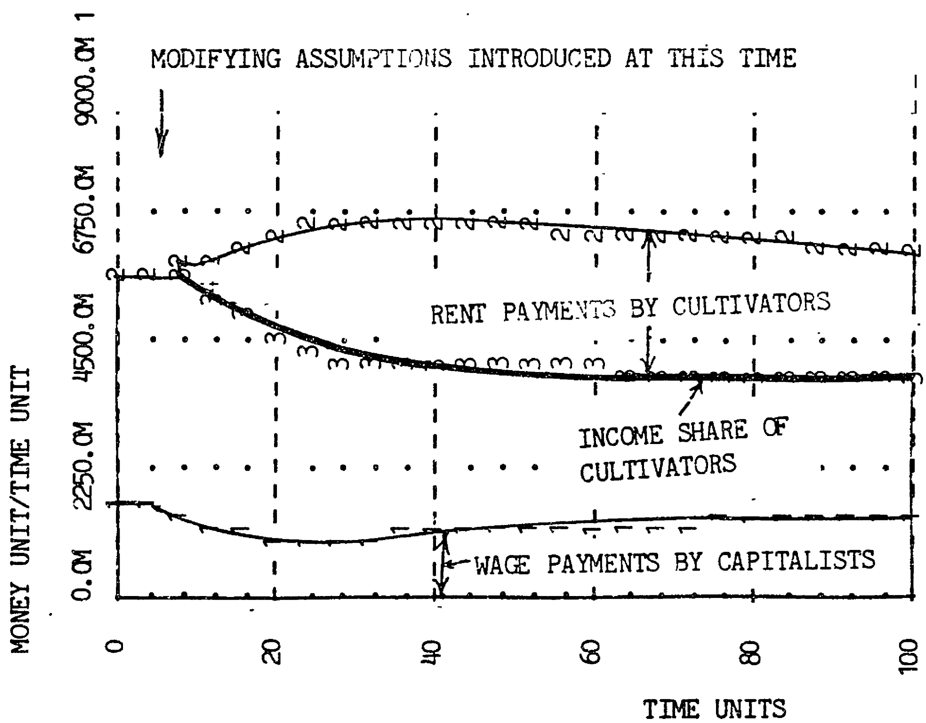


Figure 4.23: Experiment 7: Changes in Income Distribution When Capital Differentiation is Introduced.

direct wage payments, they are inadequate to compensate for the income previously available in self-employment. The net revenue of the capitalist sector is higher due to an increase in its ownership of land, an increase in its productivity, and a decrease in its labor costs.

4.4. What is Proved?

The experiments in section 4.3 serve to test the key assumptions incorporated in the model. It has been demonstrated that a model based on the neoclassical premises of a perfect market is inadequate to explain the rural income distribution in Pakistan. Further, modifying assumptions about wage determination, the land tenure system, financial markets, saving behavior, and development of capital differentiation between sectors have been tested. It has been shown that the combined effect of these modifying assumptions produces an internal tendency in the system to reach the income distribution scenarios observed in Pakistan's rural economy before and after 1950.

The interdependence of the capitalist and peasant sectors manifested in the proposed modifying assumptions allows side-by-side existence of the peasant, feudal and capitalist production modes. This interdependence is also responsible for maintaining the working class at a low income level while a significant share of the rural income is received by the capitalist land owners. Further, due to this interdependence, the burden of increasing population is primarily absorbed by the peasant sector while the gains of increased productivity primarily accrue to the capitalist sector.

Additional experiments with the model will be aimed at testing rural development policies. These experiments have two objectives: Building further confidence in the model by simulating policies with known impact and analysing the results of simulation, and simulating and analysing exploratory policies aimed at improving rural income distribution. Chapter Five describes such experiments. In these experiments, a limited set of policies incorporating the characteristics of the past and proposed rural development effort in Pakistan are tested. The results of the experiments are compared to the actual performance, where possible. The analysis leads toward development of a general framework for a rural reform aimed at improving the economic condition of the rural cultivators.

NOTES AND REFERENCES

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2. According to a report of the Land Reform Commission of 1958, 51.4% of the land was in holdings measuring >25 acres, 33.6% was in holdings measuring 5-25 acres. It is also reported by Alavi that owner-cultivated farms largely employed one pair of bullocks, which can cultivate a maximum of 12.5 acres of land. In the 1972 agricultural census, 30% of the land was reported to be under farms of <12.5 acres, in spite of two rounds of land reform and massive reductions in ownership sizes due to transfers made by owners to their family member following the reforms. Thus, even if there were a few owner-cultivated farms measuring >12.5 acres in the 1950s, the area covered by them is expected to be less than 70% of the total holdings. See Report of the Land Reform Commission for West Pakistan, 1958; Statistical Year Book of Pakistan, 1976; and ALAVI, Hamza, The Rural Elite and Agricultural Development, in Stevens et al, Rural Development in Bangladesh and Pakistan, Hawaii University Press, 1976.

3. See ALAVI, 1976, op. cit.

4. Calculated on the basis of land ownership and the prevalent income division practices in sharecropping. At least 50% of the production is claimed by the landowners as rent. In addition landowners are able to obtain seasonal gifts, rent on capital contributed by them, and interest on lendings to the sharecroppers; this additional income is assumed to constitute about 10% of the total production. Thus, income share of the capitalist sector = land share*share of production of land = 70%*60% = 42%. The balance 58% constitutes the income share of the workers.

5. Such evidence is the basis for the relatively recent "dualist economics", first introduced by Boeke in 1947, and expanded upon by Hostlitz, Fei, Ranis, and others. See BOEKE, J. E., "Dualist Economics", in Oriental Economics, Institute of Pacific Relations, NY, 1947. Other useful essays on the subject can be found in SMELSOR and LIPSET, (eds.), Social Structure and Mobility in Economic Development, Aldine Publishing Co., 1966; and ADLEMAN and THORBEKE, (eds.), The Theory and Design of Economic Development, Johns Hopkins Press, Baltimore, 1966.

6. ANDERSON, K. P., Peasant and Capitalist Agriculture in the Developing Country, Unpublished PhD Dissertation, MIT, 1968.

7. See BARDHAN, P. K., "A Model of Growth of Capitalism in a Rural Agrarian Economy," in Bhagwati and Eckaus, (eds.), Development and Planning, MIT Press, 1973.

8. Ibid.

9. ALAVI, 1976, op. cit.

10. Also see SEN, A. K., "Peasants and Dualism With or Without Surplus Labor," Journal of Political Economy, Vol. 74, No. 5, Oct 1966.

11. According to a report of the Land Reform Commission in 1959, less than 10% of the agricultural land was owned by the peasants. See GOVT. OF WEST PAKISTAN, Report of the Land Reform Commission, Government Printing Press, Lahore, 1959.

12. See MCKINNON, Ronald I., Money and Capital in Economic Development, The Brookings Institution, Washington DC, 1973.

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17. According to a rural credit survey, 75.2% of the rural credit in India was provided by private money lenders in 1951. See All India Rural Credit Survey, 1961.

18. DARLING, Malcolm L., The Punjab Peasant in Prosperity and Debt, Oxford University Press, 1947.

19. A large part of savings are consumed for meeting nonproductive expenditures on marriages and other ceremonies, as has been observed by Darling(1947), OP CIT., and several others.

20. LIPTON, Michael E., Why Poor People Stay Poor, Harvard University Press, 1977, pp 246-257.

21. ADAMS, Dale W., "Mobilizing Household Savings Through Rural Financial Markets", in Economic Development and Cultural Change, Vol. 26, No. 3, April 1978.

22. BARDHAN, op cit., p 110.

23. Ibid.

24. ALAVI, op cit.

25. ROULET, Harry, M., "The Historical Context of Pakistan's Rural Economy", in Stevens et al, op cit.

26. DARLING, op cit., p 211

27. BARKI, op cit.

28. ALAVI, op cit.

29. Ibid.

CHAPTER FIVE

RURAL DEVELOPMENT POLICIES AND INCOME DISTRIBUTION

5.1. An Overview

Over the past three decades, a variety of development programs, directly and indirectly affecting the lives of the rural population have been proposed and implemented at various scales in the developing countries [1]. In Pakistan, these programs included industrialization of the urban sector, which was expected to absorb surplus rural labor, as well as programs directly aimed at increasing productivity and alleviating poverty in the rural sector. The latter category of development programs incorporated agricultural mechanization, land reforms, introduction of high-yield seed varieties, synthetic fertilizers and pesticides, extension of institutional credit facilities to farmers, and community development efforts aimed at promoting self help and cooperation among the poorer cross-sections of the rural society [2]. The rural development effort in Pakistan is often credited with the "green revolution" in agriculture experienced over the 1960s [3]. The effort is also blamed for the increasing poverty and underemployment among the rural workers [4].

Most of the rural development programs in Pakistan can be placed in the framework of a small number of macro-policies that encompass a mixed set of economic growth and income distribution objectives. The policies incorporating growth objectives include the provision of mechanical implements, green revolution inputs, institutional credit, and industrialization of the urban sector. The policies aimed at equity include land reforms and community development efforts. These policies, as well as a limited number of fiscal instruments proposed exclusively for improving rural income distribution, are examined in this chapter for their long term impact. The policies under examination are simulated both individually and in groups using the model presented in the previous chapters as an analysis instrument.

The simulation experiments indicate that as long as the land tenure system permits easy separation between owners and cultivators of land, any programs causing increases in the productivity of land would always expand the income shares claimed on the basis of land ownership. Thus, growth policies striving to increase land productivity will assure substantial gains in the incomes of the landowners. However, the same increases in the productivity of land will not raise the wage rates or the income levels of the self-employed cultivators, unless the share of land owned by them increases concomitantly. Although, it may be infeasible to abolish ownership or to administer redistribution of land on a continuous basis, fiscal policies discouraging separation between owners and cultivators can assure gradual redistribution. Such policies must form a part of any reform effort aimed at alleviating rural mass poverty.

5.2. Preparing the Model for Policy Analysis

The model is prepared for policy analysis by incorporating into it the modifying assumption about wage determination, tenure system, fragmented financial markets, saving utility of peasant sector, and effect of rent payment pressures on peasant saving rate, which have been tested in Chapter Four. Further, the distribution of land and workers at the start of each policy simulation corresponds to the final distribution realized in Experiment six in Chapter Four, which incorporates the requisite modifying assumptions. That distribution roughly represents the conditions in Pakistan in the early 1950s. Population growth mechanisms causing increases in the rural workforce and in the demand for agricultural production are also embodied in the model in order to obtain a reasonable correspondance between the model behavior and history. The population growth rate is exogenously determined and is assumed to be 2% per year [5]. Also, because the quantity of privately cultivated land cannot increase unless the government expands irrigation infrastructure and makes land grants to private parties, total land in the system is assumed to remain constant unless exogenously changed.

The base run of the model assumes an absence of any development policies and serves as a reference for evaluating the impact of policies simulated in the following runs. Figure 5.1 shows the distribution of land and workers in the base run. The distribution of land ownership between the capitalist and peasant sectors remains unchanged throughout the simulation, although all land is cultivated by self-employed peasants tilling own or sharecropped land. The number of workers in the economy continuously increases at a rate of 2 percent due to population growth, which causes a concomitant growth in production because of an increase in the intensity of cultivation. However, as shown in Figure 5.2, a substantial share of increased production is absorbed by the capitalist sector as a result of rising rent and interest receipts.

The average wage rate in such an economy represents the average consumption level available to the peasant cultivators. As incremental increases in production due to the expansion in workforce are diminishing while land rent payments are increasing, the contribution of an incremental worker in the peasant's income share is smaller than that of the last worker. The wage rate, therefore, declines as worker population rises.

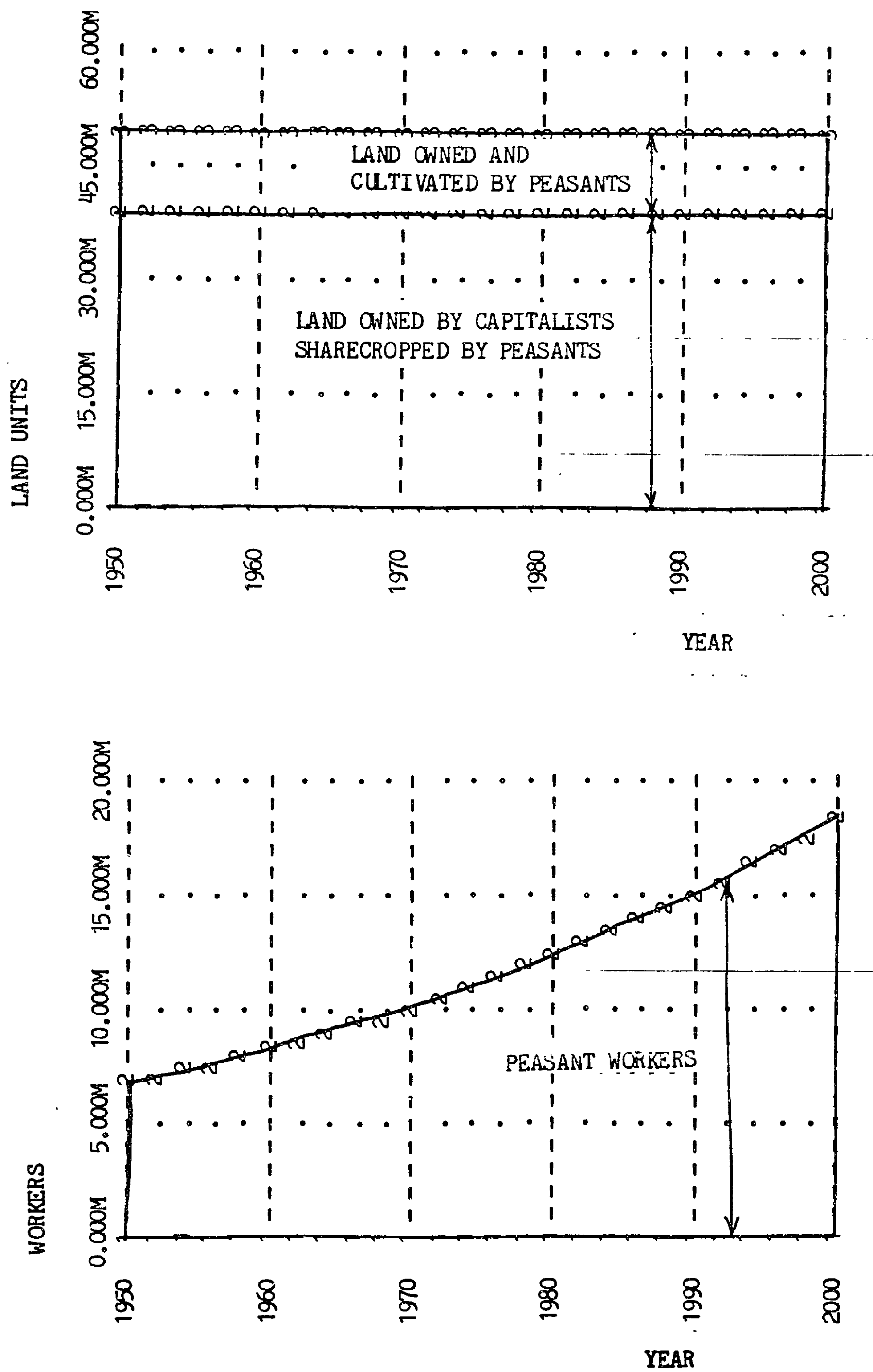


Figure 5.1: Base Run: Distribution of Land and Workers.

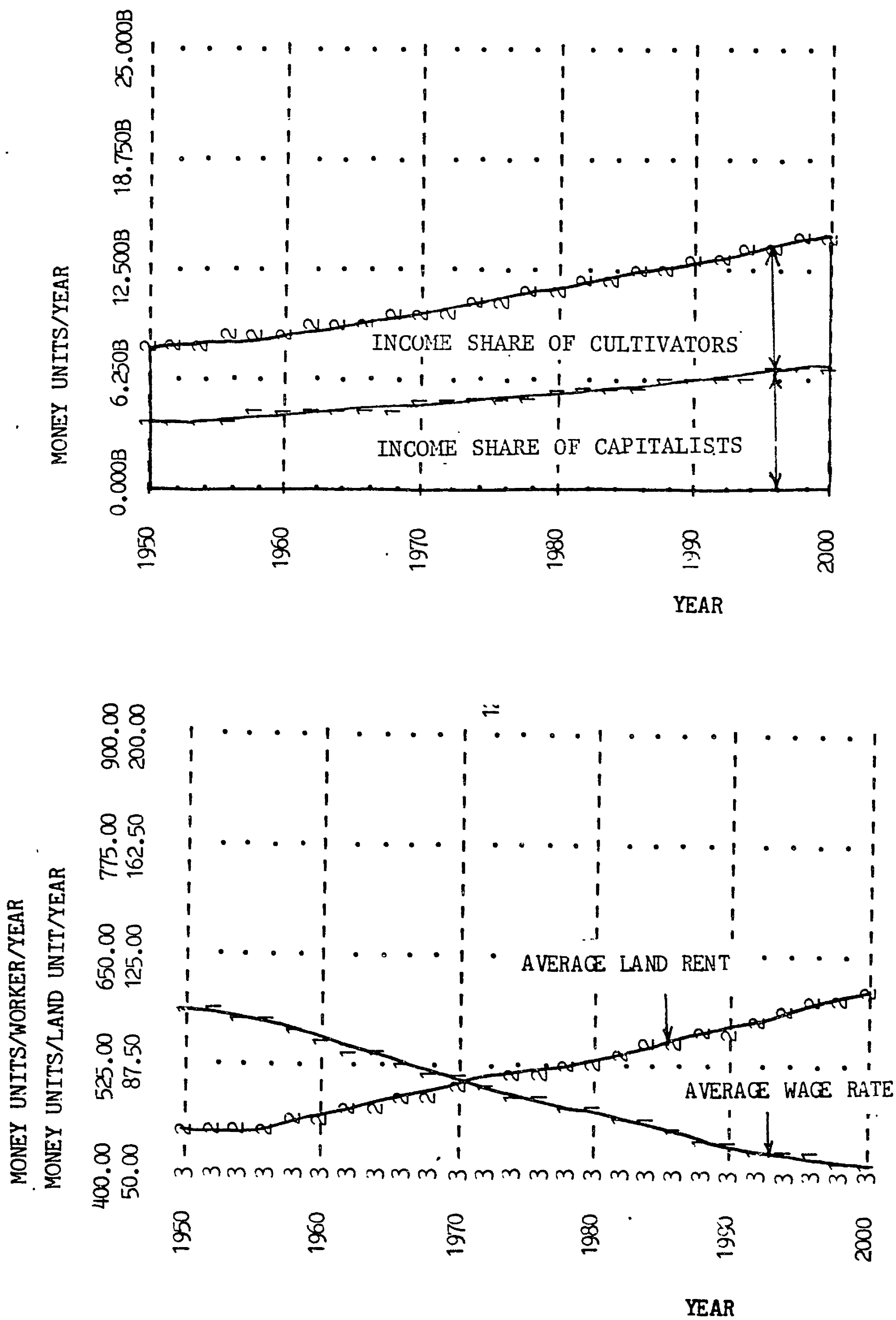


Figure 5.2: Base Run: Income Shares of Capitalists and Cultivators, Wage Rate, Land Rent.

The following sections of this chapter describe the simulation experiments performed by incorporating into the model policy changes representing the various growth and income distribution programs. The results of the experiments are compared to the impact of the relevant programs in Pakistan. These experiments help to increase understanding of the rural income distribution system and make it possible to explore policies for alleviating poverty among cultivators. The experiments also form a part of the model validation process as they test the response of the model to exogenous intervention.

5.3. Mechanization

Agricultural mechanization has been one of the earliest and most widely implemented development policies in many countries. Mechanization policies favor the use of tractors and modern implements over farming with bullocks and indigenous ploughs since the former allows the labor productivity to rise considerably. Since mechanical implements can free individuals from the drudgery of monotonous labor, the use of modern implements, if possible, is usually prefered by the farmers over the traditional means. However, the use of mechanical implements cannot be extended to all farms. First, these implements can be supplied only in limited quantities depending on the capability of the local industry to produce them and the foreign exchange availabe to import them. Second, due to their lumpy nature, most mechanical implements are cost inefficient for use on small farms. Thus, introduction of mechanical implements creates a capital differentiation in the production system wherein the available mechanical implements are employed on the larger farms while the small farms continue exclusively to use traditional implements.

Agricultural mechanization policies were enthusiastically pursued in Pakistan during the 1960s. Tractors and mechanical implements were imported in large quantities and sold to the farmers at subsidized prices. Mechanical implements were almost exclusively employed on the commercial farms. These displaced a significant number of sharecroppers while generating few job opportunities [6]. Commercial farming, however, did not completely replace sharecropping, and currently all three modes of agricultural production (peasant farming, sharecropping and commercial farming) exist side by side.

The mechanization policy is simulated by exogenously introducing a supply of modern capital implements which rises from zero at the beginning of the simulation to a fixed level by the end of the first decade of simulation and thereafter remains constant. Empirical studies show that a crop's yield per acre of land is not affected whether draught power is supplied by machines, cattle, or men. But, use of machines decreases the demand of labor per unit of land [7]. Thus, it is assumed that use of mechanical implements will increase the output elasticity of capital while simultaneously decreasing the output elasticity of labor. Further, mechanical implements are assumed to make sowing and harvesting processes faster, thus permitting multiple cropping, which increases yearly production in proportion to the intensity of mechanization. The available mechanical implements are rationed between the capitalist and peasant sectors according to their respective demands for those. However, due to their small farm size, the peasant sector demand for mechanical implements is negligible.

Figure 5.3 shows the changes in land and workforce distribution when mechanization policy is simulated. Mechanization enables the larger land owners, who previously rented out their land for sharecropping, to get higher returns on their investment in commercial farming than available in sharecropping because of multiple cropping and saving on labor costs. However, as more and more land is brought under commercial farming, while fewer workers are hired than those evicted from the sharecropped land, the surplus labor is accommodated in the peasant farms whose cultivation intensity rises, which causes their land productivity to increase.

The overall increase in land productivity due to multiple cropping in mechanized farming and increased labor intensity in peasant farming, together with a shortage of land available for sharecropping, push up land rents to the level that they start competing with the returns available on land in commercial farming. Thus, it becomes economical for the larger land owners

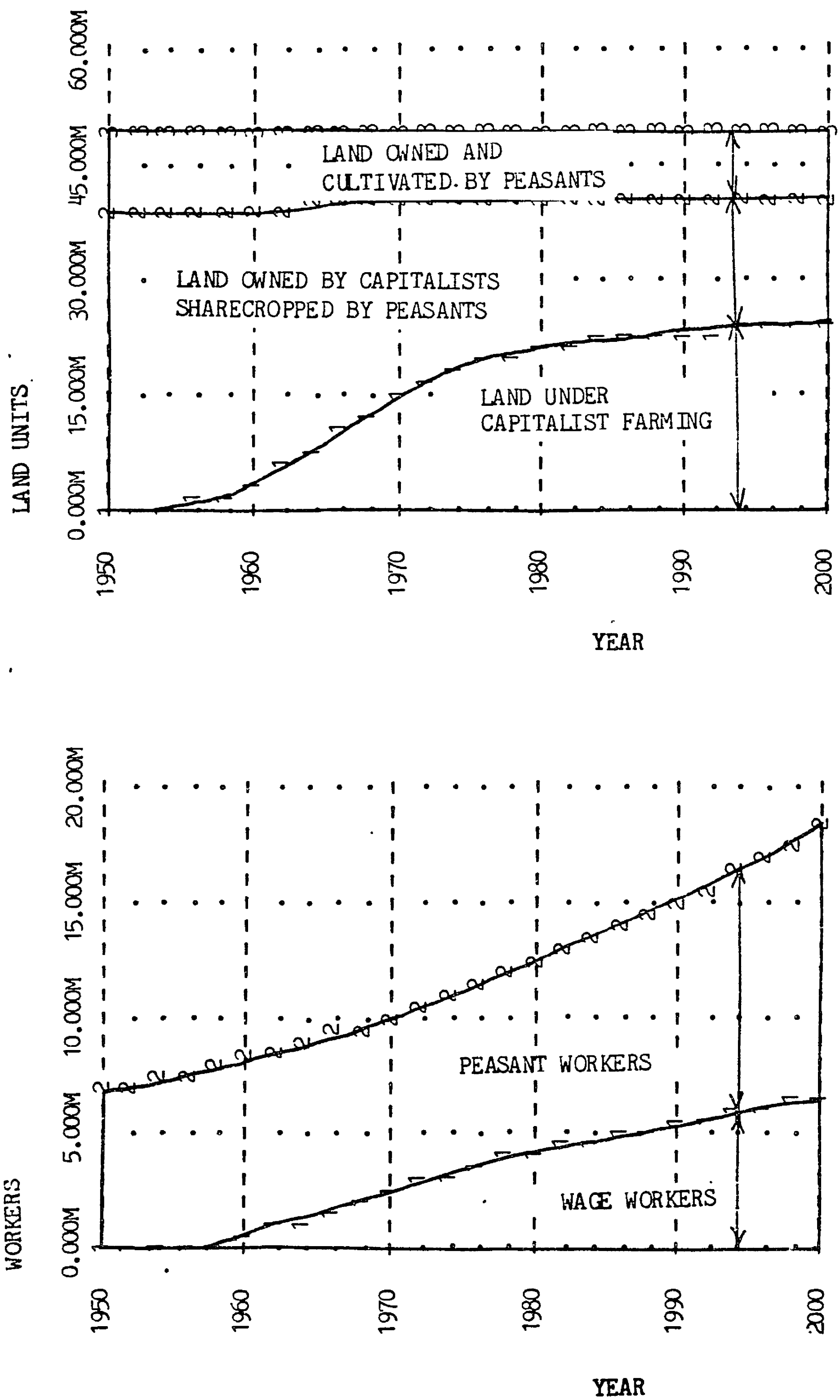


Figure 5.3: Mechanization Policy: Distribution of Land and Workers.

to continue renting out some of their land. Another equilibrium is reached in which peasant farming, sharecropping, and commercial farming modes exist side by side. But over the period of transition, the commercial farmers were able to increase their earnings and had bid the peasants out of some of their land. The workforce, which was exclusively constituted of self-employed peasants before mechanization was introduced, now consists of both self-employed peasants and wage workers.

Figure 5.4 shows income shares of the capitalists and cultivators and the changes in wage rates and land rents. The total rural income is slightly higher than the base run due to increases in production of commercial farms from multiple cropping, but more of the increase occurs in the income share of the capitalists. Wage rate falls more rapidly than in the base run because of the decrease in opportunity costs of labor in the peasant sector. This decrease is caused by loss of land by the cultivators and the consequent reduction in their claim to income on the basis of ownership. Land rents rise faster than in the base run, because of increases in land productivity and a limited supply of land for rent.

Mechanization is an important vehicle for increasing production, a goal of most development programs. A mechanization policy has almost always been in effect in Pakistan irrespective of the other programs that were periodically introduced. In the spirit of realism, the following simulations assume that

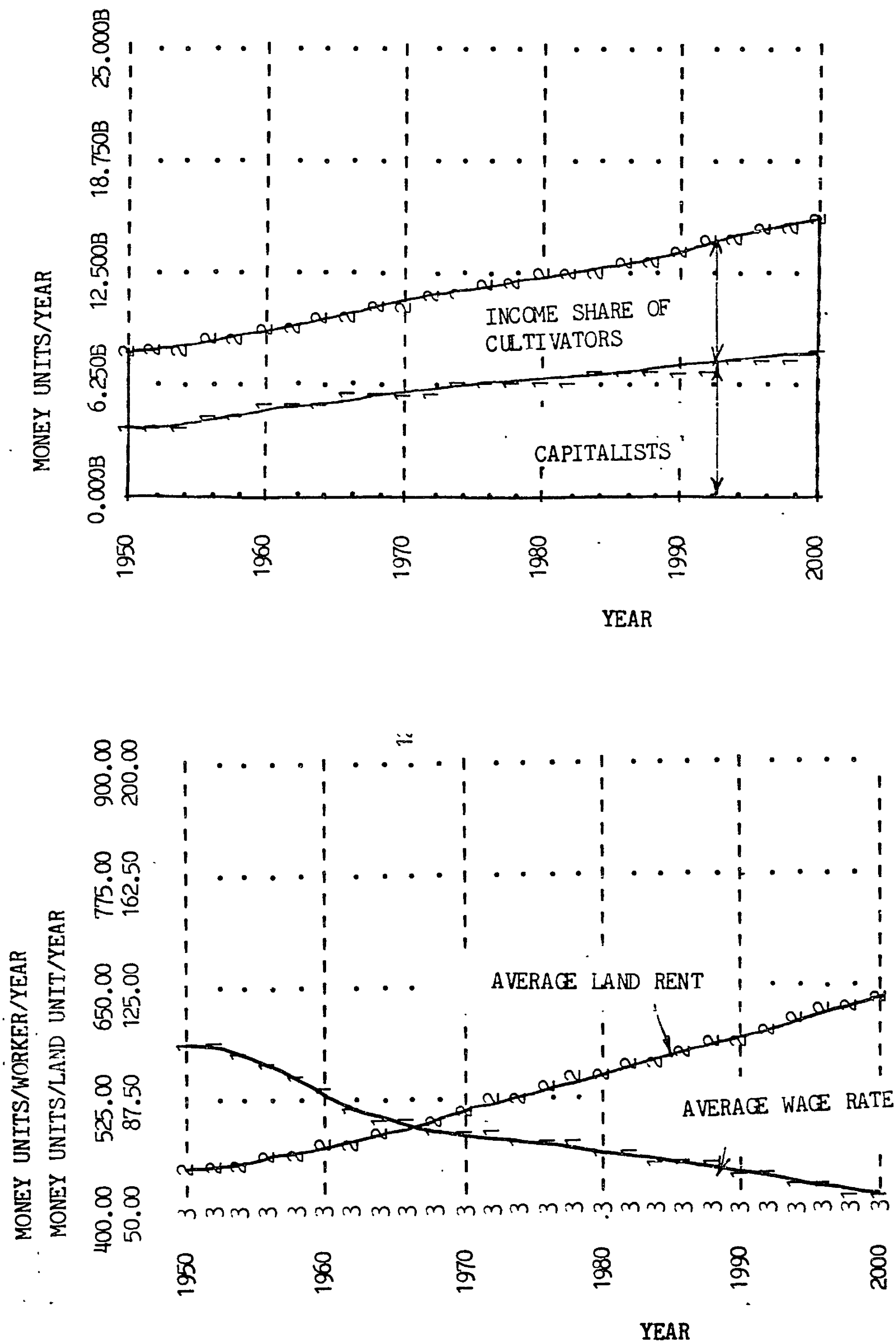


Figure 5.4: Mechanization Policy: Income Shares of Capitalists and Cultivators, Wage Rate, Land Rent.

mechanization policy is introduced simultaneously with the various other policies tested.

5.4. Land Reform

The importance of ownership in ascertaining income distribution has been widely recognized. Thus, in many developing countries, reformist policies aimed at redistributing rural income invariably incorporate redistribution of land ownership. Such policies are not easy to implement as they entail taking land away from big landowners who often wield substantial power and can strongly influence policy decisions. Thus, land reform policies have usually been implemented in the past at trivial scales. Typically, a small percentage of the holdings of the big landlords are acquired, with compensation, for redistribution among the peasants.

In Pakistan, two rounds of land reform have been implemented over a period of a little over a decade. Both were of trivial scale but were concomitant with the mechanization effort. The land reforms in Pakistan reportedly started a chain of private land transfers, largely to the family members of the big landowners. The purpose of these transfers was to bring per capita land ownership in conformance with the official ceilings but to retain its ownership within the family [8]. But land reform did little to change the land distribution pattern. In fact, the small peasant farmers have been reported to have lost 7 per cent to 12 per cent of their holdings over the decade following the 1959 land reform. Over the same period the holdings of the big landlords engaging in commercial farming considerably expanded [9].

Land reform policy is simulated by arbitrarily transferring a million acres of land from the capitalist landowners to the peasants as of the year 1960, while the mechanization policy discussed in section 5.3 is also retained. The land is given free of cost to the peasants, and the capitalists are paid compensation at a rate determined by the going price of land.

Figure 5.5 shows the changes in distribution of land resulting from the combined effects of mechanization and land reform policies. Although peasant land holdings increase when land reforms are introduced, by the end of the simulation, a large fraction of peasant holdings have been lost to the capitalist owners.

Transfer of land to the peasants at the outset reduces their rent burden while also raising their claim to the income on basis of ownership. The ensuing increases in the income of self-employed cultivators stimulate both consumption and savings rates in the peasant sector. But increases in self-employed income also bid up wage rates in the capitalist sector. This has two effects: first, the utility of saving for investment in the

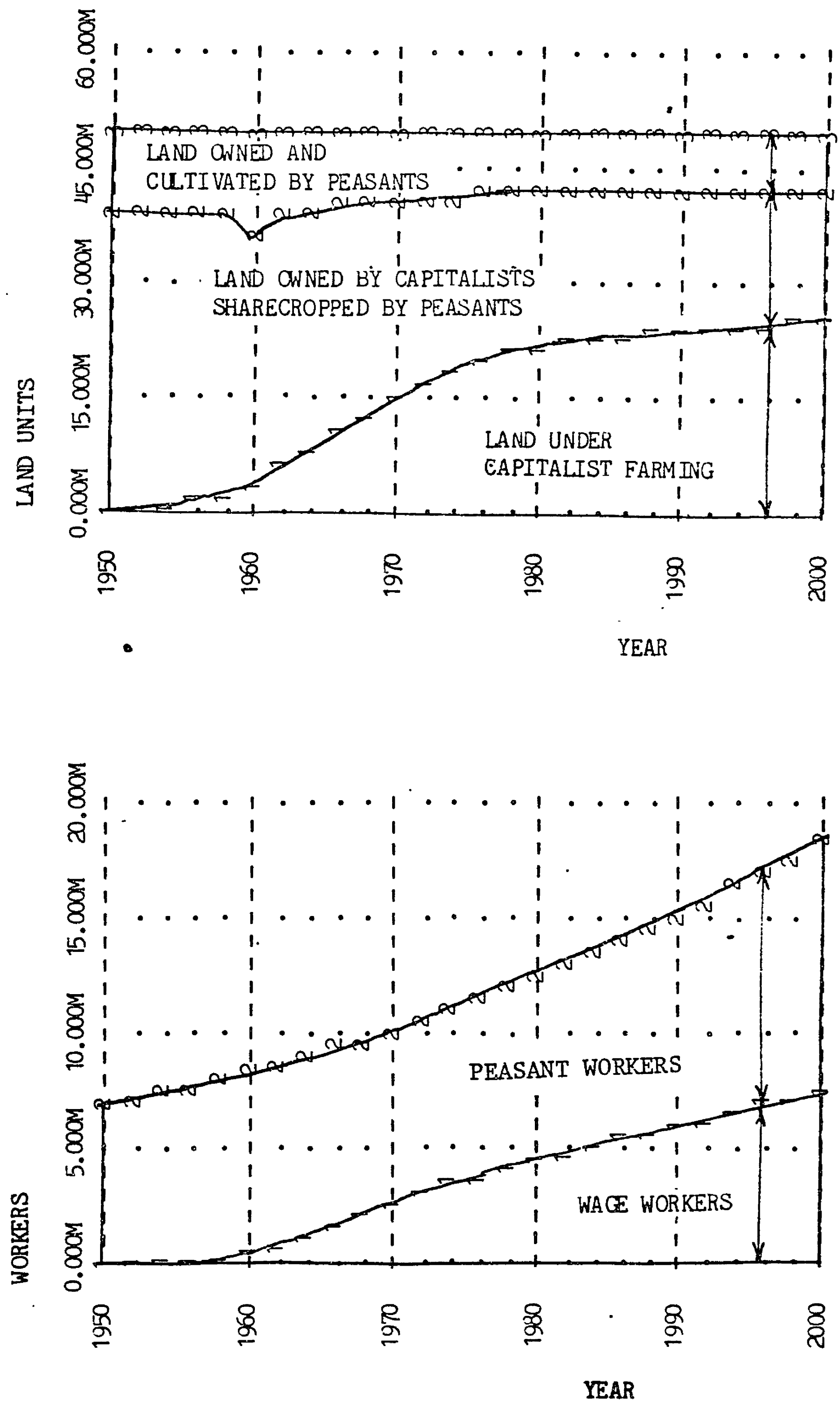
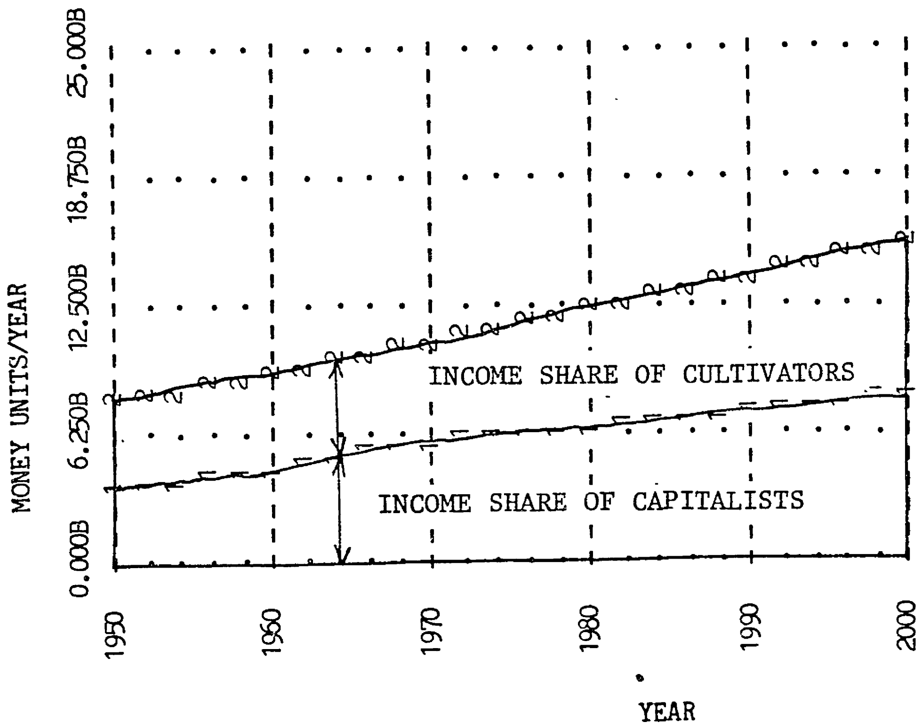


Figure 5.5: Land Reform Policy: Distribution of Land and Workers.

self-employed sector goes down; second, the number of workers desired to be employed in the formal sector decreases. As a result, a larger number of workers have to be accommodated in the peasant sector, which, in turn, depresses the sector's consumption as well as savings.

Thus, the saving ability of the peasants and their internal cash balances may not rise concomitantly with the increase in their land holdings. At the same time, the capitalist share of income is only marginally affected. Capitalists can easily increase capital intensity in commercial farming, hire fewer workers, and generate enough savings to bid the peasants out of their land holdings. As peasant land holdings decline, income in self-employment decreases, which causes wage rate to fall even faster than it would have without land reforms. (See Figure 5.6).

Thus, land reform alone may bring only temporary relief to the cultivators. Such reforms may have to be periodically repeated if their equity objectives are to be realized. Recognizing that land reform is a politically and administratively difficult policy to implement, a continued program of land redistribution may be practically impossible to implement.



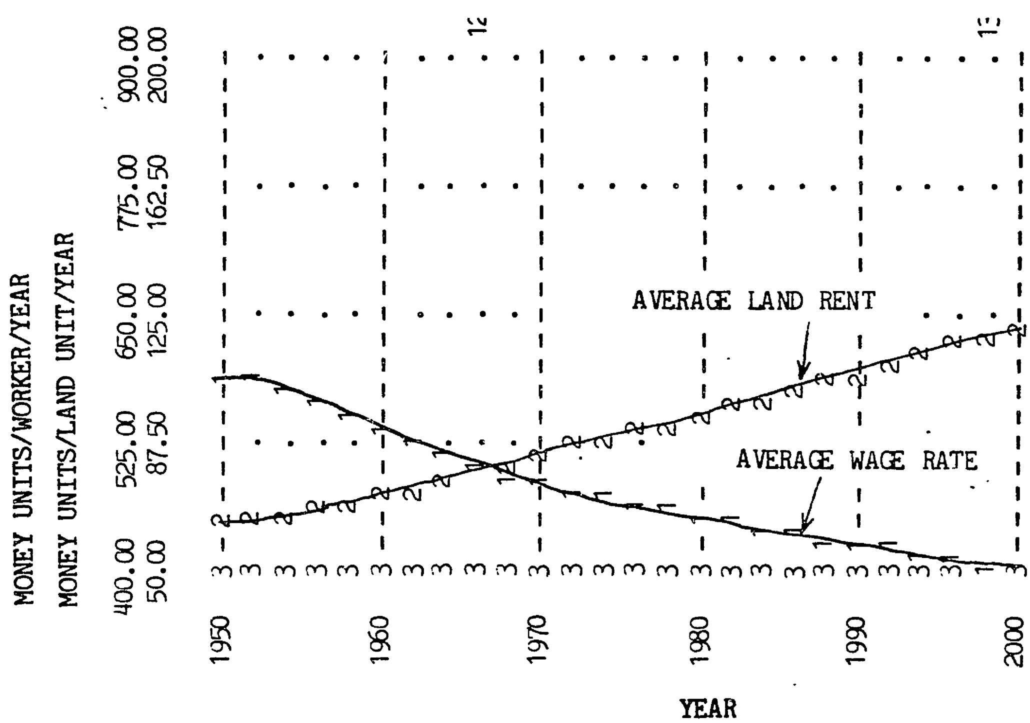


Figure 5.6: Land Reform Policy: Income Shares of Capitalists and Cultivators, Wage Rate, Land Rent.

5.5. Green Revolution

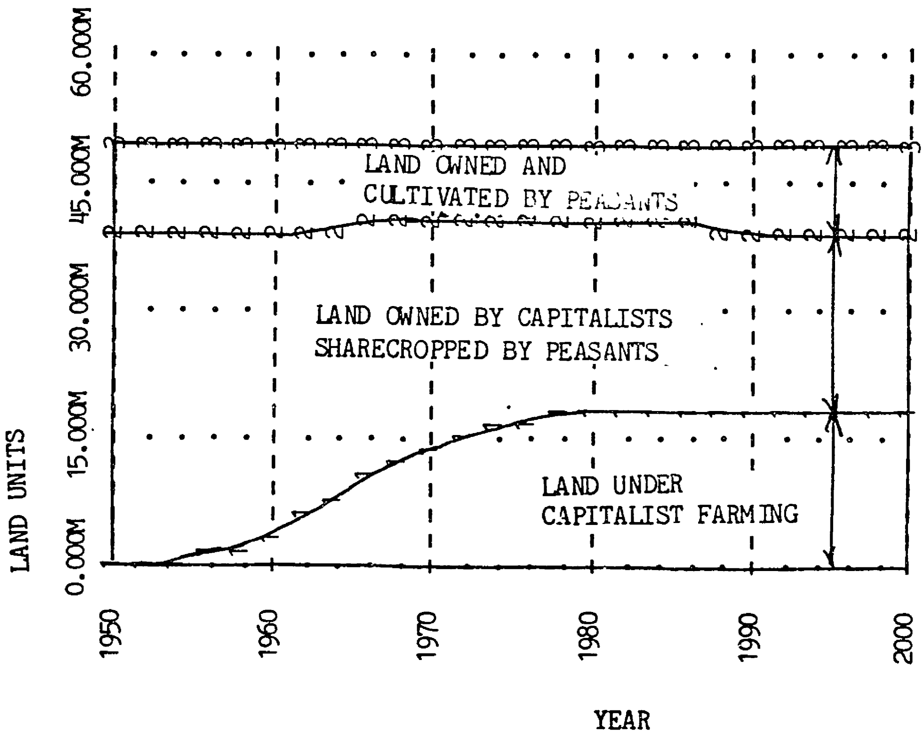
The so called "green revolution" has been one of the most publicized and practiced rural development strategies over the past two decades. Green revolution effort entails popularization of new high-yield seed varieties, synthetic fertilizers, pesticides, and improved cropping practices. Unlike mechanization, which is not accessible to smaller farms, green revolution technologies are potentially available to all cultivators, irrespective of their scale of cultivation, unless the needed inputs are in limited supply and have to be rationed.

Green revolution inputs were introduced in Pakistan over the 1960s, simultaneously with the mechanical implements. The use of these inputs have been fairly widespread, although there have been some differences between the quantities used by the commercial farmers and peasants [10]. Generally, commercial farmers with relatively greater financial ability and political influence were able to obtain and apply the new inputs in larger quantities than the peasant cultivators. The green revolution efforts made a significant contribution to the rapid increases in agricultural production in pakistan over the 1960s, although they have often been blamed for worsening rural income distribution [11].

The green revolution policy is simulated by exogenously introducing a multiplier in the production functions of the model. This multiplier increases the productions of both capitalist and peasant sectors to 1.5 times their ordinary values over the decade of 1960s. The value of the multiplier is allowed to remain 1.5 thereafter. Such a mechanism implies that green revolution inputs were equally available to all and that their use increased over the decade of 1960s, causing concomitant increases in productivity. The possibilities of increases in productivity due to the green revolution are assumed to have been exhausted by 1970. Thereafter, there is no exogenous growth in the productivity of either sector.

Figure 5.7 shows the distribution of land and workers in the model when the green revolution policy is implemented. The growth in the volume of commercial farming is less than the case when only mechanization policy is simulated, while the volume of sharecropping is higher. Further, the policy allows the peasants to buy back some of the land they initially lost to the commercial farmers, which is made possible due to the exogenous increases in productivity and income of the peasants.

Figure 5.8 shows the growth in the income shares of the two sectors and the changes in wage rates and land rents. The total income of the economy grows rapidly in the decade over which the use of green revolution inputs is expanding. Thereafter, the growth rate slows down. However, although there is an absolute increase in the income shares of both capitalists and cultivators, the relative income shares of the two hardly



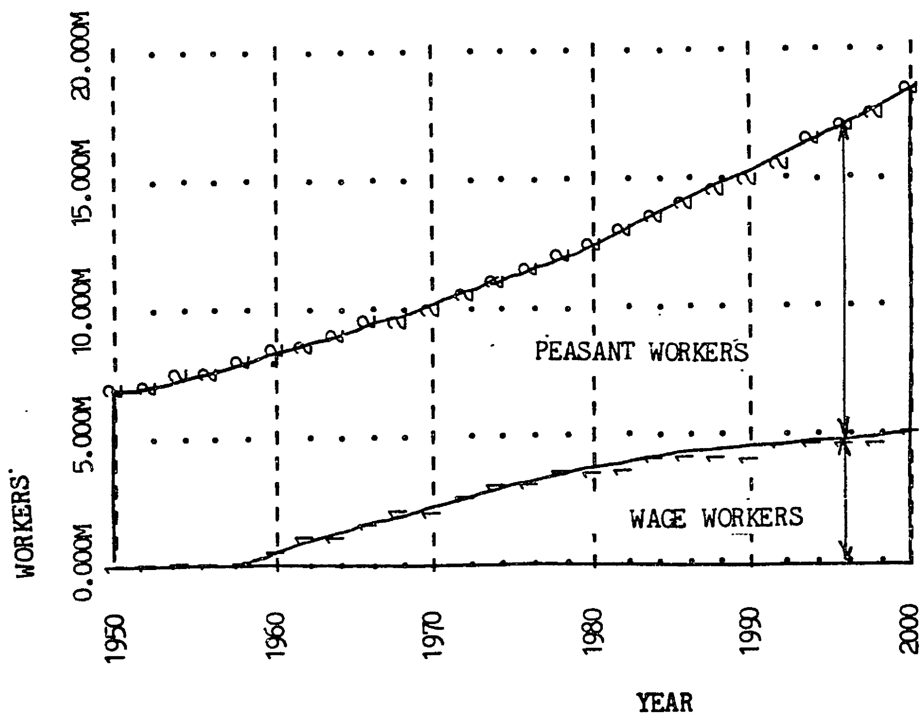


Figure 5.7: Green Revolution Policy: Distribution of Land and Workers.

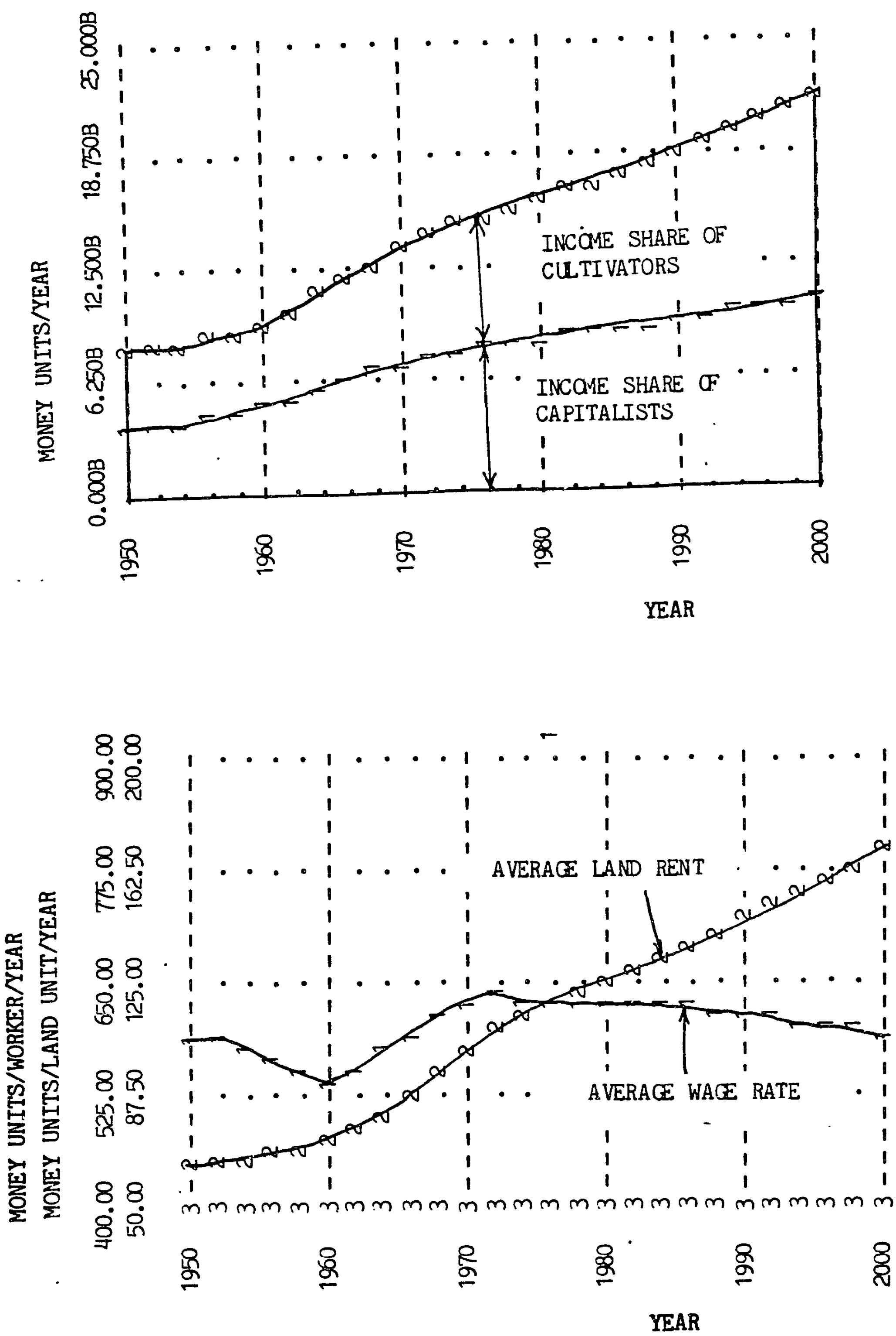


Figure 5.8: Green Revolution Policy: Income Shares of Capitalists and Peasants, Wage Rate, Land Rent.

change at all. The absolute increase in the income share of the peasants causes their consumption level to rise, and this stimulates wage rates over the green revolution decade even in the face of population growth. Thereafter, the increases in population fall short of the corresponding increases in the peasant sector income, and hence, the wage rate again starts declining.

Land rent rises much faster than before because of the increases in land productivity and the concomitant rise in the demand for renting land in the peasant sector. Thus, whether the capitalist landowners engage in commercial farming or sharecropping, a substantial increase in their income is assured.

Green revolution policies, if implemented on a wide scale, can contribute considerably to the overall growth of agricultural output, but have little effect on relative income distribution providing, as assumed, they are uniformly adopted throughout the agricultural sector. Nevertheless, the overall growth can cause a considerable increase in the incomes of the poor.

5.6. Financial Policies

Segmentation in the rural financial markets and the consequent dependence of investment on the internal cash balances of the households is often held responsible for the poor investment ability of the peasant sector. Therefore, programs and policies providing institutional credit to the farmers and the organization of rural financial markets, striving to decrease dependence of investment ability on savings of the individual households, are favored in most writings addressing the issue of rural poverty [12].

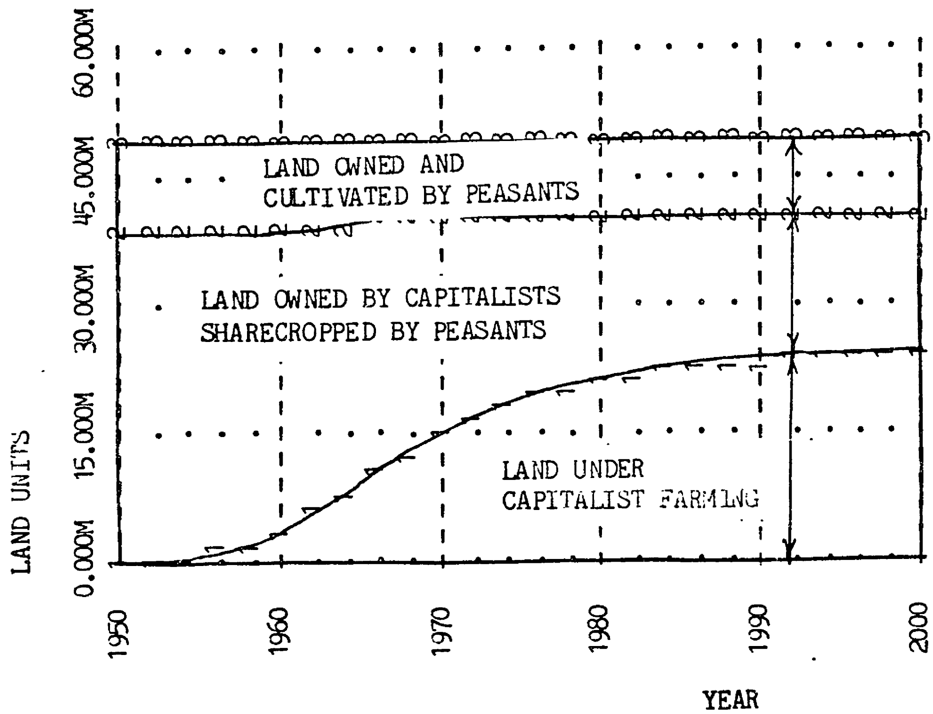
Financial poli^ies have formed an integral part of the rural development effort in Pakistan. Institutional credit facilities for the rural areas were greatly expanded over the 1960s. An agricultural development bank was established, and extension of commercial banking services to the rural areas was encouraged. The role played by the financial policies in assisting the agriculturists is a subject of much controversy. Most observers suggest that due to the equity requirements of the banking system, and the influence of the structure of the society, the limited credit facilities provided by the government and banking institutions largely aided the affluent landlords [13].

The financial policies are simulated by decreasing the degree of coupling between investment and saved cash balances in both capitalist and peasant sectors. This is done by reducing the slope of the table functions representing the effects of cash balance availability on desired land and capital acquisitions in each sector. The change allows transfers of resources to the capitalist and the peasant sectors to be made primarily on the basis of efficiency criteria although some dependence on internal cash balances continues.

Figure 5.9 shows the distribution of land and workers when the financial policy is simulated. This distribution differs only slightly from the simulation with only mechanization policy. The rise of commercial farming is slightly faster when financial policies are implemented, although the volumes of commercial farming, peasant farming and sharecropping towards the end of the simulation remain unchanged. Figure 5.10 shows the behavior of income shares of the capitalists and the cultivators, and land rents and wage rates. The financial policies appear to have no effect on income distribution, wages and rents.

Evidently, the financial policies slightly aid the commercial farmers in realizing their economic goals. These policies may also reduce the dependence of the peasant sector investments on its internal savings, but the investment opportunities for the peasants are limited due to their inability to employ mechanical implements. Thus, although credit facilities are equally made available to all in the simulation, they primarily serve the capitalist interest.

The simulation shows that unless the ability of peasants to invest in mechanical implements is enhanced, financial policies will have only a modest impact on income distribution. Community development programs emphasizing organization of peasant cooperatives are often suggested for overcoming the



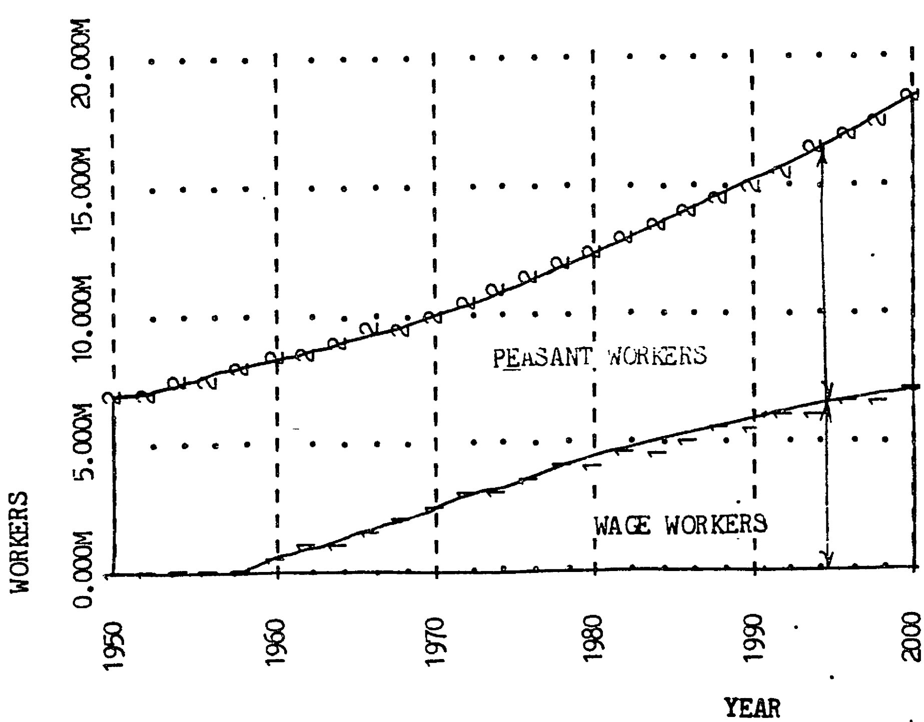


Figure 5.9: Financial Reform: Distribution of Land and Workers.

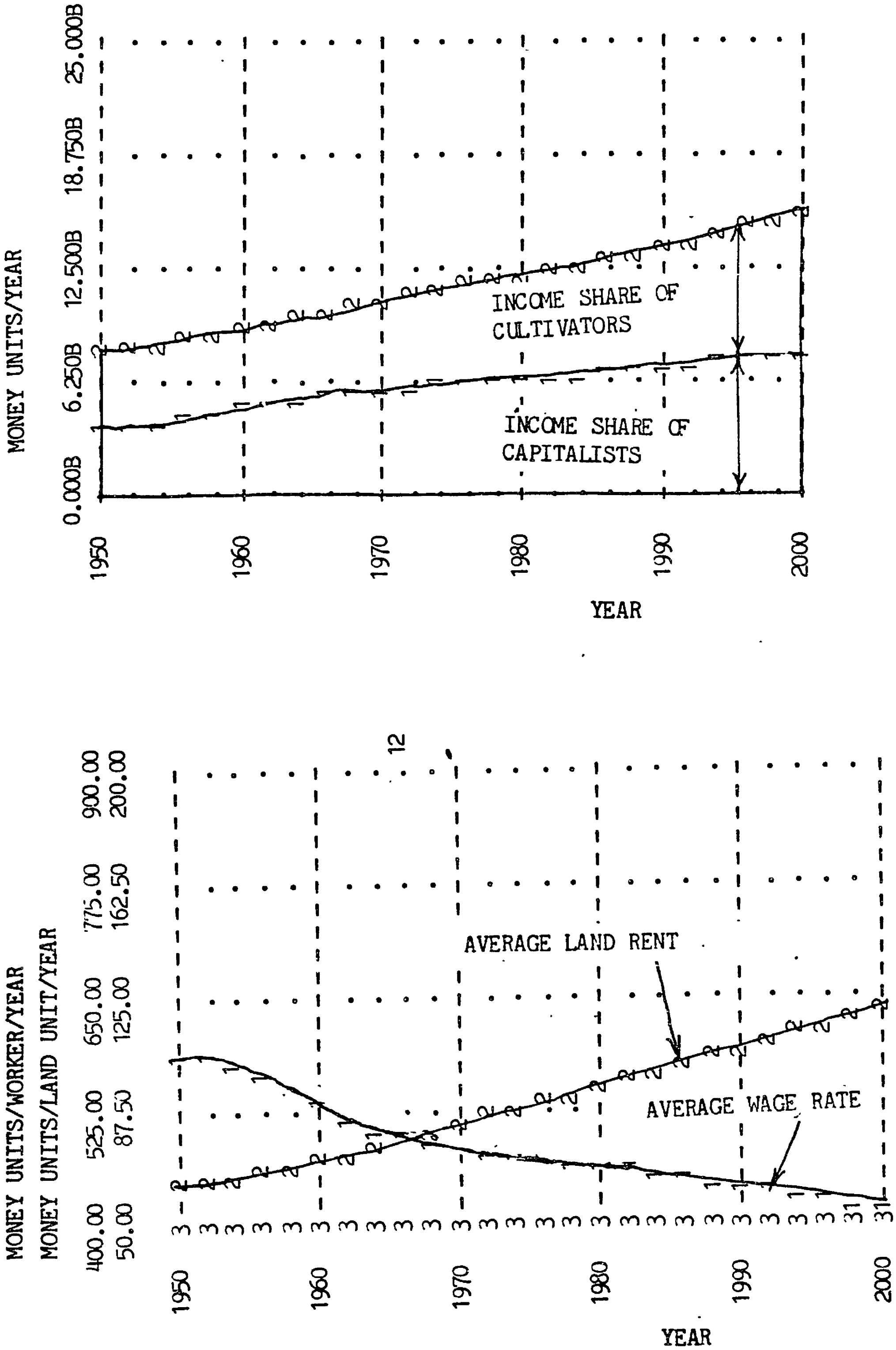


Figure 5.10: Financial Reform: Income Shares of Capitalists and Peasants, Wage Rate, Land Rent.

peasant's limited ability to take advantage of lumpy modern technologies. However, it is often not possible effectively to implement such programs due to the lack of adequate professional and administrative capabilities in government institutions in the developing countries.

5.7. Organization of Peasant Cooperatives

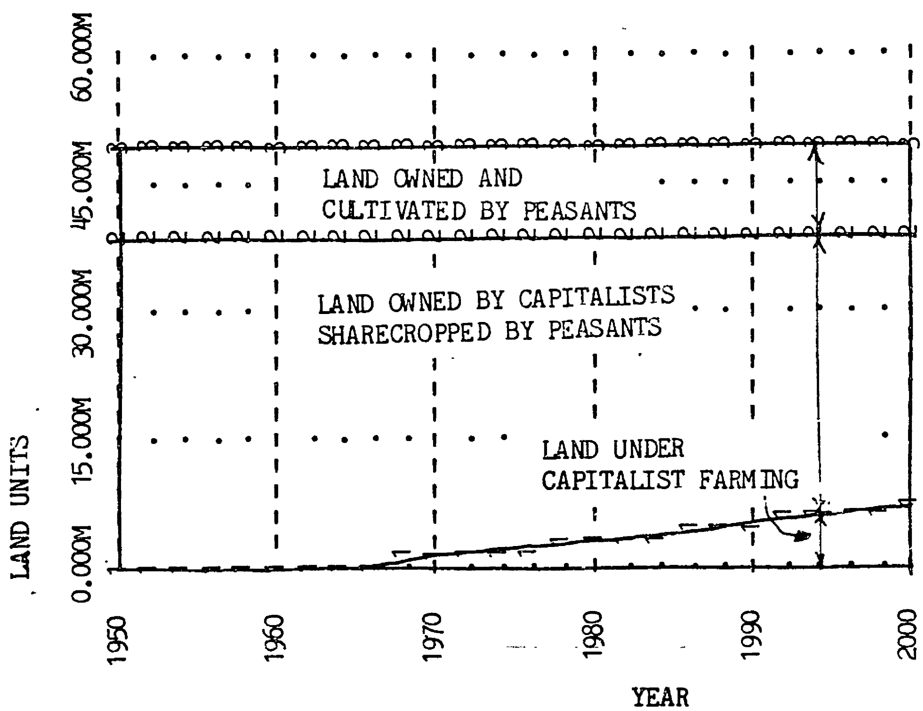
Cooperative organization programs represent an important facet of the rural community development effort in developing countries. Under such programs, all farmers are encouraged to form cooperatives. In its simplest form, members of a cooperative may jointly invest in farm equipment and share its use for cultivating land owned or sharecropped by them.

Community development policies emphasizing organization of cooperatives were implemented only on a limited scale in Pakistan, though concomitantly with the mechanization and financial programs [14]. Therefore, there is inadequate evidence for evaluating their impact empirically. It is, however, possible to assess the usefulness of such programs through simulation experiments.

The cooperative development policy is simulated by allowing modern capital equipment to be useful equally for commercial and peasant farming practices. The demand for ownership of modern capital equipment in each sector is determined on the basis of its volume of farming, marginal productivity of capital in the farming activity, and cash balance available for investment. Both sectors compete for the available modern equipment. As cooperative organization policies are specifically intended to extend the benefits of mechanization and financial programs to small cultivators, mechanisms for simulating those two policies are also retained in the model.

Figure 5.11 shows the land and worker distribution in the model when the cooperative organization policy is implemented. The policy results in severely limiting growth in commercial farming although it does not significantly alter the distribution of land ownership and income.

The use of mechanical implements together with high labor intensity considerably raises the productivity of the cooperative peasant farms. However, as a large proportion of land tilled by the peasants is rented, land rents are also bid up when the productivity of land rises. On the other hand, although the capitalist landowners find it uneconomical to engage in commercial farming due to high labor costs, they are able to receive adequate returns on their investment in land by sharecropping. The income share of the capitalists and their ability to own land, therefore, remains unaffected. The income distribution and the changes in rents and wages in this simulation are shown in Figure 5.12. As the total income of the economy, as well as the basis for its distribution are unchanged,



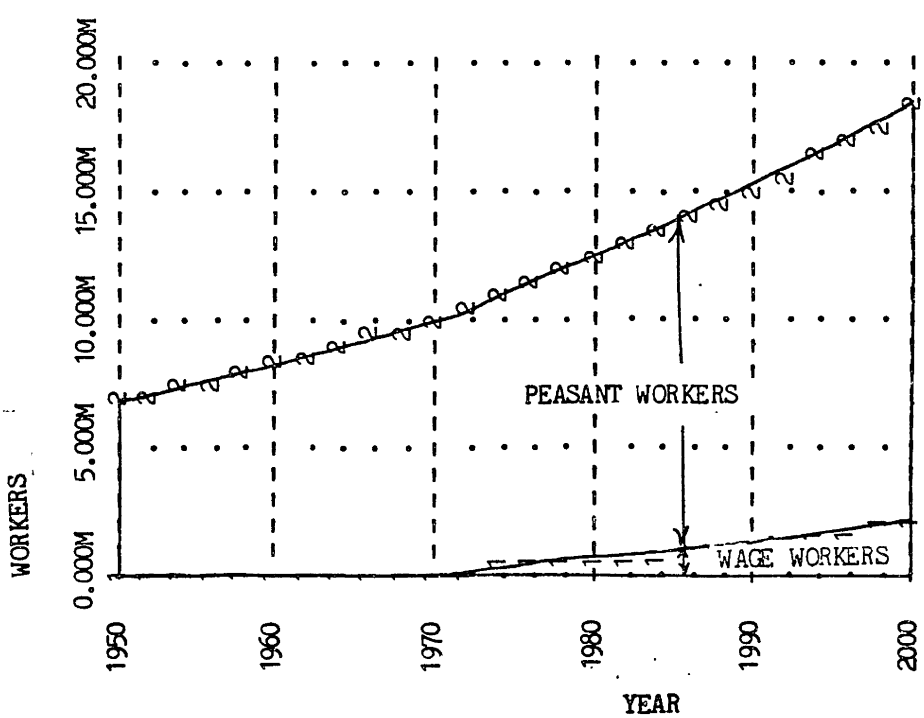
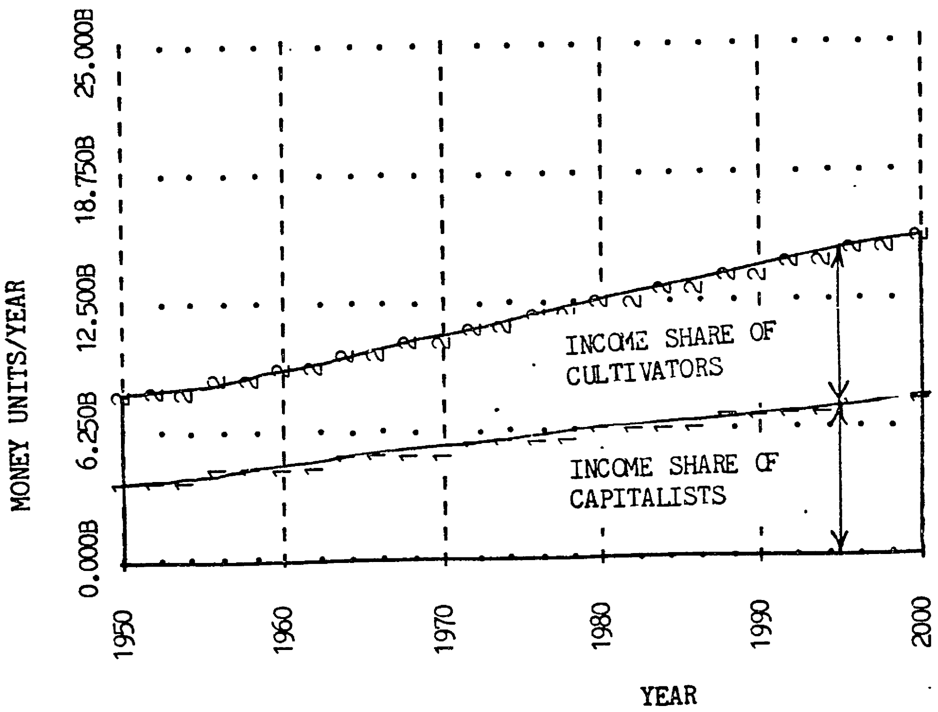


Figure 5.11: Organization of Cooperatives: Distribution of Land and Workers.



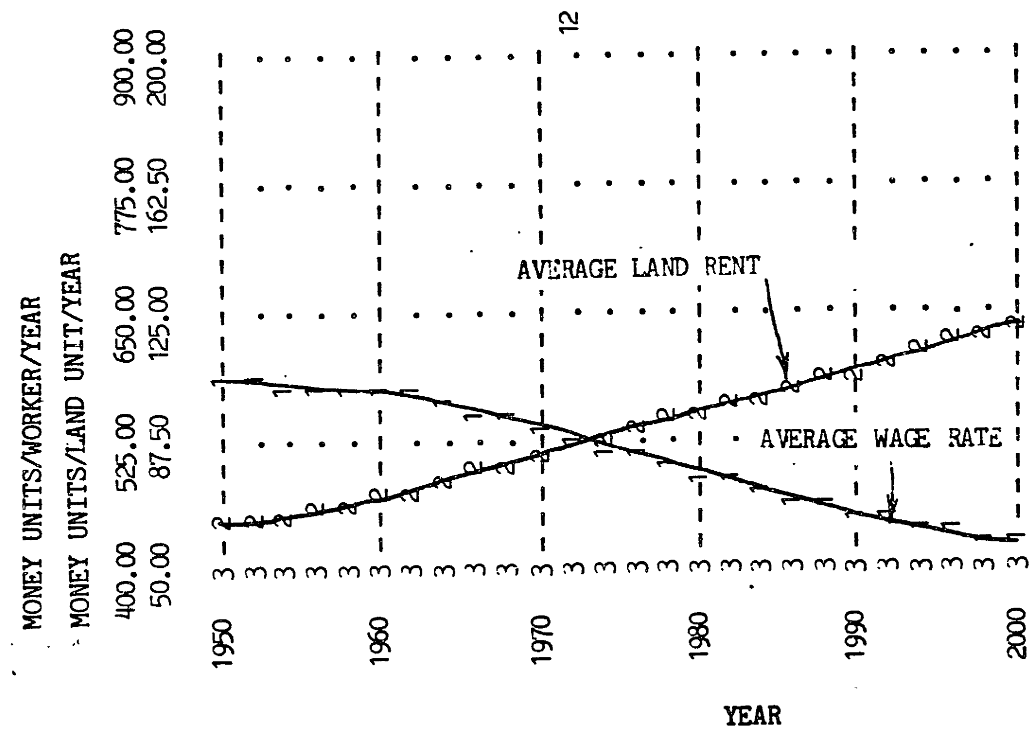


Figure 5.12: Organization of Cooperatives: Income Shares of Capitalists and Peasants, Wage Rate, Land Rent.

the income shares, wages, and rents are the same as in the absence of the cooperative organization policy.

Cooperative organization policy primarily serves to decrease capital differentiation between the commercial and the peasant production modes. As such, it tends to suppress the commercial farming mode which is unable to match the intensity of cultivation of the peasant sector due to the former's tendency to be labor extensive due to high worker costs. Thus land tenure and income distribution conditions prevalent before any rural development programs were introduced tend to persist.

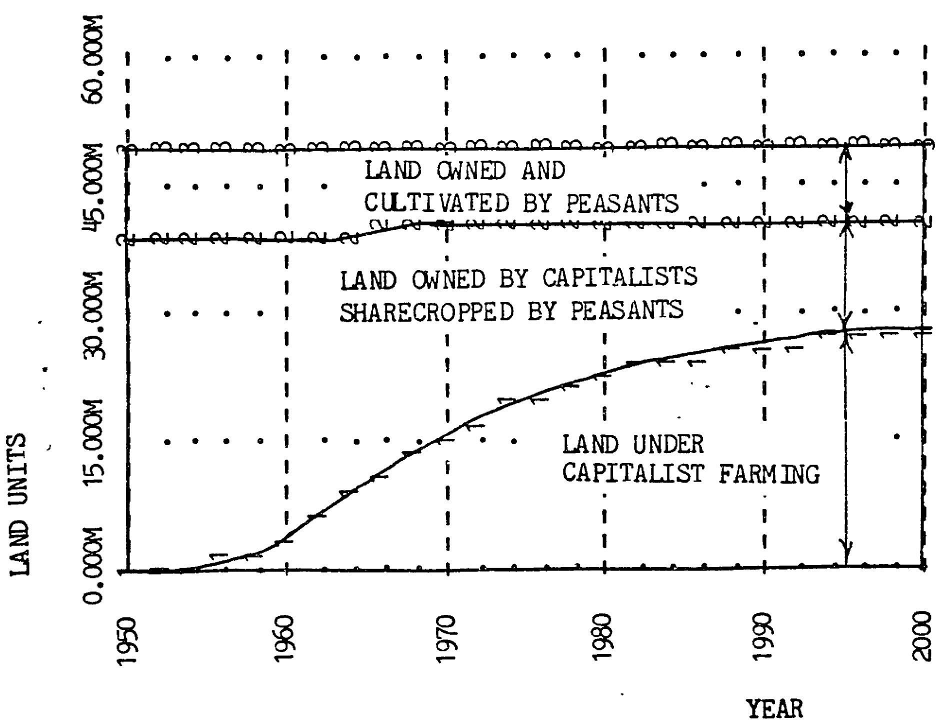
5.8. Migration

Migration out of a poor region is often seen by the planners as a way to relieve pressure on the region's overburdened endowments [15]. But migration also decreases labor resources of the donor region and thus diminishes its production ability [16]. Population redistribution policies, therefore, are a subject of much controversy and debate.

In Pakistan, migration from rural areas followed an ambitious industrial development program implemented in the urban sector over the 1950s and early 1960s. The relative expansion of the urban sector over the past three decades (from <15 per cent to over 30 per cent) indicates that the volume of rural outmigration has been quite high [17]. The persistance of rural poverty also shows that outmigration has not helped the rural poor.

Migration policy is simulated by activating a rate of rural outmigration of people in the model which depends on the urban-rural wage differential. The urban wage rate is assumed to be fixed at a level higher than the rural wage rate at the beginning of the simulation. The distribution of land and workers in the simulation is shown in Figure 5.13; the income shares, the migration rate, the land rent and, the wage rate are shown in Figure 5.14.

Migration seems to have no effect on the ownership of land, though it causes the land under commercial farming to increase at a faster rate and towards a higher level than before. The growth in workforce is limited due to outmigration. Therefore, the numbers of both self-employed and wage workers decline. The total income of the agricultural economy grows at a much slower rate due to the continuing attrition of labor resources, but the share of the capitalists is only slightly decreased. Land rent rises more slowly as lower labor intensity limits land productivity. Migration rises sharply in response to falling wages in the beginning of the simulation. But, as population pressure eases, the wage rate rises and the migration rate declines. In the long run, a migration rate proportional to the increases in population is maintained. Note that although the wage rate stops declining, as surplus labor outmigrates,



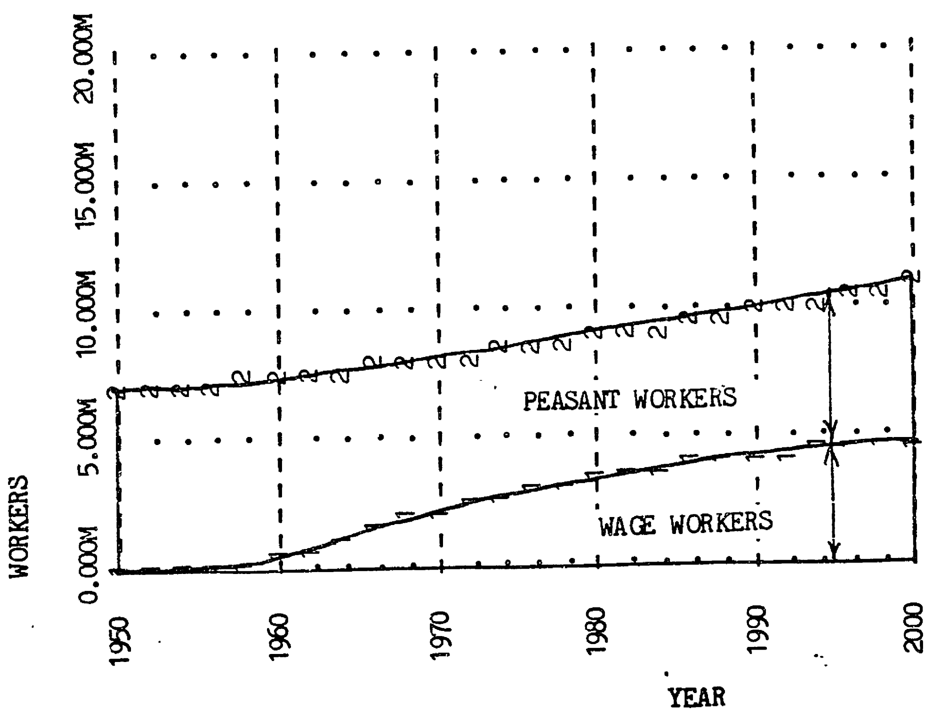
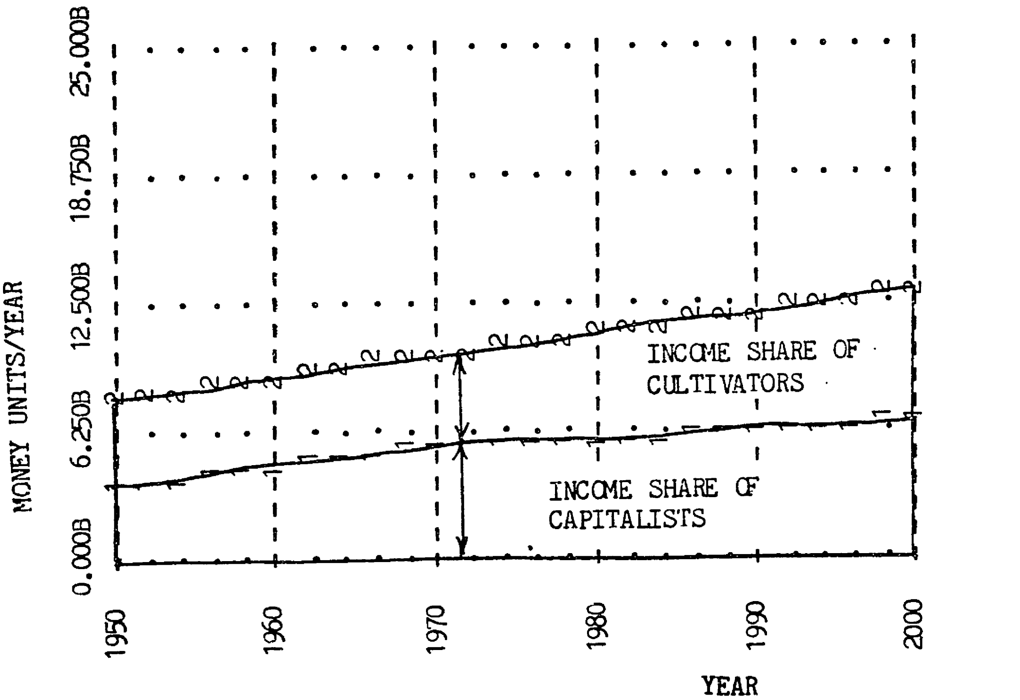


Figure 5.13: Migration Policy: Distribution of Land and Workers.



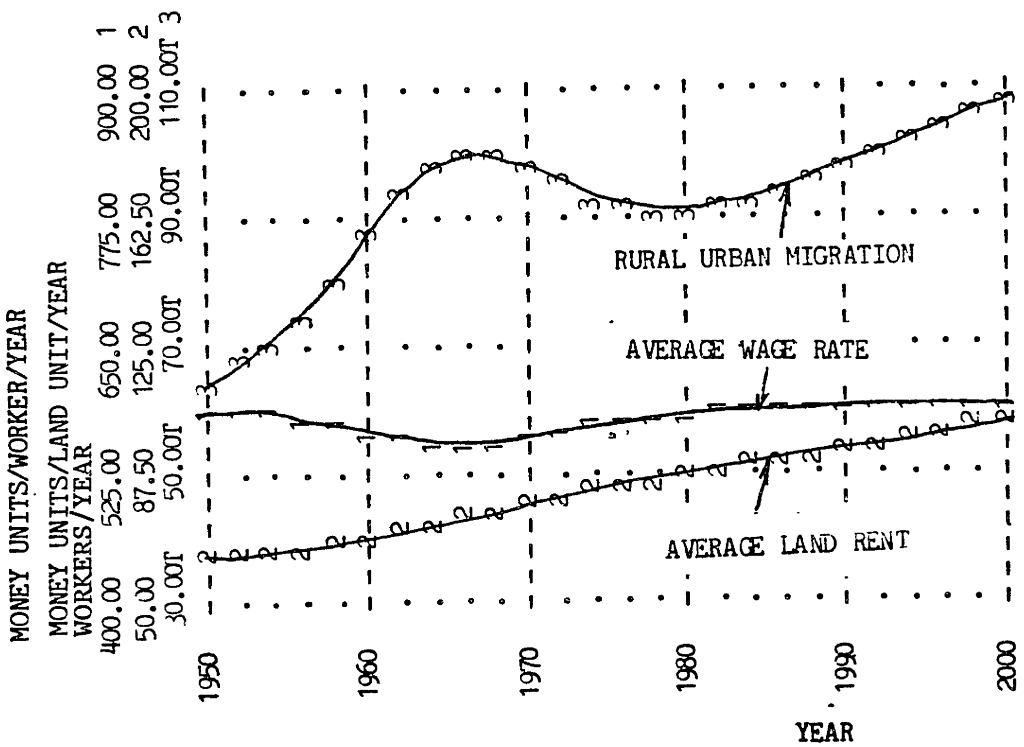


Figure 5.14: Migration Policy: Income Shares of Capitalists and Peasants, Wage Rate, Land Rent, Migration Rate.

there are considerable losses in aggregate rural income, most of which are absorbed by the peasant share of income.

The wage increases resulting from migration in this experiment cannot be over-emphasized because of the simplistic assumptions used. It is assumed in the experiment that an infinite number of jobs offering a fixed wage higher than the initial rural wage rate are available, whereas the urban wage rate is often determined by the average consumption level of the rural workers. Further, the costs of creating urban jobs are not considered. In practice, this cost may be higher than that for expanding the rural economy.

It can, however, be inferred from the experiment that migration may be able to reduce the urban-rural wage differentials, but it does not the increase income share of the cultivators. Sometimes, the emigrants are able to remit some of their income from outside although such remittances can have highly inflationary effects, especially if they increase rural disposable money income without simultaneously increasing the supply of goods and services.

Migration policies cannot be analysed in detail without taking into consideration the growth of the urban sector and the feedbacks between the urban and rural sectors. In the context of growth of agriculture and income distribution within the rural sector alone, migration policies appear to be unsatisfactory.

5.9. Fiscal Policies for Redistributing Income

The foregoing simulation experiments with the model do not exhaustively evaluate the whole range of rural development programs that have been proposed and implemented in the developing countries. But they cover most of the macro-policies underlying those programs; the macro-policies underlying most rural development programs incorporate objectives of increasing productivity, generating employment opportunities, and to some degree, helping the poor.

The policy tests performed in sections 5.2 to 5.8 reveal that policies aimed at increasing productivity in agriculture only serve to enhance income claims of the landowners, without necessarily creating employment opportunities or increasing income share of the poor cross-sections of the society. Some of the tested policies help to increase per capita income of the cultivators, but they worsen income distribution and/or decrease production of the agricultural sector.

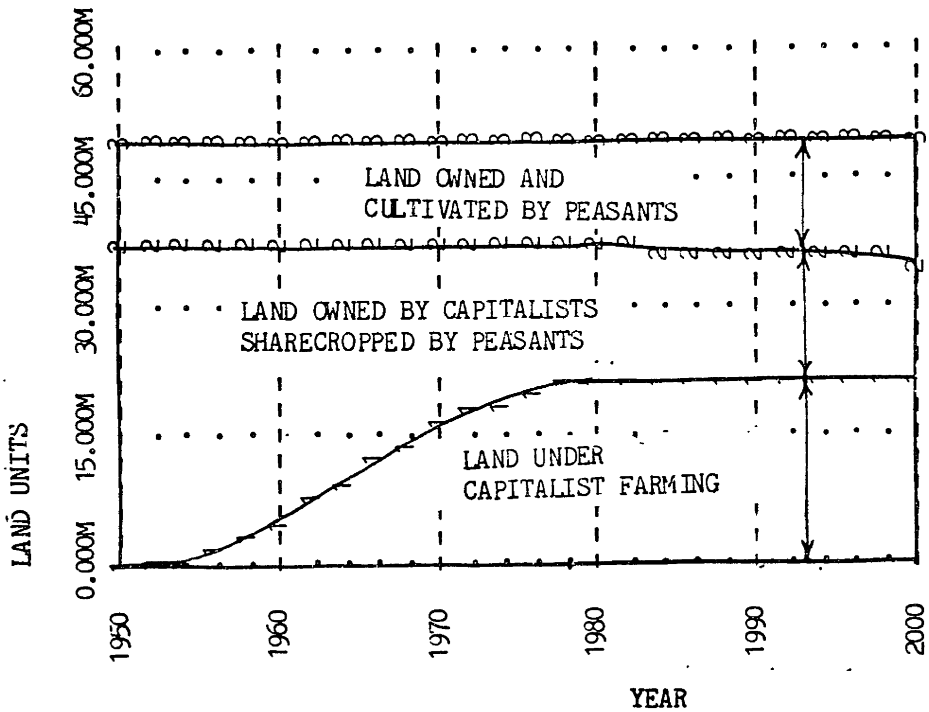
Apparently the ease with which a separation between the attributes of owning and cultivating land can be achieved allows cultivation to become the responsibility of the parties who are more productive, without a concomitant change in the ownership of resources. Thus, the benefits of the increases in the productivity of land are mostly received by the landowners whether they engage in commercial farming or sharecropping. These landowners, in turn, are able to acquire more land from the cultivators for further enhancing their claim to income. Meanwhile, due to the declining income in self-employment, the bargaining position of the workers deteriorates, and this depresses the wage rate.

Periodic large-scale land redistribution programs assuring continued ownership of land by the cultivating classes are almost impossible to implement in view of the administrative difficulties. Radical policies abolishing ownership are politically infeasible unless the existing social and institutional structure is demolished, which may entail immense social costs. One feasible way to enhance the income share of the cultivators is to encourage tranfer of land ownership to them through fiscal instruments. Such instruments entail imposition of a penalty for separating land from cultivators. Fiscal instruments such as a discriminatory land ownership taxation or a tax on rent income are examples of such penalties.

5.9.1. Land Ownership Taxation

Land ownership taxation has been a convenient way for the governments to collect revenue from the agricultural sector in the past. If such taxation discriminates against the capitalist landowners, their tax burden would raise the opportunity costs of their investment in land and they may eventually sell it out to the peasants who are favored by the tax. There are, however, obvious difficulties with implementing such policies. First, the capitalist landlords wield substantial political power and can often successfully resist any policies discriminating against them. Second, even if such policies can be implemented, they amount to waging a war against a cross-section of the society, which may lead to unhealthy social unrest conditions. Third, the administrative burden of accurately selecting the owners to be discriminated against and continuously updating their list would be overwhelming for the administrative institutions in most developing countries, which are characteristically machinistic, unprofessional, and often corrupt [18].

Discriminatory land taxation policies are simulated by imposing a fixed tax on each unit of land owned by the capitalist sector. The tax is treated by the sector as an annual cost associated with owning land. Figure 5.15 shows the changes in the distribution of land and workers resulting from such a taxation. While land holdings of the peasants slowly increase, the volume of commercial farming, with low worker intensity and high capital intensity, increases simultaneously. Consequently, an increasing number of workers is absorbed in the peasant sector, who bid up the land rent. Thus, some of the tax burden is passed on to the peasants, which holds down their income, suppresses wage rate, and substantially slows down the land transfer processes. The changes in income distribution and wages and rents are shown in Figure 5.16.



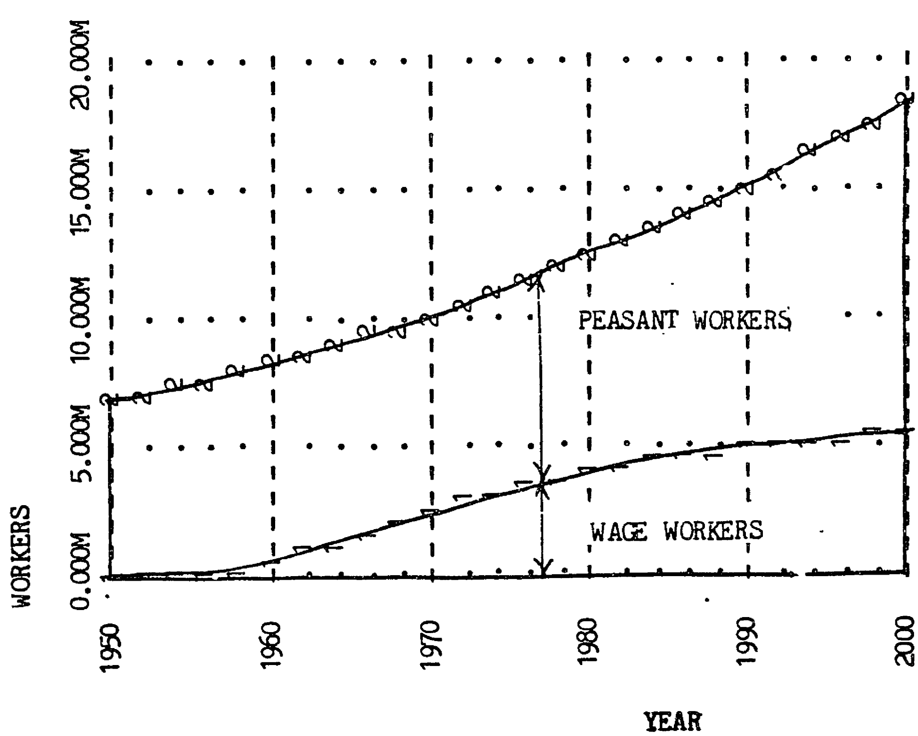
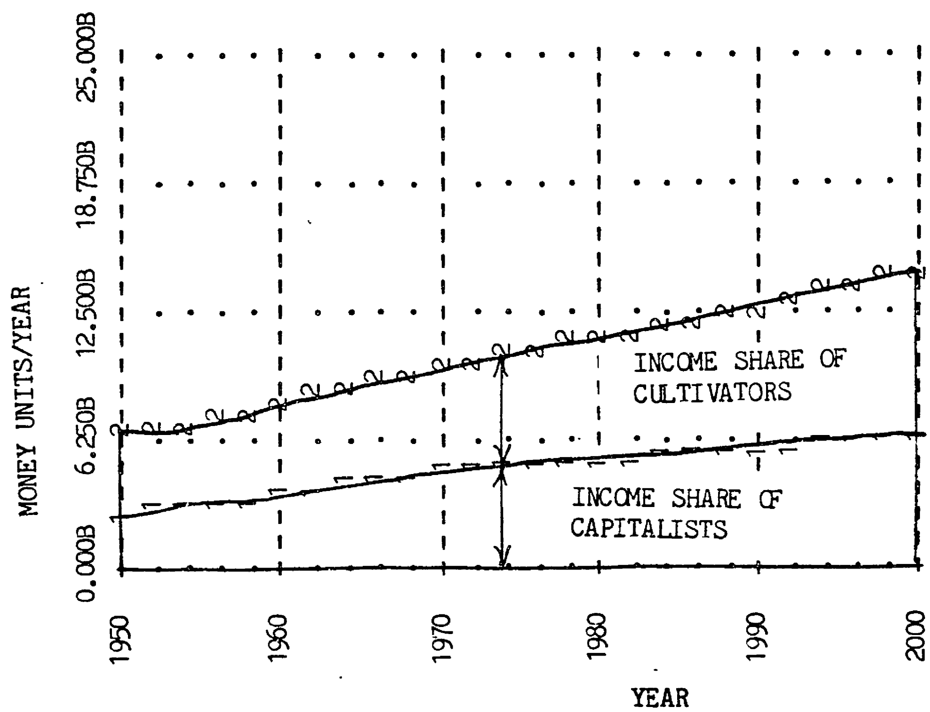


Figure 5.15: Land Ownership Taxation: Distribution of Land and Workers.



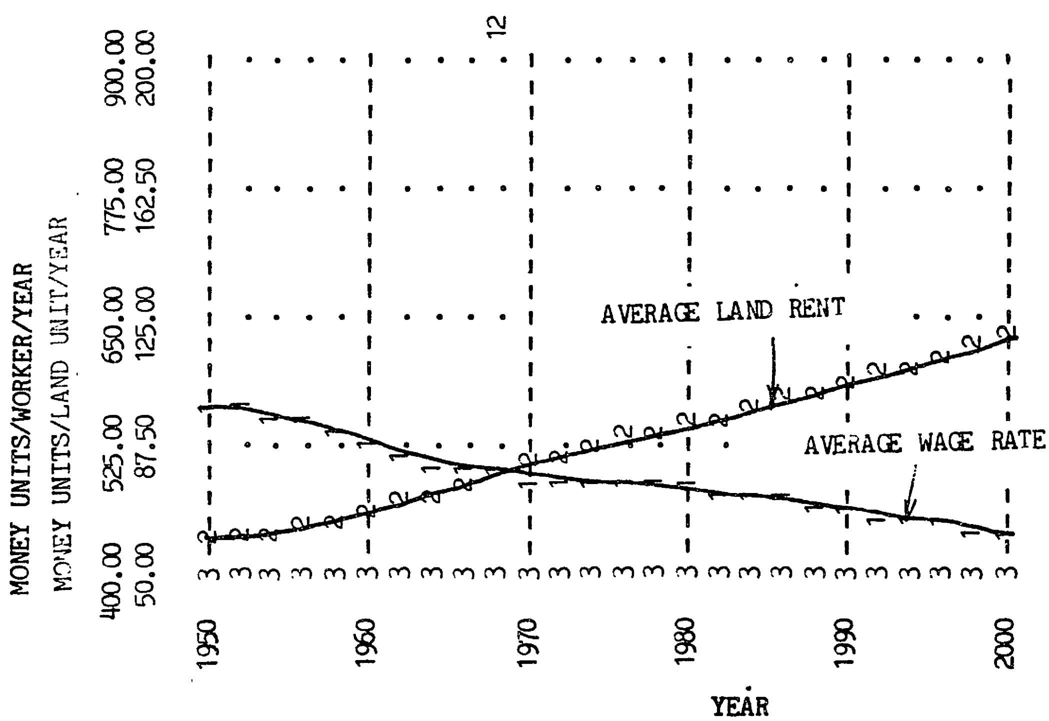


Figure 5.16: Land Ownership Taxation: Income Shares of Capitalists and Peasants, Wage Rate, Land Rent.

5.9.2. Taxing Rent Income

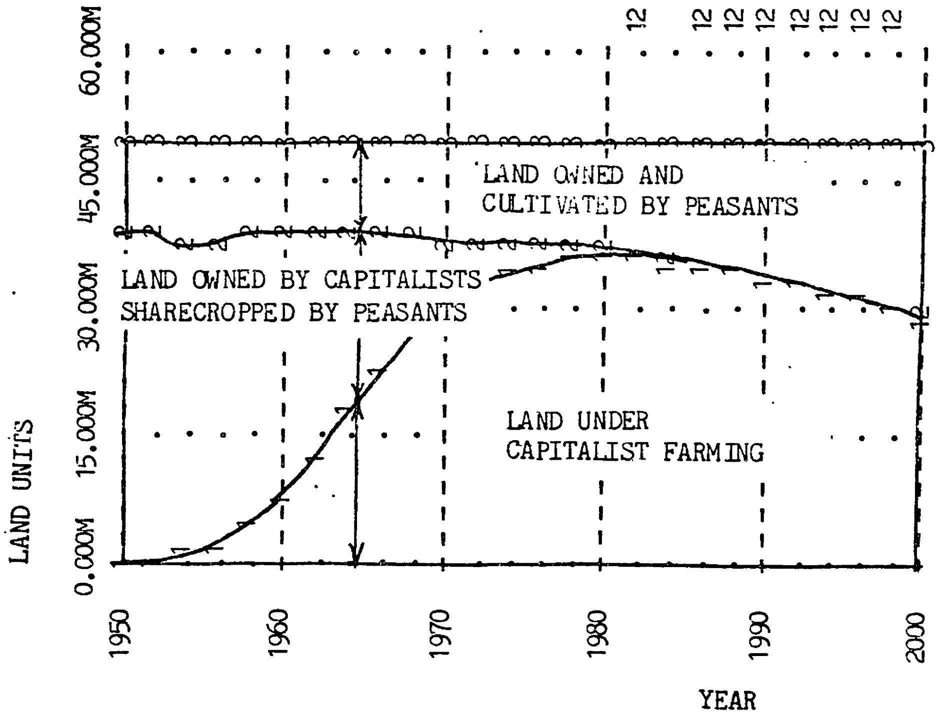
The key factor responsible for creating land owning and land-cultivating classes and the income differentials between them appears to be the absence of a force that should assure cultivation of land by its owners. Apparently, the ease with which land can be profitably rented out by the owners allows its employment in the sector that efficiently uses it as a production factor. The transfer of ownership, however, is relatively difficult, as it involves a concurrent financial transaction. Thus, the ownership of land by a party is not coterminous with the land cultivated by it. Ownership being an important basis for a claim to income, the cultivators often have to give up a substantial share of their production to the owners.

As the renting practice appears to serve as a means to separate owners from cultivators, renting, both in explicit and implicit forms, needs to be discouraged. An administrative ban on renting can not only be impossible to implement, but can be ineffective if imposed in an economic environment where renting is seen as an efficient and convenient practice both by renters and rentees. A simple fiscal policy such as taxing rent income is much simpler to implement while also being very effective.

A rent income tax perhaps is as difficult to collect as an ownership tax. Nonethless, even if the collection of such a tax is inefficient, the presence of the tax should discourage land renting and sharecropping practices. Thus, the amount of the tax needed to be collected may diminish over time, making collection easier.

It should, however, be recognized that when a fiscal instrument discouraging renting is introduced simultaneously with labor saving mechanical implements in an environment where sharecropping dominates, a wave of evictions of the sharecroppers may follow from land which is rapidly converted into commercial farms. But these evictions will also increase labor intensity in the peasant farms which absorb the surplus workers. The productivity of peasant farms and their bids for land, therefore, rise while the opportunity costs of owning land by the relatively less productive capitalist sector decline.

The policy of taxing rent income is simulated by subtracting a constant fraction of all rent income from the revenue of the capitalist sector. The changes in the distribution of land and workers caused by the policy are shown in Figure 5.17. Sharecropped land is either rapidly converted to commercial farms or sold out after the policy is in effect, but the holdings of the commercial farmers continue to decline as land prices are pushed up by the intensive peasant cultivation, and as the opportunity costs of maintaining investment in commercial farms rise. The final distribution of land between the peasant and commercial sectors will depend on the degree of



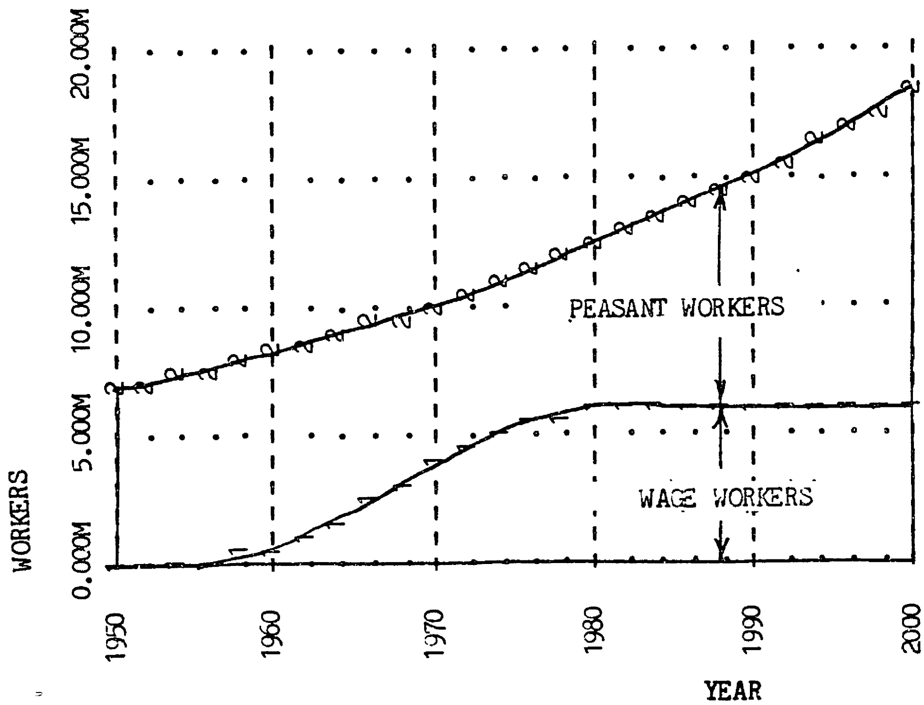


Figure 5.17: Rent Income Taxation: Distribution of Land and Workers.

capital differentiation between the two sectors permitted by the available supply of mechanized implements. The greater the supply of those inputs, the higher the profits in commercial farming, and the more the land under commercial farms. As use of modern implements can increase productivity by allowing multiple cropping, limited use of those implements along with fiscal policies to discourage renting will limit land productivity, while making income distribution more equitable. The degree of mechanization, therefore, clearly incorporates a trade off between efficiency and equity. A lower level of mechanized inputs will yield lower aggregate output with more equitable income distribution, while a higher level of mechanized inputs will yield higher output with less equitable income distribution.

Figure 5.18 shows income distribution, wages, and rents with a rent income taxation policy. The income share of capitalists is significantly less than in earlier experiments. Land rents are higher, but there is hardly any rented land in the economy. The wage rate declines rapidly in the beginning as unemployment rises due to the eviction of the sharecropping tenants, but as ownership in the peasant sector and its income share rise, the consumption levels of the cultivators can be sustained over a considerable period of time despite the growth in population.

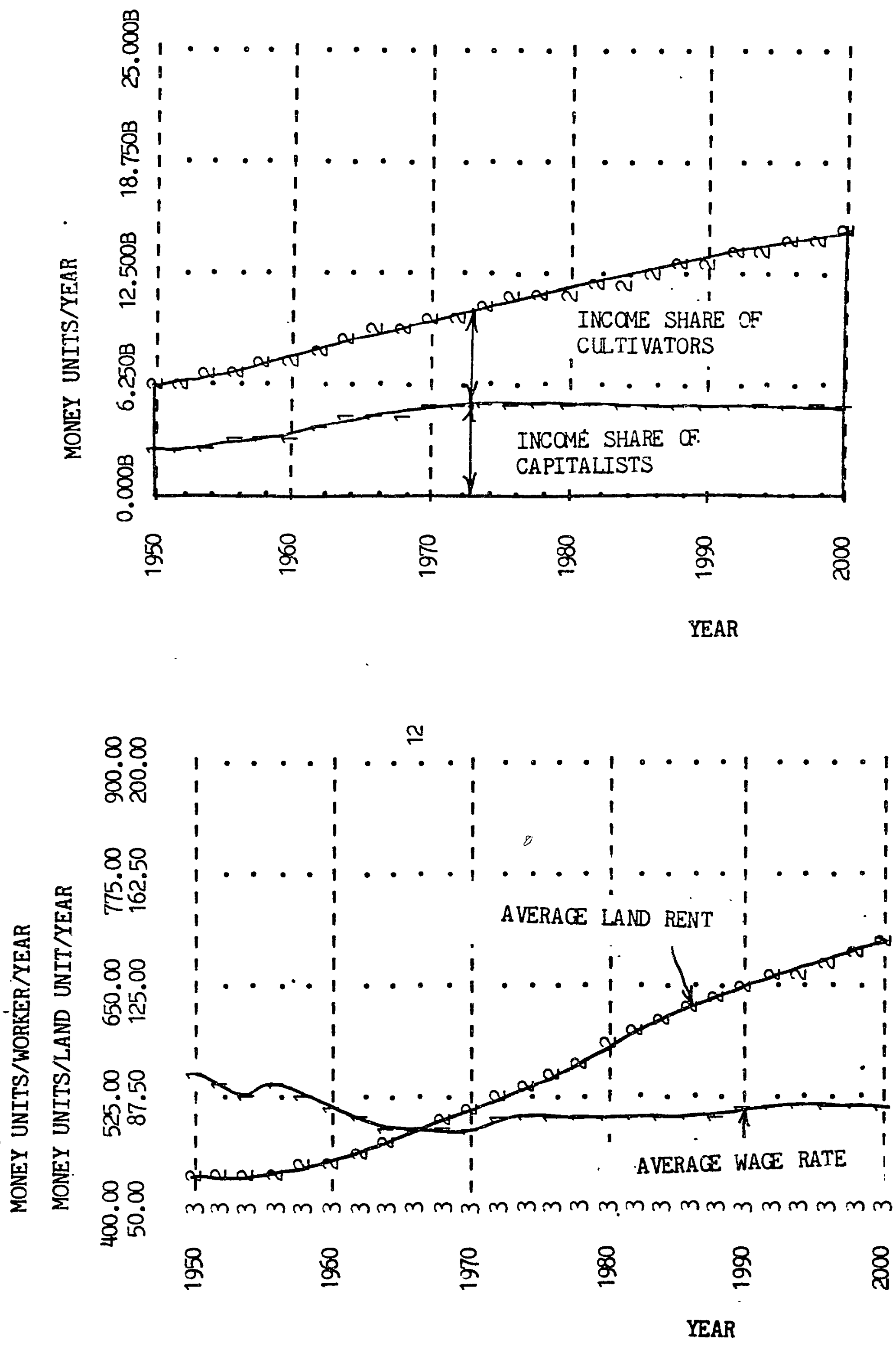


Figure 5.18: Rent Income Taxation: Income Shares of Capitalists and Peasants, Wage Rate, Land Rent.

5.10. Framework for a Rural Reform

A rural reform aimed at improving well being of the people should simultaneously incorporate objectives of growth and equity. None of the policies analysed in the foregoing can realize those objectives when implemented alone. Also, if all policies are introduced together without knowing how they interact with one another, some of them may counteract the others and thus make the outcome of a development program uncertain. Thus, it is important to have knowledge of the individual characteristics of various policies for delineating a set that must underlie a welfare oriented rural development program.

The policies selected must stimulate growth in rural production. Thus, mechanization and green revolution efforts are necessary. The peasant sector ability to invest in new technologies is limited due to its scale of farming and its low financial ability. Such handicaps should be overcome by encouraging peasant cooperatives and decoupling investment from internal cash balances by organizing rural financial markets. Finally, since the benefits of increased land productivity are largely claimed on the basis of land ownership, the increases in output rarely add to the income of the cultivators. Therefore, a fiscal measure such as taxation of rent income must be used for discouraging separation between land owning and cultivating parties. The policies considered unsuitable include land reform, which can be quickly undone, migration which reduces rural resources and thus limits growth in output, and discriminatory taxation of land ownership, which is almost impossible to implement.

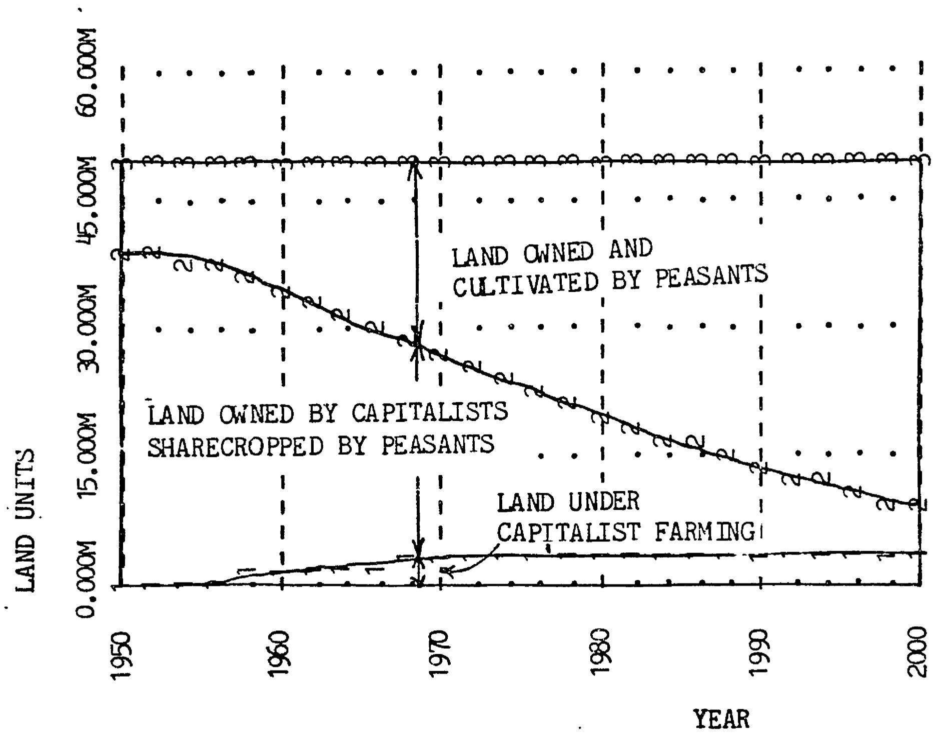
Table 5.1 compares the salient features of the simulated outcomes of the policies included in the proposed rural development framework. The policies are tested individually and as a set. The variables examined include gross rural income, taxes collected if any, average revenue product (net of taxes) of workers, and the average wage rate. The objective of the proposed development framework, i. e., to increase total production as well as to improve its distribution, should manifest expansion in the gross income as well as in a reduction of the difference between average revenue product of workers and average wage rate. It should be noted that while no individual policy can promote all of those objectives, the set of policies is able to realize both increases in gross income and improvement in its distribution. The simulations assume that tax revenue, when collected, simply siphoned off by the government. However, in practice, this revenue can serve as an important source of finance for development of rural infrastructure.

POLICY SIMULATED	YEAR	GROSS INCOME	TAXES COLLECTED	AVERAGE REVENUE PRODUCT OF WORKERS (NET OF TAXES)	AVERAGE WAGE RATE
		10^6 RS/YR	10^6 RS/YR	RS/YR	RS/YR
INITIAL CONDITIONS	1950	8,000	-	1176	588
1. None	1975	10,657	-	952	486
	2000	14,644	-	794	407
2. Mechanization	1975	11,521	-	1,029	476
	2000	15,537	-	842	407
3. Mechanization+ Green Revolution	1975	15,143	-	1,352	632
	2000	21,687	-	1,176	584
4. Mechanization+ Rural Finance	1975	11,463	-	1,024	474
	2000	15,484	-	840	407
5. Mechanization, Finance, Coops.	1975	11,492	-	1,026	509
	2000	15,600	-	845	418
6. Mechanization+ Rent Income Tax	1975	10,835	73	961	502
	2000	14,933	9	809	511
Proposed Policy Framework [*]	1975	13,485	556	1,155	781
	2000	20,357	271	1,089	880

* Includes taxation of rent income, mechanization, organization of cooperatives, provision of green revolution inputs, and organization of rural financial markets.

Table 5.1: A Comparison of Simulated Outcomes of Various Policies.

Figure 5.19 shows the changes in the distribution of land and workforce when the set of policies delineated above is simulated. Most of the workforce continues to be self-employed, but the ownership of land changes significantly. As sharecropping declines in response to taxation of rent incomes,



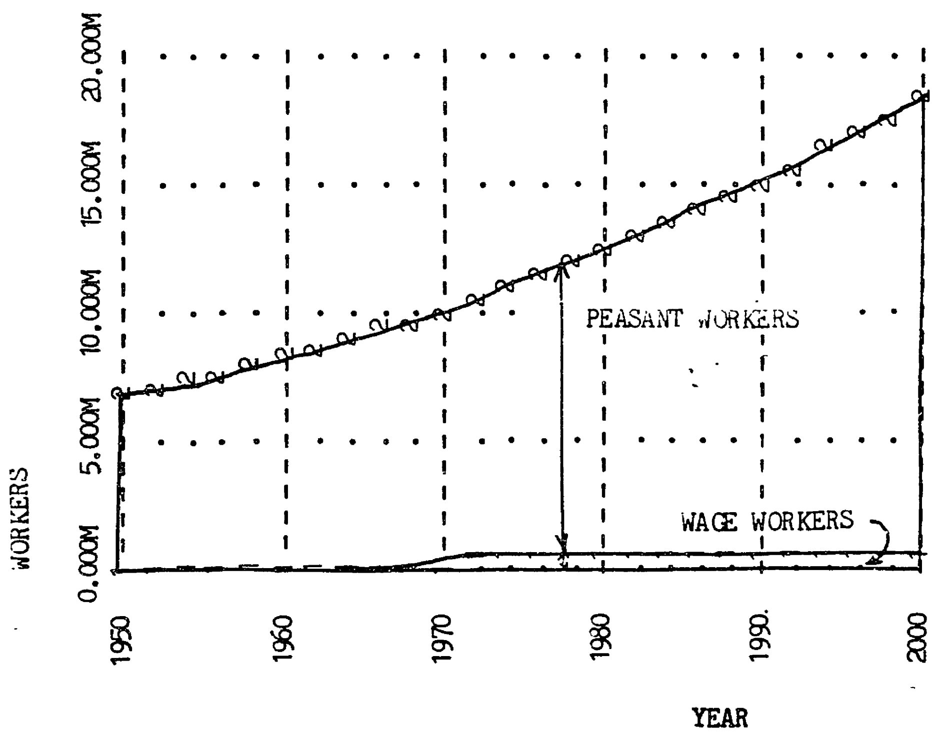
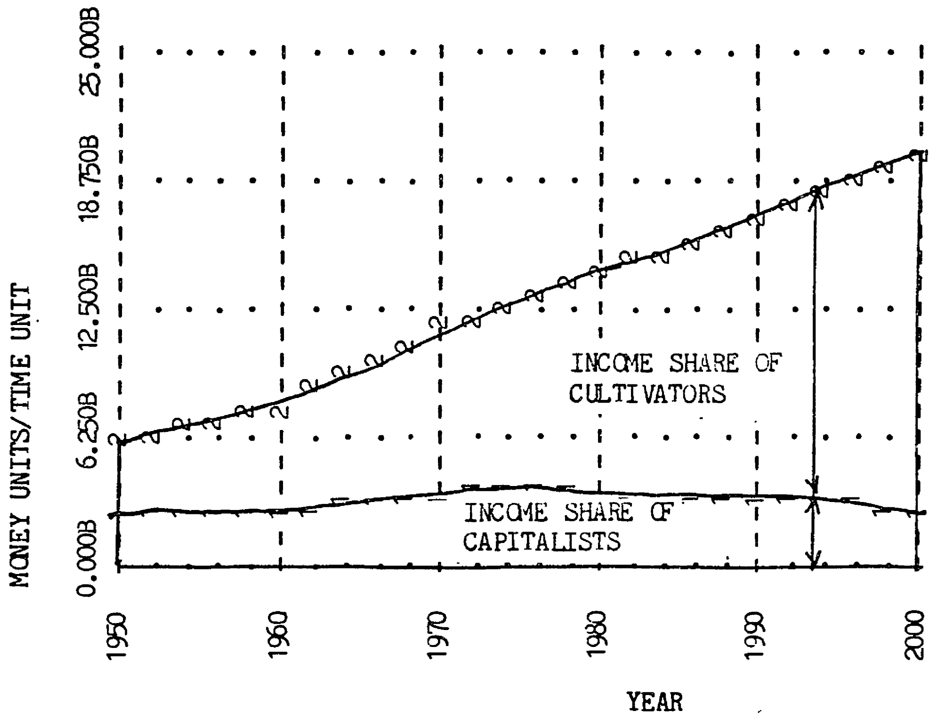


Figure 5.19: Rural Reform Policy Framework: Distribution of Land and Workers.

it is not replaced by commercial farming, but the land taken away from sharecropping is sold to the peasants and is cultivated by self-employed workers. Figure 5.20 shows the income shares of the capitalists and peasants and wages and rents. The overall income grows significantly due to mechanization and green revolution technology, albeit most of the increases occur in the income share of the cultivators. Land rent rises at a fast rate as productivity of land rises, but as the amount of land under sharecropping diminishes, the rent burden of the peasants decreases. The rising income of the cultivators allows significant increases in average earnings per worker even though population is growing exponentially.

The set of policies suggested above by no means discriminates against the big landlords, while it definitely results in eliminating the rural capitalist class. Nonetheless, the rural capitalists are able to get a fair price for their assets. Presumably, these capitalists would be inclined to invest in the industrial sector as the sale of their assets in the rural sector inflates their cash balances. Thus, the rural reform on the proposed lines may also stimulate industrial growth.



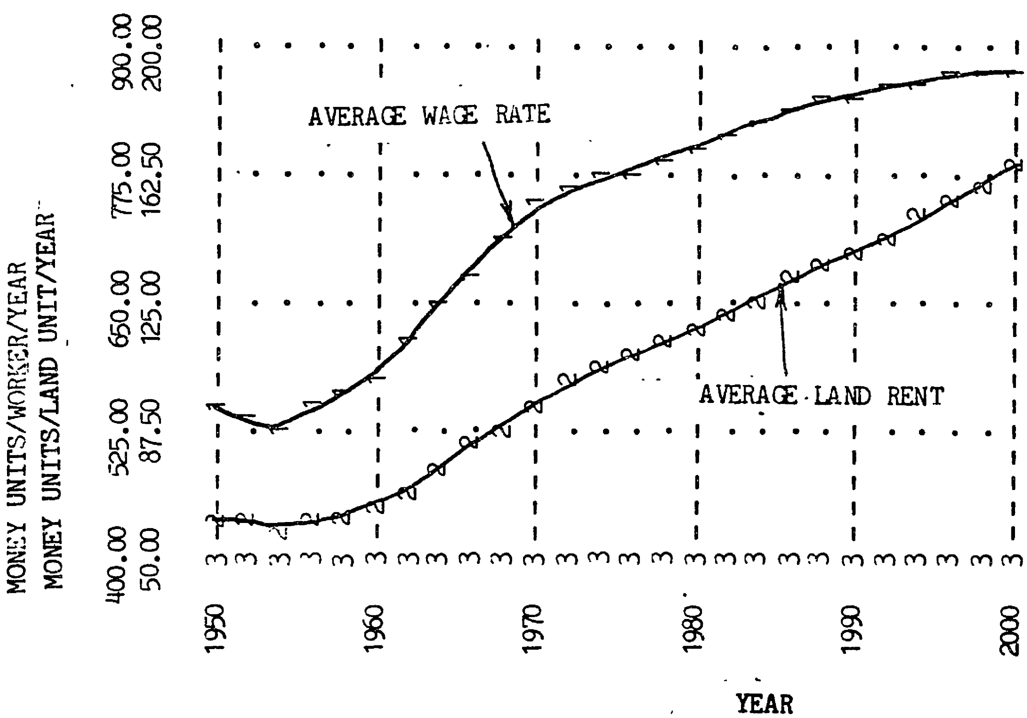


Figure 5.20: Rural Reform Policy Framework: Income Shares of Capitalists and Peasants, Wage Rate, Land Rent.

5.11. Limitations of the Policy Analysis

It should be recognized that the above policy analysis is valid only within the framework of the particular model developed in this thesis. Thus, the limitations of the model will also limit the scope of the analysis. The following limitations as well as the substantive assumption of the model given in Chapter Two should be kept in view while evaluating this policy analysis.

1. The model used for policy analysis has largely been qualitatively validated with respect to its feedback structure, its internal tendency, and its response to exogenous policy. Thus, while an argument is made for the model being a valid representation of Pakistan's rural income distribution system, the model is not claimed as an instrument of quantitative forecasting.

2. The growth of agricultural production shown by the model is too low to maintain the current degree of self-sufficiency in all policy experiments. This is unrealistic and occurs because of ignoring technological growth, underestimating the impact of green revolution, and assuming land under cultivation to be strictly fixed.

3. The decrease over time of rural wage rates would almost certainly mean that workers would move out of agriculture -- at least they would unless non-agricultural income is also

declining.

4. The origins of the policies and the way rural power groups may influence their implementation are outside the scope of the model. Interests of various economic and political groups play significant roles in initiating and directing development programs while the model assumes that the exogenously imposed development programs can be implemented independently of the influence of the various power groups.

5. The analysis is not concerned with the behavior of the urban sector or the effect of the analysed policies on urban growth and income distribution. The growth and well being of the urban sector may be important in the national context. The model must be expanded appropriately to address national issues.

6. Population growth rate is exogenously specified and no assumptions are made about a possible demographic transition or about changes in population growth rates concommitant with the changes in resources per capita as manifested in many Malthusian theories. Although such processes are controversial, their possible effects must be recognized.

NOTES AND REFERENCES

1. These programs incorporated both urban and rural development policies. The former created unprecedented migratory movements in some developing countries. The latter significantly affected rural life styles by bringing about changes in land tenure and cropping patterns. Suggested readings are JOHNSTON, Bruce, and KILBY, Peter, Agriculture and Structural Transformation, Oxford University Press, 1975; BUNTING, et. al. (eds.), Policy and Practice in Rural Development, Overseas Development Institution, 1976; HIRSCHMAN, Albert, The Strategy of Economic Development, Yale University Press, 1959; and GRIFFIN, Keith, and GHOSE, A. K., "Growth and Impoverishment in Rural Areas of Asia", World Development, Vol 7, No. 4/5, April/May 1979.

2. Accounts of the development effort in Pakistan can be found in PAPANEK, Gustav F., Pakistan's Development, Social Goals and Private Incentives, Harvard University Press, 1967; FALCON, Walter P., and STERN, Joseph J., Growth and Development in Pakistan, Center for International Affairs, Harvard University Press, 1971; and STEVENS, R. D., et. al. (eds.), Rural Development in Bangladesh and Pakistan, Hawaii University Press, 1976.

3. GOSTCH, Carl H., "Green Revolution and Future Development of Pakistan's Agriculture", in STEVENS, et al (eds), op. cit.

4. GRIFFIN, Keith, "Increasing Poverty and Changing Ideas about Development Strategies", Development and Change, No. 8, 1978, pp. 491-508.

5. This assumption has been made for excluding from the analysis, rather than ignoring, the feedbacks between population growth and income.

6. ALAVI, Hamza, "The Rural Elite and Agricultural Development in Pakistan", in Stevens, et. al. (eds), op. cit.

7. See, STROUT, Alan M., Projecting Agricultural Crop Supply from Cross Country Data, Working Paper, Department of Urban Studies and Planning, MIT, 1978.

8. A concise description of Pakistan's Land Reforms can be found in KHAN, Akhtar Hamid, Three Essays: Land Reform, Rural Works and Food Problem in Pakistan, Asian Studies Centre, South Asia Series Occasional Paper No. 20, Michigan State University, May 1973.

9. BURKI, S. J., "The Development of Pakistan's Agriculture: An Interdisciplinary Explanation", in Stevens et. al. (eds.), op. cit.

10. GOSTCH, Carl, op. cit.

11. Ibid.

12. See, McKINNON, Ronald, Money and Capital in Economic Development, The Brookings Institution, Washington D. C., 1973.

13. See, SINGH, Inderjit, Small Farms and the Landless in South Asia, World Bank Staff Working Paper # 320,1979.

14. Although community and cooperative development policies were theoretically a part of almost all rural development programs in Pakistan, they were largely set aside when the development programs were implemented. For details of community development effort over the 1950s, see MIZEROW, John D., Dynamics of Community Development, the Scarecrow Press, 1963; for details of latter periods, see BURKI, S. J., "Interest Group Involvement in Pakistan's Rural Development", Public Policy, Vol # 14, Winter 1971; and MALIK, M. Sadiq, "Report on Pakistan" in ORHAN, S.T.C. (ed), CENTO Seminar in Integrated Rural Development, Islamabad, CENTO, Ankara, 1975.

15. A concise description of logic behind this proposition is given by GALBRAITH, John Kenneth, The Nature of Mass Poverty, Harvard University Press, 1969.

16. e. g., LIPTON, Michael, Why Poor People Stay Poor, Harvard University Press, 1976. Also see the discussion on Migration in GALBRAITH, John Kenneth, The Nature of Mass Poverty, Harvard University Press, 1979.

17. The urban population is estimated to be 17.8 percent in 1951 and is projected to be 27.4 percent of the total in 1977 by the Planning Commission of Pakistan. See GOVERNMENT OF PAKISTAN, Pakistan: Basic Facts, 1977-78, 16th edition, Finance Division, Economic Advisor's Wing, Pakistan.

18. Voluminous literature exists on the role of bureaucratic institutions in the developing countries. For a survey, see ONWUCHEKWA, K. O., Bureaucracy and Nation Building, unpublished Ph.D. thesis, Department of Political Science, MIT, 1973.

CHAPTER SIX

CONCLUSION

> "Sick men are lured by the sufi's amulet or the sadhu's nostrum. Sick governments are lured by magical plans. And just as there is no dearth of sufis or sadhus, there is no shortage of magical planers".
>
> Akhtar Hamid Khan [1]

This chapter summarizes the key propositions of the thesis, and states their implications for rural development policy. Limitations of the analysis and its possible extensions are also discussed.

The study has examined the rural income distribution system of Pakistan in a holistic framework and has evaluated the key economic policies underlying the various rural development programs. The study largely reveals the illusiveness of the rural poverty problem rather than presenting a magical plan to alleviate poverty. Nonetheless, the study leads towards identification of a policy framework for the development programs if they are to help the poor cross-sections of the rural community.

The proposed policy framework, however, can hardly achieve overnight results. Thus, it entails a long-term commitment on the part of the country's governing institution to reach out for the self-employed and provide them the same level of technical and financial assistance as can be obtained by the capitalist sector, in addition to imposing a penalty on renting out land. Needless to add that such commitment is difficult to elicit in the framework of the political and administrative institutions currently available in most developing countries [2].

6.1. Key Propositions

The rural income distribution pattern of Pakistan suggests that a vast income disparity exists between the capitalist and the cultivator classes, whereas, within each class, the members enjoy relatively uniform incomes and lifestyles. The problem, therefore, is of income distribution between the capitalist and the cultivator classes and not of size distribution of income among households.

As income is divided between its various claimants on the bases of rights of ownership and labor input, the disparity between the incomes of the capitalists and the cultivators is concommitant with the distribution of land ownership. It is estimated that capitalist households, who constitute less than 3 percent of the total households, owned about 70 percent of the land in the 1950s. The balance 30 percent was shared by the 97 percent of the households constituted by sharecroppers and owner-cultivators [3].

The land distribution scenario of Pakistan in the 1950s also showed an almost dichotomous division between the land owning and cultivating parties. The capitalist households rarely engaged in commercial farming. Instead, they rented out most of their land to the sharecroping tenants. Assuming that no differentiation existed in the quality of production factors available for commercial or peasant farming and that opportunity costs of investment in land and farm capital were the same for all parties, the dominance of renting practice can be attributed to the relatively high costs of wage labor for commercial farming. This is in spite of the fact that the absolute level of rural worker compensation have been reported to be quite low in Pakistan.

When the wage rate or, in case of self-employment, the claim to income on the basis of labor input is determined independently of land ownership, the separation of ownership from cultivators may not necessarily lead to a reduction in worker compensation. However, when income is divided between its claimants through mutual agreement, the share obtained by each is strongly affected by the collective bargaining positions of the claimants. If a worker can afford a high level of consumption by being self-employed in a family farm, his opportunity cost of becoming a wage worker will be high. When self-employed workers own little land and mostly sharecrop, not only their share of income claimed on the basis of ownership is small, but the level of consumption available to them and, consequently, their opportunity costs of becoming wage workers are also low. Thus, concentration of land ownership in the capitalist sector may undermine the collective bargaining position of the cultivators and cause worker compensation to decline.

Due to a segmentation in the financial markets that strongly links ownership ability to the internal savings of a household, the cultivators may lose land ownership when they attempt to raise their consumption level in the short run. The saving rate of the cultivators declines if the utility of savings for supporting self-employment infrastructure is low as can occur when wage employment opportunities are available [4]. The wage employment opportunities, however, may soon vanish if the wage rate demanded is high and the wage employer finds it more profitable to rent out or sell land than to commercially farm it. The saving rate of the cultivators is further suppressed when they are self-employed on sharecropped land and have a heavy rent burden [5]. When the saving rate diminishes while accumulated savings tend to be consumed at the traditional rate, the saved balances of the peasant sector decline and they are bid out of land by the capitalist sector with a higher level of internal savings.

Thus, the disbursement of income on the bases of ownership and labor input, the ease with which land can be rented out, the dependence of worker compensation on the cultivators' collective bargaining position, and the presence of a segmented financial market are seen as the key factors responsible for the separation of land from the cultivators and the suppression of worker compensation.

6.2. Implications for Rural Development Policies

In an income disbursement system, where land ownership not only entitles a party to a share of income but also determines the level of compensation for the labor input to production, any development programs aimed only at increasing land productivity may only enhance the income share of the parties owning most of the land. Additionally, the dependence of investment on internal savings allows parties with rising incomes to further expand their ownership. Thus, growth oriented development programs not providing for land redistribution may worsen income distribution and draw down worker compensation.

However, even though land redistribution is recognized as an important objective of a rural development program, radical land reform policies incorporating instantaneously transfers of land from the capitlaist owners to the self-employed peasants are not without pitfalls. First, such reforms are difficult to implement at any significant scale due to the frequent involvement in development decisions of the influencial interest groups who may be hurt by the reforms [6]. Second, even if a government is able to take ownership away from the capitalist sector and give it to the peasant sector, the latter sector often does not have adequate financial resources and experience for maintaining the infrastructure needed to efficiently employ land. Thus, investment and productivity may significantly decline following a takeover of ownership by the peasants. For example, after a socialist revolution in Portugal in 1974 many tenants were encouraged to take over the latifundia that employed them. The farm production and investment drastically declined after such takeovers. Subsequently, the peasants were blamed for lack of management skills and entrepreneurship, and currently the rights of old owners are rapidly being restored by the Portuguese government [7].

In general, while the analysis of this thesis points towards worker capitalism as a means of improving income distribution, a rather slow and painstaking process for promoting worker capitalism is suggested. This process involves extending technological and financial aid to the self-employed simultaneously with imposition of a tax on separation of ownership from cultivation. No penalty may be imposed on commercial farming. Due to the higher land productivity in the peasant sector and the increasing cost of wage labor, as income of the self-employed workers expands, the opportunity costs of investment in commercial farming will rise, which will make it profitable for the capitalist farmers to sell out to the peasants.

The proposed policy framework requires a long-term commitment on the part of the polity and the administration to the cause of the rural poor. But most developing country governments appear to be preoccupied with the problems of maintaining political power and can rarely give long-term support to such a public issue. These governments have traditionally sought rapid growth with little concern for income distribution. And the administrative institutions in the developing countries continue to operate on a colonial pattern that is characterized by an orientation of the bureaucracy towards self-aggrandizement and service towards the polity and the rule [8]. Further, traditional planning theory has long advocated a growth-before-equity attitude even though it often has recognized a trade-off between growth and equity [9]. As a result, a rural reform on the suggested lines may be very difficult to perceive and implement in most developing countries unless a radical change takes place in the structure of their political and administrative institutions.

6.3. Limitations of Analysis and Extensions of the Study

The usefulness of this study is limited by many simplifying assumptions. Due to these assumptions, income distribution can be examined only in the context of a relatively closed and aggregated rural sector. The limitations of the study pertinent for examining income distribution issues and the extensions of the presented model for overcoming those limitations are discussed below:

1. The model does not endogenously incorporate mechanisms for determining population growth rate. A large part of the analysis is done with a fixed population assumption and no rural to urban migration, and when population is allowed to grow in the model the growth rate is exogenously determined and is held constant. However, both population growth rate and migration have varied in the past, depending on the resources of the region, and have been important factors in determining the economic condition of the cultivators.

For achieving a better understanding of the historical changes in income distribution and for obtaining a more realistic view of the future, the population growth and migration mechanisms must be endogenized in the model.

2. The model assumes a fixed urban economy, which is a source of supply of modern capital equipment and a sink for

agricultural production not consumed in the rural sector, and for rural out-migration. Further, the total demand for agricultural production is linked to the national population, which is either assumed to be fixed or allowed to grow at a constant rate. These simplifying assumptions do not allow an examination of the rural urban transfers of income. The price changes for agricultural commodities as their demand increases due to expansion of agro-based industry in the urban sector can also not be studied.

For an assessment of urban-rural income distribution, and a study of the impact on income distribution of the various policies aimed at "urbanization" [10] and "structural tranformation" [11], the model boundary should be expanded to explicitly incorporate mechanisms of growth in the urban sector, the urban-rural flows of income and resources, and the factors affecting the demands for agricultural and non-agricultural production.

3. The study examines income distribution in an aggregated rural economy and disregards the regional differences in endowments and in development efforts. Such differences have significantly affected regional income disparities in Pakistan [12] and in many other countries. A more detailed study of income distribution should also examine regional differences in income. For such an analysis, the model must be expanded to include mechanisms representing various regions and the flows of incomes and resources between them.

NOTES AND REFERENCES

1. Quoted from KHAN, Akhtar Hamid, "A History of Food Problem", in Three Essays by Akhtar Hamid Khan: Land Reform, Rural Works, and Food Problem in Pakistan, Asian Studies Centre, Occasional Paper No. 20, Michigan State University, May 1973.

2. For a discussion of developing country public institutions, see ONWUCHEKWA, K. Okigwe, Bureaucracy and Nation Building: Facts and Problems of Rationalization, Unpublished PhD thesis, Department of Political Science, MIT, 1973.

3. Based on ownership size and cropping pattern. All owners having holdings >20 acres or so are reported to hire sharecroppers, while most owner-cultivated farms measured 12.5 acres or less. 12.5 acres being a standard area cultivable by a pair of bullocks and two men, the number of farms measuring between 12.5 and 25 acres is expected to be small. Population data and ownership size is given in GOVERNMENT OF PAKISTAN, Statistical Year Book, Ministry of Finance and Planning, 1976. The cropping pattern is described in ALAVI, Hamza, "The Rural Elite and Agricultural Development in Pakistan", in STEVENS, et. al. (eds.), Rural Development in Bangladesh and Pakistan, Hawaii Univ. Press, 1976.

4. See, MELLOR, John W., "The Subsistence Farmer in Traditional Economies", in WHARTON JR., Clofton R. (ed.), Subsistence Agriculture and Economic Development, Aldine Publishing Co., Chicago, 1969.

5. See, BARDHAN, P. K., "A Model of Growth of Capitalism in a Dual Agrarian Economy", in BHAGWATI and ECKAUS, (eds.), Development and Planning, MIT press, 1973.

6. See, e. g., BURKI, S. J., "Interest Group Involvement in Pakistan's Rural Works Program", in Public Policy, Vol. 19, Winter 1971.

7. HARVEY, Robert, "Almost There; Portugal: A Survey", in The Economist, June 14, 1980.

8. See, Eisenstadt, S. N., The Political System of Empires, The Free Press of Glencol, McMillan Co., London, 1963.

9. See, ALONSO, William, "Urban and Regional Imbalances in Economic Development in FRIEDMAN and ALONSO (eds.), Regional Policy: Readings in Theory and Applications, MIT Press, 1975.

10. Urbanization has been an important part of most development strategies in the past. At times urbanization has even been used as an index to measure economic development. Contrasting views on urbanization as a development strategy can be found in LERNER, Daniel, The Passing of the Traditional Society, Free Press, NY 1973; and LIPTON, Michael M., Why Poor People Stay Poor, Harvard University Press, 1976.

11. The term "structural transformation" has been used in the literature to describe the change from a rural agrarian economy to an urban industrial economy. See, JOHNSTON, Bruce, and KILBY, Peter, Agriculture and Structural Transformation, Oxford University Press, 1975.

12. A brief discription of the Regional Disparities in Pakistan is given in ALAVI(1976), op. cit.

A GUIDE TO THE APPENDICES

The technical aspects of the model developed in this thesis are given in the following four Appendices. Appendix A describes the logic of the model equations, Appendix B dicusses model parameters, Appendix C gives a complete model listing in the computer code DYNAMO, and Appendix D gives a list of variables, their definitions and the equations in which they are used, in alphabetic order. The four Appendices provide sufficient technical detail for replecating experiments of this thesis.

The details of the computer code DYNAMO used in the model can be found in DYNAMO III User's Manual written by Alexander L. Pugh III and published by MIT press. Salient features of the code are described below.

1. Equation Form

A DYNAMO equation is written in the following form:

TYPE VARIABLE=EXPRESSION

TYPE is a single letter designating the type of variable being defined. Each equation is specified in the model by its TYPE and a number based on TYPE and the order of appearance of the equation in the model. The following letters are used to designate TYPE.

L	for "level" equations representing accumulations
R	for "rate" equations representing rates of change of accumulations
A	for "auxiliary" equations representing algebraic computations forming parts of rate equations
N	for initial values of variables
T	for "table functions" representing non-linear relationships between pairs of variables
C	for constant parameters
S	for "supplementary" equations used for computing variables for only studying the output

In addition, model simulation parameters such as solution interval, length of simulation, and printing and plotting intervals for output are specified by an equation TYPE designated as SPEC. Specifications can also be individually stated as C equations.

VARIABLE NAME is the specified abbreviation for the variable being defined by the equation. The name is followed by an appropriate timescript, depending on the TYPE of variable it is. Levels and auxiliaries have the timescript .K, rates have the timescript .KL. Levels are represented as difference equations, by adding the rate of change over the solution interval to the level at the past instant. The quantities at the past instant have timescripts .J (for levels) and .JK (for rates).

EXPRESSION is any algebraic expression. It may range from a simple number or a single variable to a complicated combination of factors and terms involving functions, variables and numerical values.

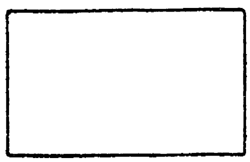
2. Special Functions

Several special functions have been built into DYNAMO in the form of MACROs. The special functions frequently used in the model are described below:

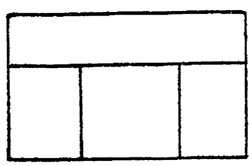
- SMOOTH — computes an exponential average of the variable or expression being operated upon by SMOOTH over a specified time interval
- STEP — allows a step change in a quantity at a specified time and can be used in switching configurations for experimenting with the model.
- PULSE — introduces a momentary change in a quantity at a designated time, and is used in switching configurations similar to STEP.
- FIFGE — changes the value of a variable depending on the relative magnitudes of two designated variables, and can be used to change policy related variables at any desired instant, while performing policy tests with the model.

3. Flow diagrams

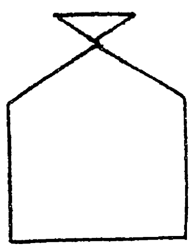
A FLOW DIAGRAM illustrates the postulated relationships between the elements in a model system. Main components of FLOW DIAGRAMS are shown below:



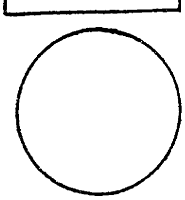
Rectangles represent LEVELS



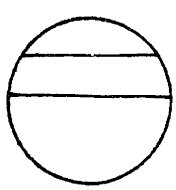
Rectangles with dividing lines represent Averages (e. g., SMOOTH)



Valves represent RATES



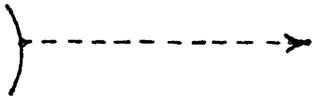
Circles represent AUXILIARIES



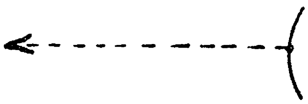
Circles with overlined and underlined variable name represent TABLE FUNCTIONS describing non-linear relationships between designated pairs of variables

Solid Arrows represent material flows

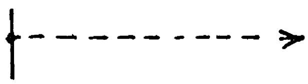
Dashed arrows represent information flows



Input lines from an arc repesent inputs from variables in sections of model not drawn in a FLOW DIAGRAM



Output lines to an arc represent inputs to variables in sections of the model not drawn in a FLOW DIAGRAM



Input lines from a streight bar represent inputs from constant parameters

Clouds represent sinks of material flows.

APPENDIX A

DESCRIPTION OF MODEL EQUATIONS

This appendix describes the model used in thesis to represent an agrarian economy. The model is described in terms of mathematical equations in dynamo notation [1]. The relationships described by the equations are also presented pictorially in the accompanied flow diagrams [2]. Each flow diagram represents a section in the model isolated from the rest for facilitating description of a specific set of equations. Sectionalization of the model in this appendix differs from the sectionalization in chapter Three, in which the discussion is focussed on the important feedback mechanisms in the model that govern interaction between the formal (or capitalist) and the peasant sectors of the agrarian economy. The model sections in Chapter Three are isolated from the rest for ease of explaining the feedbacks; the description in this appendix focuses on the logical structure of the equations constituting the model.

The model is divided into four main sections, which incorporate equations for processes underlying allocation of land, allocation of workers, acquisition of capital and disbursement of income between the sectors. Each section is sub-divided into subsections representing the decision processes within the formal (or capitalist) and the peasant sectors, and those affecting both sectors. For facilitating identification of equations for the two sectors, variable names for the formal sector end with letter F, those for the peasant sector end with the letter P.

1. Allocation of Land

1.1. Formal Sector

Figure A.1 illustrates the set of mechanisms underlying acquisition of land and its allocation to the cropping and renting activities in the formal sector. The equations representing the mechanisms describe a market in which bids are constantly being placed on all land, both by the formal and the peasant sectors. Land is redistributed amongst the bidding parties depending on their respective demands for land ownership.

Land owned by the formal sector LOF is determined by multiplying the total land available for cultivation TL by the fraction of land owned by the formal sector FLOF, which is a long term average of the ratio between the desired land ownership in the formal sector DLOF and the total desired land ownership TDLO.

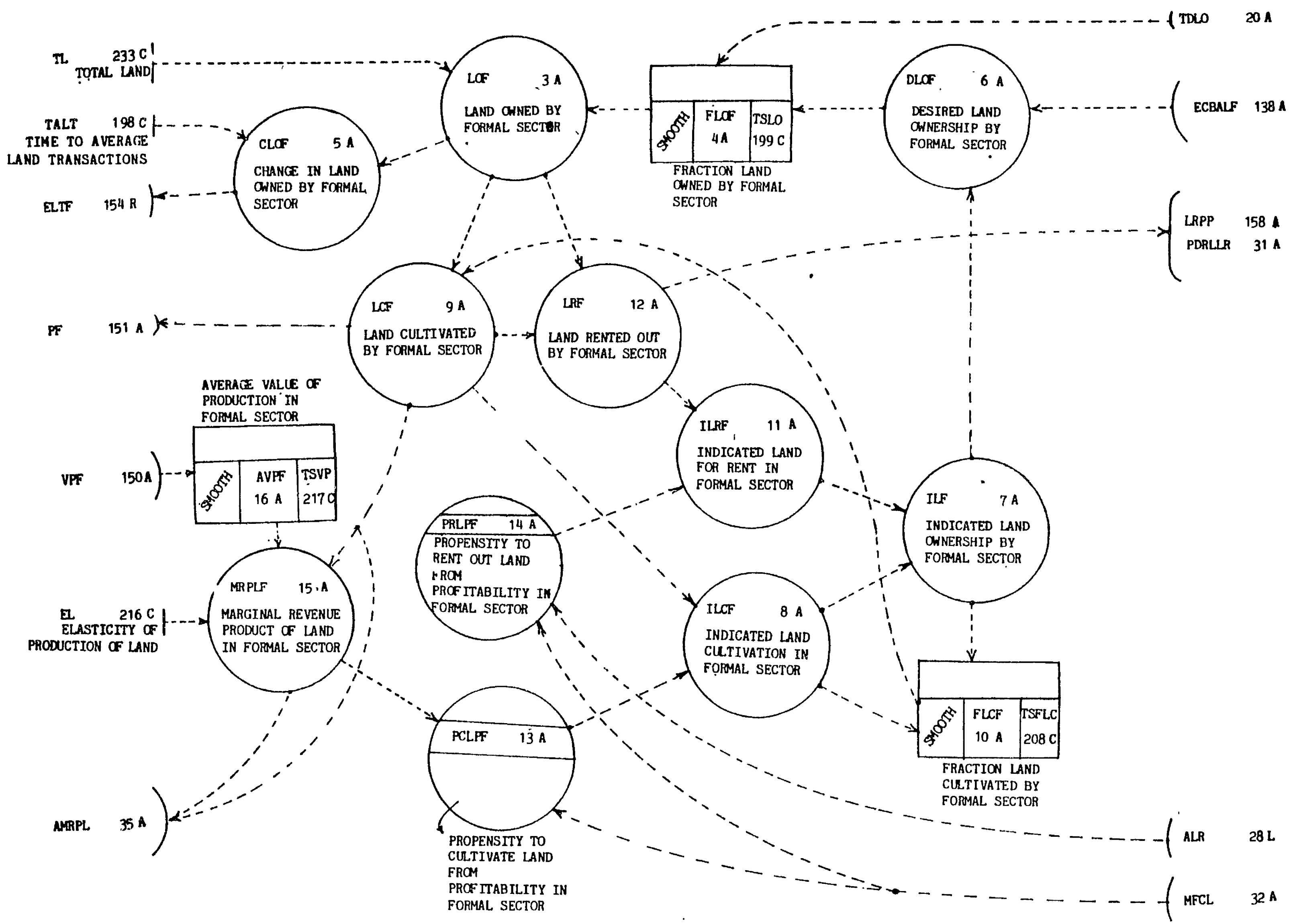


Figure A.1: Flow Diagram Showing Acquisition of Land by the Formal Sector and its Allocation to Commercial Farming and Renting Activities.

The PULSE function added to the right hand side of equation 3,A is exogenous and serves to transfer land ownership from one sector to the other for purposes of testing the model.

```
LOF.K=TL*FLOF.K-PULSE(LTPLR/DT,TPTST,10000)           3, A
LOF=NLOF                                              3.1, N
    LOF    - LAND OWNED BY FORMAL SECTOR (LAND UNITS)
    TL     - TOTAL LAND (LAND UNITS)
    FLOF   - FRACTION LAND OWNED BY FORMAL SECTOR
               (DIMENSIONLESS)
    LTPLR  - LAND TRANSFERED TO PEASANTS DUE TO LAND
               REFORM (LAND UNITS)
    DT     - SIMULATION SOLUTION INTERVAL (TIME UNITS)
    TPTST  - TIME FOR POLICY TEST (TIME UNIT)
    NLOF   - INITIAL LAND OWNED BY FORMAL SECTOR (LAND
               UNITS)

FLOF.K=SMOOTH(DLOF.K/TDLO.K,TSLO)                     4, A
FLOF=NFLOF                                            4.1, N
    FLOF   - FRACTION LAND OWNED BY FORMAL SECTOR
               (DIMENSIONLESS)
    DLOF   - DESIRED LAND OWNERSHIP BY FORMAL SECTOR
               (LAND UNITS)
    TDLO   - TOTAL DESIRED LAND OWNERSHIP (LAND UNITS)
    TSLO   - TIME TO SMOOTH LAND OWNERSHIP (TIME UNITS)
    NFLOF  - INITIAL FRACTION LAND OWNED BY FORMAL
               SECTOR (DIMENSIONLESS)
```

The rate of change of land ownership in the formal sector CLOF is calculated for accounting purposes, by constructing a derivative of LOF with respect to time. This is done by averaging LOF over a small time interval, subtracting the average from the current value of LOF, and dividing the difference by the averaging time.

```
CLOF.K=(LOF.K-SMOOTH(LOF.K,TALT))/TALT                5, A
    CLOF   - CHANGE IN LAND OWNED BY FORMAL SECTOR (LAND
               UNITS/TIME UNIT)
    LOF    - LAND OWNED BY FORMAL SECTOR (LAND UNITS)
    TALT   - TIME TO AVERAGE LAND TRANSACTIONS (TIME
               UNITS)
```

The desired land ownership in a sector depends on the current land ownership, profitability of land as a production factor or as rent accruing property, and the financial adequacy of the sector. Desired land ownership in the formal sector DLOF is calculated by multiplying the indicated land ownership ILF by the Effect of Cash Balance Availability on Land Ownership ECBALF. Indicated land ownership ILF is the sum of indicated land for cultivation ILCF and indicated land for renting ILRF, each of which depends upon the current value of land in cultivation or renting activity (LCF, and LRF), and the respective propensities to expand those activities on the basis of economic profitability of each (PCLPF, PRLPF).

Land owned by the sector is distributed between cultivating and renting activities depending on which of the two accrue higher returns on land. Equations 6 to 12 describe the mechanisms that determine DLOF, and the distribution of LOF between cultivation and renting activities.

```
DLOF.K=ILF.K*ECBALF.K                                  6, A
    DLOF   - DESIRED LAND OWNERSHIP BY FORMAL SECTOR
               (LAND UNITS)
    ILF    - INDICATED LAND OWNERSHIP BY FORMAL SECTOR
               (LAND UNITS)
    ECBALF - EFFECT OF CASH BALANCE AVAILABILITY ON LAND
               DEMAND IN FORMAL SECTOR (DIMENSIONLESS)

ILF.K=ILCF.K+ILRF.K                                    7, A
    ILF    - INDICATED LAND OWNERSHIP BY FORMAL SECTOR
               (LAND UNITS)
    ILCF   - INDICATED LAND CULTIVATION IN FORMAL SECTOR
               (LAND UNITS)
    ILRF   - INDICATED LAND FOR RENT IN FORMAL SECTOR
               (LAND UNITS)
```

```
ILCF.K=LCF.K*PCLPF.K                                        8, A
    ILCF    - INDICATED LAND CULTIVATION IN FORMAL SECTOR
                (LAND UNITS)
    LCF     - LAND CULTIVATED BY FORMAL SECTOR (LAND
                UNITS)
    PCLPF   - PROPENSITY TO CULTIVATE LAND FROM
                PROFITABILITY IN FORMAL SECTOR
                (DIMENSIONLESS)

LCF.K=FLCF.K*LOF.K-LOF.K*PULSE(NFLR,TPTSTR,10000)           9, A
LCF=NLCF                                                    9.1, N
    LCF     - LAND CULTIVATEhD BY FORMAL SECTOR (LAND
                UNITS)
    FLCF    - FRACTION LAND CULTIVATED BY FORMAL SECTOR
                (DIMENSIONLESS)
    LOF     - LAND OWNED BY FORMAL SECTOR (LAND UNITS)
    NFLR    - INITIAL FRACTION OF LAND RENTED OUT BY
                FORMAL SECTOR (DIMENSIONLESS)
    TPTSTR  - TIME OF POLICY TEST FOR RENTING (TIME UNIT)
    NLCF    - INITIAL LAND CULTIVATED BY FORMAL SECTOR
                (LAND UNITS)

FLCF.K=SMOOTH(ILCF.K/ILF.K,TSFLC)                           10, A
FLCF=NFLCF                                                  10.1, N
    FLCF    - FRACTION LAND CULTIVATED BY FORMAL SECTOR
                (DIMENSIONLESS)
    ILCF    - INDICATED LAND CULTIVATION IN FORMAL SECTOR
                (LAND UNITS)
    ILF     - INDICATED LAND OWNERSHIP BY FORMAL SECTOR
                (LAND UNITS)
    TSFLC   - TIME TO SMOOTH FRACTION OF LAND CULTIVATED
                (TIME UNITS)
    NFLCF   - INITIAL FRACTION LAND CULTIVATED IN FORMAL
                SECTOR (DIMENSIONLESS)

ILRF.K=LRF.K*PRLPF.K                                        11, A
    ILRF    - INDICATED LAND FOR RENT IN FORMAL SECTOR
                (LAND UNITS)
    LRF     - LAND RENTED OUT BY FORMAL SECTOR (LAND
                UNITS)
    PRLPF   - PROPENSITY TO RENT OUT LAND FROM
                PROFITABILITY IN FORMAL SECTOR
                (DIMENSIONLESS)

LRF.K=LOF.K-LCF.K                                           12, A
LRF=NLRF                                                    12.1, N
    LRF     - LAND RENTED OUT BY FORMAL SECTOR (LAND
                UNITS)
    LOF     - LAND OWNED BY FORMAL SECTOR (LAND UNITS)
    LCF     -- LAND CULTIVATED BY FORMAL SECTOR (LAND
                UNITS)
    NLRF    - INITIAL LAND RENTED OUT BY FORMAL SECTOR
                (LAND UNITS)
```

The propensity to cultivate land from profitability in the sector PCLPF is represented as a nonlinear function of the ratio between the marginal revenue product of land in the sector MRPLF, and the marginal factor cost of land MFCL. Figure A.2 illustrates this function. When MRPLF is zero, there will be a pressure to sell out all land. When MRPLF is equal to MFCL, there will be a tendency to maintain the current land holdings. When MRPLF exceeds MFCL, the sector will want to increase its land ownership. The speed of the decision to change land holdings, however, is limited by physical considerations and entrepreneural attitudes. Conservative and risk minimizing attitude prevails in most developing country rural economies [3], while purchazable land, particularly, around an existing farm, cannot be found easily due to intensive cultivation. Inheritence laws and land registration procedures make it further difficult to exchange land between parties [4]. Hence, the propensity PCLPF tapers off as the ratio between MRPLF and MFCL continues to rise.

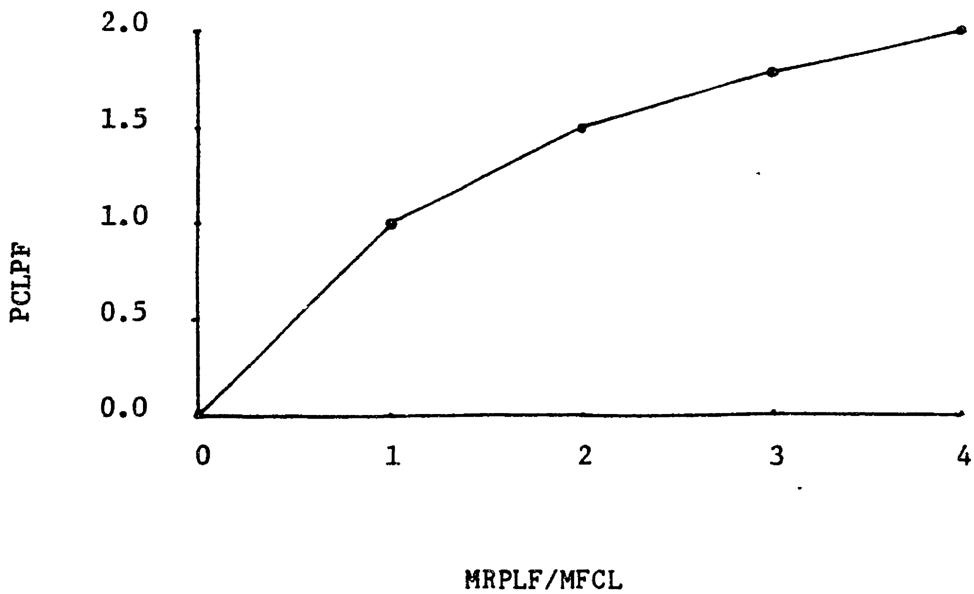


Figure A.2: The Propensity to Cultivate Land Profitability in the Formal Sector PCLPF.

```
PCLPF.K=TABHL(TLCP,MRPLF.K/(MFCL.K+STEP(LOT,          13, A
  TPTLOT)),0,4,1)
TLCP=0/1/1.5/1.8/2                                    13.1, T
    PCLPF  - PROPENSITY TO CULTIVATE LAND FROM
               PROFITABILITY IN FORMAL SECTOR
               (DIMENSIONLESS)
    TLCP   - TABLE FOR PROPENSITY TO CULTIVATE LAND FROM
               PROFITABILITY (DIMENSIONLESS)
    MRPLF  - MARGINAL REVENUE PRODUCT OF LAND IN FORMAL
               SECTOR (MONEY UNITS/LAND UNITS/TIME UNIT)
    MFCL   - MARGINAL FACTOR COST OF LAND (MONEY UNITS/
               LAND UNITS/TIME UNIT)
    STEP   - SWITCHING FUNCTION FROM DYNAMO
    LOT    - LAND OWNERSHIP TAX (MONEY UNITS/LAND UNITS/
               TIME UNIT)
    TPTLOT - TIME FOR POLICY TEST FOR LAND OWNERSHIP TAX
               (TIME UNIT)
```

PCLPF also affects the distribution of land owned by the formal sector between cultivation and renting activities. The speed of decision to redistribute land between these two activities is again limited by physical and entrepreneural factors. The upper limit for PCLPF is assumed to be 2, meaning that profit considerations may at best double targets for land under cultivation at any time. Sensitivity tests on the model indicate that an increase in the slope of the function PCLPF only increases the speed of transactions while leaving the behavior of the model unchanged.

The formal sector propensity to rent out land due to profitability in the renting activity PRLPF is represented as a nonlinear function of the ratio between average land rent ALR and the marginal factor cost of land MFCL, as shown in Figure A.3. The shape of this function is determined on considerations identical to those for PCLPF (Equation 13, A). The switching functions incorporating ownership and rent taxes have been added for testing various taxation policies:

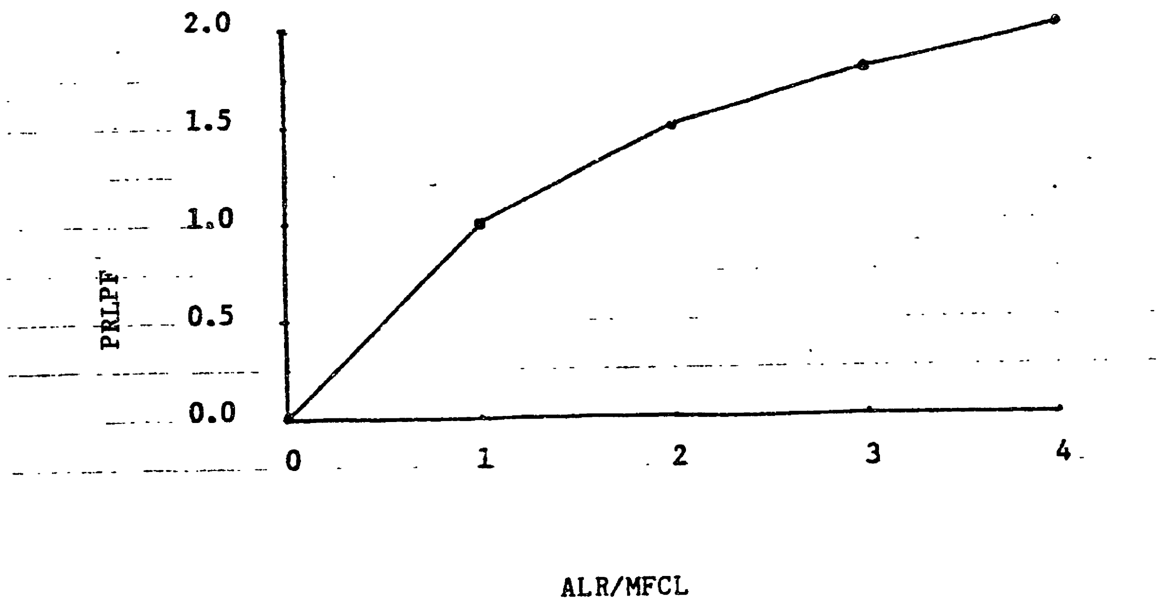


Figure A.3: The pressure to rent out land from profitability in the formal sector PRLPF

```
PRLPF.K=TABHL(TLRP,(ALR.K-ALR.K*STEP(LRT,TPTLRT))/  14, A
  (MFCL.K+STEP(LOT,TPTLOT)),0,4,1)
TLRP=0/1/1.5/1.8/2                                  14.2, T
    PRLPF  - PROPENSITY TO RENT OUT LAND FROM
               PROFITABILITY IN FORMAL SECTOR
               (DIMENSIONLESS)
    TLRP   - TABLE FOR PROPENSITY TO RENT OUT LAND FROM
               PROFITABILITY (DIMENSIONLESS)
    ALR    - AVERAGE LAND RENT (MONEY UNITS/LAND UNITS/
               TIME UNIT)
    STEP   - SWITCHING FUNCTION FROM DYNAMO
    LRT    - LAND RENT TEX (MONEY UNITS/MONEY UNIT OF
               LAND RENT)
    TPTLRT - TIME OF POLICY TEST FOR LAND RENT TEX (TIME
               UNIT)
    MFCL   - MARGINAL FACTOR COST OF LAND (MONEY UNITS/
               LAND UNITS/TIME UNIT)
```

```
        LOT    - LAND OWNERSHIP TAX (MONEY UNITS/LAND UNITS/
                   TIME UNIT)
        TPTLOT - TIME FOR POLICY TEST FOR LAND OWNERSHIP TAX
                   (TIME UNIT)
```

The marginal revenue product of land in the formal sector MRPLF is computed as a partial derivative of the average value of production of the sector AVPF with respect to the amount of land LCF cultivated by it. A Cobb Douglas type production function with constant returns to scales is assumed for simplicity. Although such a production function may not be valid under extreme conditions of factor mix, it behaves reasonably well over the range of factor variation in this study [5]. Average value of production AVPF is computed as a moving exponential average of the value of production VPF:

```
    MRPLF.K=EL*AVPF.K/LCF.K                                  15, A
        MRPLF  - MARGINAL REVENUE PRODUCT OF LAND IN FORMAL
                   SECTOR (MONEY UNITS/LAND UNITS/TIME UNIT)
        EL     - ELASTICITY OF PRODUCTION OF LAND
                   (DIMENSIONLESS)
        AVPF   - AVERAGE VALUE OF PRODUCTION IN FORMAL
                   SECTOR (MONEY UNITS/TIME UNIT)
        LCF    - LAND CULTIVATED BY FORMAL SECTOR (LAND
                   UNITS)

    AVPF.K=SMOOTH(VPF.K,TSVP)                                16, A
    AVPF=NVPF                                                16.1, N
        AVPF   - AVERAGE VALUE OF PRODUCTION IN FORMAL
                   SECTOR (MONEY UNITS/TIME UNIT)
        VPF    - VALUE OF PRODUCTION IN FORMAL SECTOR (MONEY
                   UNITS/TIME UNIT)
        TSVP   - TIME TO SMOOTH VALUE OF PRODUCTION (TIME
                   UNITS)
        NVPF   - INITIAL VALUE OF PRODUCTION IN FORMAL
                   SECTOR (MONEY UNITS/TIME UNIT)
```

1.2. Peasant Sector

Figure A.4 shows the processes that determine land cultivation and ownership in the peasant sector. Land cultivated by the peasant sector LCP is the sum of the land owned by the peasants LOP and the land rented out to peasants by the formal sector. Some models distinguish between land owning peasants and the landless tenants. In practice, it is difficult to differentiate between the two. Often, sharecropping tenants own some of the land they cultivate, while they rent the rest from the absentee landlords. The self-employed peasants may also work as wage laborers in their spare time, and un-employed wage workers may barter labor to peasant farmers for lodging and board. Thus, the assumption of a single peasant category is quite realistic:

```
LCP.K=LOP.K+LRF.K                                17, A
    LCP     - LAND CULTIVATED BY PEASANT SECTOR (LAND
                UNITS)
    LOP     - LAND OWNED BY PEASANT SECTOR (LAND UNITS)
    LRF     - LAND RENTED OUT BY FORMAL SECTOR (LAND
                UNITS)
```

Land owned by peasants LOP is determined in the same way as in case of the formal sector. Equation 18,A given below is identical to the equation 3,A. [For proof, see Note # 6].

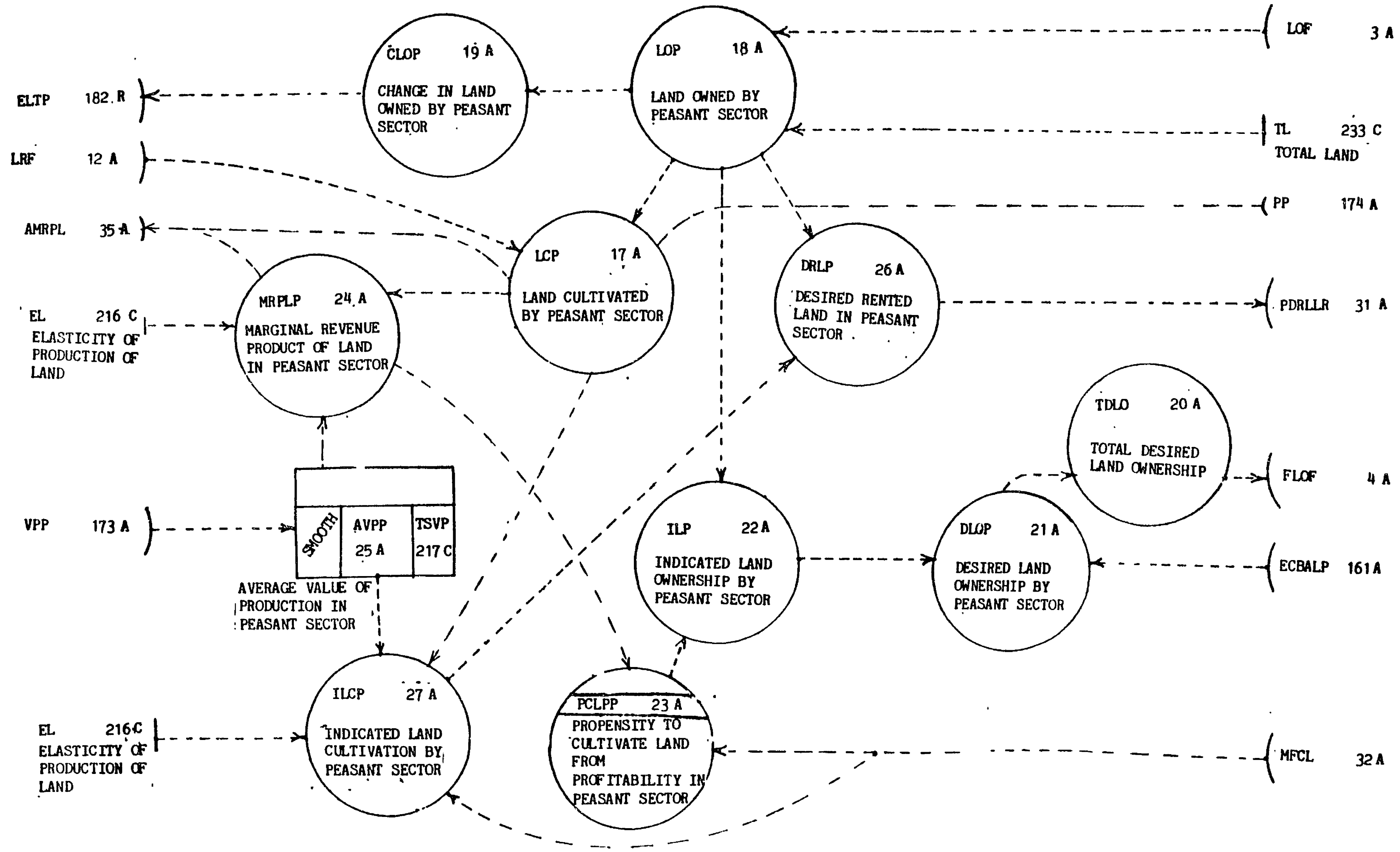


Figure A.4: Flow Diagram Showing Land Cultivation and ownership in the Peasant Sector.

```
LOP.K=TL-LOF.K                                           18, A
LOP=NLOP                                                 18.1, N
    LOP    - LAND OWNED BY PEASANT SECTOR (LAND UNITS)
    TL     - TOTAL LAND (LAND UNITS)
    LOF    - LAND OWNED BY FORMAL SECTOR (LAND UNITS)
    NLOP   - INITAIL LAND OWNED BY PEASANT SECTOR (LAND
               UNITS)
```

The change in land ownership CLOP and desired land ownership DLOP in the sector are also based on same criteria as in case of formal sector, as described in equations 19,A to 25,A.

```
 CLOP.K=(LOP.K-SMOOTH(LOP.K,TALT))/TALT                  19, A
    CLOP   - CHANGE IN LAND OWNED BY PEASANT SECTOR
               (LAND UNITS)
    LOP    - LAND OWNED BY PEASANT SECTOR (LAND UNITS)
    TALT   - TIME TO AVERAGE LAND TRANSACTIONS (TIME
               UNITS)

TDLO.K=DLOF.K+DLOP.K                                     20, A
    TDLO   - TOTAL DESIRED LAND OWNERSHIP (LAND UNITS)
    DLOF   - DESIRED LAND OWNERSHIP BY FORMAL SECTOR
               (LAND UNITS)
    DLOP   - DESIRED LAND OWNERSHIP BY PEASANT SECTOR
               (LAND UNITS)
DLOP.K=ILP.K*ECBALP.K                                    21, A
    DLOP   - DESIRED LAND OWNERSHIP BY PEASANT SECTOR
               (LAND UNITS)
    ILP    - INDICATED LAND OWNERSHIP BY PEASANT SECTOR
               (LAND UNITS)
    ECBALP - EFFECT OF CASH BALANCE AVAILABILITY ON LAND
               DEMAND IN PEASANT SECTOR (DIMENSIONLESS)

ILP.K=LOP.K*PCLPP.K                                      22, A
    ILP    - INDICATED LAND OWNERSHIP BY PEASANT SECTOR
               (LAND UNITS)
    LOP    - LAND OWNED BY PEASANT SECTOR (LAND UNITS)
    PCLPP  - PROPENSITY TO CLUTIVATE LAND
               FROM PROFITABILITY IN PEASANT SECTOR
               (DIMENSIONLESS)
```

```
PCLPP.K=TABHL(TLCP,MRPLP.K/(MFCL.K+STEP(LOTP,          23, A
  TPTLOT)),0,4,1)
    PCLPP  - PROPENSITY TO CLUTIVATE LAND
               FROM PROFITABILITY IN PEASANT SECTOR
               (DIMENSIONLESS)
    TLCP   - TABLE FOR PROPENSITY TO CULTIVATE LAND FROM
               PROFITABILITY (DIMENSIONLESS)
    MRPLP  - MARGINAL REVENUE PRODUCT OF LAND IN PEASANT
               SECTOR (MONEY UNITS/LAND UNITS/TIME UNIT)
    MFCL   - MARGINAL FACTOR COST OF LAND (MONEY UNITS/
               LAND UNITS/TIME UNIT)
    STEP   - SWITCHING FUNCTION FROM DYNAMO
    LOTP   - LAND OWNERSHIP TAX ON PEASANTS (MONEY
               UNITS/LAND UNITS/TIME UNIT)
    TPTLOT - TIME FOR POLICY TEST FOR LAND OWNERSHIP TAX
               (TIME UNIT)

MRPLP.K=EL*AVPP.K/LCP.K                                  24, A
    MRPLP  - MARGINAL REVENUE PRODUCT OF LAND IN PEASANT
               SECTOR (MONEY UNITS/LAND UNITS/TIME UNIT)
    EL     - ELASTICITY OF PRODUCTION OF LAND
               (DIMENSIONLESS)
    AVPP   - AVERAGE VALUE OF PRODUCTION IN PEASANT
               SECTOR (MONEY UNITS/TIME UNIT)
    LCP    - LAND CULTIVATED BY PEASANT SECTOR (LAND
               UNITS)

AVPP.K=SMOOTH(VPP.K,TSVP)                                25, A
AVPP=NVPP                                                25.1, N
    AVPP   - AVERAGE VALUE OF PRODUCTION IN PEASANT
               SECTOR (MONEY UNITS/TIME UNIT)
    VPP    - VALUE OF PRODUCTION IN PEASANT SECTOR
               (MONEY UNITS/TIME UNIT)
    TSVP   - TIME TO SMOOTH VALUE OF PRODUCTION (TIME
               UNITS)
    NVPP   - INITIAL VALUE OF PRODUCTION IN PEASANT
               SECTOR (MONEY UNITS/TIME UNIT)
```

While land available for renting is determined by the profitability criteria exercised by the formal sector, the demand for rented land affects these criteria by influencing land rent. The demand for rented land originates in the peasant sector and depends upon the difference between indicated land cultivation by the peasants ILCP and land owned by peasants LOP.

```
DRLP.K=ILCP.K-LOP.K                                    26, A
    DRLP   - DESIRED RENTED LAND IN PEASANT SECTOR (LAND
               UNITS)
    ILCP   - INDICATED LAND CULTIVATION BY PEASANT
               SECTOR (LAND UNITS)
    LOP    - LAND OWNED BY PEASANT SECTOR (LAND UNITS)
```

Indicated land cultivation by peasants ILCP depends upon the availabilities of workers and capital in the peasant sector and the marginal factor cost of land. ILCP is calculated by dividing the product of elasticity of production of land EL and the average value of production AVPP by the marginal factor cost of land MFCL:

```
ILCP.K=EL*AVPP.K/MFCL.K                                27, A
    ILCP   - INDICATED LAND CULTIVATION BY PEASANT
               SECTOR (LAND UNITS)
    EL     - ELASTICITY OF PRODUCTION OF LAND
               (DIMENSIONLESS)
    AVPP   - AVERAGE VALUE OF PRODUCTION IN PEASANT
               SECTOR (MONEY UNITS/TIME UNIT)
    MFCL   - MARGINAL FACTOR COST OF LAND (MONEY UNITS/
               LAND UNITS/TIME UNIT)
```

1.3. Land Rent and Price of Land

Figure A.5 shows mechanisms underlying determination of land price and land rent. Land rent is determined through bargaining between the renters and the rentees, and depends upon the aggregate marginal revenue product of land in the economy AMRPL, the demand for rented land in the peasant sector DRLP, and the availability of land for rent in the capitalist sector LRF. If the demand for rented land in the peasant sector DRLP is comparable to the land available for rent in the formal sector

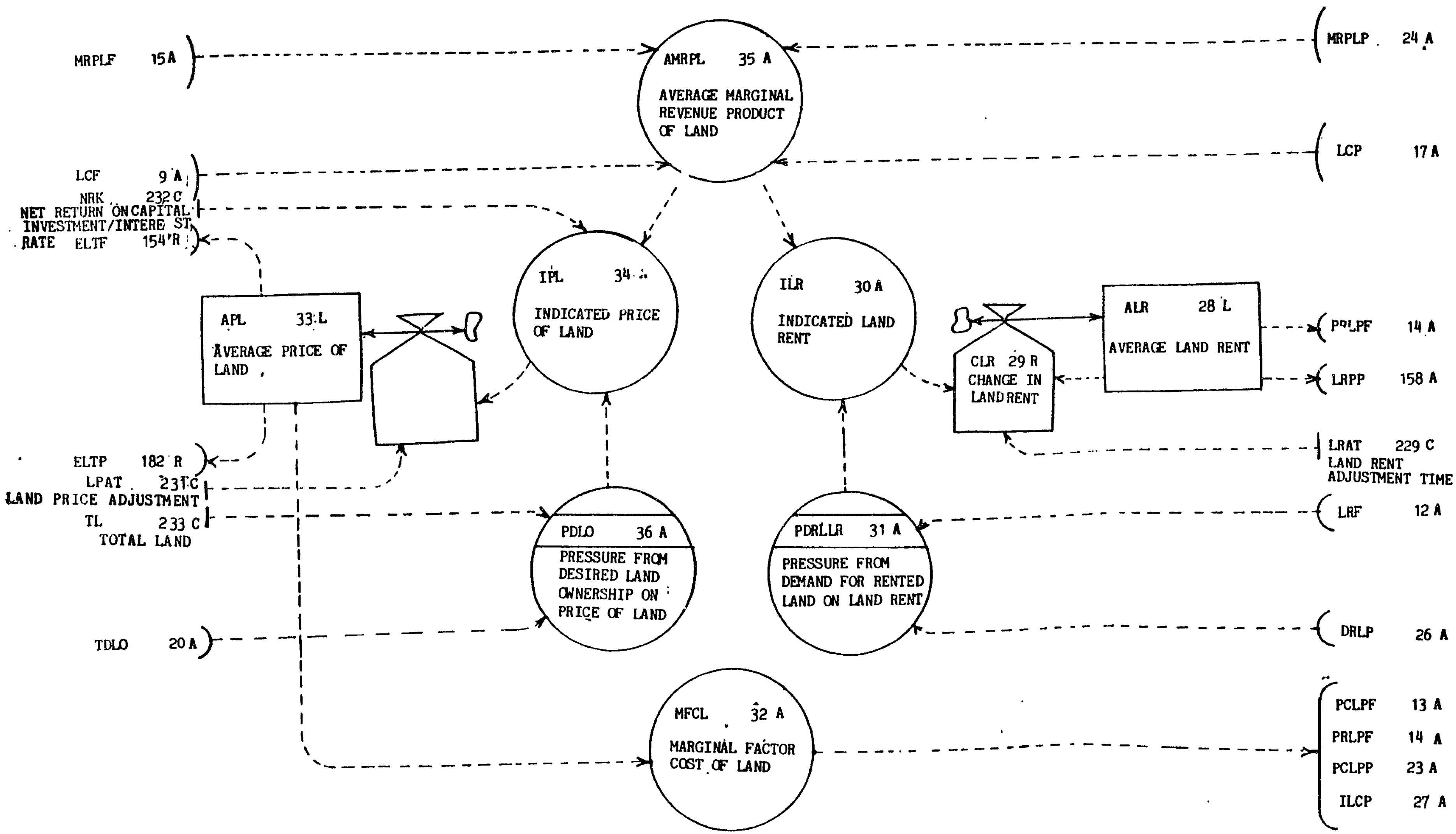


Figure A.5: Flow Diagram Showing Determination of Land Price and Rent.

LRF, a land rent equal to the aggregate marginal revenue product of land AMRPL will be charged. Land rent will tend to go up if demand for rented land exceeds the supply, and vice versa.

Average land rent ALR is represented as a level which adjusts towards an indicated land rent ILR. The indicated land rent ILR depends upon the aggregate marginal revenue product of land in the economy AMRLP and the pressure from demand for rented land on land rent PDRLLR, as described in equations 28 to 30. The switching functions in equation 28 have been introduced for switching in and out equations for land renting transactions, in order to study the role of land renting in determining system behavior.

```
ALR.K=ALR.J+(DT)(CLR.JK)                                28, L
ALR=NALR                                                28.1, N
    ALR     - AVERAGE LAND RENT (MONEY UNITS/LAND UNITS/
                TIME UNIT)
    DT      - SIMULATION SOLUTION INTERVAL (TIME UNITS)
    CLR     - CHANGE IN LAND RENT (MONEY UNITS/LAND
                UNITS/TIME UNIT/TIME UNIT)
    NALR    - INITIAL LAND RENT (MONEY UNITS/LAND UNITS/
                TIME UNIT)

CLR.KL=(ILR.K-ALR.K)/LRAT                               29, R
    CLR     - CHANGE IN LAND RENT (MONEY UNITS/LAND
                UNITS/TIME UNIT/TIME UNIT)
    ILR     - INDICATED LAND RENT (MONEY UNITS/LAND
                UNITS/TIME UNIT)
    ALR     - AVERAGE LAND RENT (MONEY UNITS/LAND UNITS/
                TIME UNIT)
    LRAT    - LAND RENT ADJUSTMENT TIME (TIME UNITS)
```

```
ILR.K=AMRPL.K*FIFGE(1,PDRLLR.K,0,STEP(SWR,TPTSTR))  30, A
    ILR     - INDICATED LAND RENT (MONEY UNITS/LAND
                UNITS/TIME UNIT)
    AMRPL   - AVERAGE MARGINAL REVENUE PRODUCT OF LAND
                (MONEY UNITS/LAND UNITS/TIME UNIT)
    FIFGE   - SWITCHING FUNCTION FROM DYNAMO
    PDRLLR  - PRESSURE FROM DEMAND FOR RENTED LAND ON
                LAND RENT (DIMENSIONLESS)
    STEP    - SWITCHING FUNCTION FROM DYNAMO
    SWR     - SWITCH FOR RENTING POLICY (DIMENSIONLESS)
    TPTSTR  - TIME OF POLICY TEST FOR RENTING (TIME UNIT)
```

The pressure from demand for rented land on land rent PDRLLR is represented as a function of the ratio between desired rented land in the peasant sector DRLP and the land rented out by the formal sector LRF, as illustrated in Figure A.6. PDRLLR is assumed to play a minor role in determining land rent, which primarily depends on AMRPL. Thus, its slope is small. The value of PDRLLR is unity when demand for rented land is equal to the supply. PDRLLR is assumed to suppress rent to 90 percent of AMPRL when there is no demand for rented land but rentable land is available. When DRLP exceeds LRF, PDRLLR rises above unity, but with decreasing increments, as unlimited increase in land rent is not possible due to finite production using land as a factor. Changing slope of the function representing PDRLLR serves only to change the speed at which land is transfered to the renting activity, while having little effect on the dynamic behavior of the system.

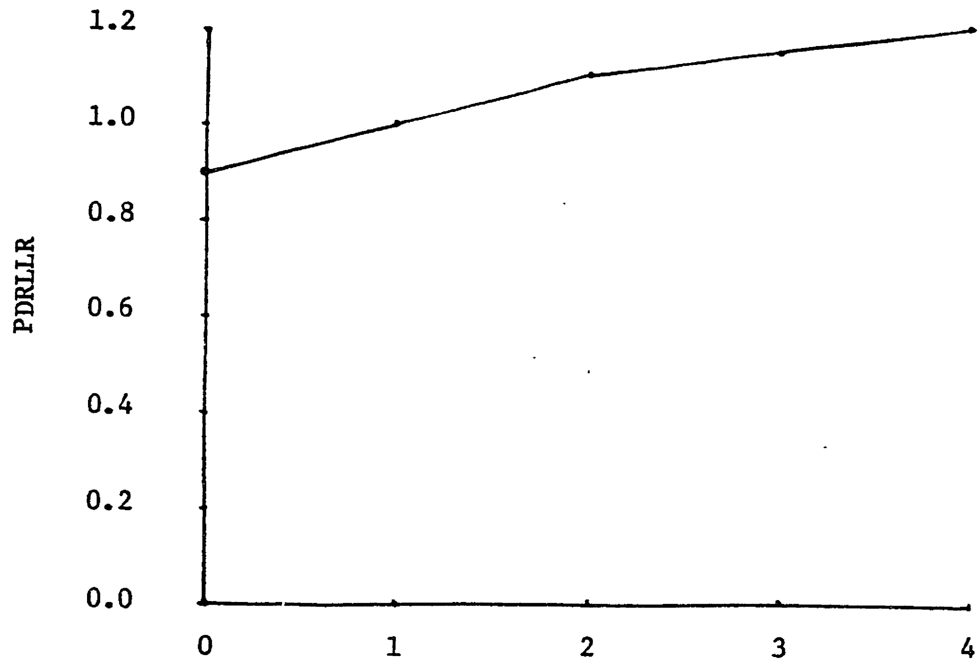


Figure A.6: The pressure from demand for rented land on land rent PDRLLR.

```
PDRLLR.K=TABHL(TDRLLR,DRLP.K/FIFGE(1,LRF.K,0,          31, A
  STEP(SWR,TPTSTR)),0,4,1)
TDRLLR=.9/1/1.1/1.15/1.2                                31.2, T
    PDRLLR - PRESSURE FROM DEMAND FOR RENTED LAND ON
               LAND RENT (DIMENSIONLESS)
    TDRLLR - TABLE FOR PRESSURE FROM DEMAND FOR RENTED
               LAND ON LAND RENT (DIMENSIONLESS)
    DRLP   - DESIRED RENTED LAND IN PEASANT SECTOR (LAND
               UNITS)
    FIFGE  - SWITCHING FUNCTION FROM DYNAMO
    LRF    - LAND RENTED OUT BY FORMAL SECTOR (LAND
               UNITS)
    STEP   - SWITCHING FUNCTION FROM DYNAMO
    SWR    - SWITCH FOR RENTING POLICY (DIMENSIONLESS)
    TPTSTR - TIME OF POLICY TEST FOR RENTING (TIME UNIT)
```

The marginal factor cost of land MFCL is the opportunity cost of investment in land. If NRK is the normal rate of return on capital (or interest rate), and APL the average price of land, MFCL is calculated as follows:

```
MFCL.K=APL.K*NRK                                          32, A
    MFCL   - MARGINAL FACTOR COST OF LAND (MONEY UNITS/
               LAND UNITS/TIME UNIT)
    APL    - AVERAGE PRICE OF LAND (MONEY UNITS/LAND
               UNITS)
    NRK    - NET RETURN ON CAPITAL INVESTMENT/INTEREST
               RATE (RUPPES/TIME UNIT/MONEY UNIT)
```

Average price of land APL is represented as a level that tends to adjust towards indicated price of land IPL. IPL depends on the average marginal revenue product of land AMRPL, the interest rate NRK, and the pressure from desired land ownership on price of land PDLO, the underlying assumption being that investors will be willing to exchange one unit of land by the amount of savings which accrue an equivalent amount of return. However, if the demand for land ownership is higher than the land available, due to an excessive supply of savings [7], land prices will be pushed up and vice versa.

```
APL.K=APL.J+(DT/LPAT)(IPL.J-APL.J)                        33, L
APL=NAPL                                                  33.1, N
    APL    - AVERAGE PRICE OF LAND (MONEY UNITS/LAND
               UNITS)
    DT     - SIMULATION SOLUTION INTERVAL (TIME UNITS)
    LPAT   - LAND PRICE ADJUSTMENT TIME (TIME UNITS)
    IPL    - INDICATED PRICE OF LAND (MONEY UNITS/LAND
               UNITS)
    NAPL   - INITIAL AVERAGE PRICE OF LAND (MONEY UNITS/
               LAND UNITS)
```

IPL.K=AMRPL.K/NRK*PDLO.K 34, A

- IPL - INDICATED PRICE OF LAND (MONEY UNITS/LAND UNITS)
- AMRPL - AVERAGE MARGINAL REVENUE PRODUCT OF LAND (MONEY UNITS/LAND UNITS/TIME UNIT)
- NRK - NET RETURN ON CAPITAL INVESTMENT/INTEREST RATE (RUPPES/TIME UNIT/MONEY UNIT)
- PDLO - PRESSURE FROM DESIRED LAND OWNERSHIP ON PRICE OF LAND (DIMENSIONLESS)

AMRPL.K=(MRPLF.K*LCF.K+MRPLP.K*LCP.K)/(LCF.K+LCP.K) 35, A

- AMRPL - AVERAGE MARGINAL REVENUE PRODUCT OF LAND (MONEY UNITS/LAND UNITS/TIME UNIT)
- MRPLF - MARGINAL REVENUE PRODUCT OF LAND IN FORMAL SECTOR (MONEY UNITS/LAND UNITS/TIME UNIT)
- LCF - LAND CULTIVATED BY FORMAL SECTOR (LAND UNITS)
- MRPLP - MARGINAL REVENUE PRODUCT OF LAND IN PEASANT SECTOR (MONEY UNITS/LAND UNITS/TIME UNIT)
- LCP - LAND CULTIVATED BY PEASANT SECTOR (LAND UNITS)

The function representing pressure from desired land ownership on price of land PDLO is illustrated in Figure A.7, and incorporates the same criteria as those for the function PDRLLR described in equation 31,A.

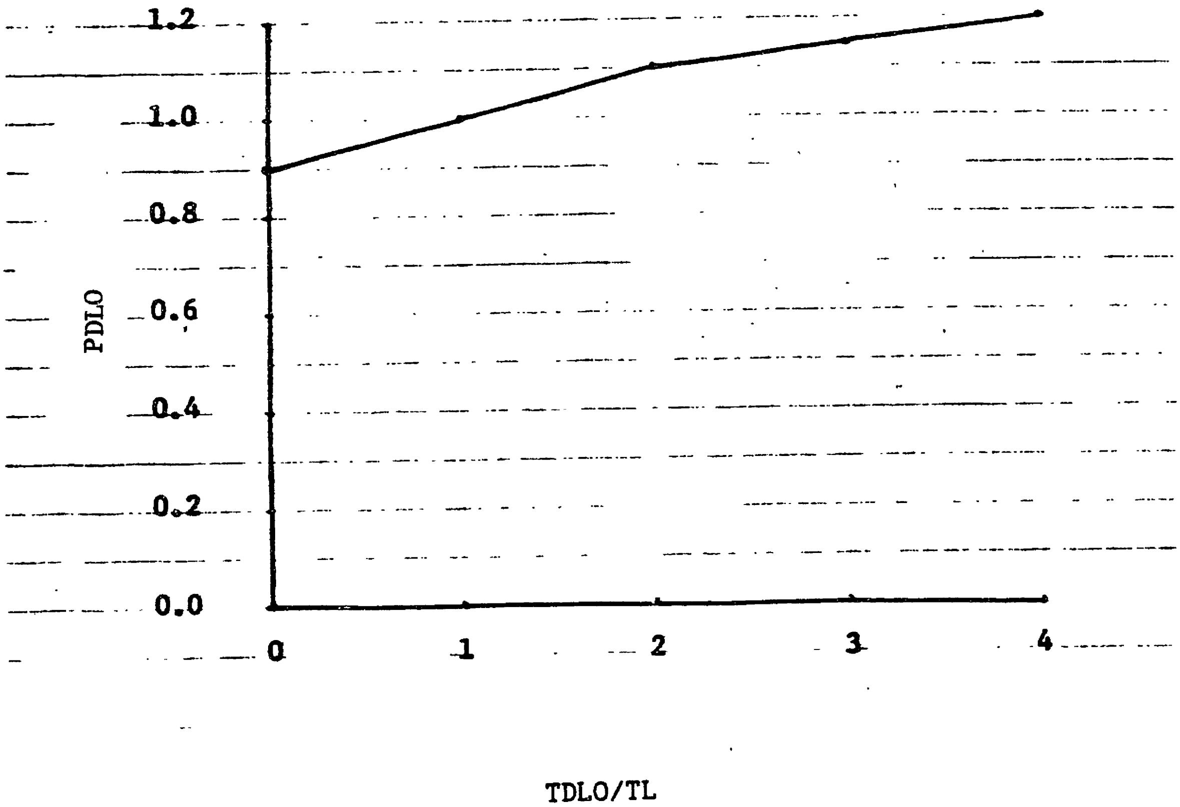


Figure A.7: The pressure from demand for land ownership on average price of land PDLO.

```
PDLO.K=TABHL(TPDLO,TDLO.K/TL,0,4,1)                    36, A
TPDLO=.9/1/1.1/1.15/1.2                                36.1, T
    PDLO    - PRESSURE FROM DESIRED LAND OWNERSHIP ON
                PRICE OF LAND (DIMENSIONLESS)
    TPDLO   - TABLE FOR PRESSURE FOR DESIRED LAND
                OWNERSHIP ON PRICE OF LAND
                (DIMENSIONLESS)
    TDLO    - TOTAL DESIRED LAND OWNERSHIP (LAND UNITS)
    TL      - TOTAL LAND (LAND UNITS)
```

Total land available for cultivation TL is specified as a parameter. Thus, changes in TL can be instituted only exogenously, as policy changes. Only privately owned land is considered, as in case of Pakistan, 49 million hectares of the total 49.2 million hectares of farm area is constituted by private farms. Also due to a formalized land ownership system, total private land ownership cannot increase until state land is transfered to the private sector. Private farm area has slightly increased over the past few decades due to opening up of new irrigation schemes and allotment of state land to private farmers. Over 82% of the private farm area is cultivated. The percentage of owned area cultivated decreases with the increase in farm size [8,9]. For simplification, it has been assumed in the model that all privately owned farmland is cultivated, but the intensity of cultivation depends upon the availability of capital and labor.

2. Allocation of Workers

2.1. Formal Sector

Figure A.8 shows the processes governing allocation of workers between the formal and the peasant sectors. The key assumption underlying this allocation is that formal sector will adjust its workforce on the basis of profitability criteria, while the peasant sector will absorb the balance of the rural workforce. The profitability of workers in the formal sector, however, is affected by the wage rate, which depends upon the collective bargaining position of the workers, determined by their opportunity costs of refusing wage-employment in the formal sector. These opportunity costs are given by the overall average consumption per worker, including wage-workers as well as self-employed peasants. The workers will be indifferent towards staying in the peasant sector or being employed by the formal sector as long as wage offered to them is equal to the consumption forgone by the peasant sector due to their departure from the peasant sector workforce. Thus, the formal sector is able to hire as many workers as it needs (provided their number does not exceed total workforce), at a wage rate equal to the average per capita consumption of workers [10,11,12].

The assumption that the workers in the peasant sector and the wage labor are part of one big family that strives to

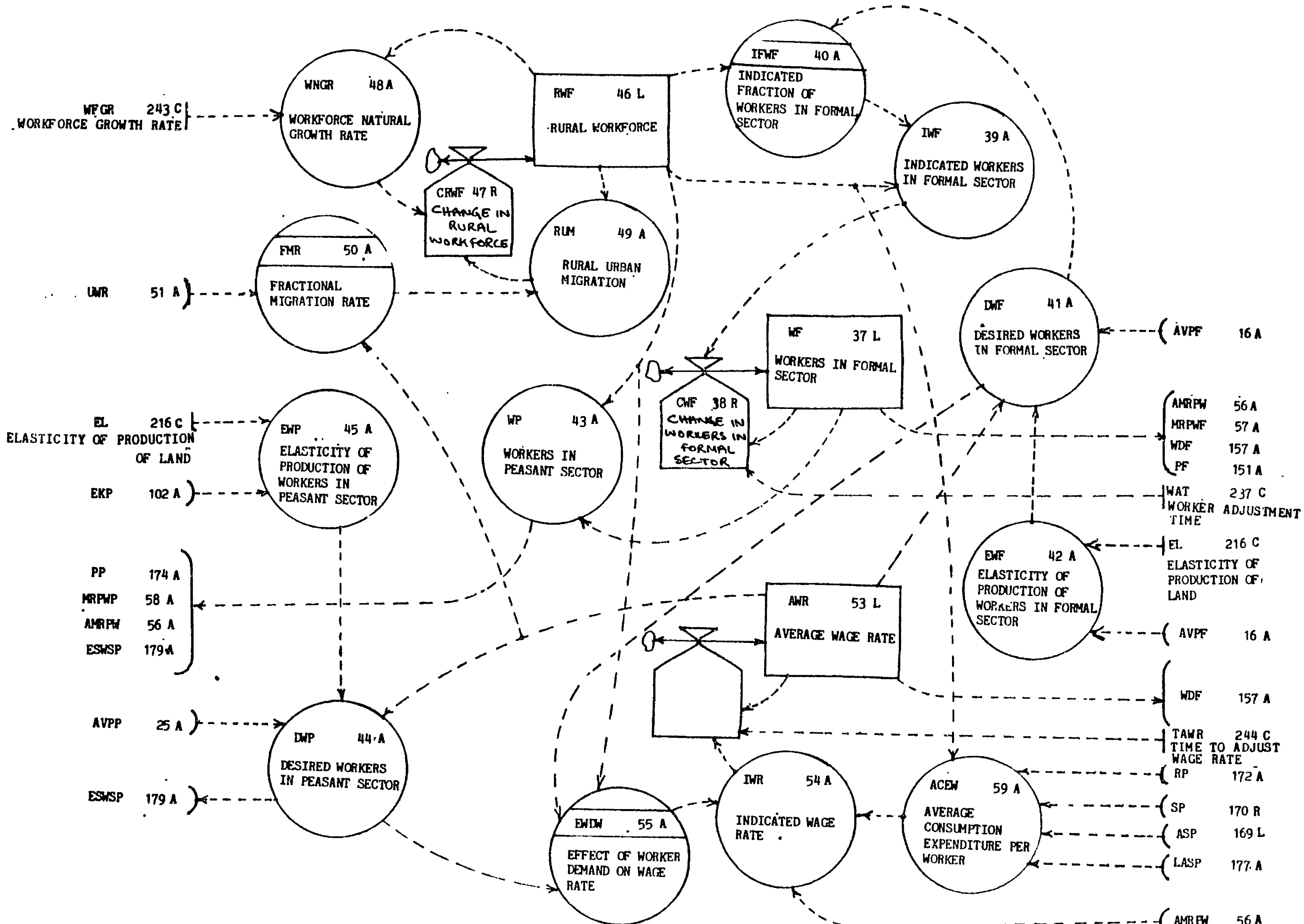


Figure A.8: Flow Diagram Showing Allocation of Workers Between Sectors.

maximize its consumption is quite reasonable. Family ties between peasants and wage workers are quite common, and unemployed workers usually share board and lodging with self-employed relatives and friends in exchange for helping them with farming. It is also not uncommon for the self-employed peasants and sharecroppers to seek wage work in the formal sector when they have surplus time.

The number of landlords in the formal sector is not explicitly represented in the model. This number is assumed to be small as compared to the number of workers, so that it does not add to the worker strength. Indeed, most bigger landlords in Pakistan were absentee and relied largely on sharecropping before modern capital inputs were made available in the country. Over the decade of 1960s, commercial farming using modern capital inputs expanded considerably, but the number of commercial farm owners never exceeded 10,000 [13]. Labor or managerial contribution of these farmers is neglected.

Workers in the formal sector WF are represented as a level, which adjusts towards an indicated level IWF. Indicated workforce IWF is computed as a product of indicated fraction of workforce in the formal sector IFWF, and the rural workforce RWF. The switching function in equation 38,R is not a part of the model structure, but represents a mechanism for testing the model response to exogeneous changes in worker distribution.

```
WF.K=WF.J+(DT)(CWF.JK)                                         37, L
WF=NWF                                                         37.1, N
    WF     - WORKERS IN FORMAL SECTOR (PERSONS)
    DT     - SIMULATION SOLUTION INTERVAL (TIME UNITS)
    CWF    - CHANGE IN WORKERS IN FORMAL SECTOR
               (PERSONS/TIME UNIT)
    NWF    - INITIAL WORKERS IN FORMAL SECTOR (PERSONS)

CWF.KL=(IWF.K-WF.K)/WAT+PULSE(WTTST/DT,TPTST,10000) 38, R
    CWF    - CHANGE IN WORKERS IN FORMAL SECTOR
               (PERSONS/TIME UNIT)
    IWF    - INDICATED WORKERS IN FORMAL SECTOR
               (PERSONS)
    WF     - WORKERS IN FORMAL SECTOR (PERSONS)
    WAT    - WORKER ADJUSTMENT TIME (TIME UNITS)
    WTTST  - WORKERS TRANSFERED FOR TESTING MODEL
               (PERSONS)
    DT     - SIMULATION SOLUTION INTERVAL (TIME UNITS)
    TPTST  - TIME FOR POLICY TEST (TIME UNIT)

IWF.K=RWF.K*IFWF.K                                             39, A
    IWF    - INDICATED WORKERS IN FORMAL SECTOR
               (PERSONS)
    RWF    - RURAL WORKFORCE (PERSONS)
    IFWF   - INDICATED FRACTION OF WORKERS IN FORMAL
               SECTOR (DIMENSIONLESS)
```

The indicated fraction of workforce in the formal sector IFWF is represented as a function of the ratio between indicated workers in the formal sector IWF and the rural workforce RWF. The shape of this function is illustrated in Figure A.9. IFWF is a non-linear function of the ratio IWF/RWF, with a maximum value of .975, meaning that due to frictional unemployment and job changes, a frictional unemployment of 2.5 percent must remain even when jobs are available for all.

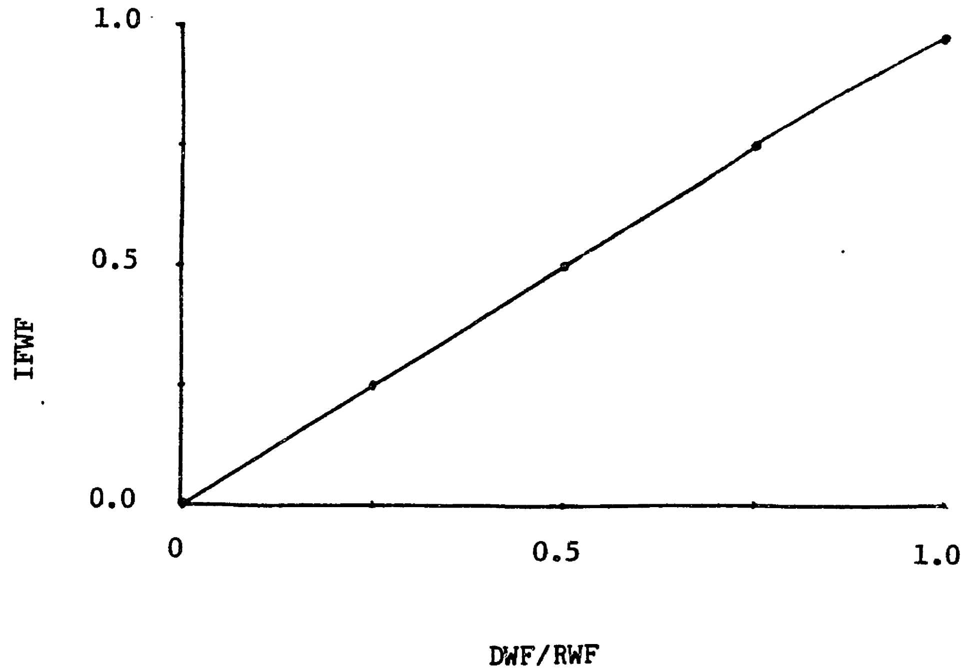


Figure A.9: The Indicated Fraction of Workers in the Formal Sector IFWF.

```
IFWF.K=TABHL(TFWF,DWF.K/RWF.K,0,1,.25)                   40, A
TFWF=0/.25/.5/.75/.975                                   40.1, T
    IFWF    - INDICATED FRACTION OF WORKERS IN FORMAL
                SECTOR (DIMENSIONLESS)
    TFWF    - TABLE FOR FRACTION OF WORKERS IN FORMAL
                SECTOR (DIMENSIONLESS)
    DWF     - DESIRED WORKERS IN FORMAL SECTOR (PERSONS)
    RWF     - RURAL WORKFORCE (PERSONS)
```

The desired workers in the formal sector DWF are determined by dividing the factor contribution of workers by the average wage rate AWR:

DWF.K=EWF.K*AVPF.K/AWR.K 41, A

DWF - DESIRED WORKERS IN FORMAL SECTOR (PERSONS)
EWF - ELASTICITY OF PRODUCTION OF WORKERS IN FORMAL SECTOR (DIMENSIONLESS)
AVPF - AVERAGE VALUE OF PRODUCTION IN FORMAL SECTOR (MONEY UNITS/TIME UNIT)
AWR - AVERAGE WAGE RATE (MONEY UNITS/PERSON/TIME UNIT)

EWF.K=1-EL-EKF.K 42, A

EWF - ELASTICITY OF PRODUCTION OF WORKERS IN FORMAL SECTOR (DIMENSIONLESS)
EL - ELASTICITY OF PRODUCTION OF LAND (DIMENSIONLESS)
EKF - ELASTICITY OF PRODUCTION OF CAPITAL IN FORMAL SECTOR

2.2. Peasant Sector

Workers in the peasant sector WP are calculated by subtracting workers in the formal sector from the rural workforce. As the peasant sector cannot exercise hiring or firing ability, WP can exceed desired workers in the peasant sector DWP or fall short of it, depending on the hiring and firing behavior of the formal sector.

DWP is determined on the basis of the remuneration available in wage employment. When wage rate depends on the average consumption level of workers, DWP will be less than WP as long as average consumption of workers exceed their marginal revenue product. DWP will equal WP only when workers have no claim to income on the basis of ownership, which can occur if self-employed workers use only rented resources.

Determination of DWP in this way embodies the short term consumption maximixing attitude of workers as discussed in various studies [14]. As self-employment using own resources requires investment for maintaining those resources, extra revenue for such investment must be generated for supporting a given consumption level. If wage employment offering equivalent consumption level is available, the peasant sector would prefer to transfer some of its workers to wage employment instead of continuing to support self-emplyment infrastructure at the current level. Further implications of this assumption are discussed in the context of saving equations.

```
WP.K=RWF.K-WF.K                                          43, A
WP=NWP                                                   43.1, N
    WP     - WORKERS IN PEASANT SECTOR (PERSONS)
    RWF    - RURAL WORKFORCE (PERSONS)
    WF     - WORKERS IN FORMAL SECTOR (PERSONS)
    NWP    - INITIAL WORKERS IN PEASANT SECTOR (PERSONS)

DWP.K=EWP.K*AVPP.K/AWR.K                                 44, A
    DWP    - DESIRED WORKERS IN PEASANT SECTOR (PERSONS)
    EWP    - ELASTICITY OF PRODUCTION OF WORKERS IN
               PEASANT SECTOR (DIMENSIONLESS)
    AVPP   - AVERAGE VALUE OF PRODUCTION IN PEASANT
               SECTOR (MONEY UNITS/TIME UNIT)
    AWR    - AVERAGE WAGE RATE (MONEY UNITS/PERSON/TIME
               UNIT)

EWP.K=1-EL-EKP.K                                         45, A
    EWP    - ELASTICITY OF PRODUCTION OF WORKERS IN
               PEASANT SECTOR (DIMENSIONLESS)
    EL     - ELASTICITY OF PRODUCTION OF LAND
               (DIMENSIONLESS)
    EKP    - ELASTYICITY OF PRODUCTION OF CAPITAL IN
               PEASANT SECTOR (DIMENSIONLESS)
```

2.3. Rural Workforce and Average Wage Rate

The rural workforce RWF is represented as a level, which is changed by the workforce natural growth rate WNGR due to births and deaths, and the rural urban migration RUM. The step function in equation 50,A represents a switching arrangement for testing exogeneous migration policies.

```
RWF.K=RWF.J+(DT)(CRWF.JK)                                   46, L
RWF=NRWF                                                    46.1, N
    RWF     - RURAL WORKFORCE (PERSONS)
    DT      - SIMULATION SOLUTION INTERVAL (TIME UNITS)
    CRWF    - CHANGE IN RURAL WORKFORCE (PERSONS/TIME
                UNIT)
    NRWF    - INITAIL RURAL WORKFORCE (PERSONS)

CRWF.KL=WNGR.K-RUM.K                                        47, R
    CRWF    - CHANGE IN RURAL WORKFORCE (PERSONS/TIME
                UNIT)
    WNGR    - WORKFORCE NATURAL GROWTH RATE (PERSONS/TIME
                UNIT)
    RUM     - RURAL URBAN MIGRATION (PERSONS/TIME UNIT)

WNGR.K=RWF.K*STEP(WFGR,TPTSTG)                              48, A
    WNGR    - WORKFORCE NATURAL GROWTH RATE (PERSONS/TIME
                UNIT)
    RWF     - RURAL WORKFORCE (PERSONS)
    STEP    - SWITCHING FUNCTION FROM DYNAMO
    WFGR    - WORKFORCE GROWTH RATE (FRACTION/TIME UNIT)
    TPTSTG  - TIME OF POLICY TEST FOR GROWTH (TIME UNIT)

RUM.K=RWF.K*FMR.K                                           49, A
    RUM     - RURAL URBAN MIGRATION (PERSONS/TIME UNIT)
    RWF     - RURAL WORKFORCE (PERSONS)
    FMR     - FRACTIONAL MIGRATION RATE (FRACTION/TIME
                UNIT)
```

The fractional migration rate FMR is a function of the ratio between urban and rural wage rates, as shown in Figure A.10. When urban wage rate UWR is the same as the rural wage rate AWR (which is also equal to the average per capita consumption of rural workers), FMR is assumed to be zero. When UWR is less than AWR, migration towards the rural sector results. When UWR exceeds AWR, outmigration from the rural sector takes place. The maximum out-migration rate from the rural sector is assumed not to exceed 10 percent of the rural workforce, as higher migration rates will be physically impossible due to limited transportation facilities and high transportation costs, migration towards the rural sector is assumed not to exceed 0.5 percent of the rural population because of limited urban populations serving as sources of such migration.

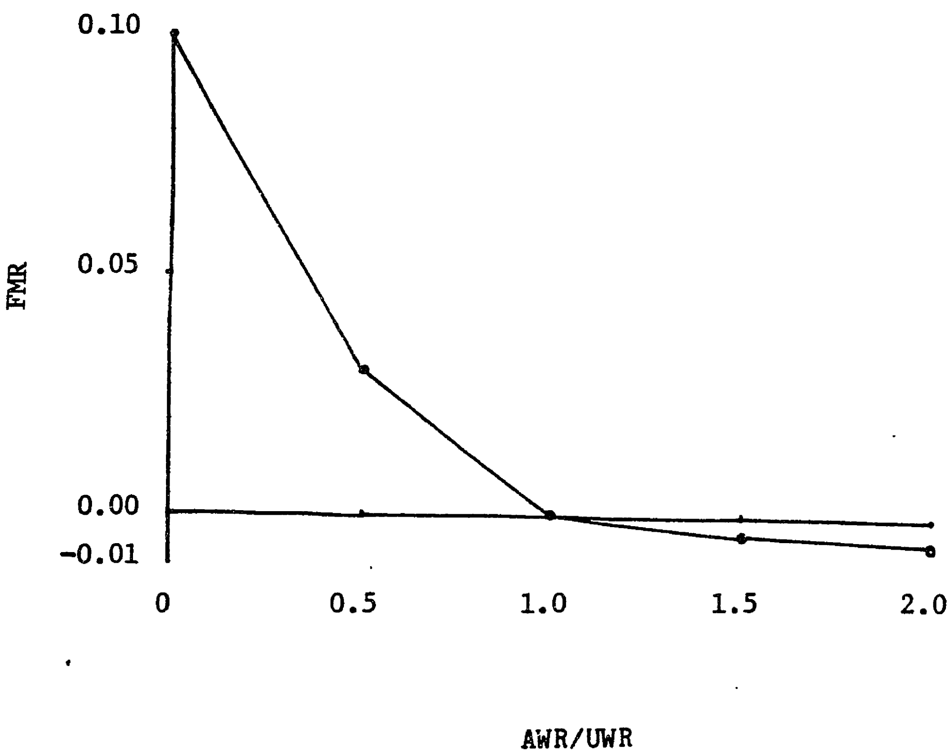


Figure A.10: The Fractional Migration Rate FMR.

```
FMR.K=TABHL(TFMR,AWR.K/UWR.K,0,2,.5)                        50, A
TFMR=.1/.03/0/-.0035/-.005                                  50.1, T
    FMR    - FRACTIONAL MIGRATION RATE (FRACTION/TIME
               UNIT)
    TFMR   - TABLE FOR FRACTIONAL MIGRATION RATE
               (FRACTION/TIME UNIT)
    AWR    - AVERAGE WAGE RATE (MONEY UNITS/PERSON/TIME
               UNIT)
    UWR    - URBAN WAGE RATE (MONEY UNITS/PERSON/TIME
               UNIT)
```

The urban wage rate UWR is an exogenous policy variable. Equations 51 and 52 represent mechanisms for testing urban wage policies. Urban wage rate, according to these equations can be fixed at a discretionary minimum level or be allowed to be determined by the rural wage rate through use of switching functions.

```
UWR.K=FIFGE(AWR.K,MUWR.K,0,STEP(SWM,TPTSTM))                51, A
    UWR    - URBAN WAGE RATE (MONEY UNITS/PERSON/TIME
               UNIT)
    FIFGE  - SWITCHING FUNCTION FROM DYNAMO
    AWR    - AVERAGE WAGE RATE (MONEY UNITS/PERSON/TIME
               UNIT)
    MUWR   - MINIMUM URBAN WAGE RATE (MONEY UNITS/
               PERSON/TIME UNIT)
    STEP   - SWITCHING FUNCTION FROM DYNAMO
    SWM    - SWITCH FOR MIGRATION POLICY (DIMENSIONLESS)
    TPTSTM - TIME FOR POLICY TEST FOR MIGRATION (TIME
               UNIT)

MUWR.K=TABHL(TMUW,TIME.K,1940,2000,10)                      52, A
TMUW=700/700/700/700/700/700/700                            52.1, T
    MUWR   - MINIMUM URBAN WAGE RATE (MONEY UNITS/
               PERSON/TIME UNIT)
    TMUW   - TABLE FOR MINIMUM URBAN WAGE RATE
               (MONEY UNITS/PERSON/TIME UNIT)
    TIME   - SIMULATION TIME (TIME UNIT)
```

The average wage rate in the rural sector AWR is represented as a level, which adjusts towards an indicated wage rate IWR determined by the average consumption expenditure per worker ACEW and the effect of worker demand on wage rate EWDW. The switching function in equation 54,A represents arrangements for behavior tests of the model, and allows wage rate to be fixed according to ACEW or average marginal revenue product of workers AMRPW, as suggested in several neoclassical models.

```
AWR.K=AWR.J+(DT/TAWR)(IWR.J-AWR.J)                    53, L
AWR=NAWR                                               53.1, N
    AWR    - AVERAGE WAGE RATE (MONEY UNITS/PERSON/TIME
               UNIT)
    DT     - SIMULATION SOLUTION INTERVAL (TIME UNITS)
    TAWR   - TIME TO ADJUST WAGE RATE (TIME UNITS)
    IWR    - INDICATED WAGE RATE (MONEY UNITS/PERSON/
               TIME UNIT)
    NAWR   - INITIAL WAGE RATE (MONEY UNITS/PERSON/TIME
               UNIT)

IWR.K=FIFGE(AMRPW.K,ACEW.K,0,STEP(SWW,TPTSTW))*      54, A
  EWDW.K
    IWR    - INDICATED WAGE RATE (MONEY UNITS/PERSON/
               TIME UNIT)
    FIFGE  - SWITCHING FUNCTION FROM DYNAMO
    AMRPW  - AVERAGE MARGINAL REVENUE PRODUCT OF WORKERS
               (MONEY UNITS/PERSON/TIME UNIT)
    ACEW   - AVERAGE CONSUMPTION EXPENDITURE PER WORKER
               (MONEY UNITS/PERSON/TIME UNIT)
    STEP   - SWITCHING FUNCTION FROM DYNAMO
    SWW    - SWITCH FOR WAGE POLICY (DIMENSIONLESS)
    TPTSTW - TIME OF POLICY TEST FOR WAGE RATE (TIME
               UNIT)
    EWDW   - EFFECT OF WORKER DEMAND ON WAGE RATE
               (DIMENSIONLESS)
```

The effect of worker demand on wage rate EWDW is represented as a non-linear function of the demand supply ratio of wage workers. As long as the demand for wage workers is less than the number of workers seeking wage employment, the indicated wage rate is determined by the opportunity costs of workers ACEW. However, when the demand for wage workers exceeds supply, the wage rate is bid up. EWDW is illustrated in Figure A.11.

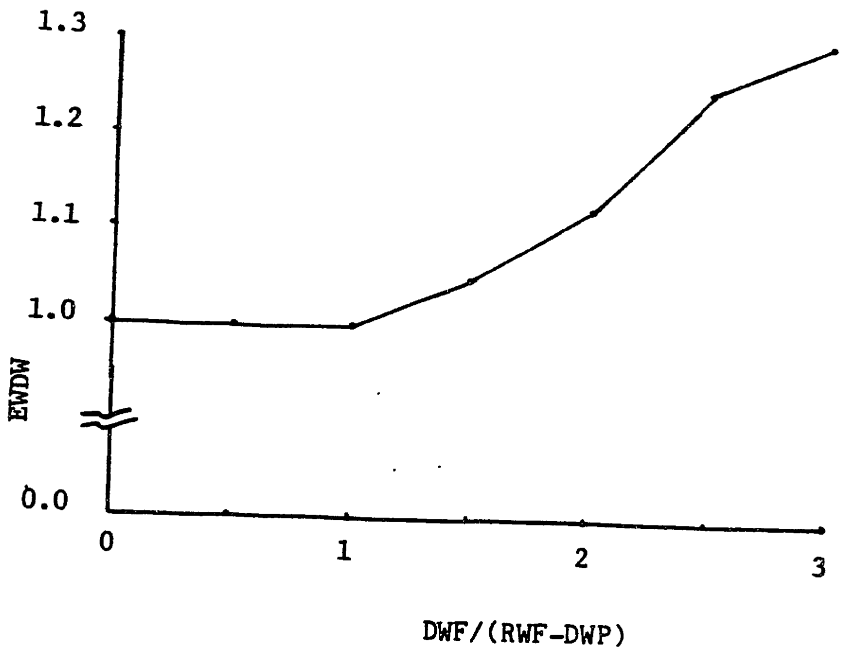


Figure A.11: The Effect of Worker Demand on Wage Rate EWDW

```
EWDW.K=TABHL(TWDW,DWF.K/(RWF.K-DWP.K),0,3,.5)          55, A
TWDW=1/1/1/1.05/1.15/1.25/1.3                           55.1, T
    EWDW    - EFFECT OF WORKER DEMAND ON WAGE RATE
                (DIMENSIONLESS)
    TWDW    - TABLE FOR EFFECT OF WORKER DEMAND ON
                WAGE RATE (DIMENSIONLESS)
    DWF     - DESIRED WORKERS IN FORMAL SECTOR (PERSONS)
    RWF     - RURAL WORKFORCE (PERSONS)
    DWP     - DESIRED WORKERS IN PEASANT SECTOR (PERSONS)
```

Average marginal revenue product of workers AMRPW is calculated as a weighted average of the marginal revenue products of workers in the two sectors, MRPWF and MRPWP. The marginal revenue product of workers in each sector is computed as a partial derivative of the value of production, with respect to workers, using a Cobb Douglas production function.

```
AMRPW.K=(MRPWF.K*WF.K+MRPWP.K*WP.K)/(WF.K+WP.K)      56, A
    AMRPW  - AVERAGE MARGINAL REVENUE PRODUCT OF WORKERS
               (MONEY UNITS/PERSON/TIME UNIT)

    MRPWF  - MARGINAL REVENUE PRODUCT OF WORKERS IN
               FOMAL SECTOR (MONEY UNITS/PERSON/TIME
               UNIT)
    WF     - WORKERS IN FORMAL SECTOR (PERSONS)
    MRPWP  - MARGINAL REVENUE PRODUCT OF WORKERS IN
               PEASANT SECTOR (MONEY UNITS/PERSON/TIME
               UNIT)
    WP     - WORKERS IN PEASANT SECTOR (PERSONS)

MRPWF.K=EWF.K*AVPF.K/WF.K                             57, A
    MRPWF  - MARGINAL REVENUE PRODUCT OF WORKERS IN
               FOMAL SECTOR (MONEY UNITS/PERSON/TIME
               UNIT)
    EWF    - ELASTICITY OF PRODUCTION OF WORKERS IN
               FORMAL SECTOR (DIMENSIONLESS)
    AVPF   - AVERAGE VALUE OF PRODUCTION IN FORMAL
               SECTOR (MONEY UNITS/TIME UNIT)
    WF     - WORKERS IN FORMAL SECTOR (PERSONS)

MRPWP.K=EWP.K*AVPP.K/WP.K                             58, A
    MRPWP  - MARGINAL REVENUE PRODUCT OF WORKERS IN
               PEASANT SECTOR (MONEY UNITS/PERSON/TIME
               UNIT)
    EWP    - ELASTICITY OF PRODUCTION OF WORKERS IN
               PEASANT SECTOR (DIMENSIONLESS)
    AVPP   - AVERAGE VALUE OF PRODUCTION IN PEASANT
               SECTOR (MONEY UNITS/TIME UNIT)
    WP     - WORKERS IN PEASANT SECTOR (PERSONS)
```

The average consumption expenditure per worker ACEW is calculated by subtracting savings in the peasant sector SP from the sum of revenue of the peasant sector RP and the savings consumption rate in the peasant sector SSRP, dividing the result by rural workforce RWF, and computing an yearly average of the quantity.

```
ACEW.K=SMOOTH((RP.K-SP.JK+ASP.K/LASP.K)/RWF.K,      59, A
 TACEW)
ACEW=NCEW                                            59.1, N
    ACEW   - AVERAGE CONSUMPTION EXPENDITURE PER WORKER
               (MONEY UNITS/PERSON/TIME UNIT)
    RP     - REVENUE IN PEASANT SECTOR (MONEY UNITS/TIME
               UNIT)
    SP     - SAVINGS IN PEASANT SECTOR (MONEY UNITS/TIME
               UNIT)
    ASP    - ACCUMULATED SAVINGS IN PEASANT SECTOR
               (MONEY UNITS)
    LASP   - LIFE OF ACCUMULATED SAVINGS IN PEASANT
               SECTOR (TIME UNITS)
    RWF    - RURAL WORKFORCE (PERSONS)
    TACEW  - TIME TO AVERAGE CONSUMPTION EXPENDITURE PER
               WORKER (TIME UNIT)
    NCEW   - INITIAL CONSUMPTION EXPENDITURE PER WORKER
               (MONEY UNITS/WORKER/TIME UNIT)
```

3. Acquisition of Capital

Capital as defined in the model primarily represents durable capital for providing draught power. Thus farming implements and machinery, live stock, etc., are included in Capital [15]. Capital available for acquisition is divided into two categories: Traditional capital produced within the rural economy, and modern capital supplied from outside.

3.1. Capital Ownership and Capital Employment in the Formal Sector

Figure A.12 illustrates the processes that determine ownership and employment of capital in the formal sector. Capital owned by the formal sector KOF is the sum of the modern and traditional capital accumulated by the sector. The two categories of capital are increased by their respective acquisition rates (MKAF, TKAF), and depleted by depreciation rates (MKDRF, TKDRF). The acquisition rates depend upon the demands for the two categories of capital (MKDF, TKDF), and the respective supply inventory availabilities (MKIA, TKIA). The depreciation rates depend on the respective accumulations and the average life of capital ALF.

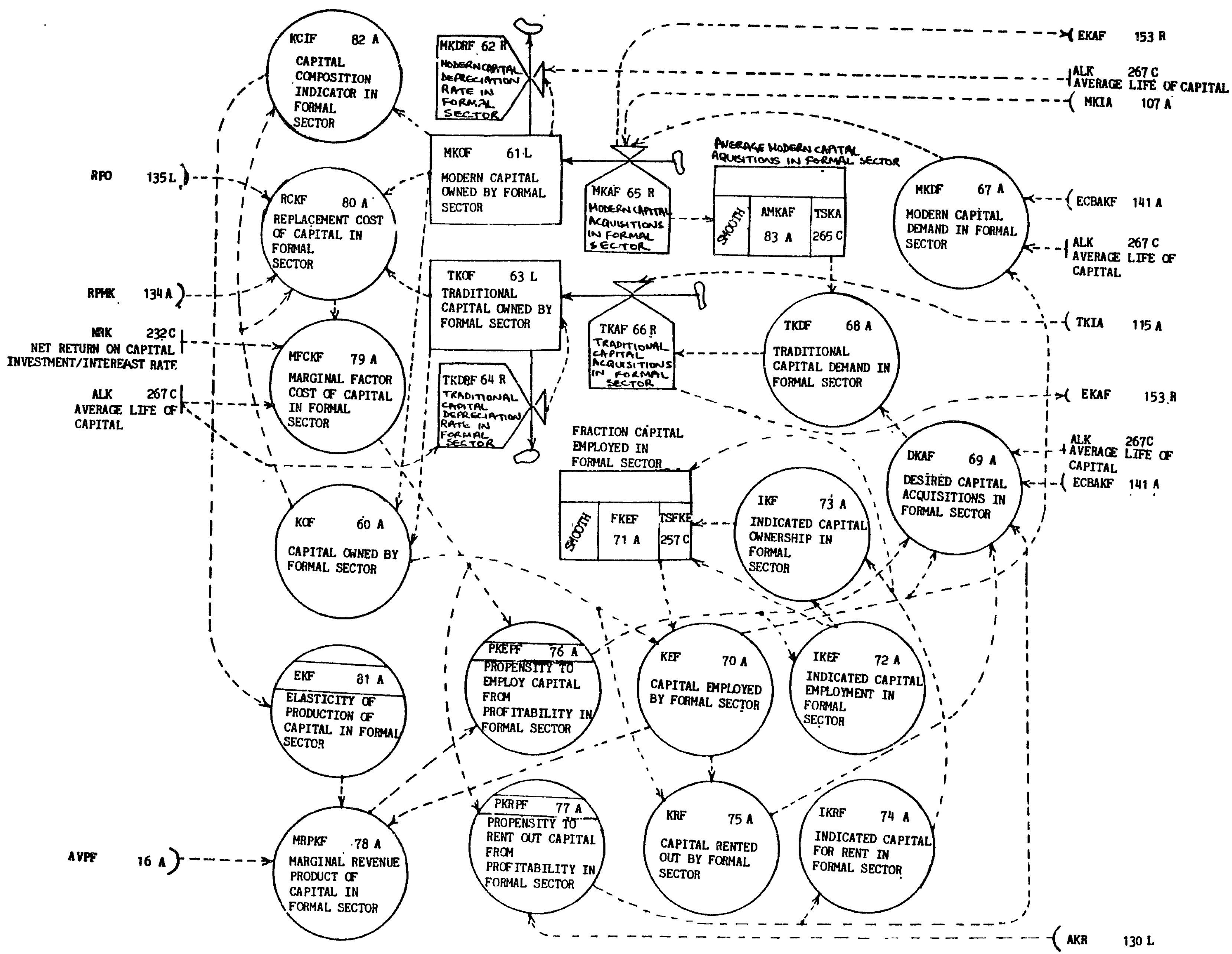


Figure A.12: Flow Diagram Showing Acquisition of Capital by the Formal Sector and its Allocation to Commercial Farming and Renting Activities.

```
KOF.K=MKOF.K+TKOF.K                                        60, A
    KOF     - CAPITAL OWNED BY FORMAL SECTOR (CAPITAL
                UNITS)
    MKOF    - MODERN CAPITAL OWNED BY FORMAL SECTOR
                (CAPITAL UNITS)
    TKOF    - TRADITIONAL CAPITAL OWNED BY FORMAL SECTOR
                (CAPITAL UNITS)

MKOF.K=MKOF.J+(DT)(MKAF.JK-MKDRF.JK)                       61, L
MKOF=NMKOF                                                 61.1, N
    MKOF    - MODERN CAPITAL OWNED BY FORMAL SECTOR
                (CAPITAL UNITS)
    DT      - SIMULATION SOLUTION INTERVAL (TIME UNITS)
    MKAF    - MODERN CAPITAL ACQUISITIONS IN FORMAL
                SECTOR (CAPITAL UNITS/TIME UNIT)
    MKDRF   - MODERN CAPITAL DEPERECIATION RATE IN FORMAL
                SECTOR (CAPITAL UNITS/TIME UNIT)
    NMKOF   - INITIAL MODERN CAPITAL OWNED BY FORMAL
                SECTOR (CAPITAL UNITS)

MKDRF.KL=MKOF.K/ALK                                        62, R
    MKDRF   - MODERN CAPITAL DEPERECIATION RATE IN FORMAL
                SECTOR (CAPITAL UNITS/TIME UNIT)
    MKOF    - MODERN CAPITAL OWNED BY FORMAL SECTOR
                (CAPITAL UNITS)
    ALK     - AVERAGE LIFE OF CAPITAL (TIME UNITS)

TKOF.K=TKOF.J+(DT)(TKAF.JK-TKDRF.JK)                       63, L
TKOF=NTKOF                                                 63.1, N
    TKOF    - TRADITIONAL CAPITAL OWNED BY FORMAL SECTOR
                (CAPITAL UNITS)
    DT      - SIMULATION SOLUTION INTERVAL (TIME UNITS)
    TKAF    - TRADITIONAL CAPITAL ACQUISITIONS IN FORMAL
                SECTOR (CAPITAL UNITS/TIME UNIT)
    TKDRF   - TRADITIONAL CAPITAL DEPRECIATION RATE IN
                FORMAL SECTOR (CAPITAL UNITS/TIME UNIT)
    NTKOF   - INITIAL TRADITIONAL CAPITAL OWNED BY FORMAL
                SECTOR (CAPITAL UNITS)

TKDRF.KL=TKOF.K/ALK                                        64, R
    TKDRF   - TRADITIONAL CAPITAL DEPRECIATION RATE IN
                FORMAL SECTOR (CAPITAL UNITS/TIME UNIT)
    TKOF    - TRADITIONAL CAPITAL OWNED BY FORMAL SECTOR
                (CAPITAL UNITS)
    ALK     - AVERAGE LIFE OF CAPITAL (TIME UNITS)
```

```
MKAF.KL=MKDF.K*MKIA.K                                       65, R
    MKAF   - MODERN CAPITAL ACQUISITIONS IN FORMAL
               SECTOR (CAPITAL UNITS/TIME UNIT)
    MKDF   - MODERN CAPITAL DEMAND IN FORMAL SECTOR
               (CAPITAL UNITS/TIME UNIT)
    MKIA   - MODERN CAPITAL INVENTORY AVAILABILITY
               (DIMENSIONLESS)

TKAF.KL=TKDF.K*TKIA.K                                       66, R
    TKAF   - TRADITIONAL CAPITAL ACQUISITIONS IN FORMAL
               SECTOR (CAPITAL UNITS/TIME UNIT)
    TKDF   - TRADITIONAL CAPITAL DEMAND IN FORMAL SECTOR
               (CAPITAL UNITS /TIME UNIT)
    TKIA   - TRADITIONAL CAPITAL INVENTORY AVAILABILITY
               (DIMENSIONLESS)
```

Modern capital demand in the formal sector MKDF depends upon how much capital is previously employed by the sector in commercial farming, the sector's propensity to increase or decrease capital employment on basis of economic profit, and the availability of internal cash resources for investment. The traditional capital demand TKDF is the difference between the desired capital acquisitions DKAF, and the average modern capital acquisitions AMKAF. The equation structure for capital demands incorporates a preference for modern capital services. If modern capital is available and all capital demand can be met by it, traditional capital services will not be required. However, if only a limited quantity of modern capital servies are available, they are rationed between the sectors on the basis of their respective demands. The demand for capital not met by the modern capital supply serves as the net demand for the indigenouly produced traditional capital.

MKDF.K=KEF.K/ALK*PKEPF.K*ECBAKF.K 67, A

MKDF - MODERN CAPITAL DEMAND IN FORMAL SECTOR (CAPITAL UNITS/TIME UNIT)
KEF - CAPITAL EMPLOYED BY FORMAL SECTOR (CAPITAL UNITS)
ALK - AVERAGE LIFE OF CAPITAL (TIME UNITS)
PKEPF - PROPENSITY TO EMPLOY CAPITAL FROM PROFITABILITY IN FORMAL SECTOR (DIMENSIONLESS)
ECBAKF - EFFECT OF CASH BALANCE AVAILABILITY ON CAPITAL DEMAND IN FORMAL SECTOR (DIMENSIONLESS)

TKDF.K=DKAF.K-AMKAF.K 68, A

TKDF - TRADITIONAL CAPITAL DEMAND IN FORMAL SECTOR (CAPITAL UNITS /TIME UNIT)
DKAF - DESIRED CAPITAL ACQUISITIONS IN FORMAL SECTOR (CAPITAL UNITS/TIME UNIT)
AMKAF - AVERAGE MODERN CAPITAL ACQUISITIONS IN FORMAL SECTOR (CAPITAL UNITS/TIME UNIT)

The desired capital acquisitions in the formal sector DKAF comprize the demand for new capital and replacement capital both for employment in commercial farming and for renting. DKAF is obtained by adding the capital demands for commercial farming and renting, initially calculated on basis of economic efficiency, and multiplying the sum by the effect of cash balance availability ECBAF. The replacement requirements are calculated on basis of depreciation rates.

DKAF.K=(KEF.K/ALK*PKEPF.K+KRF.K/ALK*PKRPF.K)* ECBAKF.K 69, A

DKAF - DESIRED CAPITAL ACQUISITIONS IN FORMAL SECTOR (CAPITAL UNITS/TIME UNIT)
KEF - CAPITAL EMPLOYED BY FORMAL SECTOR (CAPITAL UNITS)
ALK - AVERAGE LIFE OF CAPITAL (TIME UNITS)
PKEPF - PROPENSITY TO EMPLOY CAPITAL FROM PROFITABILITY IN FORMAL SECTOR (DIMENSIONLESS)
KRF - CAPITAL RENTED OUT BY FORMAL SECTOR (CAPITAL UNITS)

PKRPF - PROPENSITY TO RENT OUT CAPITAL FROM PROFITABILITY IN FORMAL SECTOR (DIMENSIONLESS)
ECBAKF - EFFECT OF CASH BALANCE AVAILABILITY ON CAPITAL DEMAND IN FORMAL SECTOR (DIMENSIONLESS)

Capital owned by the formal sector is distributed between cultivation and renting activities on the basis of indicated capital in each activity. The redistribution of capital between the two activities, however, is not instantaneous but involves a time delay implicit in equation 71,A (for fraction of capital employed in the formal sector FKEF). The PULSE function in equation 70,A represents switching arrangements for initiating renting activity in the model, and is not a part of the logical structure of the model.

```
KEF.K=FKEF.K*KOF.K-KOF.K*PULSE(NFKR,TPTSTR,10000)   70, A
KEF=NKEF                                            70.1, N
    KEF    - CAPITAL EMPLOYED BY FORMAL SECTOR (CAPITAL
               UNITS)
    FKEF   - FRACTION CAPITAL EMPLOYED IN FORMAL SECTOR
               (DIMENSIONLESS)
    KOF    - CAPITAL OWNED BY FORMAL SECTOR (CAPITAL
               UNITS)
    NFKR   - INITIAL FRACTION OF CAPITAL RENTED OUT BY
               FORMAL SECTOR (CAPITAL UNITS)
    TPTSTR - TIME OF POLICY TEST FOR RENTING (TIME UNIT)
    NKEF   - INITIAL CAPITAL EMPLOYED BY FORMAL SECTOR
               (CAPITAL UNITS)

FKEF.K=SMOOTH(IKEF.K/IKF.K,TSFKE)                   71, A
FKEF=NFKEF                                          71.1, N
    FKEF   - FRACTION CAPITAL EMPLOYED IN FORMAL SECTOR
               (DIMENSIONLESS)
    IKEF   - INDICATED CAPITAL EMPLOYMENT IN FORMAL
               SECTOR (CAPITAL UNITS)
    IKF    - INDICATED CAPITAL OWNERSHIP IN FORMAL
               SECTOR (CAPITAL UNITS)
    TSFKE  - TIME TO SMOOTH FRACTION OF CAPITAL EMPLOYED
               (TIME UNITS)
    NFKEF  - INITIAL FRACTION OF CAPITAL EMPLOYED IN
               FORMAL SECTOR (DIMENSIONLESS)
```

Indicated capital employment in the sector IKEF depends upon existing capital employment KEF and the propensity to employ capital from profitability PKEPF. Indicated capital ownership in the sector IKF is calculated by adding indicated capital employment IKEF and indicated capital for rent IKRF. Indicated capital for rent in the sector IKRF depends upon the existing capital for rent KRF and the propensity to rent out capital from profitability in renting activity PKRPF.

```
IKEF.K=KEF.K*PKEPF.K                                    72, A
    IKEF    - INDICATED CAPITAL EMPLOYMENT IN FORMAL
                SECTOR (CAPITAL UNITS)
    KEF     - CAPITAL EMPLOYED BY FORMAL SECTOR (CAPITAL
                UNITS)
    PKEPF   - PROPENSITY TO EMPLOY CAPITAL FROM
                PROFITABILITY IN FORMAL SECTOR
                (DIMENSIONLESS)

IKF.K=IKEF.K+IKRF.K                                     73, A
    IKF     - INDICATED CAPITAL OWNERSHIP IN FORMAL
                SECTOR (CAPITAL UNITS)
    IKEF    - INDICATED CAPITAL EMPLOYMENT IN FORMAL
                SECTOR (CAPITAL UNITS)
    IKRF    - INDICATED CAPITAL FOR RENT IN FORMAL SECTOR
                (CAPITAL UNITS)

IKRF.K=KRF.K*PKRPF.K                                    74, A
    IKRF    - INDICATED CAPITAL FOR RENT IN FORMAL SECTOR
                (CAPITAL UNITS)
    KRF     - CAPITAL RENTED OUT BY FORMAL SECTOR
                (CAPITAL UNITS)
    PKRPF   - PROPENSITY TO RENT OUT CAPITAL FROM
                PROFITABILITY IN FORMAL SECTOR
                (DIMENSIONLESS)
```

Capital rented out by the formal sector KRF is calculated as the difference between KOF and KEF.

```
KRF.K=KOF.K-KEF.K                                        75, A
KRF=NKRF                                                 75.1, N
    KRF    - CAPITAL RENTED OUT BY FORMAL SECTOR
              (CAPITAL UNITS)
    KOF    - CAPITAL OWNED BY FORMAL SECTOR (CAPITAL
              UNITS)
    KEF    - CAPITAL EMPLOYED BY FORMAL SECTOR (CAPITAL
              UNITS)
    NKRF   - INITIAL CAPITAL RENTED OUT BY FORMAL SECTOR
              (CAPITAL UNITS)
```

The propensity for capital employment from profitability in the sector PKEPF is represented as a function of the ratio between marginal revenue product of capital in the sector MRPKF and the marginal factor costs of capital MFCKF, as shown in Figure A.13. When MRPKF is equal to MFCKF, PKEPF is unity and the indicated capital employment is the same as current capital employment, meaning that only replacement capital will be acquired. When MRPPKF is zero, the indicated capital employment IKEF is driven down to zero, no capital is acquired while the current stock is transferred to renting activity or allowed to deteriorate. When MRPKF exceeds MFCKF, it becomes profitable to increase capital employment at a rate proportional to the ratio between MRPKF and MFCKF, but with diminishing increments. Changes in the slope of the function PKEPF affect only the speed of transactions, while leaving the dynamic behavior unchanged as substantiated in the sensitivity tests of the model.

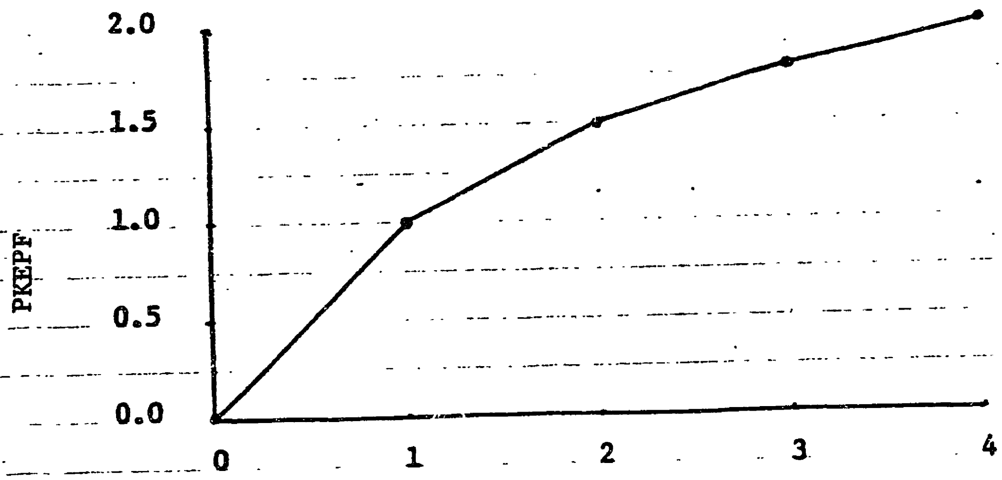


Figure A.13: The pressure to employ capital from profitability in capital employment in formal sector PKEPF.

```
PKEPF.K=TABHL(TKEP,MRPKF.K/MFCKF.K,0,4,1)          76, A
TKEP=0/1/1.5/1.8/2                                 76.1, T
     PKEPF  - PROPENSITY TO EMPLOY CAPITAL FROM
                PROFITABILITY IN FORMAL SECTOR
                (DIMENSIONLESS)
     TKEP   - TABLE FOR PROPRNSITY TO EMPLOY CAPITAL FROM
                PROFITABILITY (DIMENSIONLESS)
     MRPKF  - MARGINAL REVENUE PRODUCT OF CAPITAL IN
                FORMAL SECTOR (MONEY UNITS/CAPITAL UNIT/
                TIME UNIT)
     MFCKF  - MARGINAL FACTOR COST OF CAPITAL IN FORMAL
                SECTOR (MONEY UNITS/CAPITAL UNIT/TIME
                UNIT)
```

The propensity to rent out capital from profitability in the formal sector PKRPF is represented as function of the ratio between average capital rent AKR and the marginal factor cost of capital in the sector MFCKF. The shape of this function is shown in Figure A.14 and incorporates the same criteria as those for

PKEPF (Equation 76,A).

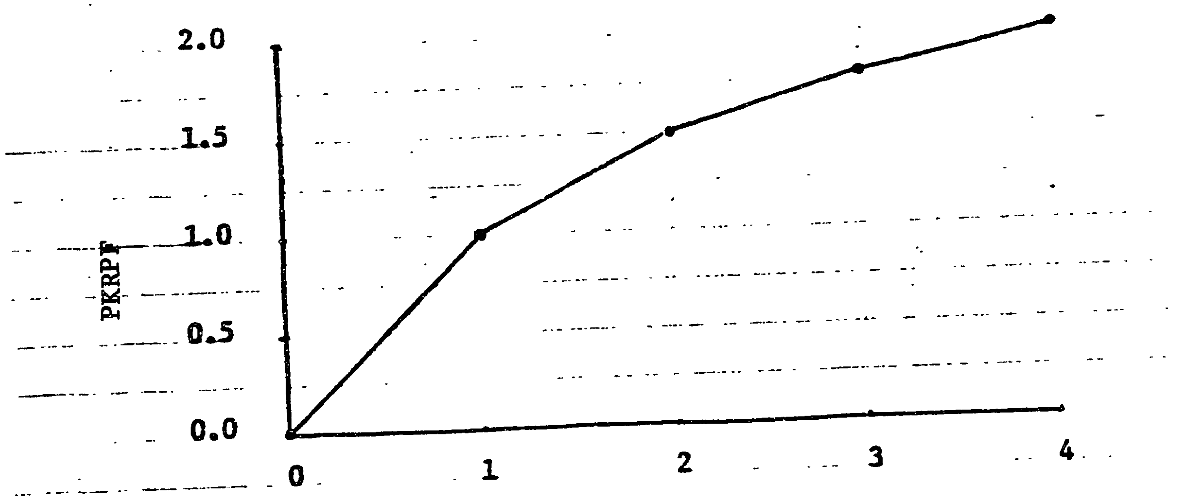


Figure A.14: The propensity to rent out capital from Profitability in formal sector PRKPF.

```
PKRPF.K=TABHL(TKRP,(AKR.K-AKR.K*STEP(KRT,TPTKRT))/  77, A
  MFCKF.K,0,4,1)
TKRP=0/1/1.5/1.8/2                                   77.2, T
    PKRPF  - PROPENSITY TO RENT OUT CAPITAL FROM
               PROFITABILITY IN FORMAL SECTOR
               (DIMENSIONLESS)
    TKRP   - TABLE FOR PROPENSITY TO RENT OUT CAPITAL
               FROM PROFITABILITY (DIMENSIONLESS)
    AKR    - AVERAGE CAPITAL RENT (MONEY UNITS/CAPITAL
               UNIT/TIME UNIT)
    STEP   - SWITCHING FUNCTION FROM DYNAMO
    KRT    - CAPITAL RENT TAX (MONEY UNITS/MONEY UNIT
               CAPITAL RENT)
    TPTKRT - TIME OF POLICY TEST FOR CAPITAL RENT TAX
               (TIME UNIT)
    MFCKF  - MARGINAL FACTOR COST OF CAPITAL IN FORMAL
               SECTOR (MONEY UNITS/CAPITAL UNIT/TIME
               UNIT)
```

The marginal revenue product of capital in the formal sector MRPKF is calculated by taking the partial derivative of the average value of production in the sector AVPF with respect to the quantity of capital employed by it KEF. As pointed out earlier, a Cobb Douglas production function with constant returns to scale is used. MRPKF is given by multiplying the elasticity of production of capital in the sector EKF with the average value of production AVPF, and dividing the product by the quantity of capital employed by the sector KEF.

```
MRPKF.K=EKF.K*AVPF.K/KEF.K                                78, A
    MRPKF  - MARGINAL REVENUE PRODUCT OF CAPITAL IN
               FORMAL SECTOR (MONEY UNITS/CAPITAL UNIT/
               TIME UNIT)
    EKF    - ELASTICITY OF PRODUCTION OF CAPITAL IN
               FORMAL SECTOR (DIMENSIONLESS)
    AVPF   - AVERAGE VALUE OF PRODUCTION IN FORMAL
               SECTOR (MONEY UNITS/TIME UNIT)
    KEF    - CAPITAL EMPLOYED BY FORMAL SECTOR (CAPITAL
               UNITS)
```

The marginal factor cost of capital in the formal sector MFCKF is the opportunity cost of capital accrued to the sector. If the normal return on capital NRK is assumed to be determined exogeneously, MFCKF is given by adding NRK and the expenditure on maintaining a unit of capital, obtained by dividing the relative cost of capital in the sector RCKF by the average life of capital ALK. Relative prices are used in the model as against absolute prices, as production and capital are represented in units whose normal price is taken as one money unit/capital or output unit. The relative cost of capital in the formal sector RCKF is calculated as a weighted average of the prices of modern and traditional capital wieghted on the basis of the amount of each owned by the sector.

```
MFCKF.K=NRK+RCKF.K/ALK                                   79, A
    MFCKF  - MARGINAL FACTOR COST OF CAPITAL IN FORMAL
               SECTOR (MONEY UNITS/CAPITAL UNIT/TIME
               UNIT)
    NRK    - NET RETURN ON CAPITAL INVESTMENT/INTEREST
               RATE (MONEY UNITS/TIME UNIT/MONEY UNIT)
    RCKF   - REPLACEMENT COST OF CAPITAL IN FORMAL
               SECTOR (MONEY UNITS /CAPITAL UNIT/TIME
               UNIT)
    ALK    - AVERAGE LIFE OF CAPITAL (TIME UNITS)

RCKF.K=(MKOF.K*RPMK.K+TKOF.K*RPO.K)/KOF.K                80, A
    RCKF   - REPLACEMENT COST OF CAPITAL IN FORMAL
               SECTOR (MONEY UNITS /CAPITAL UNIT/TIME
               UNIT)
    MKOF   - MODERN CAPITAL OWNED BY FORMAL SECTOR
               (CAPITAL UNITS)
    RPMK   - RELATIVE PRICE OF MODERN CAPITAL (MONEY
               UNITS/CAPITAL UNIT)
    TKOF   - TRADITIONAL CAPITAL OWNED BY FORMAL SECTOR
               (CAPITAL UNITS)
    RPO    - RELATIVE PRICE OF OUTPUT (MONEY UNITS/
               PRODUCT UNIT)
    KOF    - CAPITAL OWNED BY FORMAL SECTOR (CAPITAL
               UNITS)
```

The elasticity of production in the sector EKF is represented as a function of the capital composition indicator KCIF. The capital composition indicator KCIF is a measure of the proportion of modern capital in the sector, and is calculated by dividing the modern capital stock MKOF by the total capital stock. Empirical studies show that productivity of land remains practically unchanged irrespective of the mode of supply of draught power, although use of modern implements may allow an increase in the frequency of cropping [16]. Thus, while availability of modern capital will not affect productivity of land, it will serve to decrease requirement of labor. The elasticity of production of labor, as reported in many accounts, varies from .4 in traditional economies to about .2 in modern economies, depending upon the proportion of modern capital employed. The elasticity of production of land is reported to be about .4 in both traditional and modern economies [17, 18]. If constant returns to scale are assumed, the elasticity of production of capital EKF will vary between .2 and .4 depending on the proportion of modern capital in the sector. Figure A.15 shows the general shape of the functin representing EKF. The slight S-shape implies that the production characteristics will be dominated by the properties of the traditional capital when the fraction of modern capital in the system is minor, and vice

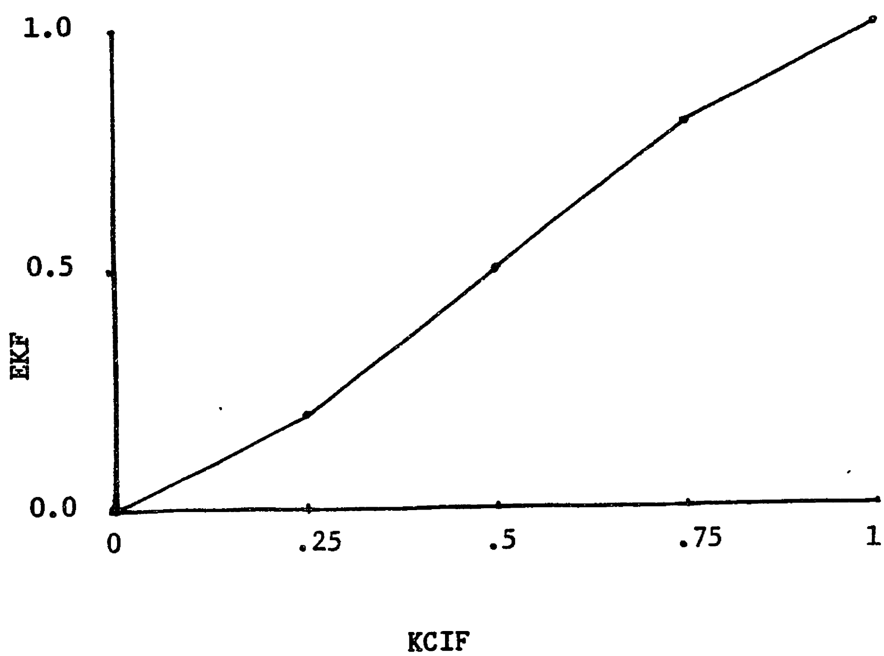


Figure A.15: The elasticity of production of capital in the formal sector EKF.

```
EKF.K=TABHL(TEK,KCIF.K,0,1,.25)                       81, A
TEK=.2/.24/.3/.36/.4                                  81.1, T
    EKF     - ELASTICITY OF PRODUCTION OF CAPITAL IN
                FORMAL SECTOR (DIMENSIONLESS)
    TEK     - TABLE FOR ELASTICITY OF PRODUCTION OF
                CAPITAL (DIMENSIONLESS)
    KCIF    - CAPITAL COMPOSITION INDICATOR IN FORMAL
                SECTOR (DIMENSIONLESS)

KCIF.K=MKOF.K/KEF.K                                   82, A
    KCIF    - CAPITAL COMPOSITION INDICATOR IN FORMAL
                SECTOR (DIMENSIONLESS)
    MKOF    - MODERN CAPITAL OWNED BY FORMAL SECTOR
                (CAPITAL UNITS)
    KEF     - CAPITAL EMPLOYED BY FORMAL SECTOR (CAPITAL
                UNITS)
```

Average modern capital acquisition rate in the formal sector AMKAF determines the traditional capital demand which is a residual of the desired capital acquisitions DKAF and the average modern capital acquisitions AMKAF. AMKAF is calculated as an exponential moving average of MKAF.

```
AMKAF.K=SMOOTH(MKAF.JK,TSKA)                          83, A
AMKAF=NMKAF                                           83.1, N
    AMKAF   - AVERAGE MODERN CAPITAL ACQUISITIONS IN
                FORMAL SECTOR (CAPITAL UNITS/TIME UNIT)
    MKAF    - MODERN CAPITAL ACQUISITIONS IN FORMAL
                SECTOR (CAPITAL UNITS/TIME UNIT)
    TSKA    - TIME TO SMOOTH CAPITAL ACQUISITIONS (TIME
                UNITS)
    NMKAF   - INITIAL MODERN CAPITAL ACQUISITIONS IN
                FORMAL SECTOR (CAPITAL UNITS/TIME UNIT)
```

3.2. Capital Ownership and Capital Employment in the Peasant Sector

The mechanisms for capital acquisition and capital employment in the peasant sector, in most part, are similar to those in the formal sector. Some differences exist due to characteristics specific to the peasant sector. Figure A.16

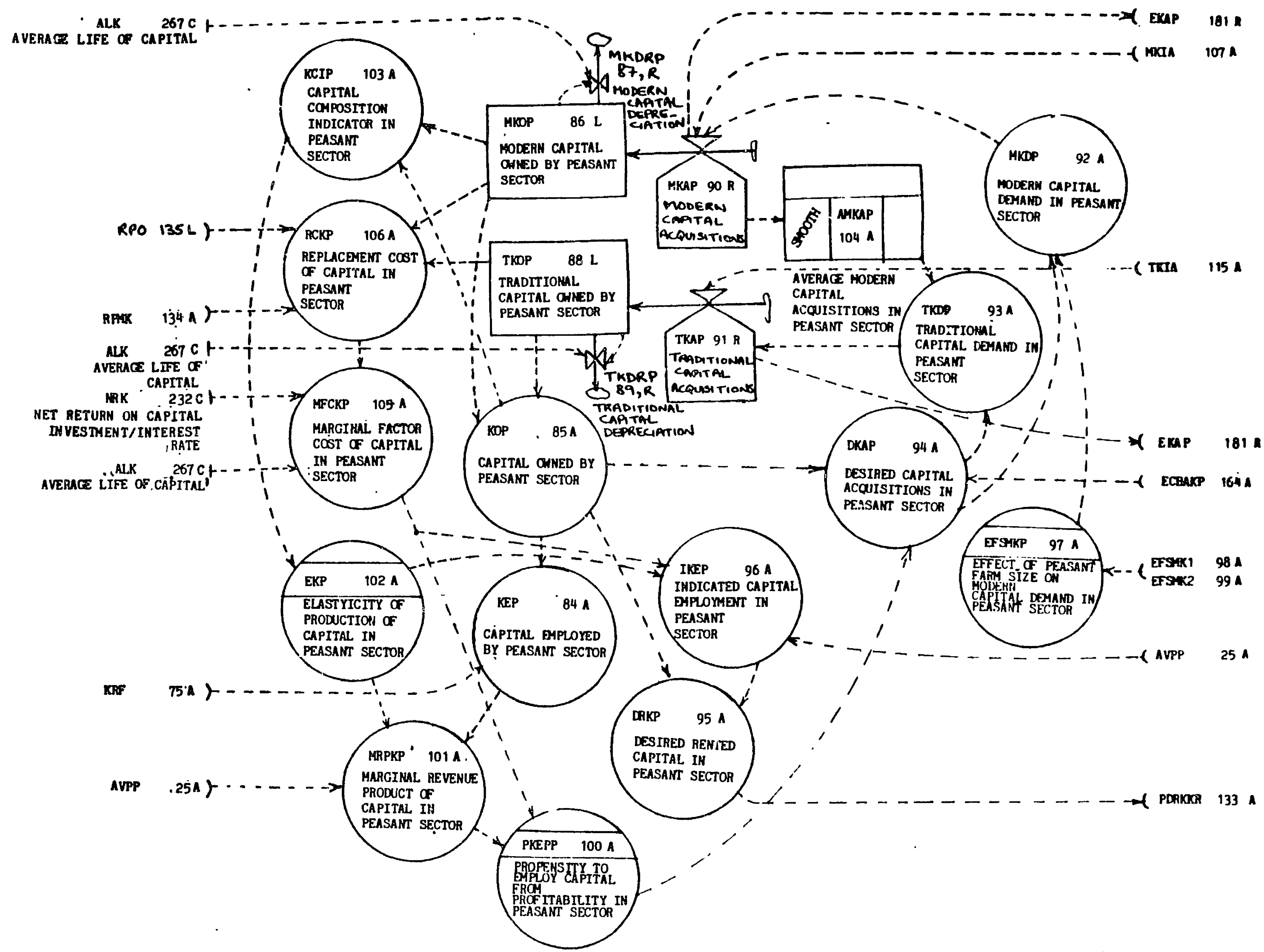


Figure A.16: Flow Diagram Showing Acquisition of Capital and its Employment by the Peasant Sector.

shows the processes of capital acquisition and employment in the peasant sector. Capital employed by the peasant sector KEP is the sum of the capital owned by it KOP and the capital rented out by the formal sector KRF. Capital acquisition and capital depreciation in the sector is based on the same logic as in formal sector but, since the sector employs both rented and owned capital, the demand for capital, modern as well as traditional, is based on capital ownership in the sector. But the demand for modern capital is constrained by the effect of farm size EFSMKP.

```
KEP.K=KOP.K+KRF.K                                    84, A
   KEP    - CAPITAL EMPLOYED BY PEASANT SECTOR (CAPITAL
              UNITS)
   KOP    - CAPITAL OWNED BY PEASANT SECTOR (CAPITAL
              UNITS)
   KRF    - CAPITAL RENTED OUT BY FORMAL SECTOR
              (CAPITAL UNITS)

KOP.K=MKOP.K+TKOP.K                                  85, A
   KOP    - CAPITAL OWNED BY PEASANT SECTOR (CAPITAL
              UNITS)
   MKOP   - MODERN CAPITAL OWNED BY PEASANT SECTOR
              (CAPITAL UNITS)
   TKOP   - TRADITIONAL CAPITAL OWNED BY PEASANT SECTOR
              (CAPITAL UNITS)

MKOP.K=MKOP.J+(DT)(MKAP.JK-MKDRP.JK)                 86, L
MKOP=NMKOP                                           86.1, N
   MKOP   - MODERN CAPITAL OWNED BY PEASANT SECTOR
              (CAPITAL UNITS)
   DT     - SIMULATION SOLUTION INTERVAL (TIME UNITS)
   MKAP   - MODERN CAPITAL ACQUISITIONS IN PEASANT
              SECTOR (CAPITAL UNITS/TIME UNIT)
   MKDRP  - MODERN CAPITAL DEPRECIATION RATE IN PEASANT
              SECTOR (CAPITAL UNITS/TIME UNIT)
   NMKOP  - INITIAL MODERN CAPITAL OWNED BY PEASANT
              SECTOR (CAPITAL UNITS)

MKDRP.KL=MKOP.K/ALK                                  87, R
   MKDRP  - MODERN CAPITAL DEPRECIATION RATE IN PEASANT
              SECTOR (CAPITAL UNITS/TIME UNIT)
   MKOP   - MODERN CAPITAL OWNED BY PEASANT SECTOR
              (CAPITAL UNITS)
   ALK    - AVERAGE LIFE OF CAPITAL (TIME UNITS)
```

```
TKOP.K=TKOP.J+(DT)(TKAP.JK-TKDRP.JK)                     88, L
TKOP=NTKOP                                               88.1, N
    TKOP   - TRADITIONAL CAPITAL OWNED BY PEASANT SECTOR
               (CAPITAL UNITS)
    DT     - SIMULATION SOLUTION INTERVAL (TIME UNITS)
    TKAP   - TRADITION CAPITAL UNITS IN PEASANT SECTOR
               (CAPITAL UNITS/TIME UNIT)
    TKDRP  - TRADITIONAL CAPITAL DEPRECIATION RATE IN
               PEASANT SECTOR (CAPITAL UNITS/TIME UNIT)
    NTKOP  - INITIAL TRADITIONAL CAPITAL OWNED BY
               PEASANT SECTOR (CAPITAL UNITS)

TKDRP.KL=TKOP.K/ALK                                      89, R
    TKDRP  - TRADITIONAL CAPITAL DEPRECIATION RATE IN
               PEASANT SECTOR (CAPITAL UNITS/TIME UNIT)
    TKOP   - TRADITIONAL CAPITAL OWNED BY PEASANT SECTOR
               (CAPITAL UNITS)
    ALK    - AVERAGE LIFE OF CAPITAL (TIME UNITS)

MKAP.KL=MKDP.K*MKIA.K                                    90, R
    MKAP   - MODERN CAPITAL ACQUISITIONS IN PEASANT
               SECTOR (CAPITAL UNITS/TIME UNIT)
    MKDP   - MODERN CAPITAL DEMAND IN PEASANT SECTOR
               (CAPITAL UNITS/TIME UNIT)
    MKIA   - MODERN CAPITAL INVENTORY AVAILABILITY
               (DIMENSIONLESS)

TKAP.KL=TKDP.K*TKIA.K                                    91, R
    TKAP   - TRADITION CAPITAL UNITS IN PEASANT SECTOR
               (CAPITAL UNITS/TIME UNIT)
    TKDP   - TRADITIONAL CAPITAL DEMAND IN PEASANT
               SECTOR (CAPITAL UNITS/TIME UNIT)
    TKIA   - TRADITIONAL CAPITAL INVENTORY AVAILABILITY
               (DIMENSIONLESS)

MKDP.K=DKAP.K*EFSMKP.K                                   92, A
    MKDP   - MODERN CAPITAL DEMAND IN PEASANT SECTOR
               (CAPITAL UNITS/TIME UNIT)
    DKAP   - DESIRED CAPITAL ACQUISITIONS IN PEASANT
               SECTOR (CAPITAL UNITS /TIME UNIT)
    EFSMKP - EFFECT OF PEASANT FARM SIZE ON MODERN
               CAPITAL DEMAND IN PEASANT SECTOR
               (DIMENSIONLESS)

TKDP.K=DKAP.K-AMKAP.K                                    93, A
    TKDP   - TRADITIONAL CAPITAL DEMAND IN PEASANT
               SECTOR (CAPITAL UNITS/TIME UNIT)
    DKAP   - DESIRED CAPITAL ACQUISITIONS IN PEASANT
               SECTOR (CAPITAL UNITS /TIME UNIT)
    AMKAP  - AVERAGE MODERN CAPITAL ACQUISITIONS IN
               PEASANT SECTOR (CAPITAL UNITS/TIME UNIT)
```

```
DKAP.K=KOP.K/ALK*PKEPP.K*ECBAKP.K                          94, A
    DKAP   - DESIRED CAPITAL ACQUISITIONS IN PEASANT
               SECTOR (CAPITAL UNITS /TIME UNIT)
    KOP    - CAPITAL OWNED BY PEASANT SECTOR (CAPITAL
               UNITS)
    ALK    - AVERAGE LIFE OF CAPITAL (TIME UNITS)
    PKEPP  - PROPENSITY TO EMPLOY CAPITAL FROM
               PROFITABILITY IN PEASANT SECTOR
               (DIMENSIONLESS)
    ECBAKP - EFFECT OF CASH BALANCE AVAILABILITY ON
               CAPITAL DEMAND IN PEASANT SECTOR
               (DIMENSIONLESS)
```

The desired rented capital in the peasant sector is the difference between the indicated capital employment, calculated on the basis of availbility of other factors in the sector, and the capital owned.

```
DRKP.K=IKEP.K-KOP.K                                        95, A
    DRKP   - DESIRED RENTED CAPITAL IN PEASANT SECTOR
               (CAPITAL UNITS)
    IKEP   - INDICATED CAPITAL EMPLOYMENT IN PEASANT
               SECTOR (CAPITAL UNITS)
    KOP    - CAPITAL OWNED BY PEASANT SECTOR (CAPITAL
               UNITS)

IKEP.K=EKP.K*AVPP.K/MFCKP.K                                96, A
    IKEP   - INDICATED CAPITAL EMPLOYMENT IN PEASANT
               SECTOR (CAPITAL UNITS)
    EKP    - ELASTYICITY OF PRODUCTION OF CAPITAL IN
               PEASANT SECTOR (DIMENSIONLESS)
    AVPP   - AVERAGE VALUE OF PRODUCTION IN PEASANT
               SECTOR (MONEY UNITS/TIME UNIT)
    MFCKP  - MARGINAL FACTOR COST OF CAPITAL IN PEASANT
               SECTOR (MONEY UNITS/CAPITAL UNIT/TIME
               UNIT)
```

The effect of farm size on the modern capital demand in the peasant sector EFSMKP is represented as a function of the peasant cultivated land and the self-employed workers. EFSMKP is treated as a policy variable, meaning that farm size can be changed by organizing cooperatives and discouraging small farms that are unable to employ undivisible modern capital inputs. Under ordinary conditions, it is assumed that peasant farm size is small and that peasant sector cannot use modern capital. The assumption is changed when analysing policies using the model. Hence the set of equations providing for switching between two sets of values for EFSMKP.

```
EFSMKP.K=FIFGE(EFSMK1.K,EFSMK2.K,0,STEP(SWCP,TMCP)) 97, A
    EFSMKP - EFFECT OF PEASANT FARM SIZE ON MODERN
               CAPITAL DEMAND IN PEASANT SECTOR
               (DIMENSIONLESS)
    FIFGE  - SWITCHING FUNCTION FROM DYNAMO
    EFSMK1 - FUNCTION ONE FOR EFSMKP (DIMENSIONLESS)
    EFSMK2 - FUNCTION TWO FOR EFSMKP (DIMENSIONLESS)
    STEP   - SWITCHING FUNCTION FROM DYNAMO
    SWCP   - SWITCH FOR COOPERATIVES POLICY
               (DIMENSIONLESS)
    TMCP   - TIME OF COOPERATIVES POLICY (TIME UNIT)

EFSMK1.K=TABHL(TFSMK1,LCP.K/WP.K,0,50,6.25)          98, A
TFSMK1=0/0/0/0/0/0/0/0/0                            98.1, T
    EFSMK1 - FUNCTION ONE FOR EFSMKP (DIMENSIONLESS)
    TFSMK1 - TABLE1 FOR EFFECT OF PEASANT FARM SIZE ON
               MODERN CAPITAL DEMAND (DIMENSIONLESS)
    LCP    - LAND CULTIVATED BY PEASANT SECTOR (LAND
               UNITS)
    WP     - WORKERS IN PEASANT SECTOR (PERSONS)

EFSMK2.K=TABHL(TFSMK2,LCP.K/WP.K,0,50,6.25)          99, A
TFSMK2=1/1/1/1/1/1/1/1/1                            99.1, T
    EFSMK2 - FUNCTION TWO FOR EFSMKP (DIMENSIONLESS)
    TFSMK2 - TABLE2 FOR EFFECT OF PEASANT FARM SIZE ON
               MODERN CAPITAL DEMAND (DIMENSIONLESS)
    LCP    - LAND CULTIVATED BY PEASANT SECTOR (LAND
               UNITS)
    WP     - WORKERS IN PEASANT SECTOR (PERSONS)
```

The rest of the equations for capital acquisition and employment in the peasant sector are identical to those in the formal sector and are given below.

```
PKEPP.K=TABHL(TKEP,MRPKP.K/MFCKP.K,0,4,1)              100, A
    PKEPP  - PROPENSITY TO EMPLOY CAPITAL FROM
               PROFITABILITY IN PEASANT SECTOR
               (DIMENSIONLESS)
    TKEP   - TABLE FOR PROPENSITY TO EMPLOY CAPITAL FROM
               PROFITABILITY (DIMENSIONLESS)
    MRPKP  - MARGINAL REVENUE PRODUCT OF CAPITAL IN
               PEASANT SECTOR (MONEY UNITS/CAPITAL UNIT/
               TIME UNIT)
    MFCKP  - MARGINAL FACTOR COST OF CAPITAL IN PEASANT
               SECTOR (MONEY UNITS/CAPITAL UNIT/TIME
               UNIT)

MRPKP.K=EKP.K*AVPP.K/KEP.K                              101, A
    MRPKP  - MARGINAL REVENUE PRODUCT OF CAPITAL IN
               PEASANT SECTOR (MONEY UNITS/CAPITAL UNIT/
               TIME UNIT)
    EKP    - ELASTICITY OF PRODUCTION OF CAPITAL IN
               PEASANT SECTOR (DIMENSIONLESS)
    AVPP   - AVERAGE VALUE OF PRODUCTION IN PEASANT
               SECTOR (MONEY UNITS/TIME UNIT)
    KEP    - CAPITAL EMPLOYED BY PEASANT SECTOR (CAPITAL
               UNITS)

EKP.K=TABHL(TEK,KCIP.K,0,1,.25)                         102, A
    EKP    - ELASTICITY OF PRODUCTION OF CAPITAL IN
               PEASANT SECTOR (DIMENSIONLESS)
    TEK    - TABLE FOR ELASTICITY OF PRODUCTION OF
               CAPITAL (DIMENSIONLESS)
    KCIP   - CAPITAL COMPOSITION INDICATOR IN PEASANT
               SECTOR (DIMENSIONLESS)

KCIP.K=MKOP.K/KEP.K                                     103, A
    KCIP   - CAPITAL COMPOSITION INDICATOR IN PEASANT
               SECTOR (DIMENSIONLESS)
    MKOP   - MODERN CAPITAL OWNED BY PEASANT SECTOR
               (CAPITAL UNITS)
    KEP    - CAPITAL EMPLOYED BY PEASANT SECTOR (CAPITAL
               UNITS)

AMKAP.K=SMOOTH(MKAP.JK,TSKA)                            104, A
AMKAP=NMKAP                                             104.1, N
    AMKAP  - AVERAGE MODERN CAPITAL ACQUISITIONS IN
               PEASANT SECTOR (CAPITAL UNITS/TIME UNIT)
    MKAP   - MODERN CAPITAL ACQUISITIONS IN PEASANT
               SECTOR (CAPITAL UNITS/TIME UNIT)
    TSKA   - TIME TO SMOOTH CAPITAL ACQUISITIONS (TIME
               UNITS)
    NMKAP  - INITIAL MODERN CAPITAL ACQUISITIONS IN
               PEASANT SECTOR (CAPITAL UNITS/TIME UNIT)
```

```
MFCKP.K=NRK+RCKP.K/ALK                                  105, A
    MFCKP  - MARGINAL FACTOR COST OF CAPITAL IN PEASANT
               SECTOR (MONEY UNITS/CAPITAL UNIT/TIME
               UNIT)
    NRK    - NET RETURN ON CAPITAL INVESTMENT/INTEREST
               RATE (MONEY UNITS/TIME UNIT/MONEY UNIT)
    RCKP   - REPLACEMENT COST OF CAPITAL IN PEASANT
               SECTOR (MONEY UNITS /CAPITAL UNIT/TIME
               UNIT)
    ALK    - AVERAGE LIFE OF CAPITAL (TIME UNITS)

RCKP.K=(MKOP.K*RPMK.K+TKOP.K*RPO.K)/KOP.K              106, A
    RCKP   - REPLACEMENT COST OF CAPITAL IN PEASANT
               SECTOR (MONEY UNITS /CAPITAL UNIT/TIME
               UNIT)
    MKOP   - MODERN CAPITAL OWNED BY PEASANT SECTOR
               (CAPITAL UNITS)
    RPMK   - RELATIVE PRICE OF MODERN CAPITAL (MONEY
               UNITS/CAPITAL UNIT)
    TKOP   - TRADITIONAL CAPITAL OWNED BY PEASANT SECTOR
               (CAPITAL UNITS)
    RPO    - RELATIVE PRICE OF OUTPUT (MONEY UNITS/
               PRODUCT UNIT)
    KOP    - CAPITAL OWNED BY PEASANT SECTOR (CAPITAL
               UNITS)
```

3.3. Modern and Traditional Capital Inventories

Mechanisms governing modern capital inventory availability are shown in Figure A.17. Modern Capital Inventory Availability MKIA is represented as a function of the ratio between modern capital inventory MKI and the desired modern capital inventory DMKI, as illustrated in Figure A.18. When modern capital inventory is equal to or greater than the desired modern capital inventory DMKI, all demand for modern capital is met and MKIA is unity. If MKI is smaller than DMKI, only a fraction of the demand can be met, though due to higher demand, inventory will tend to be over-drawn. Hence the concave shape of the function.

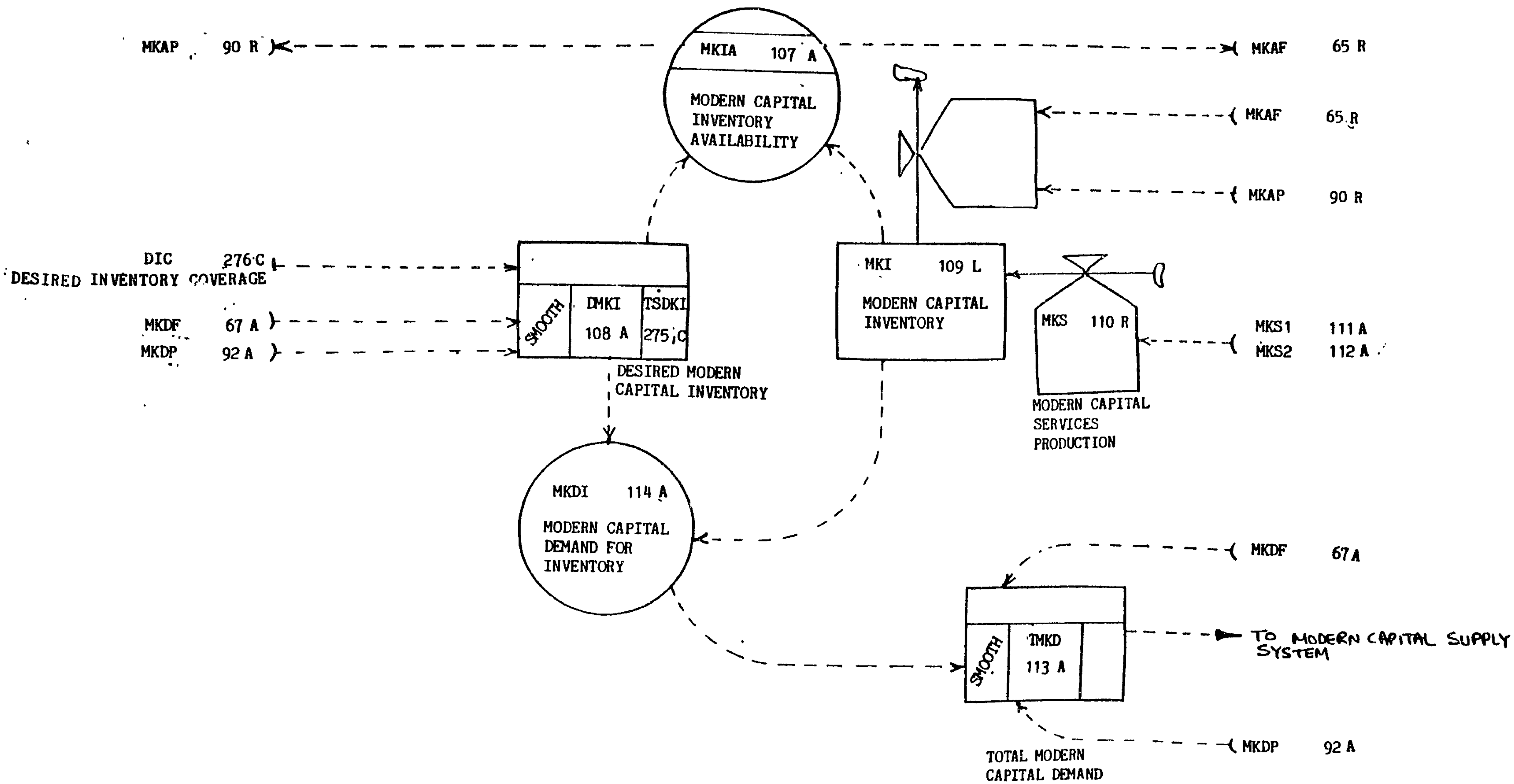


Figure A.17: Flow Diagram Showing Determination of Modern Capital Inventory Availability.

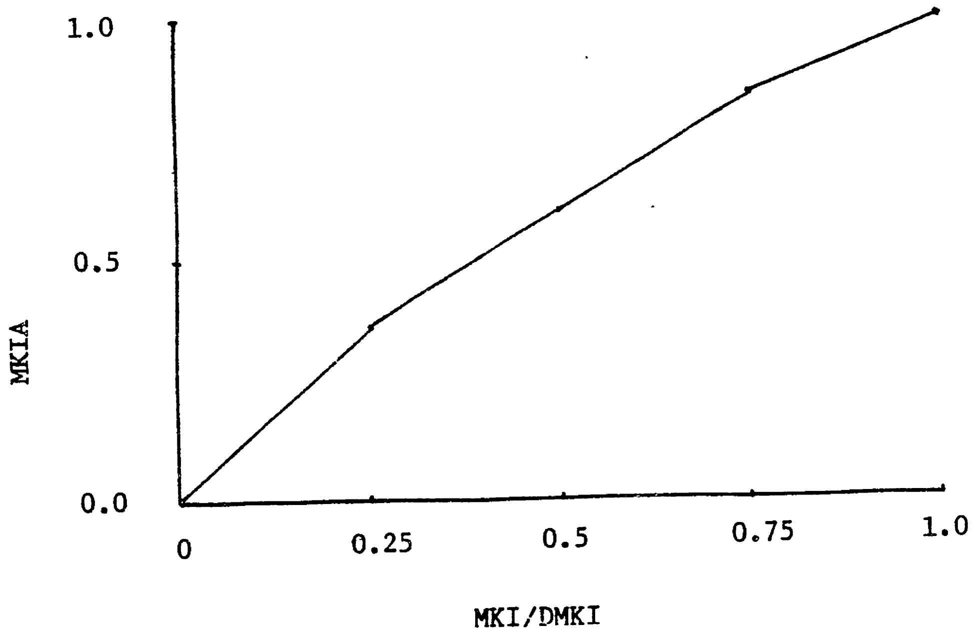


Figure A.18: The modern capital inventory availability MKIA.

```
MKIA.K=TABHL(TMKIA,MKI.K/DMKI.K,0,1,.25)                107, A
TMKIA=0/.36/.6/.84/1                                    107.1, T
    MKIA    - MODERN CAPITAL INVENTORY AVAILABILITY
                (DIMENSIONLESS)
    TMKIA   - TABLE FOR MODERN CAPITAL INVENTORY
                AVAILABILITY (DIMENSIONLESS)
    MKI     - MODERN CAPITAL INVENTORY (CAPITAL UNITS)
    DMKI    - DESIRED MODERN CAPITAL INVENTORY (CAPITAL
                UNITS)
```

The desired modern capital inventory DMKI is calculated by averaging the sum of modern capital demands from the two sectors (MKDF, MKDP), and multiplying the result by desired inventory coverage DIC.

```
DMKI.K=SMOOTH(MKDF.K+MKDP.K,TSDKI)*DIC                 108, A
DMKI=NDMKI                                             108.1, N
    DMKI   - DESIRED MODERN CAPITAL INVENTORY (CAPITAL
               UNITS)
    MKDF   - MODERN CAPITAL DEMAND IN FORMAL SECTOR
               (CAPITAL UNITS/TIME UNIT)
    MKDP   - MODERN CAPITAL DEMAND IN PEASANT SECTOR
               (CAPITAL UNITS/TIME UNIT)
    TSDKI  - TIME TO SMOOTH DESIRED CAPITAL INVENTORY
               (TIME UNITS)
    DIC    - DESIRED INVENTORY COVERAGE (TIME UNITS)
    NDMKI  - INITIAL DESIRED MODERN CAPITAL INVENTORY
               (CAPITAL UNITS)
```

Modern capital inventory MKI is represented as a level, which is increased by modern capital services production MKS, and depleted by modern capital acquisitions in the two sectors MKAF and MKAP.

```
MKI.K=MKI.J+(DT)(MKS.JK-MKAF.JK-MKAP.JK)                109, L
MKI=NMKI                                                109.1, N
    MKI    - MODERN CAPITAL INVENTORY (CAPITAL UNITS)
    DT     - SIMULATION SOLUTION INTERVAL (TIME UNITS)
    MKS    - MODERN CAPITAL SERVICES PRODUCTION (CAPITAL
               UNITS/TIME UNIT)
    MKAF   - MODERN CAPITAL ACQUISITIONS IN FORMAL
               SECTOR (CAPITAL UNITS/TIME UNIT)
    MKAP   - MODERN CAPITAL ACQUISITIONS IN PEASANT
               SECTOR (CAPITAL UNITS/TIME UNIT)
    NMKI   - INITIAL MODERN CAPITAL INVENTORY (CAPITAL
               UNITS)
```

As modern capital services are assumed to be produced outside the rural economy, their supply depends upon the policy to modernize agriculture sector. This policy is represented as a set of time dependent function that allow either a gradual or a step increase in the modern capital supply MKS at any specified time. The desired supply function can be switched in for policy tests by changing paramaters of the switching function.

```
MKS.KL=FIFGE(MKS1.K,MKS2.K,0,SWMKSP)                    110, R
    MKS    - MODERN CAPITAL SERVICES PRODUCTION (CAPITAL
               UNITS/TIME UNIT)
    FIFGE  - SWITCHING FUNCTION FROM DYNAMO
    MKS1   - FUNCTION ONE FOR MKS (CAPITAL UNITS/TIME
               UNIT)
    MKS2   - FUNCTION TWO FOR MKS (CAPITAL UNITS/TIME
               UNIT)
    SWMKSP - SWITCH FOR MODERN CAPITAL SUPPLY POLICY
               (DIMENSIONLESS)

MKS1.K=TABHL(TMKDM,TIME.K,1940,2000,10)                 111, A
TMKDM=0/0/0/0/0/0/0                                     111.1, T
    MKS1   - FUNCTION ONE FOR MKS (CAPITAL UNITS/TIME
               UNIT)
    TMKDM  - TABLE FOR MODERN CAPITAL DEMAND MET
               (CAPITAL UNITS/TIME UNIT)
    TIME   - SIMULATION TIME (TIME UNIT)

MKS2.K=STEP(HTMK,TMK)                                   112, A
    MKS2   - FUNCTION TWO FOR MKS (CAPITAL UNITS/TIME
               UNIT)
    STEP   - SWITCHING FUNCTION FROM DYNAMO
    HTMK   - HEIGHT OF TEST INPUT FOR MODERN CAPITAL
               SUPPLY (CAPITAL UNITS/TIME UNIT)
    TMK    - TIME OF MODERN CAPITAL POLICY (TIME UNIT)
```

Total modern capital demand TMKD is represented as an average of the modern capital demand from the two sectors (MKDP, MKDF), and the modern capital demand from inventory MKDI. MKDI is calculated by dividing the modern capital inventory discrepancy by modern capital inventory adjustment time MKIAT.

```
TMKD.K=SMOOTH(MKDF.K+MKDP.K+MKDI.K,TSMKD)               113, A
TMKD=NMKD                                               113.1, N
    TMKD   - TOTAL MODERN CAPITAL DEMAND (CAPITAL UNITS/
               TIME UNIT)
    MKDF   - MODERN CAPITAL DEMAND IN FORMAL SECTOR
               (CAPITAL UNITS/TIME UNIT)
    MKDP   - MODERN CAPITAL DEMAND IN PEASANT SECTOR
               (CAPITAL UNITS/TIME UNIT)
    MKDI   - MODERN CAPITAL DEMAND FOR INVENTORY
               (CAPITAL UNITS/TIME UNIT)
```

TSMKD - TIME TO SMOOTH MODERN CAPITAL DEMAND (TIME UNITS)
NMKD - INITIAL MODERN CAPITAL DEMAND (CAPITAL UNITS/TIME UNIT)

```
MKDI.K=(DMKI.K-MKI.K)/MKIAT                              114, A
```

MKDI - MODERN CAPITAL DEMAND FOR INVENTORY (CAPITAL UNITS/TIME UNIT)
DMKI - DESIRED MODERN CAPITAL INVENTORY (CAPITAL UNITS)
MKI - MODERN CAPITAL INVENTORY (CAPITAL UNITS)
MKIAT - MODERN CAPITAL INVENTORY ADJUSTMENT TIME (TIME UNITS)

The mechanisms for determining the traditional capital inventory availability TKIA are illustrated in Figure A.19. The equations for traditional capital inventory availability TKIA, Desired Traditional Capital Inventory DTKI, and Traditional Capital Inventory TKI are identical to the respective equations for modern capital inventory, as described below.

```
TKIA.K=TABHL(TTKIA,TKI.K/DTKI.K,0,1,.25)                 115, A
TTKIA=0/.36/.6/.84/1                                     115.1, T
```

TKIA - TRADITIONAL CAPITAL INVENTORY AVAILABILITY (DIMENSIONLESS)
TTKIA - TABLE FOR TRADITIONAL CAPITAL INVENTORY AVAILABILITY (DIMENSIONLESS)
TKI - TRADITIONAL CAPITAL INVENTORY (CAPITAL UNITS)
DTKI - DESIRED TRADITIONAL CAPITAL INVENTORY (CAPITAL UNITS)

```
DTKI.K=SMOOTH(TKDF.K+TKDP.K,TSDKI)*DIC                   116, A
DTKI=NTKI                                                116.1, N
```

DTKI - DESIRED TRADITIONAL CAPITAL INVENTORY (CAPITAL UNITS)
TKDF - TRADITIONAL CAPITAL DEMAND IN FORMAL SECTOR (CAPITAL UNITS /TIME UNIT)
TKDP - TRADITIONAL CAPITAL DEMAND IN PEASANT SECTOR (CAPITAL UNITS/TIME UNIT)
TSDKI - TIME TO SMOOTH DESIRED CAPITAL INVENTORY (TIME UNITS)
DIC - DESIRED INVENTORY COVERAGE (TIME UNITS)
NTKI - INITIAL TRADITIONAL CAPITAL INVENTORY (CAPITAL UNITS)

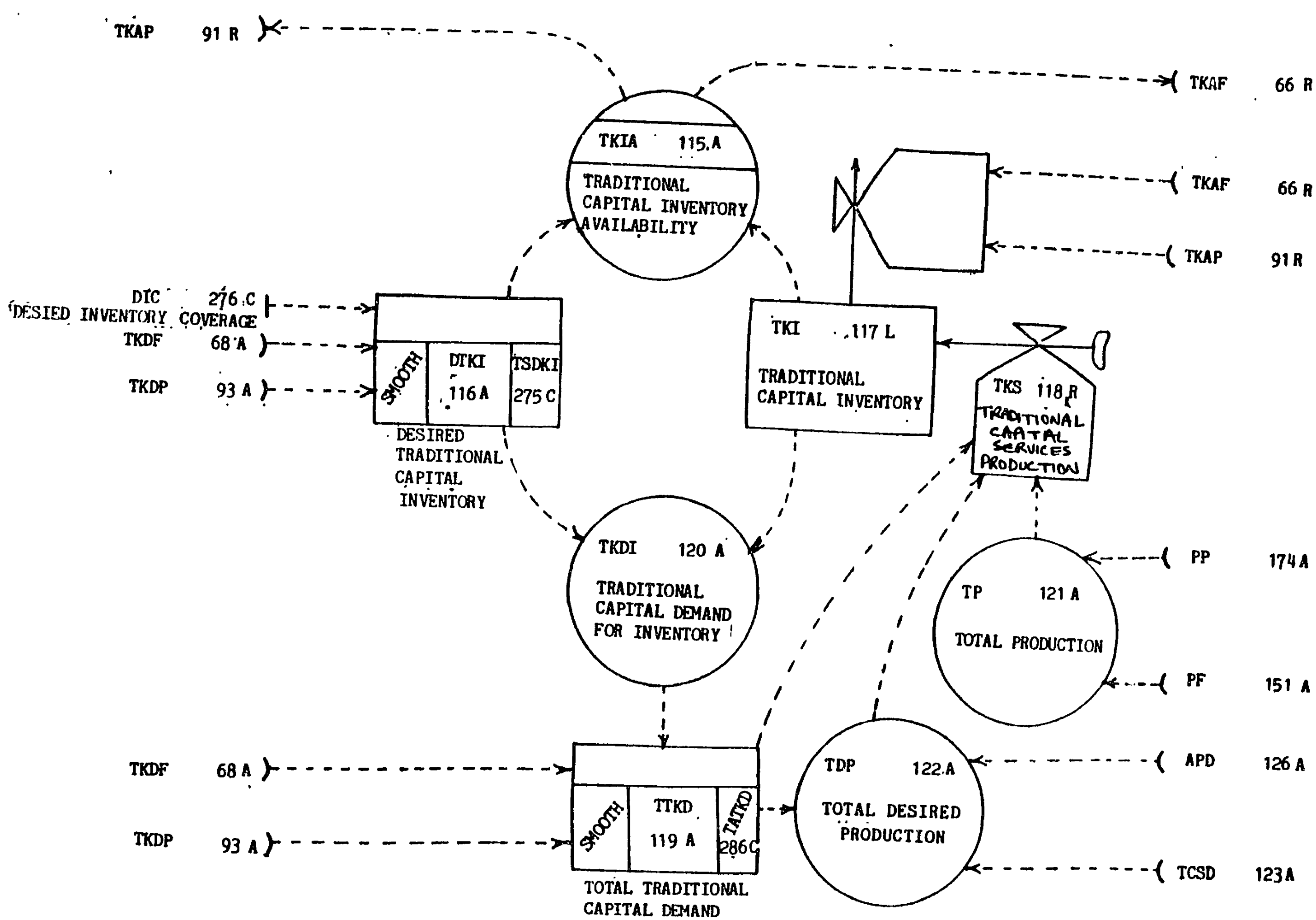


Figure A.19: Flow Diagram Showing Determination of Traditional Capital Inventory Availability

```
TKI.K=TKI.J+(DT)(TKS.JK-TKAF.JK-TKAP.JK)                117, L
TKI=NTKI                                                117.1, N
    TKI    - TRADITIONAL CAPITAL INVENTORY (CAPITAL
               UNITS)
    DT     - SIMULATION SOLUTION INTERVAL (TIME UNITS)
    TKS    - TRADITIONAL CAPITAL SERVICES PRODUCTION
               (CAPITAL UNITS/TIME UNIT)
    TKAF   - TRADITIONAL CAPITAL ACQUISITIONS IN FORMAL
               SECTOR (CAPITAL UNITS/TIME UNIT)
    TKAP   - TRADITIONAL CAPITAL UNITS IN PEASANT SECTOR
               (CAPITAL UNITS/TIME UNIT)
    NTKI   - INITIAL TRADITIONAL CAPITAL INVENTORY
               (CAPITAL UNITS)
```

Traditional capital services production TKS forms part of the total production TP of the rural economy. The proportion of traditional capital services in TP is determined by the ratio between the total traditional capital demand TTKD and the total desired production TDP.

```
TKS.KL=TTKD.K/TDP.K*TP.K                                118, R
    TKS    - TRADITIONAL CAPITAL SERVICES PRODUCTION
               (CAPITAL UNITS/TIME UNIT)
    TTKD   - TOTAL TRADITIONAL CAPITAL DEMAND (CAPITAL
               UNITS/TIME UNIT)
    TDP    - TOTAL DESIRED PRODUCTION (PRODUCT UNITS/
               TIME UNIT)
    TP     - TOTAL PRODUCTION (PRODUCT UNITS/TIME UNIT)
```

Total traditional capital demand TTKD depends upon an average of the sum of traditional capital demands from the two sectors, and the traditional capital demand from inventory, as in case of modern capital.

```
TTKD.K=SMOOTH(TKDF.K+TKDP.K+TKDI.K,TATKD)               119, A
TTKD=NTKD                                               119.1, N
    TTKD   - TOTAL TRADITIONAL CAPITAL DEMAND (CAPITAL
               UNITS/TIME UNIT)
    TKDF   - TRADITIONAL CAPITAL DEMAND IN FORMAL SECTOR
               (CAPITAL UNITS /TIME UNIT)
```

TKDP - TRADITIONAL CAPITAL DEMAND IN PEASANT SECTOR (CAPITAL UNITS/TIME UNIT)
TKDI - TRADITIONAL CAPITAL DEMAND FOR INVENTORY (CAPITAL UNITS/TIME UNIT)
TATKD - TIME TO AVERAGE TRADITIONAL CAPITAL DEMAND (TIME UNITS)
NTKD - INITIAL TRADITIONAL CAPITAL DEMAND (CAPITAL UNITS/TIME UNIT)

TKDI.K=(DTKI.K-TKI.K)/TKIAT 120, A
TKDI - TRADITIONAL CAPITAL DEMAND FOR INVENTORY (CAPITAL UNITS/TIME UNIT)
DTKI - DESIRED TRADITIONAL CAPITAL INVENTORY (CAPITAL UNITS)
TKI - TRADITIONAL CAPITAL INVENTORY (CAPITAL UNITS)
TKIAT - TRADITIONAL CAPITAL INVENTORY ADJUSTMENT TIME (TIME UNITS)

3.4. Total Production and its Components

Figure A.20 shows how the total production of the rural economy is divided into its components. Total production TP is the sum of productions of the two sectors. Total desired production TDP is the sum of the total traditional capital demand TTKD, Agricultural production demand APD and traditional consumption services demand TCSD.

TP.K=PP.K+PF.K 121, A
TP - TOTAL PRODUCTION (PRODUCT UNITS/TIME UNIT)
PP - PRODUCTION OF PEASANT SECTOR (PRODUCT UNITS/TIME UNIT)
PF - PRODUCTION OF FORMAL SECTOR (PRODUCT UNITS/TIME UNIT)

TDP.K=TTKD.K+APD.K+TCSD.K 122, A
TDP - TOTAL DESIRED PRODUCTION (PRODUCT UNITS/TIME UNIT)
TTKD - TOTAL TRADITIONAL CAPITAL DEMAND (CAPITAL UNITS/TIME UNIT)
APD - AGRICULTURAL PRODUCT DEMAND (PRODUCT UNITS/TIME UNIT)
TCSD - TRADITIONAL CONSUMPTION SERVICES DEMAND (PRODUCT UNITS/TIME UNIT)

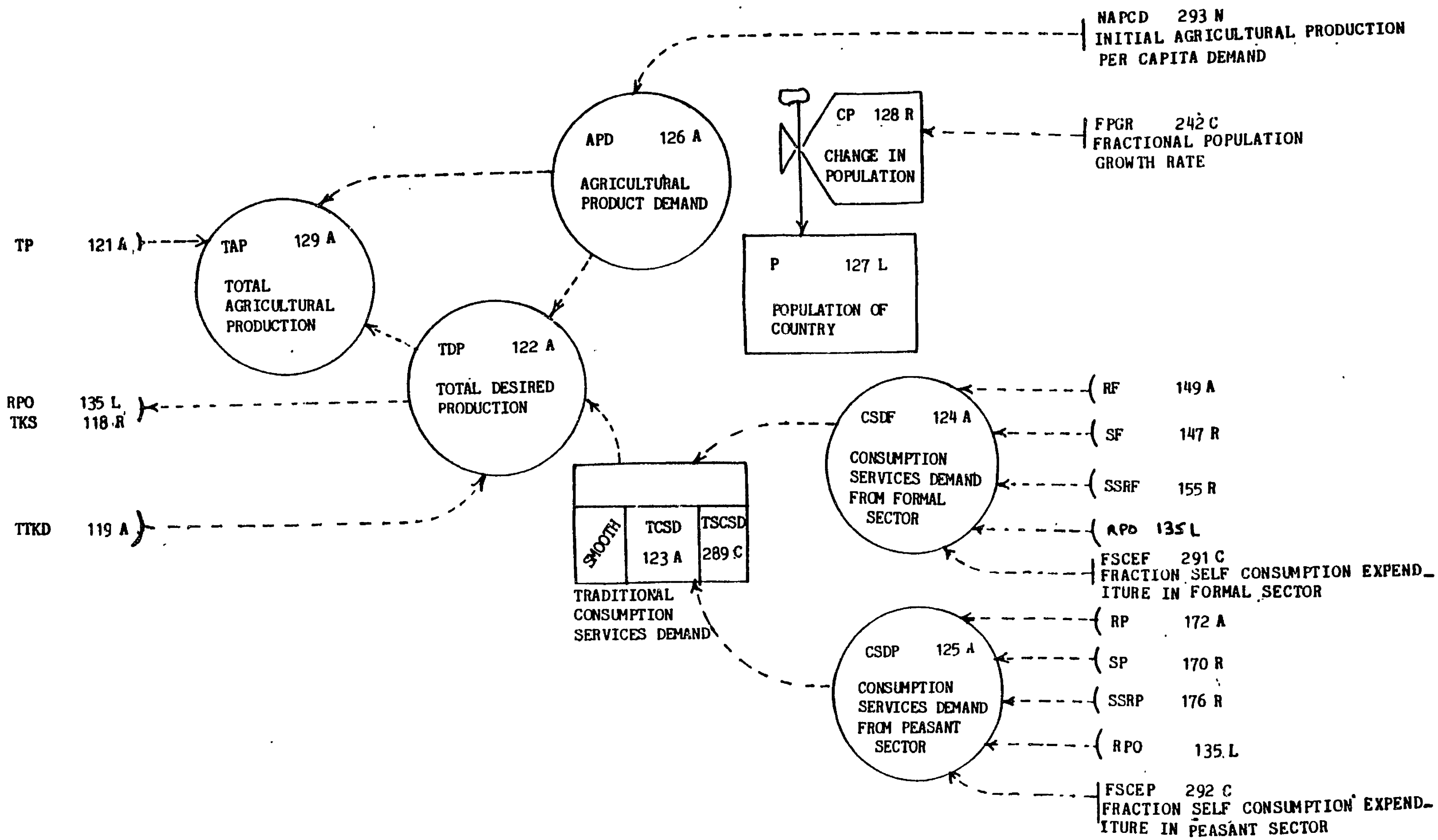


Figure A.20: Flow Diagram Showing Compsition of Demand for Rural Production.

The traditional consumption services demand TCSD is obtained by averaging the sum of consumption services demands in the two sectors.

```
TCSD.K=SMOOTH(CSDF.K+CSDP.K,TSCSD)                    123, A
TCSD=NCSD                                             123.1, N
    TCSD   - TRADITIONAL CONSUMPTION SERVICES DEMAND
               (PRODUCT UNITS/TIME UNIT)
    CSDF   - CONSUMPTION SERVICES DEMAND FROM FORMAL
               SECTOR (PRODUCT UNITS/TIME UNIT)
    CSDP   - CONSUMPTION SERVICES DEMAND FROM PEASANT
               SECTOR (PRODUCT UNITS/TIME UNIT)
    TSCSD  - TIME TO SMOOTH CONSUMPTION SERVICES DEMAND
               (TIME UNITS)
    NCSD   - INITIAL CONSUMPTION SERVICES DEMAND
               (SERVICE UNITS/TIME UNIT)
```

Traditional consumption services demand TCSD forms only a fraction of the total consumption, due to direct self consumption of production by the households. In many developing countries, including Pakistan, direct self consumption of farm production is an important mode of consumption, particulaly in the peasant sector, in which, most farms are small and are used for production of food crops for the farmer's own family [19]. The consumption services demand in the two sectors is obtained by multiplying the consumption component of the money income by the fraction remaining after self consumption, and dividing the product by the relative price of output, for converting consumption demand into product units.

```
CSDF.K=(RF.K-SF.JK+SSRF.JK)*(1-FSCEF)/RPO.K          124, A
    CSDF   - CONSUMPTION SERVICES DEMAND FROM FORMAL
              SECTOR (PRODUCT UNITS/TIME UNIT)
    RF     - REVENUE IN FORMAL SECTOR (MONEY UNITS/TIME
              UNIT)
    SF     - SAVINGS IN FORMAL SECTOR (MONEY UNITS/TIME
              UNIT)
    SSRF   - SAVING SPENDING RATE IN FORMAL SECTOR
              (MONEY UNITS/TIME UNIT)
    FSCEF  - FRACTION SELF CONSUMPTION EXPENDITURE IN
              FORMAL SECTOR (DIMENSIONLESS)
    RPO    - RELATIVE PRICE OF OUTPUT (MONEY UNITS/
              PRODUCT UNIT)

CSDP.K=(RP.K-SP.JK+SSRP.JK)*(1-FSCEP)/RPO.K          125, A
    CSDP   - CONSUMPTION SERVICES DEMAND FROM PEASANT
              SECTOR (PRODUCT UNITS/TIME UNIT)
    RP     - REVENUE IN PEASANT SECTOR (MONEY UNITS/TIME
              UNIT)
    SP     - SAVINGS IN PEASANT SECTOR (MONEY UNITS/TIME
              UNIT)
    SSRP   - SAVING SPENDING RATE IN PEASANT SECTOR
              (MONEY UNITS/TIME UNIT)
    FSCEP  - FRACTION SELF CONSUMPTION EXPENDITURE IN
              PEASANT SECTOR (DIMENSIONLESS)
    RPO    - RELATIVE PRICE OF OUTPUT (MONEY UNITS/
              PRODUCT UNIT)
```

Agriculture production demand ADP depends upon the population of the country P, and the normal agricultural product demand per capita NAPCD. The population P is represented as a level with a fractional population growth rate FPGR.

```
APD.K=P.K*NAPCD                                      126, A
    APD    - AGRICULTURAL PRODUCT DEMAND (PRODUCT UNITS/
              TIME UNIT)
    P      - POPULATION OF COUNTRY (PERSONS)
    NAPCD  - INITIAL AGRICULTURAL PRODUCTION PER CAPITA
              DEMAND (PRODUCT UNITS/PERSON/TIME UNIT)

P.K=P.J+(DT)(CP.JK)                                  127, L
P=NP                                                 127.1, N
    P      - POPULATION OF COUNTRY (PERSONS)
    DT     - SIMULATION SOLUTION INTERVAL (TIME UNITS)
    CP     - CHANGE IN POPULATION (PERSONS/TIME UNIT)
    NP     - INITIAL POPULATION OF COUNTRY (PERSONS)
```

```
CP.KL=P.K*STEP(FPGR,TPTSTG)                              128, R
    CP     - CHANGE IN POPULATION (PERSONS/TIME UNIT)
    P      - POPULATION OF COUNTRY (PERSONS)
    STEP   - SWITCHING FUNCTION FROM DYNAMO
    FPGR   - FRACTIONAL POPULATION GROWTH RATE (1/TIME
               UNITS)
    TPTSTG - TIME OF POLICY TEST FOR GROWTH (TIME UNIT)
```

Total agricultural production TAP is part of the total production, depending upon the share of agricultural production demand APD in the total desired production TDP.

```
TAP.K=APD.K/TDP.K*TP.K                                   129, A
    TAP    - TOTAL AGRICULTURAL PRODUCTION (PRODUCT
               UNITS/TIME UNIT)
    APD    - AGRICULTURAL PRODUCT DEMAND (PRODUCT UNITS/
               TIME UNIT)
    TDP    - TOTAL DESIRED PRODUCTION (PRODUCT UNITS/
               TIME UNIT)
    TP     - TOTAL PRODUCTION (PRODUCT UNITS/TIME UNIT)
```

3.5. Capital Rent and Price of Output

Figure A.21 shows how average capital rent AKR and relative price of output RPO are determined in the model. Average capital rent AKR is represented as a level that adjusts towards an indicated capital rent IKR. The indicated capital rent IKR depends upon the aggregate marginal revenue product of capital in the economy AMRPK and a pressure from demand for renting capital on capital rent PDRKKR.

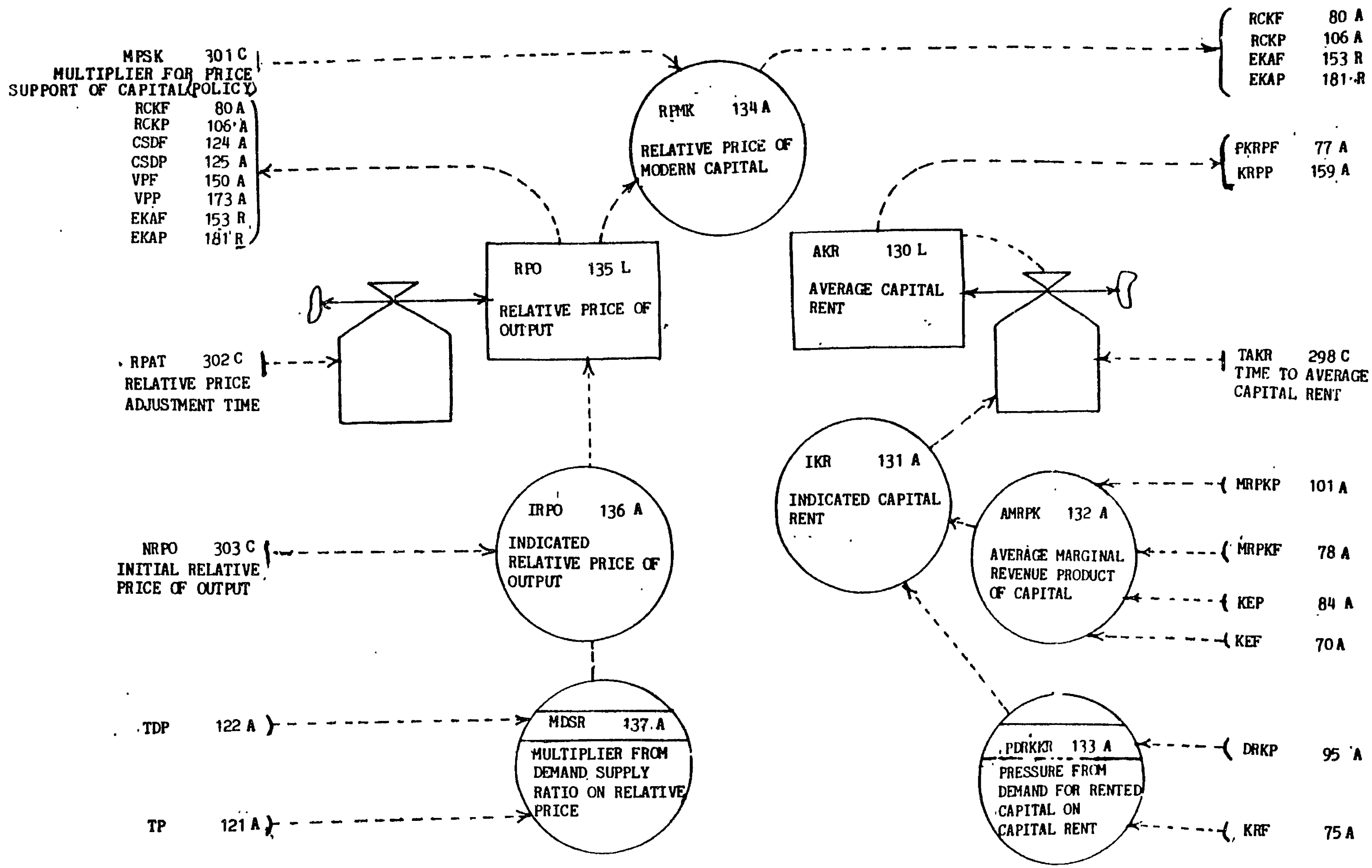


Figure A.21: Flow Diagram Showing Determination of Price of Output Capital Rent.

```
AKR.K=AKR.J+(DT)(DT/TAKR)(IKR.J-AKR.J)                    130, L
AKR=NAKR                                                  130.1, N
    AKR    - AVERAGE CAPITAL RENT (MONEY UNITS/CAPITAL
               UNIT/TIME UNIT)
    DT     - SIMULATION SOLUTION INTERVAL (TIME UNITS)
    TAKR   - TIME TO AVERAGE CAPITAL RENT (TIME UNITS)
    IKR    - INDICATED CAPITAL RENT (MONEY UNITS/CAPITAL
               UNIT/TIME UNIT)
    NAKR   - INITIAL CAPITAL RENT (MONEY UNITS/CAPITAL
               UNIT/TIME UNIT)

IKR.K=AMRPK.K*FIFGE(1,PDRKKR.K,0,STEP(SWR,TPTSTR))  131, A
    IKR    - INDICATED CAPITAL RENT (MONEY UNITS/CAPITAL
               UNIT/TIME UNIT)
    AMRPK  - AVERAGE MARGINAL REVENUE PRODUCT OF CAPITAL
               (MONEY UNITS/CAPITAL UNIT/TIME UNIT)
    FIFGE  - SWITCHING FUNCTION FROM DYNAMO
    PDRKKR - PRESSURE FROM DEMAND FOR RENTED CAPITAL ON
               CAPITAL RENT (DIMENSIONLESS)
    STEP   - SWITCHING FUNCTION FROM DYNAMO
    SWR    - SWITCH FOR RENTING POLICY (DIMENSIONLESS)
    TPTSTR - TIME OF POLICY TEST FOR RENTING (TIME UNIT)
```

The average marginal revenue product of capital AMRPK is computed for latter use in policy analysis, as a weighted average of the marginal revenue product of capital in the two sectors.

```
AMRPK.K=(MRPKF.K*KEF.K+MRPKP.K*KEP.K)/(KEF.K+KEP.K) 132, A
    AMRPK  - AVERAGE MARGINAL REVENUE PRODUCT OF CAPITAL
               (MONEY UNITS/CAPITAL UNIT/TIME UNIT)
    MRPKF  - MARGINAL REVENUE PRODUCT OF CAPITAL IN
               FORMAL SECTOR (MONEY UNITS/CAPITAL UNIT/
               TIME UNIT)
    KEF    - CAPITAL EMPLOYED BY FORMAL SECTOR (CAPITAL
               UNITS)
    MRPKP  - MARGINAL REVENUE PRODUCT OF CAPITAL IN
               PEASANT SECTOR (MONEY UNITS/CAPITAL UNIT/
               TIME UNIT)
    KEP    - CAPITAL EMPLOYED BY PEASANT SECTOR (CAPITAL
               UNITS)
```

The pressure from demand for rented capital on capital rent PDRKKR is represented as a nonlinear function, depending upon the ratio between the desired rented capital in the peasant sector

DRKP and the capital rented out by the formal sector KRF, as illustrated in Figure A.22. The shape of the function representing PDRKKR is based on the same logic as for the pressure form demand for rented land on land rent described in equation 31,A.

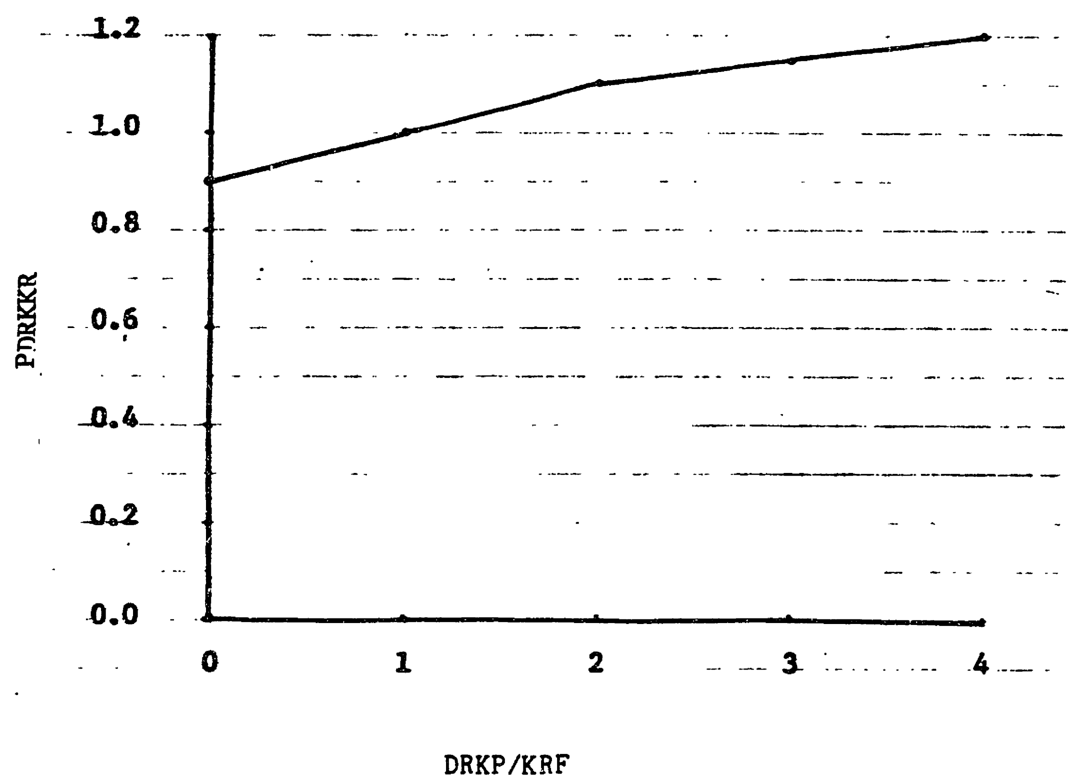


Figure A.22: The Pressure from Demand for Rented Capital on Capital Rent PDRKKR.

```
PDRKKR.K=TABHL(TDRKKR,DRKP.K/FIFGE(1,KRF.K,0,          133, A
  STEP(SWR,TPTSTR)),0,4,1)
TDRKKR=.9/1/1.1/1.15/1.2                              133.2, T
    PDRKKR - PRESSURE FROM DEMAND FOR RENTED CAPITAL ON
               CAPITAL RENT (DIMENSIONLESS)
    TDRKKR - TABLE FOR EFFECT OF DEMAND FOR RENTED
               CAPITAL ON CAPITAL RENT (DIMENSIONLESS)
    DRKP   - DESIRED RENTED CAPITAL IN PEASANT SECTOR
               (CAPITAL UNITS)
    FIFGE  - SWITCHING FUNCTION FROM DYNAMO
```

KRF - CAPITAL RENTED OUT BY FORMAL SECTOR (CAPITAL UNITS)
STEP - SWITCHING FUNCTION FROM DYNAMO
SWR - SWITCH FOR RENTING POLICY (DIMENSIONLESS)
TPTSTR - TIME OF POLICY TEST FOR RENTING (TIME UNIT)

The relative price of modern capital RPMK depends upon the relative price of output RPO and a multiplier representing modern capital pricing policy MPSK determined outside the model.

RPMK.K=RPO.K*MPSK 134, A
RPMK - RELATIVE PRICE OF MODERN CAPITAL (MONEY UNITS/CAPITAL UNIT)
RPO - RELATIVF PRICE OF OUTPUT (MONEY UNITS/ PRODUCT UNIT)
MPSK - MULTIPLIER FOR PRICE SUPPORT OF CAPITAL POLICY (DIMENSIONLESS)

The relative price of output RPO is represented as a level that adjusts towards an indicated relative price IRPO, which depends upon the normal worth of output in money units NRPO, and a multiplier from demand supply ratio on relative price MDSR.

RPO.K=RPO.J+(DT/RPAT)(IRPO.J-RPO.J) 135, L
RPO=NRPO 135.1, N
RPO - RELATIVE PRICE OF OUTPUT (MONEY UNITS/ PRODUCT UNIT)
DT - SIMULATION SOLUTION INTERVAL (TIME UNITS)
RPAT - RELATIVE PRICE ADJUSTMENT TIME (TIME UNITS)
IRPO - INDICATED RELATIVE PRICE OF OUTPUT (MONEY UNITS/PRODUCT UNIT)
NRPO - INITIAL RELATIVE PRICE OF OUTPUT (MONEY UNITS/OUTPUT UNIT)

IRPO.K=NRPO*MDSR.K 136, A
IRPO - INDICATED RELATIVE PRICE OF OUTPUT (MONEY UNITS/PRODUCT UNIT)
NRPO - INITIAL RELATIVE PRICE OF OUTPUT (MONEY UNITS/OUTPUT UNIT)
MDSR - MULTIPLIER FROM DEMAND SUPPLY RATIO ON RELATIVE PRICE (DIMENSIONLESS)

The multiplier from demand supply ratio on relative price MDSR is represented as a nonlinear function of the ratio between total desired production TDP and total production TP, as illustrated Figure A.23. The shape of the function MDSR is based on criteria similar to those for PDRKKR (Equation 133,A), and PDRLLR (Equation 31,A).

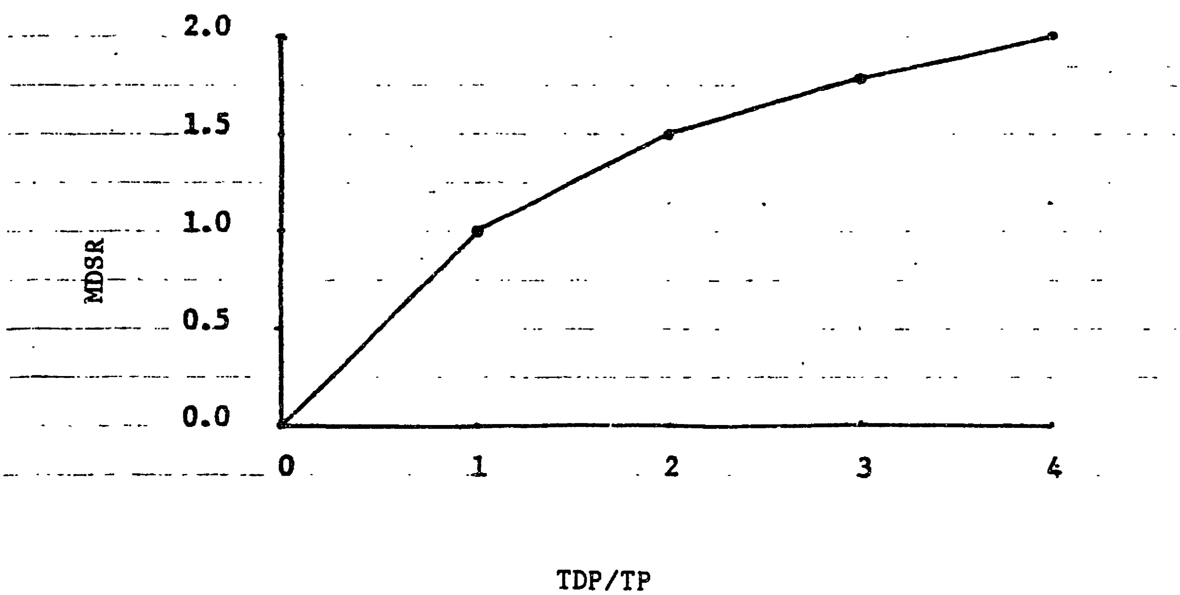


Figure A.23: The Multiplier from Demand Supply Ratio on Relative Price of Output MDSR.

```
MDSR.K=TABHL(TDSRP,TDP.K/TP.K,0,4,1)                    137, A
TDSRP=0/1/1.5/1.8/2                                      137.1, T
    MDSR    - MULTIPLIER FROM DEMAND SUPPLY RATIO ON
                RELATIVE PRICE (DIMENSIONLESS)
    TDSRP   - TABLE FOR EFFECT OF DEMAND SUPPLY RATIO ON
                RELATIVE PRICE (DIMENSIONLESS)
    TDP     - TOTAL DESIRED PRODUCTION (PRODUCT UNITS/
                TIME UNIT)
    TP      - TOTAL PRODUCTION (PRODUCT UNITS/TIME UNIT)
```

4. Savings, Income Disbursement, and Production

This section of the model represents the financial transactions in the rural economy. The financial markets are assumed to be segmented. Thus, savings of one sector are not available for investment in the other sector, unless they are transfered through property transactions between the sectors. Such segmentation gives rise to dependence of land and capital ownership on the internal cash balances of the respective sectors.

4.1. Formal Sector

Figure A.24 shows the income disbursement and saving processes, and their effect on ownership of land and capital in the formal sector. The effect of cash balance availability on land demand in the formal sector ECBALF is represented as a set of nonlinear functions of the savings adequacy, which is based on the ratio between the savings available for consumption and the average saving consumption rate, obtained by dividing accumulated savings ASF by the life of accumulated savings LASF, as shown in Figure A.25. Multiple functions are provided for testing financial policies by switching in the desired degree of coupling between internal cash balances and investment. The savings available for consumption are computed as the difference between average saving rate ASRF and average investment expenditure AIEF.

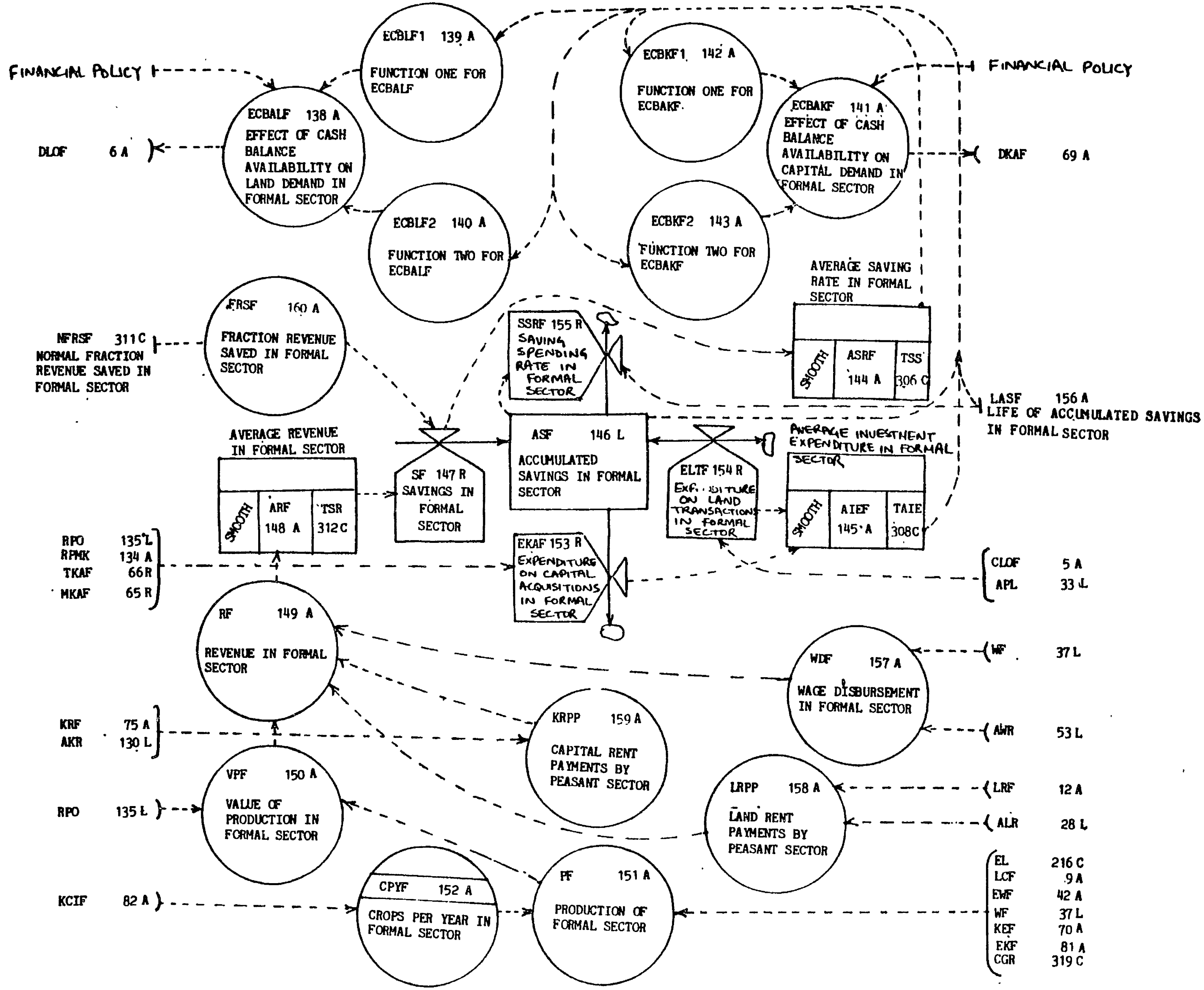


Figure A.24: Flow Diagram Showing Income Disbursement and Savings in the Formal Sector.

The effect of cash balance availability on capital demand ECBAKF is based on similar criteria.

An appreciable part of accumulated savings in the rural sector is consumed in the form of lumpy expenditures on marriages, births and deaths. In instances, land is liquidated to meet such expenditures. A certain level of accumulated savings are often necessary to maintain the lumpy consumption expenditure as well as the investment expenditure needed for capital acquisitions and land transactions. If the saving rate falls and the saving spending and investment rates continue at the same level, the accumulated savings will rapidly decline, thus making it impossible to maintain the past rates of saving expenditure, and forcing the sector to liquidate some of its assets. A surplus of savings, on the other hand, will increase propensity to acquire or hold on to property.

In the model, when the difference between the average saving rate ASRF and the average investment expenditure AIEF is equal to the average savings consumption rate, there is no pressure from savings to expand or contract land and capital holdings. When the difference between ASRF and AIEF exceeds saving consumption rate, surplus savings are available for investment activity, and the propensity to invest in land and capital increases, and vice versa. As an extreme condition, it is assumed that if ASRF is equal to AIEF and no savings are available for supporting the past saving consumption rate, part of the land may be liquidated, while capital acquisitions are driven down to zero. However, as liquidation starts, the proceeds from liquidation drive AIEF negative, and the pressure to liquidate decreases. On the other hand, it is assumed that when the difference between ASRF and AIEF exceeds past saving consumption rate, there will be a pressure to increase land and capital holdings (see Figures A.25 and A.26). Changes in the slope of the function representing the effects of cash balance availability only serve to increase or decrease the amount of coupling between internal savings and investment ability of a sector.

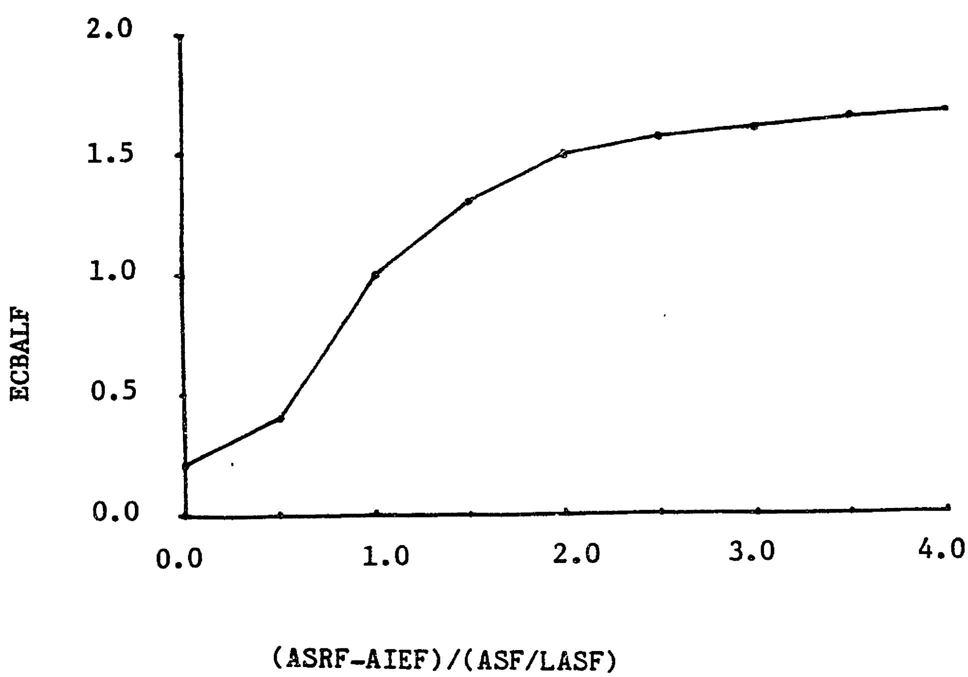


Figure A.25: The Effect of Cash Balance Availablilty on land ownership demand in the formal sector ECBALF.

```
ECBALF.K=FIFGE(ECBLF1.K,ECBLF2.K,0,STEP(SWFP,TFP))  138, A
    ECBALF - EFFECT OF CASH BALANCE AVAILABILITY ON LAND
               DEMAND IN FORMAL SECTOR (DIMENSIONLESS)
    FIFGE  - SWITCHING FUNCTION FROM DYNAMO
    ECBLF1 - FUNCTION ONE FOR ECBALF (DIMENSIONLESS)
    ECBLF2 - FUNCTION TWO FOR ECBALF (DIMENSIONLESS)
    STEP   - SWITCHING FUNCTION FROM DYNAMO
    SWFP   - SWITCH FOR FINANCIAL POLICY (DIMENSIONLESS)
    TFP    - TIME OF FINANCIAL POLICY (DIMENSIONLESS)

ECBLF1.K=TABHL(TCBL1,((ASRF.K-AIEF.K))/(ASF.K/      139, A
  LASF.K),0,4,.5)
TCBL1=.2/.4/1/1.3/1.5/1.57/1.6/1.65/1.68            139.1, T
    ECBLF1 - FUNCTION ONE FOR ECBALF (DIMENSIONLESS)
    TCBL1  - TABLE1 FOR EFFECT OF CASH BALANCE
               AVAILABILITY ON DEMAND FOR LAND
               (DIMENSIONLESS)
    ASRF   - AVERAGE SAVING RATE IN FORMAL SECTOR (MONEY
               UNITS/TIME UNIT)
    AIEF   -  AVERAGE INVESTMENT EXPENDITURE IN FORMAL
               SECTOR (MONEY UNITS/TIME UNIT)
    ASF    - ACCUMULATED SAVINGS IN FORMAL SECTOR (MONEY
               UNITS)
    LASF   - LIFE OF ACCUMULATED SAVINGS IN FORMAL
               SECTOR (TIME UNITS)

ECBLF2.K=TABHL(TCBL2,((ASRF.K-AIEF.K))/(ASF.K/      140, A
  LASF.K),0,4,.5)
TCBL2=.2/.4/1/1.3/1.5/1.57/1.6/1.65/1.68            140.1, T
    ECBLF2 - FUNCTION TWO FOR ECBALF (DIMENSIONLESS)
    TCBL2  - TABLE2 FOR EFFECT OF CASH BALANCE
               AVAILABILITY ON DEMAND FOR LAND
               (DIMENSIONLESS)
    ASRF   - AVERAGE SAVING RATE IN FORMAL SECTOR (MONEY
               UNITS/TIME UNIT)
    AIEF   -  AVERAGE INVESTMENT EXPENDITURE IN FORMAL
               SECTOR (MONEY UNITS/TIME UNIT)
    ASF    - ACCUMULATED SAVINGS IN FORMAL SECTOR (MONEY
               UNITS)
    LASF   - LIFE OF ACCUMULATED SAVINGS IN FORMAL
               SECTOR (TIME UNITS)
```

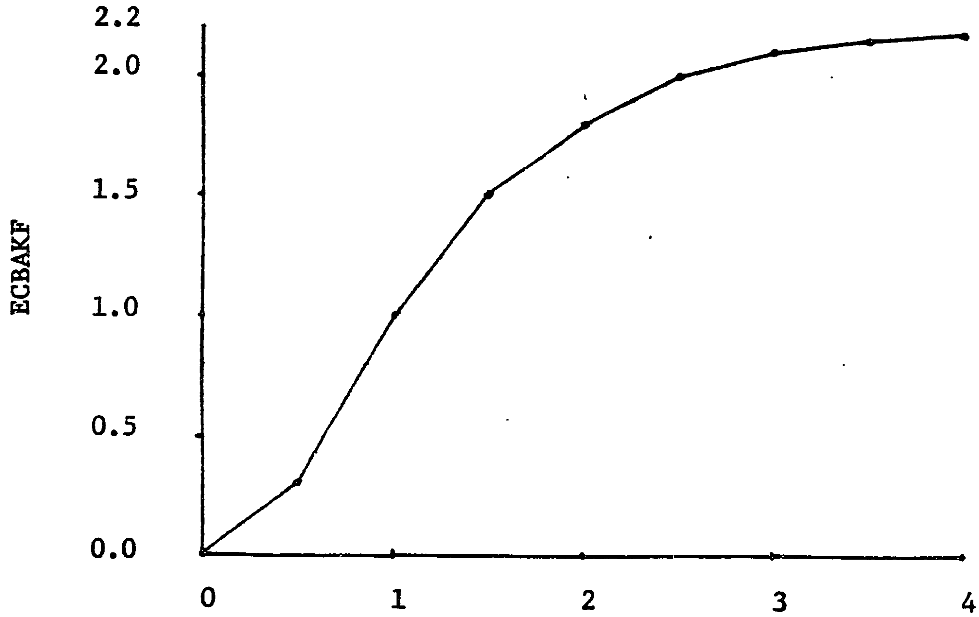


Figure A.26. The Effect of Cash Balance Availability on Capital Demand in Formal Sector ECBAKF

```
ECBAKF.K=FIFGE(ECBKF1.K,ECBKF2.K,0,STEP(SWFP,TFP))  141, A
    ECBAKF - EFFECT OF CASH BALANCE AVAILABILITY ON
               CAPITAL DEMAND IN FORMAL SECTOR
               (DIMENSIONLESS)
    FIFGE  - SWITCHING FUNCTION FROM DYNAMO
    ECBKF1 - FUNCTION ONE FOR ECBAKF (DIMENSIONLESS)
    ECBKF2 - FUNCTION TWO FOR ECBAKF (DIMENSIONLESS)
    STEP   - SWITCHING FUNCTION FROM DYNAMO
    SWFP   - SWITCH FOR FINANCIAL POLICY (DIMENSIONLESS)
    TFP    - TIME OF FINANCIAL POLICY (DIMENSIONLESS)

ECBKF1.K=TABHL(TCBK1,(ASRF.K-AIEF.K)/(ASF.K/LASF.K) 142, A
  ,0,4,.5)
TCBK1=0/.3/1/1.5/1.8/2/2.1/2.15/2.18                142.1, T
    ECBKF1 - FUNCTION ONE FOR ECBAKF (DIMENSIONLESS)
    TCBK1  - TABLE1 FOR EFFECT OF CASH BALANCE
               AVAILABILITY ON DEMAND FOR CAPITAL
               (DIMENSIONLESS)
    ASRF   - AVERAGE SAVING RATE IN FORMAL SECTOR (MONEY
               UNITS/TIME UNIT)
    AIEF   -  AVERAGE INVESTMENT EXPENDITURE IN FORMAL
               SECTOR (MONEY UNITS/TIME UNIT)
    ASF    - ACCUMULATED SAVINGS IN FORMAL SECTOR (MONEY
               UNITS)
    LASF   - LIFE OF ACCUMULATED SAVINGS IN FORMAL
               SECTOR (TIME UNITS)
```

```
ECBKF2.K=TABHL(TCBK2,(ASRF.K-AIEF.K)/(ASF.K/LASF.K) 143, A
  ,0,4,.5)
TCBK2=0/.3/1/1.5/1.8/2/2.1/2.15/2.18                 143.1, T
    ECBKF2 - FUNCTION TWO FOR ECBAKF (DIMENSIONLESS)
    TCBK2  - TABLE2 FOR EFFECT OF CASH BALANCE
               AVAILABILITY ON DEMAND FOR CAPITAL
               (DIMENSIONLESS)
    ASRF   - AVERAGE SAVING RATE IN FORMAL SECTOR (MONEY
               UNITS/TIME UNIT)
    AIEF   -  AVERAGE INVESTMENT EXPENDITURE IN FORMAL
               SECTOR (MONEY UNITS/TIME UNIT)
    ASF    - ACCUMULATED SAVINGS IN FORMAL SECTOR (MONEY
               UNITS)
    LASF   - LIFE OF ACCUMULATED SAVINGS IN FORMAL
               SECTOR (TIME UNITS)

ASRF.K=SMOOTH(SF.JK;TSS)                             144, A
    ASRF   - AVERAGE SAVING RATE IN FORMAL SECTOR (MONEY
               UNITS/TIME UNIT)
    SF     - SAVINGS IN FORMAL SECTOR (MONEY UNITS/TIME
               UNIT)
    TSS    - TIME TO SMOOTH SAVINGS (TIME UNITS)

AIEF.K=SMOOTH(ELTF.JK+EKAF.JK,TAIE)                  145, A
AIEF=NIEF                                            145.1, N
    AIEF   -  AVERAGE INVESTMENT EXPENDITURE IN FORMAL
               SECTOR (MONEY UNITS/TIME UNIT)
    ELTF   - EXPENDITURE ON LAND TRANSACTIONS IN FORMAL
               SECTOR (MONEY UNITS/TIME UNIT)
    EKAF   - EXPENDITURE ON CAPITAL ACQUISITIONS IN
               FORMAL SECTOR (MONEY UNITS/TIME UNIT)
    TAIE   - TIME TO AVERAGE INVESTMENT EXPENDITURE
               (TIME UNITS)
    NIEF   - INITIAL INVESTMENT EXPENDITURE IN FORMAL
               SECTOR ((MONEY UNITS/TIME UNIT)
```

The accumulated savings ASF are represented as a level which is increased by the saving rate SF and depleted by expenditure on capital acquisitions EKAF, expenditure on land transactions ELTF, and the savings spending rate SSRF.

```
ASF.K=ASF.J+(DT)(SF.JK-EKAF.JK-ELTF.JK-SSRF.JK)        146, L
ASF=NASF                                               146.1, N
    ASF     - ACCUMULATED SAVINGS IN FORMAL SECTOR (MONEY
                UNITS)
    DT      - SIMULATION SOLUTION INTERVAL (TIME UNITS)
    SF      - SAVINGS IN FORMAL SECTOR (MONEY UNITS/TIME
                UNIT)
    EKAF    - EXPENDITURE ON CAPITAL ACQUISITIONS IN
                FORMAL SECTOR (MONEY UNITS/TIME UNIT)
    ELTF    - EXPENDITURE ON LAND TRANSACTIONS IN FORMAL
                SECTOR (MONEY UNITS/TIME UNIT)
    SSRF    - SAVING SPENDING RATE IN FORMAL SECTOR
                (MONEY UNITS/TIME UNIT)
    NASF    - INITIAL ACCUMULATED SAVINGS IN FORMAL
                SECTOR (MONEY UNITS)
```

Savings in the formal sector depend upon the average revenue in the sector ARF and the fraction of revenue saved FRSF. ARF is obtained by taking a yearly average of revenue RF, which is constituted by the value of production of the sector VPF, less wage dibursements by the sector WDF, plus the land and capital rent payments to the sector (LRPP and KRPP).

```
SF.KL=ARF.K*FRSF.K                                     147, R
    SF      - SAVINGS IN FORMAL SECTOR (MONEY UNITS/TIME
                UNIT)
    ARF     - AVERAGE REVENUE IN FORMAL SECTOR (MONEY
                UNITS/TIME UNIT)
    FRSF    - FRACTION REVENUE SAVED IN FORMAL SECTOR
                (DIMENSIONLESS)

ARF.K=SMOOTH(RF.K,TSR)                                 148, A
ARF=NRF                                                148.1, N
    ARF     - AVERAGE REVENUE IN FORMAL SECTOR (MONEY
                UNITS/TIME UNIT)
    RF      - REVENUE IN FORMAL SECTOR (MONEY UNITS/TIME
                UNIT)
    TSR     - TIME TO SMOOTH REVENUE (TIME UNITS)
    NRF     - INITIAL REVENUE IN FORMAL SECTOR (MONEY
                UNITS/TIME UNIT)
```

```
RF.K=VPF.K+LRPP.K+KRPP.K-WDF.K-LOF.K*LOT-LRPP.K*     149, A
  LRT-KRPP.K*KRT
    RF      - REVENUE IN FORMAL SECTOR (MONEY UNITS/TIME
                UNIT)
    VPF     - VALUE OF PRODUCTION IN FORMAL SECTOR (MONEY
                UNITS/TIME UNIT)
    LRPP    - LAND RENT PAYMENTS BY PEASANT SECTOR (MONEY
                UNITS/TIME UNIT)
    KRPP    - CAPITAL RENT PAYMENTS BY PEASANT SECTOR
                (MONEY UNITS/TIME UNIT)
    WDF     - WAGE DISBURSEMENT IN FORMAL SECTOR (MONEY
                UNITS/TIME UNIT)
    LOF     - LAND OWNED BY FORMAL SECTOR (LAND UNITS)
    LOT     - LAND OWNERSHIP TAX (MONEY UNITS/LAND UNITS/
                TIME UNIT)
    LRT     - LAND RENT TAX (MONEY UNITS/MONEY UNIT OF
                LAND RENT)
    KRT     - CAPITAL RENT TAX (MONEY UNITS/MONEY UNIT
                CAPITAL RENT)
```

Value of production VPF is given by multiplying production of the sector PF by the relative price of output RPO. The production PF is calculated on the basis of land, workers, and capital employed by the sector, and the production technology used. A Cobb Douglas Type production function is used. Effect of modern capital is incorporated by multiplying the function by crops per year CPYF which depend on the draught power technology (see Figure A.27). Further an exogenous multiplier representing the effect of green revolution technology is added. Switching functions are for policy tests related to green revolution technology.

```
VPF.K=PF.K*RPO.K                                      150, A
    VPF     - VALUE OF PRODUCTION IN FORMAL SECTOR (MONEY
                UNITS/TIME UNIT)
    PF      - PRODUCTION OF FORMAL SECTOR (PRODUCT UNITS/
                TIME UNIT)
    RPO     - RELATIVE PRICE OF OUTPUT (MONEY UNITS/
                PRODUCT UNIT)
```

```
PF.K=SFPF*EXP(EL*LOGN(LCF.K))*EXP(EWF.K*LOGN(WF.K)) 151, A
  *EXP(EKF.K*LOGN(KEF.K))*CPYF.K*FIFGE(1,CGR,0,
  STEP(SWGR,TGR))
    PF      - PRODUCTION OF FORMAL SECTOR (PRODUCT UNITS/
                TIME UNIT)
    SFPF    - SCALING FACTOR OF PRODUCTION FUNCTION
                (DIMENSIONLESS)
    EL      - ELASTICITY OF PRODUCTION OF LAND
                (DIMENSIONLESS)
    LCF     - LAND CULTIVATED BY FORMAL SECTOR (LAND
                UNITS)
    EWF     - ELASTICITY OF PRODUCTION OF WORKERS IN
                FORMAL SECTOR (DIMENSIONLESS)
    WF      - WORKERS IN FORMAL SECTOR (PERSONS)
    EKF     - ELASTICITY OF PRODUCTION OF CAPITAL IN
                FORMAL SECTOR (DIMENSIONLESS)
    KEF     - CAPITAL EMPLOYED BY FORMAL SECTOR (CAPITAL
                UNITS)
    CPYF    - CROPS PER YEAR IN FORMAL SECTOR (NUMBER)
    FIFGE   - SWITCHING FUNCTION FROM DYNAMO
    CGR     - COEFFICIENT FOR GREEN REVOLUTION
                (DIMENSIONLESS)
    STEP    - SWITCHING FUNCTION FROM DYNAMO
    SWGR    - SWITCH FOR GREEN REVOLUTION POLICY
                (DIMENSIONLESS)
    TGR     - TIME OF GREEN REVOLUTION POLICY (TIME UNIT)
```

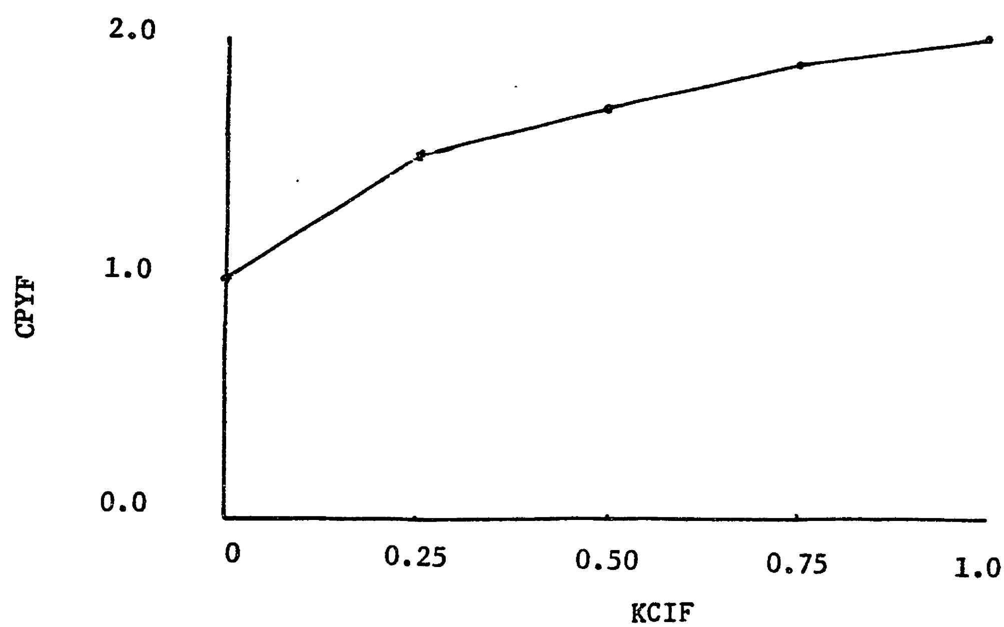


Figure A.27. Crops per Year in Formal Sector CPYF as Affected by the Draught Power Technology.

```
CPYF.K=TABHL(TCPY,KCIF.K,0,1,.25)                 152, A
TCPY=1/1.5/1.7/1.9/2                              152.1, T
```

CPYF - CROPS PER YEAR IN FORMAL SECTOR (NUMBER)
TCPY - TABLE FOR CROPS PER YEAR (NUMBER)
KCIF - CAPITAL COMPOSITION INDICATOR IN FORMAL SECTOR (DIMENSIONLESS)

The expenditure on capital acquisitions, EKAF is an accounting flow, calculated by multiplying capital acquisitions in the modern and traditional categories by their respective prices and adding the two products.

```
EKAF.KL=MKAF.JK*RPMK.K+TKAF.JK*RPO.K                    153, R
```

EKAF - EXPENDITURE ON CAPITAL ACQUISITIONS IN FORMAL SECTOR (MONEY UNITS/TIME UNIT)
MKAF - MODERN CAPITAL ACQUISITIONS IN FORMAL SECTOR (CAPITAL UNITS/TIME UNIT)
RPMK - RELATIVE PRICE OF MODERN CAPITAL (MONEY UNITS/CAPITAL UNIT)
TKAF - TRADITIONAL CAPITAL ACQUISITIONS IN FORMAL SECTOR (CAPITAL UNITS/TIME UNIT)
RPO - RELATIVE PRICE OF OUTPUT (MONEY UNITS/PRODUCT UNIT)

The expenditure on land transactions ELTF is another accounting flow, which is calculated by multiplying the change in land ownership in the sector CLOF by the average price of land APL.

```
ELTF.KL=CLOF.K*APL.K                                    154, R
```

ELTF - EXPENDITURE ON LAND TRANSACTIONS IN FORMAL SECTOR (MONEY UNITS/TIME UNIT)
CLOF - CHANGE IN LAND OWNED BY FORMAL SECTOR (LAND UNITS/TIME UNIT)
APL - AVERAGE PRICE OF LAND (MONEY UNITS/LAND UNITS)

The saving spending rate in the sector SSRF is obtained by dividing accumulated savings ASF by life of accumulated savings LASF. The life of accumulated savings LASF is assumed to remain constant a value represented by NLASF.

```
SSRF.KL=ASF.K/LASF.K                                  155, R
    SSRF    - SAVING SPENDING RATE IN FORMAL SECTOR
                (MONEY UNITS/TIME UNIT)
    ASF     - ACCUMULATED SAVINGS IN FORMAL SECTOR (MONEY
                UNITS)
    LASF    - LIFE OF ACCUMULATED SAVINGS IN FORMAL
                SECTOR (TIME UNITS)

LASF.K=NLASF                                          156, A
    LASF    - LIFE OF ACCUMULATED SAVINGS IN FORMAL
                SECTOR (TIME UNITS)
    NLASF   - INITIAL LIFE OF ACCUMULATED SAVINGS IN
                FORMAL SAETOR (TIME UNITS)
```

Wage disbursement in the formal sector WDF is calculated by multiplying the number of workers employed by the sector WF by the average wage rate AWR. Land rent payments by peasants LRPP are obtained by multiplying together land rented out by formal sector LRF and average land rent ALR. Capital rent payments by peasants KRPP are obtained by multiplying together capital rented out by formal sector KRF and the average capital rent AKR.

```
WDF.K=WF.K*AWR.K                                      157, A
    WDF     - WAGE DISBURSEMENT IN FORMAL SECTOR (MONEY
                UNITS/TIME UNIT)
    WF      - WORKERS IN FORMAL SECTOR (PERSONS)
    AWR     - AVERAGE WAGE RATE (MONEY UNITS/PERSON/TIME
                UNIT)

LRPP.K=LRF.K*ALR.K                                    158, A
    LRPP    - LAND RENT PAYMENTS BY PEASANT SECTOR (MONEY
                UNITS/TIME UNIT)
    LRF     - LAND RENTED OUT BY FORMAL SECTOR (LAND
                UNITS)
    ALR     - AVERAGE LAND RENT (MONEY UNITS/LAND UNITS/
                TIME UNIT)
```

```
KRPP.K=KRF.K*AKR.K                                    159, A
    KRPP   - CAPITAL RENT PAYMENTS BY PEASANT SECTOR
               (MONEY UNITS/TIME UNIT)
    KRF    - CAPITAL RENTED OUT BY FORMAL SECTOR
               (CAPITAL UNITS)
    AKR    - AVERAGE CAPITAL RENT (MONEY UNITS/CAPITAL
               UNIT/TIME UNIT)
```

The fraction of revenue saved in the formal sector FRSF is assumed to remain constant as suggested in several macro-economic models and empirical studies.

```
FRSF.K=NFRSF                                          160, A
    FRSF   - FRACTION REVENUE SAVED IN FORMAL SECTOR
               (DIMENSIONLESS)
    NFRSF  - NORMAL FRACTION REVENUE SAVED IN FORMAL
               SECTOR (DIMENSIONLESS)
```

4.2. Peasant Sector

Figure A.27 shows the income disbursement and saving processes in the peasant sector. The effects of cash balance availability on land and capital demands ECBALP and ECBAKP are calculated in the same way as in case of the formal sector.

```
ECBALP.K=FIFGE(ECBLP1.K,ECBLP2.K,0,STEP(SWFP,TFP))  161, A
    ECBALP - EFFECT OF CASH BALANCE AVAILABILITY ON LAND
               DEMAND IN PEASANT SECTOR (DIMENSIONLESS)
    FIFGE  - SWITCHING FUNCTION FROM DYNAMO
    ECBLP1 - FUNCTION ONE FOR ECBALP (DIMENSIONLESS)
    ECBLP2 - FUNCTION TWO FOR ECBALP (DIMENSIONLESS)
    STEP   - SWITCHING FUNCTION FROM DYNAMO
    SWFP   - SWITCH FOR FINANCIAL POLICY (DIMENSIONLESS)
    TFP    - TIME OF FINANCIAL POLICY (DIMENSIONLESS)
```

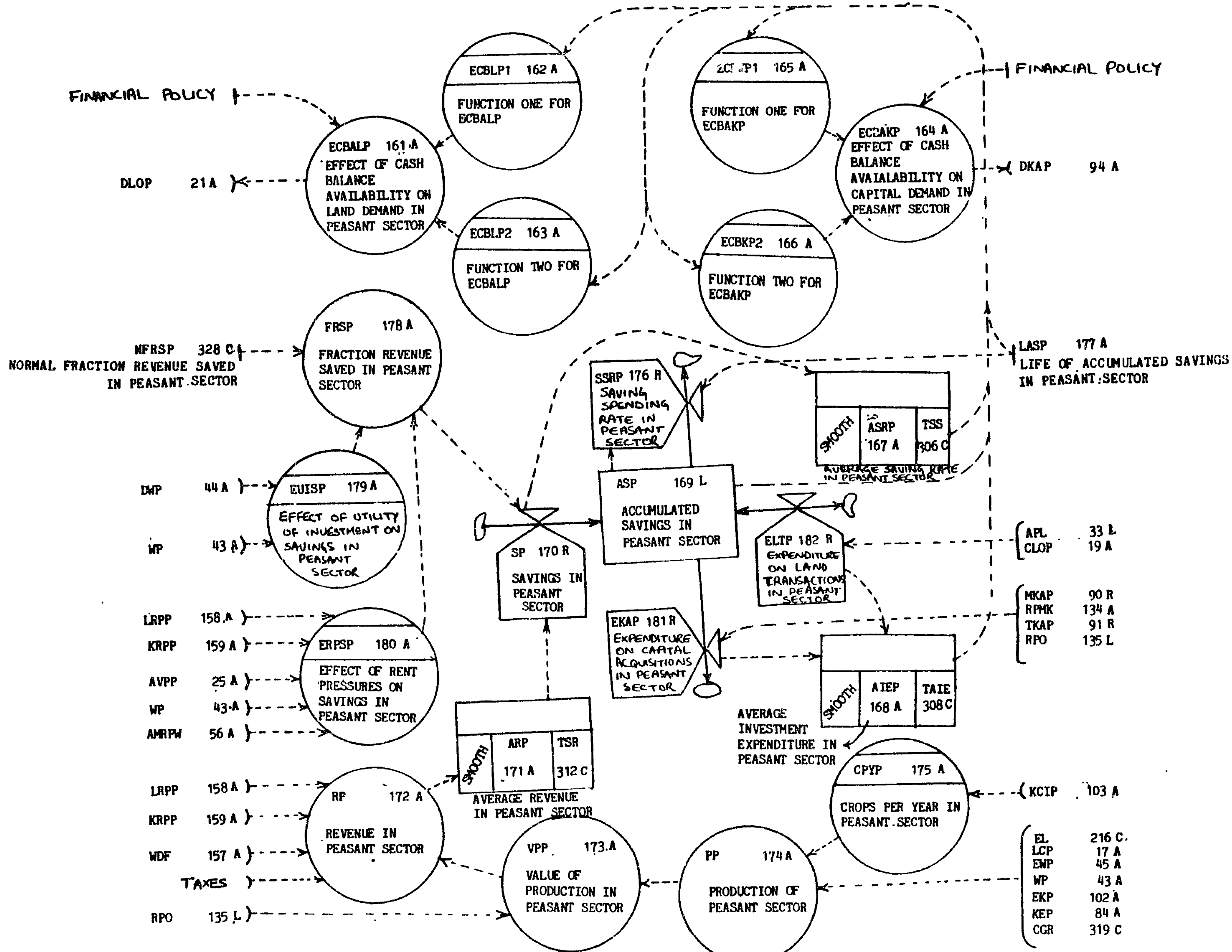


Figure A.27: Flow Diagram Showing Income Disbursement and Savings in the Peasant Sector.

```
ECBLP1.K=TABHL(TCBL1,(ASRP.K-AIEP.K)/(ASP.K/LASP.K) 162, A
  ,0,4,.5)
    ECBLP1 - FUNCTION ONE FOR ECBALP (DIMENSIONLESS)
    TCBL1  - TABLE1 FOR EFFECT OF CASH BALANCE
               AVAILABILITY ON DEMAND FOR LAND
               (DIMENSIONLESS)
    ASRP   - AVERAGE SAVING RATE IN PEASANT SECTOR
               (MONEY UNITS/TIME UNIT)
    AIEP   - AVERAGE INVESTMENT EXPENDITURE IN PEASANT
               SECTOR (MONEY UNITS/TIME UNIT)
    ASP    - ACCUMULATED SAVINGS IN PEASANT SECTOR
               (MONEY UNITS)
    LASP   - LIFE OF ACCUMULATED SAVINGS IN PEASANT
               SECTOR (TIME UNITS)

ECBLP2.K=TABHL(TCBL2,(ASRP.K-AIEP.K)/(ASP.K/LASP.K) 163, A
  ,0,4,.5)
    ECBLP2 - FUNCTION TWO FOR ECBALP (DIMENSIONLESS)
    TCBL2  - TABLE2 FOR EFFECT OF CASH BALANCE
               AVAILABILITY ON DEMAND FOR LAND
               (DIMENSIONLESS)
    ASRP   - AVERAGE SAVING RATE IN PEASANT SECTOR
               (MONEY UNITS/TIME UNIT)
    AIEP   - AVERAGE INVESTMENT EXPENDITURE IN PEASANT
               SECTOR (MONEY UNITS/TIME UNIT)
    ASP    - ACCUMULATED SAVINGS IN PEASANT SECTOR
               (MONEY UNITS)
    LASP   - LIFE OF ACCUMULATED SAVINGS IN PEASANT
               SECTOR (TIME UNITS)

ECBAKP.K=FIFGE(ECBKP1.K,ECBKP2.K,0,STEP(SWFP,TFP))  164, A
    ECBAKP - EFFECT OF CASH BALANCE AVAILABILITY ON
               CAPITAL DEMAND IN PEASANT SECTOR
               (DIMENSIONLESS)
    FIFGE  - SWITCHING FUNCTION FROM DYNAMO
    ECBKP1 - FUNCTION ONE FOR ECBAKP (DIMENSIONLESS)
    ECBKP2 - FUNCTION TWO FOR ECBAKP (DIMENSIONLESS)
    STEP   - SWITCHING FUNCTION FROM DYNAMO
    SWFP   - SWITCH FOR FINANCIAL POLICY (DIMENSIONLESS)
    TFP    - TIME OF FINANCIAL POLICY (DIMENSIONLESS)

ECBKP1.K=TABHL(TCBK1,(ASRP.K-AIEP.K)/(ASP.K/LASP.K) 165, A
  ,0,4,.5)
    ECBKP1 - FUNCTION ONE FOR ECBAKP (DIMENSIONLESS)
    TCBK1  - TABLE1 FOR EFFECT OF CASH BALANCE
               AVAILABILITY ON DEMAND FOR CAPITAL
               (DIMENSIONLESS)
    ASRP   - AVERAGE SAVING RATE IN PEASANT SECTOR
               (MONEY UNITS/TIME UNIT)
    AIEP   - AVERAGE INVESTMENT EXPENDITURE IN PEASANT
               SECTOR (MONEY UNITS/TIME UNIT)
    ASP    - ACCUMULATED SAVINGS IN PEASANT SECTOR
               (MONEY UNITS)
```

```
    LASP    - LIFE OF ACCUMULATED SAVINGS IN PEASANT
                SECTOR (TIME UNITS)

ECBKP2.K=TABHL(TCBK2,(ASRP.K-AIEP.K)/(ASP.K/LASP.K) 166, A
  ,0,4,.5)
    ECBKP2 - FUNCTION TWO FOR ECBAKP (DIMENSIONLESS)
    TCBK2  - TABLE2 FOR EFFECT OF CASH BALANCE
                AVAILABILITY ON DEMAND FOR CAPITAL
                (DIMENSIONLESS)
    ASRP   - AVERAGE SAVING RATE IN PEASANT SECTOR
                (MONEY UNITS/TIME UNIT)
    AIEP   - AVERAGE INVESTMENT EXPENDITURE IN PEASANT
                SECTOR (MONEY UNITS/TIME UNIT)
    ASP    - ACCUMULATED SAVINGS IN PEASANT SECTOR
                (MONEY UNITS)
    LASP   - LIFE OF ACCUMULATED SAVINGS IN PEASANT
                SECTOR (TIME UNITS)

ASRP.K=SMOOTH(SP.JK,TSS)                               167, A
    ASRP   - AVERAGE SAVING RATE IN PEASANT SECTOR
                (MONEY UNITS/TIME UNIT)
    SP     - SAVINGS IN PEASANT SECTOR (MONEY UNITS/TIME
                UNIT)
    TSS    - TIME TO SMOOTH SAVINGS (TIME UNITS)

AIEP.K=SMOOTH(ELTP.JK+EKAP.JK,TAIE)                    168, A
AIEP=NIEP                                              168.1, N
    AIEP   - AVERAGE INVESTMENT EXPENDITURE IN PEASANT
                SECTOR (MONEY UNITS/TIME UNIT)
    ELTP   - EXPENDITURE ON LAND TRANSACTIONS IN PEASANT
                SECTOR (MONEY UNITS/TIME UNIT)
    EKAP   - EXPENDITURE ON CAPITAL ACQUISITIONS IN
                PEASANT SECTOR (MONEY UNITS/TIME UNIT)
    TAIE   - TIME TO AVERAGE INVESTMENT EXPENDITURE
                (TIME UNITS)
    NIEP   - INITIAL INVESTMENT EXPENDITURE IN PEASANT
                SECTOR (MONEY UNITS/TIME UNIT)

ASP.K=ASP.J+(DT)(SP.JK-EKAP.JK-ELTP.JK-SSRP.JK)       169, L
ASP=NASP                                               169.1, N
    ASP    - ACCUMULATED SAVINGS IN PEASANT SECTOR
                (MONEY UNITS)
    DT     - SIMULATION SOLUTION INTERVAL (TIME UNITS)
    SP     - SAVINGS IN PEASANT SECTOR (MONEY UNITS/TIME
                UNIT)
    EKAP   - EXPENDITURE ON CAPITAL ACQUISITIONS IN
                PEASANT SECTOR (MONEY UNITS/TIME UNIT)
    ELTP   - EXPENDITURE ON LAND TRANSACTIONS IN PEASANT
                SECTOR (MONEY UNITS/TIME UNIT)
    SSRP   - SAVING SPENDING RATE IN PEASANT SECTOR
                (MONEY UNITS/TIME UNIT)
    NASP   - INITIAL ACCUMULATED SAVINGS IN PEASANT
                SECTOR (MONEY UNITS)
```

```
SP.KL=ARP.K*FRSP.K                                    170, R
    SP      - SAVINGS IN PEASANT SECTOR (MONEY UNITS/TIME
                UNIT)
    ARP     - AVERAGE REVENUE IN PEASANT SECTOR (MONEY
                UNITS/TIME UNIT)
    FRSP    - FRACTION REVENUE SAVED IN PEASANT SECTOR
                (DIMENSIONLESS)

ARP.K=SMOOTH(RP.K,TSR)                                171, A
ARP=NRP                                               171.1, N
    ARP     - AVERAGE REVENUE IN PEASANT SECTOR (MONEY
                UNITS/TIME UNIT)
    RP      - REVENUE IN PEASANT SECTOR (MONEY UNITS/TIME
                UNIT)
    TSR     - TIME TO SMOOTH REVENUE (TIME UNITS)
    NRP     - INITIAL REVENUE OF PEASANT SECTOR (MONEY
                UNITS/TIME UNIT)
```

The revenue in the peasant sector RP is constituted by the value of production from self-employment in the peasant sector VPP and the wage disbursements in the formal sector WDF, less land and capital rent payments by the peasants, LRPP and KRPP, and if any taxes. The equations for value of production in the peasant sector VPP, production PP, and saving spending rate SSRP are identical to those in the formal sector.

```
RP.K=VPP.K-LRPP.K-KRPP.K+WDF.K-LOP.K*LOTP             172, A
    RP      - REVENUE IN PEASANT SECTOR (MONEY UNITS/TIME
                UNIT)
    VPP     - VALUE OF PRODUCTION IN PEASANT SECTOR
                (MONEY UNITS/TIME UNIT)
    LRPP    - LAND RENT PAYMENTS BY PEASANT SECTOR (MONEY
                UNITS/TIME UNIT)
    KRPP    - CAPITAL RENT PAYMENTS BY PEASANT SECTOR
                (MONEY UNITS/TIME UNIT)
    WDF     - WAGE DISBURSEMENT IN FORMAL SECTOR (MONEY
                UNITS/TIME UNIT)
    LOP     - LAND OWNED BY PEASANT SECTOR (LAND UNITS)
    LOTP    - LAND OWNERSHIP TAX ON PEASANTS (MONEY
                UNITS/LAND UNITS/TIME UNIT)
```

```
VPP.K=PP.K*RPO.K                                        173, A
    VPP     - VALUE OF PRODUCTION IN PEASANT SECTOR
               (MONEY UNITS/TIME UNIT)
    PP      - PRODUCTION OF PEASANT SECTOR (PRODUCT
               UNITS/TIME UNIT)
    RPO     - RELATIVE PRICE OF OUTPUT (MONEY UNITS/
               PRODUCT UNIT)

PP.K=SFPF*EXP(EL*LOGN(LCP.K))*EXP(EKP.K*                174, A
  LOGN(KEP.K))*EXP(EWP.K*LOGN(WP.K))*CPYP.K*
  FIFGE(1,CGR,0,STEP(SWGR,TGR))
    PP      - PRODUCTION OF PEASANT SECTOR (PRODUCT
               UNITS/TIME UNIT)
    SFPF    - SCALING FACTOR OF PRODUCTION FUNCTION
               (DIMENSIONLESS)
    EL      - ELASTICITY OF PRODUCTION OF LAND
               (DIMENSIONLESS)
    LCP     - LAND CULTIVATED BY PEASANT SECTOR (LAND
               UNITS)
    EKP     - ELASTICITY OF PRODUCTION OF CAPITAL IN
               PEASANT SECTOR (DIMENSIONLESS)
    KEP     - CAPITAL EMPLOYED BY PEASANT SECTOR (CAPITAL
               UNITS)
    EWP     - ELASTICITY OF PRODUCTION OF WORKERS IN
               PEASANT SECTOR (DIMENSIONLESS)
    WP      - WORKERS IN PEASANT SECTOR (PERSONS)
    CPYP    - CROPS PER YEAR IN PEASANT SECTOR (NUMBER)
    FIFGE   - SWITCHING FUNCTION FROM DYNAMO
    CGR     - COEFFICIENT FOR GREEN REVOLUTION
               (DIMENSIONLESS)
    STEP    - SWITCHING FUNCTION FROM DYNAMO
    SWGR    - SWITCH FOR GREEN REVOLUTION POLICY
               (DIMENSIONLESS)
    TGR     - TIME OF GREEN REVOLUTION POLICY (TIME UNIT)

CPYP.K=TABHL(TCPY,KCIP.K,0,1,.25)                       175, A
    CPYP    - CROPS PER YEAR IN PEASANT SECTOR (NUMBER)
    TCPY    - TABLE FOR CROPS PER YEAR (NUMBER)
    KCIP    - CAPITAL COMPOSITION INDICATOR IN PEASANT
               SECTOR (DIMENSIONLESS)

SSRP.KL=ASP.K/LASP.K                                    176, R
    SSRP    - SAVING SPENDING RATE IN PEASANT SECTOR
               (MONEY UNITS/TIME UNIT)
    ASP     - ACCUMULATED SAVINGS IN PEASANT SECTOR
               (MONEY UNITS)
    LASP    - LIFE OF ACCUMULATED SAVINGS IN PEASANT
               SECTOR (TIME UNITS)
```

```
LASP.K=NLASP                                          177, A
    LASP   - LIFE OF ACCUMULATED SAVINGS IN PEASANT
               SECTOR (TIME UNITS)
    NLASP  - INITIAL LIFE OF ACCUMULATED SAVINGS IN
               PEASANT SECTOR (TIME UNITS)
```

The fraction of revenue saved in the peasant sector FRSP depends upon the normal fraction of revenue saved in the sector NFRSP, the effect of utility of investment on savings in the peasant sector, EUISP and the effect of rent pressures on savings in the peasant sector ERPSP.

The effect of utility of investment depends on the availability of wage employment. As wage rates are determined by the opportunity cost of leaving self employment by the workers, availablilty of such wage employment reduces the utility of investment for supporting sef-employment infrastructure and prompts the peasant sector to increase consumption and let some of its workers seek wage employment. Thus, wage rate determines the number of workers desired in the peasant sector. When wage rate is high, the number of workers desired in the peasant sector is low, and the propensity to increase consumption is high.

If the sector also employes rented land and capital, at the time of each harvest, the owners of rented land and capital will demand rent payments. The peasants' revenue thus shrinks and the continuing consumption pressures reduce the fraction that can be saved. Land rent payments, therefore, can also limit the capability of the peasant sector to save.

FRSP.K=NFRSP*ESWSP.K*ERPSP.K 178, A

FRSP - FRACTION REVENUE SAVED IN PEASANT SECTOR (DIMENSIONLESS)
NFRSP - NORMAL FRACTION REVENUE SAVED IN PEASANT SECTOR (DIMENSIONLESS)
ESWSP - EFFECT OF SURPLUS WORKERS ON SAVINGS IN PEASANT SECTOR (DIMENSIONLESS)
ERPSP - EFFECT OF RENT PRESSURES ON SAVINGS IN PEASANT SECTOR (DIMENSIONLESS)

The effect of utility of investment on savings in the peasant sector EUISP is represented as a function of the ratio between desired workers in the sector DWP, and the actual number of workers in the sector WP. DWP depends on wage rate and the availbility of other resources in the peasant sector (owned as well as rented), whereas, WP include all rural workers who are not absorbed by the formal sector.

The general shape of the function representing EUISP is shown in Figure A.29. When wage rate is infinitely high, DWP is zero. Under such conditions it is unnecessary for the peasants to save for supporting self-employment. However, a small rate of savings for lumpy consumption needs continues (assumed to be 10 percent of the normal value). Thus, the value of EUISP is driven down to 0.1. When DWP is equal to WP, wage rate exactly equals marginal revenue product of workers in the sector and the existing level of self-employment facilities must be supported for maintaining the current level of worker consumption. When DWP is greater than WP, wage rate is lower than the marginal revenue product of workers in the sector and it is highly profitable to expand self-employment facilities. The consumption pressure is less than normal, and the saving fraction is driven up. The S-shape of the function EUISP implicitly incorporates assumptions of adaptation due the learning experience of the sector.

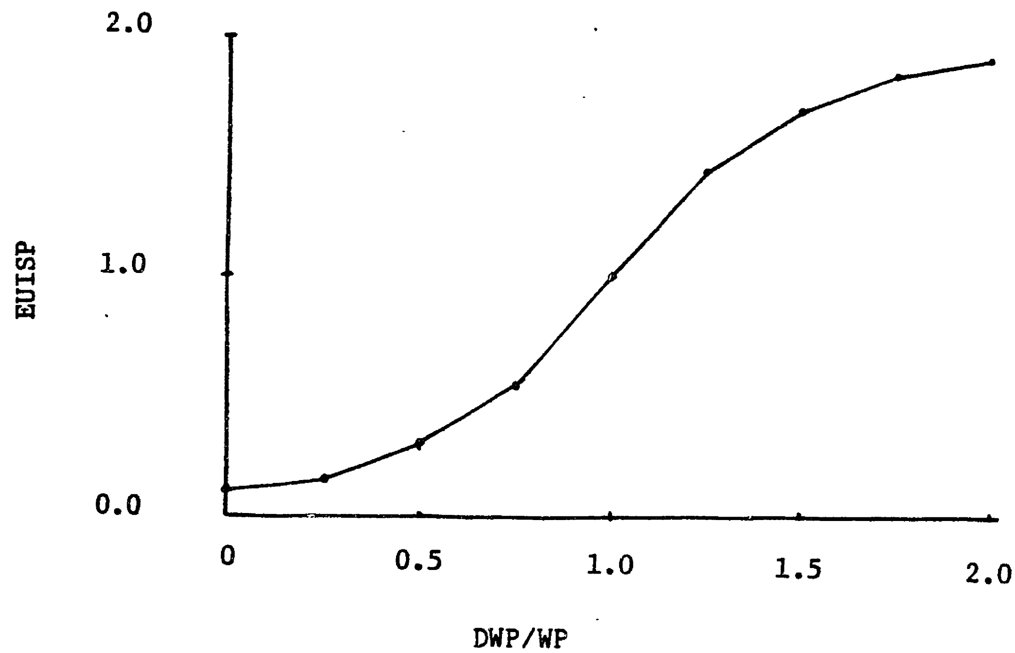


Figure A.29: The effect of utility of investment on saving rate in the peasant sector EUISP.

```
EUISP.K=TABHL(TUIS,DWP.K/WP.K,0,2,.25)                179, A
TUIS=.1/.15/.3/.55/1/1.45/1.7/1.85/1.9                179.1, T
    EUISP   - EFFECT OF UTILITY OF INVESTMENT ON SAVINGS IN
                PEASANT SECTOR (DIMENSIONLESS)
    TUIS    - TABLE FOR EFFECT OF SURPLUS WORKERS ON
                SAVINGS IN PEASANT SECTOR (DIMENSIONLESS)
    DWP     - DESIRED WORKERS IN PEASANT SECTOR (PERSONS)
    WP      - WORKERS IN PEASANT SECTOR
```

The effect of rent pressure on saving in the peasant sector ERPSP is represented as a function of the ratio between the total rent payments and the total income from land and capital employed in the sector. The shape of the function for ERPSP is shown in Figure A.30. When the rent payments are equal to zero, there is no rent pressure. When rent payments are being made and are causing to reduce workers' revenue, the consumption pressures reduce the saving propensity of the peasant sector.

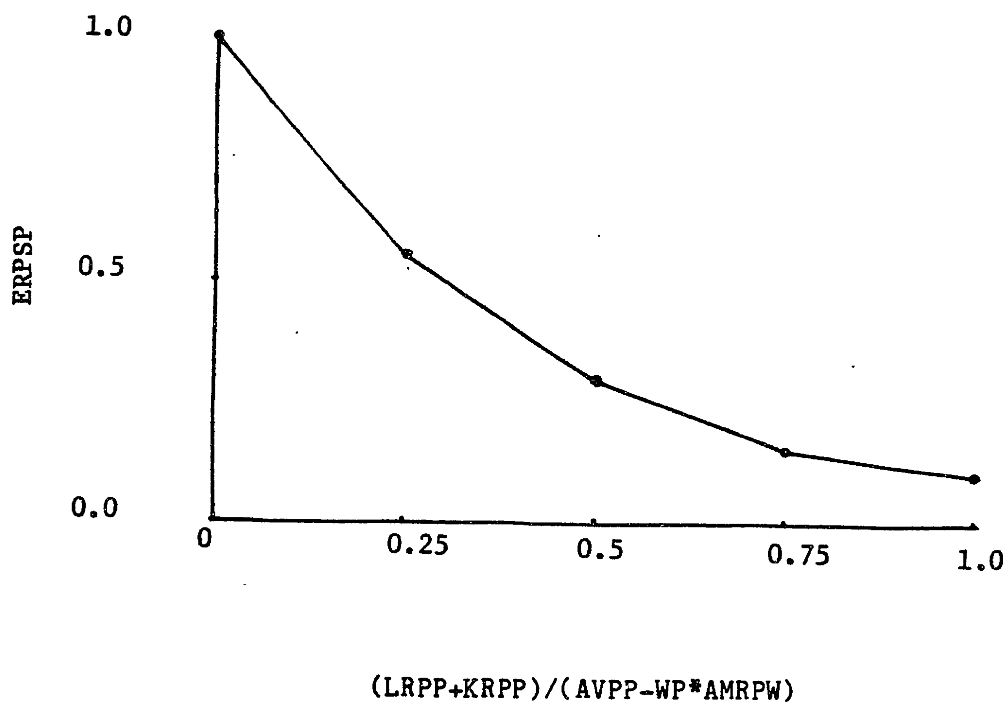


Figure A.28: The effect of rent pressure on saving in the peasant sector ERPSP.

```
ERPSP.K=TABHL(TRPS,(LRPP.K+KRPP.K)/(AVPP.K-WP.K*     180, A
  AMRPW.K),0,1,.25)
TRPS=1/.55/.3/.15/.1                                 180.1, T
    ERPSP  - EFFECT OF RENT PRESSURES ON SAVINGS IN
               PEASANT SECTOR (DIMENSIONLESS)
    TRPS   - TABLE FOR RENT PRESSURES ON SAVINGS
               (DIMENSIONLESS)
    LRPP   - LAND RENT PAYMENTS BY PEASANT SECTOR (MONEY
               UNITS/TIME UNIT)
    KRPP   - CAPITAL RENT PAYMENTS BY PEASANT SECTOR
               (MONEY UNITS/TIME UNIT)
    AVPP   - AVERAGE VALUE OF PRODUCTION IN PEASANT
               SECTOR (MONEY UNITS/TIME UNIT)
    WP     - WORKERS IN PEASANT SECTOR (PERSONS)
    AMRPW  - AVERAGE MARGINAL REVENUE PRODUCT OF WORKERS
               (MONEY UNITS/PERSON/TIME UNIT)
```

The expenditures on capital acquisition and land transactions in the peasant sector, EKAP and ELTP, are accounting flows identical to those in the formal sector.

```
EKAP.KL=MKAP.JK*RPMK.K+TKAP.JK*RPO.K                    181, R
    EKAP   - EXPENDITURE ON CAPITAL ACQUISITIONS IN
               PEASANT SECTOR (MONEY UNITS/TIME UNIT)
    MKAP   - MODERN CAPITAL ACQUISITIONS IN PEASANT
               SECTOR (CAPITAL UNITS/TIME UNIT)
    RPMK   - RELATIVE PRICE OF MODERN CAPITAL (MONEY
               UNITS/CAPITAL UNIT)
    TKAP   - TRADITION CAPITAL UNITS IN PEASANT SECTOR
               (CAPITAL UNITS/TIME UNIT)
    RPO    - RELATIVE PRICE OF OUTPUT (MONEY UNITS/
               PRODUCT UNIT)

ELTP.KL=(CLOP.K-PULSE(LTPLR/DT,TPTST,10000))*APL.K  182, R
    ELTP   - EXPENDITURE ON LAND TRANSACTIONS IN PEASANT
               SECTOR (MONEY UNITS/TIME UNIT)
    CLOP   - CHANGE IN LAND OWNED BY PEASANT SECTOR
               (LAND UNITS)
    LTPLR  - LAND TRANSFERED TO PEASANTS DUE TO LAND
               REFORM (LAND UNITS)
    DT     - SIMULATION SOLUTION INTERVAL (TIME UNITS)
    TPTST  - TIME FOF POLICY TEST (TIME UNIT)
    APL    - AVERAGE PRICE OF LAND (MONEY UNITS/LAND
               UNITS)
```

5. Supplementary Equations

The following supplementary equations are not part of the feedback structure of the model, but represent variables computed for studying the output of the model.

```
LWRF.K=LCF.K/WF.K                                   183, S
    LWRF   - LAND WORKER RATIO IN FORMAL SECTOR (LAND
               UNITSS/WORKER)
    LCF    - LAND CULTIVATED BY FORMAL SECTOR (LAND
               UNITS)
    WF     - WORKERS IN FORMAL SECTOR (PERSONS)

LWRP.K=LCP.K/WP.K                                   184, S
    LWRP   - LAND WORKER RATIO IN PEASANT SECTOR (LAND
               UNITSS/WORKER)
    LCP    - LAND CULTIVATED BY PEASANT SECTOR (LAND
               UNITS)
    WP     - WORKERS IN PEASANT SECTOR (PERSONS)

TR.K=RF.K+RP.K                                      185, S
    TR     - TOTAL REVENUE (MONEY UNITS/TIME UNIT)
    RF     - REVENUE IN FORMAL SECTOR (MONEY UNITS/TIME
               UNIT)
    RP     - REVENUE IN PEASANT SECTOR (MONEY UNITS/TIME
               UNIT)

TOL.K=LOF.K+LOP.K                                   186, S
    TOL    - TOTAL OWNED LAND (LAND UNITS)
    LOF    - LAND OWNED BY FORMAL SECTER (LAND UNITS)
    LOP    - LAND OWNED BY PEASANT SECTOR (LAND UNITS)

TOK.K=KOF.K+KOP.K                                   187, S
    TOK    - TOTAL OWNED CAPITAL (CAPITAL UNITS)
    KOF    - CAPITAL OWNED BY FORMAL SECTOR (CAPITAL
               UNITS)
    KOP    - CAPITAL OWNED BY PEASANT SECTOR (CAPITAL
               UNITS)

TREF.K=TRPP.K+VPF.K                                 188, S
    TREF   - TOTAL RECEIPTS IN FORMAL SECTOR (MONEY
               UNITS/TIME UNIT)
    TRPP   - TOTAL RENT PAYMENTS BY PEASANT SECTOR
               (MONEY UNITS/TIME UNIT)
    VPF    - VALUE OF PRODUCTION IN FORMAL SECTOR (MONEY
               UNITS/TIME UNIT)
```

TRPP.K=LRPP.K+KRPP.K 189, S

TRPP - TOTAL RENT PAYMENTS BY PEASANT SECTOR (MONEY UNITS/TIME UNIT)

LRPP - LAND RENT PAYMENTS BY PEASANT SECTOR (MONEY UNITS/TIME UNIT)

KRPP - CAPITAL RENT PAYMENTS BY PEASANT SECTOR (MONEY UNITS/TIME UNIT)

TREP.K=WDF.K+VPP.K 190, S

TREP - TOTAL RECEIPTS IN PEASANT SECTOR (MONEY UNITS/TIME UNIT)

WDF - WAGE DISBURSEMENT IN FORMAL SECTOR (MONEY UNITS/TIME UNIT)

VPP - VALUE OF PRODUCTION IN PEASANT SECTOR (MONEY UNITS/TIME UNIT)

RELRPP.K=TREP.K-LRPP.K 191, S

RELRPP - RECEIPTS LESS LAND RENT PAYMENTS IN PEASANT SECTOR (MONEY UNITS/TIME UNIT)

TREP - TOTAL RECEIPTS IN PEASANT SECTOR (MONEY UNITS/TIME UNIT)

LRPP - LAND RENT PAYMENTS BY PEASANT SECTOR (MONEY UNITS/TIME UNIT)

NOTES AND REFERENCES

1. DYNAMO is a widely available computer code in which recursive relationships can be conveniently represented. Subscripts J, K, and L are used to delineate between the values of variables in the past, curent, and next time periods, respectively. For details, see PUGH III, Alexander L., DYNAMO User's Manual, Fifth edition, MIT press, 1976.

2. For technical details of FLOW DIAGRAMING, see FORRESTER, Jay W., Principles of Systems, Wright Allen Press, 1968.

3. See MELLOR, John W., "The Subsistance Farming in Traditional Economies, in WHARTON JR., Clifton R. (ed.), Subsistance Agriculture and Economic Development, Aldine Publishing Co., Chicago, 1969.

4. Inheritence laws often require concurrence of all heirs to a piece of property before it can be bought or sold.

5. See HEADY, E. O., and DILLON, J. L., Agricultural Production Function, Iowa State University Press, 1961.

6. LOP=TL-LOF
   =TL-TL*FLOF
   =TL(1-FLOF)
   =TL(1-DLOF/(DLOP+DLOF))
   =TL*DLOP/(DLOP+DLOF)
   =TL*FLOP   [FLOP=DLOP/(DLOP+DLOF]

7. The excessive supply of savings, in effect, lower interest rates and increase the amount of savings which accrue returns equivalent to those for a unit of land. As interest rates are assumed to remain constant and are determined outside the model, the change in land price in response to change in savings is explictly represented.

8. Source: PAKISTAN, Statistical Year Book 1976, Statistical Division, Ministry of Finance, Planning, and Provincial Coordination.

9. Source: PAKISTAN: Basic Facts 1977-78, Finance Division, Economic Affairs Wing.

10. BARDHAN, P. K., A Model of Growth of Capitalism in a Dual Agrarian Economy, in Bhagwati and Eckaus (eds), Development and Planning: Essays in Honour of Paul Rosenstein-Roden, George Allen and Unwin Ltd., 1973.

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14. MELLOR (1969), op. cit.

15. HANUMANTHA RAO, C., Agricultural Production Function, Costs and Returns in India, Asia Publishing House, NY 1965.

16. STROUT, Alan M., Projecting Agricultural Crop Supply From Cross-Country Data, Working Paper, Department of Urban Studies and Planning, MIT, 1978.

17. HEADY and DILLON (1961), op. cit.

18. HANUMANTHA RAO(1965) op cit.

19. MELLOR (1969), op. cit.

APPENDIX B

DESCRIPTION OF MODEL PARAMETERS

This appendix describes the numerical parameters of the model and the bases of their estimation [1]. The parameters are grouped into four categories for facilitating the discussion. These categories are:

1. Time constants
2. Scaling factors
3. Initial conditions
4. Paramaters for testing the model and analysing policies

Time constants determine how fast the LEVELS change. Scaling factors are used to transform dimensions of an algebraic expression to conform to those of the variable it computes. Initial conditions represents the state of the system at the begining of a simulation. Parameters for testing the model and analysing policies consist of exogeneous inputs and switches allowing those inputs to be inserted into the model when desired.

In addition, the model also uses numerical functions representing non-linear relationships between pairs of designated variables (called Table Functions). Such functions have already been discussed in Appendix A. The following description delineates the first three of the above categories of parameters for each section of the model described in appendix A. Parameters for testing the model and analysing policies are given in the last section of this appendix.

1. Parameters Related to Mechanisms for Allocation of Land

1.1. Time Constants

Table B.1 shows the time constants used in the land allocation mechanisms of the model. The time to average land transactions TALT affects the speed at which land distribution changes. This change involves land transactions between various parties entailing decisions for perceiving the need for the transaction by the parties, selection of the transcating parties through a process of mutual search, time taken by the transaction, and the time for renovations on land needed for commissioning it by the purchazing party. TALT is assumed to be relatively long.

PARAMETER	DEFINITION	UNITS	VALUE
TALT	TIME TO AVERAGE LAND TRANSACTIONS	YEARS	5.0
TSLO	TIME TO SMOOTH LAND OWNERSHIP	YEARS	0.5
TSFLC	TIME TO SMOOTH FRACTION OF LAND CULTIVATED (BY FORMAL SECTOR)	YEARS	0.5
TSVP	TIME TO SMOOTH VALUE OF PRODUCTION	YEARS	1.0
LRAT	LAND RENT ADJUSTMENT TIME	YEARS	1.0
LPAT	LAND PRICE ADJUSTMENT TIME	YEARS	1.0

Table B.1: Time Constants for Land Allocation Mechanisms

TSLO is used for computing the change in land ownership of a sector for accounting purposes and is kept as small as can be permitted by the numerical differentiation process entailed in computing the change.

TSFLC represents the time needed for transferring land from one activity to another within a sector. As such a transfer does not involve any external transactions, it can be realized quite fast. Hence the relatively small value of TSFLC.

The rest of the parameters in Table B.1 are based on a production planning horrizon of one year. Albeit, the model is generally insensitive to the changes in the values of its time constants. A variation of over a 100 percent in their values is possible without significantly affecting model behavior. The relative differences in the magnitudes of the parameters are more important, but these differences can also be varied over a small range.

1.2. Scaling Factors

The scaling factors used in the land allocation mechanisms are shown in Table B.2. EL, the elasticity of output of land, is based on the available empirical studies [2]. NRK represents a fixed net return available on capital outside the rural economy and is assumed to be 20 percent. Variation in the values of these parameters also does not affect dynamic behavior of the model.

PARAMETER	DEFINITION	UNITS	VALUE
EL	ELASTICITY OF OUTPUT OF LAND	DIMENSION -LESS	0.4
NRK	NORMAL RATE OF RETURN ON CAPITAL	MONEY UNITS/YEAR PER MONEY UNIT	0.2

Table B.2: Scaling Factors for Land Allocation Mecanisms

1.3. Initial Condition Parameters

The model is initialized in a state of general market equilibrium, irrespective of the distribution of resources between the sectors. Thus, while switching functions are provided for changing the initial distribution of resources, most of the initial values of the model variables are computed by using scaling factors, time constants, and a few numerical parameters specifying the key initial conditions. The initial condition parameters for land allocation mechanisms of the model are described below and are self explanatory. Numerical values, where specified, are based on total production of Pakistan's rural sector in the 1950s and total land under cultivation. These numerical values, however, are unimportant from the point of view of the analysis of this thesis.

```
NLOF=FIFGE(NLOF1,NLOF2,0,SWN)
    NLOF    - INITIAL LAND OWNED BY FORMAL SECTOR (LAND
               UNITS)
    FIFGE   - SWITCHING FUNCTION FROM DYNAMO
    NLOF1   - VALUE ONE FOR NLOF (LAND UNITS)
    NLOF2   - VALUE TWO FOR NLOF (LAND UNITS)
    SWN     - SWITCH FOR CHANGING INITIAL CONDITIONS
               (DIMENSIONLESS)

NLOF1=25E6
    NLOF1   - VALUE ONE FOR NLOF (LAND UNITS)

NLOF2=10E6
    NLOF2   - VALUE TWO FOR NLOF (LAND UNITS)

SWN=0
    SWN     - SWITCH FOR CHANGING INITIAL CONDITIONS
               (DIMENSIONLESS)

NFLOF=NLOF/TL
    NFLOF   - INITIAL FRACTION LAND OWNED BY FORMAL
               SECTOR (DIMENSIONLESS)
    NLOF    - INITIAL LAND OWNED BY FORMAL SECTOR (LAND
               UNITS)
    TL      - TOTAL LAND (LAND UNITS)

NLCF=FIFGE(NLCF1,NLCF2,0,SWN)
    NLCF    - INITIAL LAND CULTIVATED BY FORMAL SECTOR
               (LAND UNITS)
    FIFGE   - SWITCHING FUNCTION FROM DYNAMO
    NLCF1   - VALUE ONE FOR NLCF (LAND UNITS)
    NLCF2   - VALUE TWO FOR NLCF (LAND UNITS)
    SWN     - SWITCH FOR CHANGING INITIAL CONDITIONS
               (DIMENSIONLESS)

NLCF1=25E6
    NLCF1   - VALUE ONE FOR NLCF (LAND UNITS)

NLCF2=10E6
    NLCF2   - VALUE TWO FOR NLCF (LAND UNITS)
```

```
NFLCF=1
    NFLCF  - INITIAL FRACTION LAND CULTIVATED IN FORMAL
               SECTOR (DIMENSIONLESS)

NFLR=0
    NFLR   - INITIAL FRACTION OF LAND RENTED OUT BY
               FORMAL SECTOR (DIMENSIONLESS)

NLRF=NLOF-NLCF
    NLRF   - INITIAL LAND RENTED OUT BY FORMAL SECTOR
               (LAND UNITS)
    NLOF   - INITIAL LAND OWNED BY FORMAL SECTOR (LAND
               UNITS)
    NLCF   - INITIAL LAND CULTIVATED BY FORMAL SECTOR
               (LAND UNITS)

NVPF=FIFGE(NVPF1,NVPF2,0,SWN)
    NVPF   - INITIAL VALUE OF PRODUCTION IN FORMAL
               SECTOR (MONEY UNITS/TIME UNIT)
    FIFGE  - SWITCHING FUNCTION FROM DYNAMO
    NVPF1  - VALUE ONE FOR NVPF (MONEY UNITS/TIME UNIT)
    NVPF2  - VALUE TWO FOR NVPF (MONEY UNITS/TIME UNIT)
    SWN    - SWITCH FOR CHANGING INITIAL CONDITIONS
               (DIMENSIONLESS)

NVPF1=4000E6
    NVPF1  - VALUE ONE FOR NVPF (MONEY UNITS/TIME UNIT)

NVPF2=1600E6
    NVPF2  - VALUE TWO FOR NVPF (MONEY UNITS/TIME UNIT)

NLCP=TL-NLCF
    NLCP   - INITIAL LAND CULTIVATED BY PEASANT SECTOR
               (LAND UNITS)
    TL     - TOTAL LAND (LAND UNITS)
    NLCF   - INITIAL LAND CULTIVATED BY FORMAL SECTOR
               (LAND UNITS)

NLOP=NLCP-NLRF
    NLOP   - INITAIL LAND OWNED BY PEASANT SECTOR (LAND
               UNITS)
    NLCP   - INITIAL LAND CULTIVATED BY PEASANT SECTOR
               (LAND UNITS)
    NLRF   - INITIAL LAND RENTED OUT BY FORMAL SECTOR
               (LAND UNITS)

NVPP=TVP-NVPF
    NVPP   - INITIAL VALUE OF PRODUCTION IN PEASANT
               SECTOR (MONEY UNITS/TIME UNIT)
    TVP    - TOTAL VALUE OF PRODUCTION (MONEY UNITS/TIME
               UNIT)
    NVPF   - INITIAL VALUE OF PRODUCTION IN FORMAL
               SECTOR (MONEY UNITS/TIME UNIT)
```

TVP=8000E6
    TVP - TOTAL VALUE OF PRODUCTION (MONEY UNITS/TIME UNIT)

NALR=NMPL
    NALR - INITIAL LAND RENT (MONEY UNITS/LAND UNITS/TIME UNIT)
    NMPL - INITIAL MARGINAL REVENUE PRODUCT OF LAND (MONEY UNITS/LAND UNITS/TIME UNIT)

NAPL=NMPL/NRK
    NAPL - INITIAL AVERAGE PRICE OF LAND (MONEY UNITS/LAND UNITS)
    NMPL - INITIAL MARGINAL REVENUE PRODUCT OF LAND (MONEY UNITS/LAND UNITS/TIME UNIT)
    NRK - NET RETURN ON CAPITAL INVESTMENT/INTEREST RATE (MONEY UNITS/TIME UNIT/MONEY UNIT)

NMPL=EL*(NVPF+NVPP)/(NLCF+NLCP)
    NMPL - INITIAL MARGINAL REVENUE PRODUCT OF LAND (MONEY UNITS/LAND UNITS/TIME UNIT)
    EL - ELASTICITY OF PRODUCTION OF LAND (DIMENSIONLESS)
    NVPF - INITIAL VALUE OF PRODUCTION IN FORMAL SECTOR (MONEY UNITS/TIME UNIT)
    NVPP - INITIAL VALUE OF PRODUCTION IN PEASANT SECTOR (MONEY UNITS/TIME UNIT)
    NLCF - INITIAL LAND CULTIVATED BY FORMAL SECTOR (LAND UNITS)
    NLCP - INITIAL LAND CULTIVATED BY PEASANT SECTOR (LAND UNITS)

TL=50E6
    TL - TOTAL LAND (LAND UNITS)

2. Parameters Related to Mechanisms for Allocation of Workers

2.1. Time Constants

Table B.3 shows time constants for the worker allocation mechanisms of the model. WAT is the worker adjustment time for the formal (capitalist) sector and represents vacancy filling delays. Although hiring arrangements are informal, firing entails eviction from land which can be quite time consuming.

Thus, WAT is assumed to be one year.

PARAMETER	DEFINITION	UNITS	VALUE
WAT	WORKER ADJUSTMENT TIME	YEARS	1.0
TAWR	TIME TO AVERAGE WAGE RATE	YEARS	0.5
TACEW	TIME TO AVERAGE AVERAGE CONSUMPTION EXPENDITURE PER WORKER	YEARS	0.5

Table B.3: Time Constants for Worker Allocation Mechanisms

TAWR and TACEW collectively represent delays in the response of wage rate to changes in the average consumption expenditure per worker. Since wage contracts are usually drawn in the begining of the cropping year, a total wage adjustment time of one year is assumed. Again substantial variation in the values of these time constants is possible without affecting model behavior.

2.2. Scaling Factors

Only one scaling factor is used in equations for worker allocation: the workforce growth rate WFGR. WFGR is kept zero for tests of the model with a fixed economy assumption. When population is allowed to grow for policy tests, workforce is also allowed to grow proportionately. The fractional population growth rate is assumed to be 2 percent.

2.3. Initial Condition Parameters

As in case of land allocation, the initial condition parameters for worker allocation also manifest a general market equilibrium for any designated initial distribution of resources. Thus, the numerical and computed initial value parameters given below incorporate considerations similar to those in case of land allocation.

```
NWF=FIFGE(NWF1,NWF2,0,SWN)
    NWF    - INITIAL WORKERS IN FORMAL SECTOR (PERSONS)
    FIFGE  - SWITCHING FUNCTION FROM DYNAMO
    NWF1   - VALUE ONE FOR NWF (PERSONS)
    NWF2   - VALUE TWO FOR NWF (PERSONS)
    SWN    - SWITCH FOR CHANGING INITIAL CONDITIONS
               (DIMENSIONLESS)

NWF1=3.4E6
    NWF1   - VALUE ONE FOR NWF (PERSONS)

NWF2=1.36E6
    NWF2   - VALUE TWO FOR NWF (PERSONS)

NWP=NRWF-NWF
    NWP    - INITIAL WORKERS IN PEASANT SECTOR (PERSONS)
    NRWF   - INITAIL RURAL WORKFORCE (PERSONS)
    NWF    - INITIAL WORKERS IN FORMAL SECTOR (PERSONS)

NRWF=6.8E6
    NRWF   - INITAIL RURAL WORKFORCE (PERSONS)

NAWR=NMPW
    NAWR   - INITIAL WAGE RATE (MONEY UNITS/PERSON/TIME
               UNIT)
    NMPW   - INITIAL MARGINAL REVENUE PRODUCT OF WORKERS
               (MONEY UNITS/PERSON/TIME UNIT)
```

NMPW=(NEW*NVPF+NEW*NVPP)/NRWF

- NMPW - INITIAL MARGINAL REVENUE PRODUCT OF WORKERS (MONEY UNITS/PERSON/TIME UNIT)
- NEW - INITIAL ELASTICITY OF PRODUCTION OF WORKERS (DIMENSIONLESS)
- NVPF - INITIAL VALUE OF PRODUCTION IN FORMAL SECTOR (MONEY UNITS/TIME UNIT)
- NVPP - INITIAL VALUE OF PRODUCTION IN PEASANT SECTOR (MONEY UNITS/TIME UNIT)
- NRWF - INITAIL RURAL WORKFORCE (PERSONS)

NCEW=(NRP*(1-NFRSP)+NASP/NLASP)/NRWF

- NCEW - INITIAL CONSUMPTION EXPENDITURE PER WORKER (MONEY UNITS/WORKER/TIME UNIT)
- NRP - INITIAL REVENUE OF PEASANT SECTOR (MONEY UNITS/TIME UNIT)
- NFRSP - NORMAL FRACTION REVENUE SAVED IN PEASANT SECTOR (DIMENSIONLESS)
- NASP - INITIAL ACCUMULATED SAVINGS IN PEASANT SECTOR (MONEY UNITS)
- NLASP - INITIAL LIFE OF ACCUMULATED SAVINGS IN PEASANT SECTOR (TIME UNITS)
- NRWF - INITAIL RURAL WORKFORCE (PERSONS)

3. Parameters Related to Mechanisms for Acquisition and Employment of Capital

3.1. Time Constants

Table B.4 shows the parameters representing time constants for capital acquisition mechanisms of the model. TSFKE represents time needed to transfer capital from one activity to another within the formal sector. Since such a change does not entail a transaction with outside parties, it can be made relatively quickly. TSKA is for averaging modern capital acquisitions for subsequently assessing the needs for traditional capital, which represent the residual demand for capital after part of the demand has been met by the limited supply of modern capital. Since all information for averaging is available within the sector and can be readily used for modifying capital ordering decisions, TSKA is small.

PARAMETER	DEFINITION	UNITS	VALUE
TSFKE	TIME TO SMOOTH FRACTIONAL CAPITAL EMPLOYMENT	YEARS	0.5
TSKA	TIME TO SMOOTH CAPITAL ACQUISITIONS	YEARS	0.5
ALK	AVERAGE LIFE OF CAPITAL EQUIPMENT	YEARS	5.0
TSDKI	TIME TO SMOOTH DESIRED CAPITAL INVENTORY	YEARS	1.0
DIC	DESIRED INVENTORY COVERAGE	YEARS	1.0
TSMKD	TIME TO SMOOTH MODERN CAPITAL DEMAND	YEARS	1.0
MKIAT	MODERN CAPITAL INVENTORY ADJUSTMENT TIME	YEARS	1.0
TKIAT	TRADITIONAL CAPITAL INVENTORY ADJUSTMENT TIME	YEARS	1.0
TATKD	TIME TO AVERAGE TRADITIONAL CAPITAL DEMAND	YEARS	1.0
TSCSD	TIME TO SMOOTH CONSUMPTION SERVICES DEMAND	YEARS	1.0
TAKR	TIME TO AVERAGE CAPITAL RENT	YEARS	1.0
RPAT	RELATIVE PRICE ADJUSTMENT TIME	YEARS	1.0

Table B.4: Time Constants For Capital Acquisition Mechanisms of the model

ALK represents average life of capital equipment consisting of several items with varying durability, e.g., ploughs, hoes, bullocks, machinery and implements, tractors, etc. ALK is assumed to be 5 years, which represents a collective average of life of all capital equipment. For simplification ALK is allowed to remain constant irrespective of the composition of capital equipment used by a sector. The rest of the parameters are based on an approximate production planning horrizon of one year. As in previous cases, substantial variations in the values of these parameters are possible without significantly changing the model behavior.

3.2. Scaling Factors

Table B.5 shows the scaling factors used in the equations for capital acquisition and capital employment. FSCEF and FSCEP represent the fraction of income (in kind) directly consumed by the respective sectors. Such self consumption is quite common in the developing country rural economies, particularly by peasant cultivators. Some empirical studies estimate the fraction of output directly consumed to be between 30 and 60 percent. The self consumption fraction is reported to be higher for the peasant sector than for the capitalist sector [3]. The model assumes this fraction to be 50 percent for both the sectors for simplification. Changes in these fractions alter the multiplier effects in the economy, while they do not significantly affect the income distribution behavior.

PARAMETER	DEFINITION	UNITS	VALUE
FSCEF	FRACTION SELF CONSUMPTION EXPENDITURE IN FORMAL (CAPITALIST) SECTOR	DIMENSIONLESS	0.5
FSCEP	FRACTION SELF CONSUMTION EXPENDITURE IN PEASANT SECTOR	DIMENSIONLESS	0.5
FPGR	FRACTIONAL POPULATION GROWTH RATE	FRACTION/YEAR	0 - .02
NAPCD	NORMAL AGRICULTURAL PRODUCTION PER CAPITA DEMAND	PRODUCT UNITS /PERSON/YEAR	NAP/NP
NRPO	NORMAL RELATIVE PRICE OF OUTPUT	MONEY UNITS/ OUTPUT UNIT	1.0

Table B.5: Scaling Factors for Capital Acquisition and Capital Employment Mechanisms.

The fractional population growth rate FPGR is either kept at zero (for fixed economy experiments) or given a value of 2 percent (for policy analysis experiments). NAPCD the normal demand for agricultural output per person is calculated by dividing the initial value of agricultural production NAP by the initial value of population NP. Relative prices are used in the model instead of money prices. When demand and supply of output exactly match, the relative price is assumed to be unity.

3.3. Initial Value Parameters

The initial value parameters for capital acquisition and employment mechanisms embody the same considerations as those for the initial values in the previous cases. These parameters are given below:

```
NMKOF=NKOF*NFMKF
    NMKOF  - INITIAL MODERN CAPITAL OWNED BY FORMAL
               SECTOR (CAPITAL UNITS)
    NKOF   - INITIAL CAPITAL OWNED BY FORMAL SECTOR
               (CAPITAL UNITS)
    NFMKF  - INITIAL FRACTION MODERN CAPITAL IN FORMAL
               SECTOR (DIMENSIONLESS)

NTKOF=NKOF*NFTKF
    NTKOF  - INITIAL TRADITIONAL CAPITAL OWNED BY FORMAL
               SECTOR (CAPITAL UNITS)
    NKOF   - INITIAL CAPITAL OWNED BY FORMAL SECTOR
               (CAPITAL UNITS)
    NFTKF  - INITIAL FRACTION TRADITIONAL CAPITAL IN
               FORMAL SECTOR (DIMENSIONLESS)

NFMKF=0
    NFMKF  - INITIAL FRACTION MODERN CAPITAL IN FORMAL
               SECTOR (DIMENSIONLESS)

NFTKF=1-NFMKF
    NFTKF  - INITIAL FRACTION TRADITIONAL CAPITAL IN
               FORMAL SECTOR (DIMENSIONLESS)
    NFMKF  - INITIAL FRACTION MODERN CAPITAL IN FORMAL
               SECTOR (DIMENSIONLESS)
```

NKOF=(NKEF+NKEP)*NFKOF
- NKOF - INITIAL CAPITAL OWNED BY FORMAL SECTOR (CAPITAL UNITS)
- NKEF - INITIAL CAPITAL EMPLOYED BY FORMAL SECTOR (CAPITAL UNITS)
- NKEP - INITIAL CAPITAL EMPLOYED BY PEASANT SECTOR (CAPITAL UNITS)
- NFKOF - INITIAL FRACTION OF CAPITAL OWNED BY FORMAL SECTOR (DIMENSIONLESS)

NFKOF=NFLOF
- NFKOF - INITIAL FRACTION OF CAPITAL OWNED BY FORMAL SECTOR (DIMENSIONLESS)
- NFLOF - INITIAL FRACTION LAND OWNED BY FORMAL SECTOR (DIMENSIONLESS)

NKEF=NEK*NVPF/NMPK
- NKEF - INITIAL CAPITAL EMPLOYED BY FORMAL SECTOR (CAPITAL UNITS)
- NEK - INITIAL ELASTICITY OF PRODUCTION OF CAPITAL (DIMENSIONLESS)
- NVPF - INITIAL VALUE OF PRODUCTION IN FORMAL SECTOR (MONEY UNITS/TIME UNIT)
- NMPK - INITIAL MARGINAL REVENUE PRODUCT OF CAPITAL (MONEY UNITS/CAPITAL UNIT/TIME UNIT)

NFKEF=1
- NFKEF - INITIAL FRACTION OF CAPITAL EMPLOYED IN FORMAL SECTOR (DIMENSIONLESS)

NKRF=NKOF-NKEF
- NKRF - INITIAL CAPITAL RENTED OUT BY FORMAL SECTOR (CAPITAL UNITS)
- NKOF - INITIAL CAPITAL OWNED BY FORMAL SECTOR (CAPITAL UNITS)
- NKEF - INITIAL CAPITAL EMPLOYED BY FORMAL SECTOR (CAPITAL UNITS)

NFKR=0
- NFKR - INITIAL FRACTION OF CAPITAL RENTED OUT BY FORMAL SECTOR (CAPITAL UNITS)

NMKAF=0
- NMKAF - INITAIL MODERN CAPITAL ACQUISITIONS IN FORMAL SECTOR (CAPITAL UNITS/TIME UNIT)

NMKOP=NKOP*NFMKP
- NMKOP - INITIAL MODERN CAPITAL OWNED BY PEASANT SECTOR (CAPITAL UNITS)
- NKOP - INITIAL CAPITAL OWNED BY PEASANT SECTOR (CAPITAL UNITS)
- NFMKP - INITIAL FRACTION MODERN CAPITAL IN PEASANT SECTOR (DIMENSIONLESS)

NTKOP=NKOP*NFTKP

NTKOP - INITIAL TRADITIONAL CAPITAL OWNED BY PEASANT SECTOR (CAPITAL UNITS)

NKOP - INITIAL CAPITAL OWNED BY PEASANT SECTOR (CAPITAL UNITS)

NFTKP - INITIAL FRACTION TRADITIONAL CAPITAL IN PEASANT SECTOR (DIMENSIONLESS)

NFMKP=0

NFMKP - INITIAL FRACTION MODERN CAPITAL IN PEASANT SECTOR (DIMENSIONLESS)

NFTKP=1-NFMKP

NFTKP - INITIAL FRACTION TRADITIONAL CAPITAL IN PEASANT SECTOR (DIMENSIONLESS)

NFMKP - INITIAL FRACTION MODERN CAPITAL IN PEASANT SECTOR (DIMENSIONLESS)

NKOP=(NKEP+NKEF)*(1-NFKOF)

NKOP - INITIAL CAPITAL OWNED BY PEASANT SECTOR (CAPITAL UNITS)

NKEP - INITIAL CAPITAL EMPLOYED BY PEASANT SECTOR (CAPITAL UNITS)

NKEF - INITIAL CAPITAL EMPLOYED BY FORMAL SECTOR (CAPITAL UNITS)

NFKOF - INITIAL FRACTION OF CAPITAL OWNED BY FORMAL SECTOR (DIMENSIONLESS)

NKEP=NEK*NVPP/NMPK

NKEP - INITIAL CAPITAL EMPLOYED BY PEASANT SECTOR (CAPITAL UNITS)

NEK - INITIAL ELASTICITY OF PRODUCTION OF CAPITAL (DIMENSIONLESS)

NVPP - INITIAL VALUE OF PRODUCTION IN PEASANT SECTOR (MONEY UNITS/TIME UNIT)

NMPK - INITIAL MARGINAL REVENUE PRODUCT OF CAPITAL (MONEY UNITS/CAPITAL UNIT/TIME UNIT)

NMKAP=0

NMKAP - INITIAL MODERN CAPITAL ACQUISITIONS IN PEASANT SECTOR (CAPITAL UNITS/TIME UNIT)

NDMKI=(NTKOF/ALK+NTKOP/ALK*EFSMKP)*DIC

NDMKI - INITIAL DESIRED MODERN CAPITAL INVENTORY (CAPITAL UNITS)

NTKOF - INITIAL TRADITIONAL CAPITAL OWNED BY FORMAL SECTOR (CAPITAL UNITS)

ALK - AVERAGE LIFE OF CAPITAL (TIME UNITS)

NTKOP - INITIAL TRADITIONAL CAPITAL OWNED BY PEASANT SECTOR (CAPITAL UNITS)

EFSMKP - EFFECT OF PEASANT FARM SIZE ON MODERN CAPITAL DEMAND IN PEASANT SECTOR (DIMENSIONLESS)

DIC - DESIRED INVENTORY COVERAGE (TIME UNITS)

NMKI=0

NMKI - INITIAL MODERN CAPITAL INVENTORY (CAPITAL UNITS)

NTKI=(NTKOP+NTKOF)/ALK*DIC

NTKI - INITIAL TRADITIONAL CAPITAL INVENTORY (CAPITAL UNITS)

NTKOP - INITIAL TRADITIONAL CAPITAL OWNED BY PEASANT SECTOR (CAPITAL UNITS)

NTKOF - INITIAL TRADITIONAL CAPITAL OWNED BY FORMAL SECTOR (CAPITAL UNITS)

ALK - AVERAGE LIFE OF CAPITAL (TIME UNITS)

DIC - DESIRED INVENTORY COVERAGE (TIME UNITS)

NTKD=NTKI/DIC

NTKD - INITIAL TRADITIONAL CAPITAL DEMAND (CAPITAL UNITS/TIME UNIT)

NTKI - INITIAL TRADITIONAL CAPITAL INVENTORY (CAPITAL UNITS)

DIC - DESIRED INVENTORY COVERAGE (TIME UNITS)

NMKD=NDMKI/DIC+(NDMKI-NMKI)/MKIAT

NMKD - INITIAL MODERN CAPITAL DEMAND (CAPITAL UNITS/TIME UNIT)

NDMKI - INITIAL DESIRED MODERN CAPITAL INVENTORY (CAPITAL UNITS)

DIC - DESIRED INVENTORY COVERAGE (TIME UNITS)

NMKI - INITIAL MODERN CAPITAL INVENTORY (CAPITAL UNITS)

MKIAT - MODERN CAPITAL INVENTORY ADJUSTMENT TIME (TIME UNITS)

NCSD=(NRF*(1-NFRSF)+NASF/NLASF)*(1-FSCEF)+(NRP*(1-NFRSP)+NASP/NLASP)*(1-FSCEP)

NCSD - INITIAL CONSUMPTION SERVICES DEMAND (SERVICE UNITS/TIME UNIT)

NRF - INITIAL REVENUE IN FORMAL SECTOR (MONEY UNITS/TIME UNIT)

NFRSF - NORMAL FRACTION REVENUE SAVED IN FORMAL SECTOR (DIMENSIONLESS)

NASF - INITIAL ACCUMULATED SAVINGS IN FORMAL SECTOR (MONEY UNITS)

NLASF - INITIAL LIFE OF ACCUMULATED SAVINGS IN FORMAL SECTOR (TIME UNITS)

FSCEF - FRACTION SELF CONSUMPTION EXPENDITURE IN FORMAL SECTOR (DIMENSIONLESS)

NRP - INITIAL REVENUE OF PEASANT SECTOR (MONEY UNITS/TIME UNIT)

NFRSP - NORMAL FRACTION REVENUE SAVED IN PEASANT SECTOR (DIMENSIONLESS)

NASP - INITIAL ACCUMULATED SAVINGS IN PEASANT SECTOR (MONEY UNITS)

NLASP - INITIAL LIFE OF ACCUMULATED SAVINGS IN PEASANT SECTOR (TIME UNITS)

FSCEP - FRACTION SELF CONSUMPTION EXPENDITURE IN PEASANT SECTOR (DIMENSIONLESS)

NAPCD=NAP/NP

NAPCD - INITIAL AGRICULTURAL PRODUCTION PER CAPITA DEMAND (PRODUCT UNITS/PERSON/TIME UNIT)

NAP - INITAIL AGRICULTURAL PRODUCTION (PRODUCT UNITS/TIME UNIT)

NP - INITIAL POPULATION OF COUNTRY (PERSONS)

NP=50E6

NP - INITIAL POPULATION OF COUNTRY (PERSONS)

NAP=NVPP+NVPF-NCSP-NKSP

NAP - INITAIL AGRICULTURAL PRODUCTION (PRODUCT UNITS/TIME UNIT)

NVPP - INITIAL VALUE OF PRODUCTION IN PEASANT SECTOR (MONEY UNITS/TIME UNIT)

NVPF - INITIAL VALUE OF PRODUCTION IN FORMAL SECTOR (MONEY UNITS/TIME UNIT)

NCSP - INITIAL CONSUMPTION SERVICES PRODUCTION (PRODUCT UNITS/TIME UNIT)

NKSP - INITIAL CAPITAL SERVICES PRODUCTION (CAPITAL UNITS/TIME UNIT)

NCSP=NCSD

NCSP - INITIAL CONSUMPTION SERVICES PRODUCTION (PRODUCT UNITS/TIME UNIT)

NCSD - INITIAL CONSUMPTION SERVICES DEMAND (SERVICE UNITS/TIME UNIT)

NKSP=(NTKOP+NTKOF)/ALK

NKSP - INITIAL CAPITAL SERVICES PRODUCTION (CAPITAL UNITS/TIME UNIT)

NTKOP - INITIAL TRADITIONAL CAPITAL OWNED BY PEASANT SECTOR (CAPITAL UNITS)

NTKOF - INITIAL TRADITIONAL CAPITAL OWNED BY FORMAL SECTOR (CAPITAL UNITS)

ALK - AVERAGE LIFE OF CAPITAL (TIME UNITS)

NAKR=NMPK

NAKR - INITIAL CAPITAL RENT (MONEY UNITS/CAPITAL UNIT/TIME UNIT)

NMPK - INITIAL MARGINAL REVENUE PRODUCT OF CAPITAL (MONEY UNITS/CAPITAL UNIT/TIME UNIT)

NMPK=NRK+1/ALK

NMPK - INITIAL MARGINAL REVENUE PRODUCT OF CAPITAL (MONEY UNITS/CAPITAL UNIT/TIME UNIT)

NRK - NET RETURN ON CAPITAL INVESTMENT/INTEREST RATE (MONEY UNITS/TIME UNIT/MONEY UNIT)

ALK - AVERAGE LIFE OF CAPITAL (TIME UNITS)

4. Parameters Related to Mechanisms for Savings, Income Disbursement, and Production

4.1. Time Constants

The time constants used in the equations for savings, income disbursement, and production are given in Table B.6. These equations also use some of the constants discussed earlier. The times to average saving rates, investment expenditures, and revenue (TSS, TAIE, and TSR) are based on an yearly production cycle. NLASF and NLASP represent the years of coverage needed for supporting the saving consumption rates in the two sectors. No empirical information is available about such coverage. The normal life of accumulated savings in both sectors is arbitrarily assumed to be 2.5 years, but it can be freely changed without significantly affecting model behavior.

PARAMETER	DEFINITION	UNITS	VALUE
TSS	TIME TO SMOOTH SAVING RATE	YEARS	1
TAIE	TIME TO AVERAGE INVESTMENT EXPENDITURE	YEARS	1
TSR	TIME TO AVERAGE REVENUE	YEARS	1
NLASF	NORMAL LIFE OF ACCUMULATED SAVINGS IN FORMAL SECTOR	YEARS	2.5
NLASP	NORMAL LIFE OF ACCUMULATED SAVINGS IN PEASANT SECTOR	YEARS	2.5

Table B.6: Time Constants Used in Equations for Saving, Income Disbursement, and Production

4.2. Scaling Factors

Table B.7 shows the scaling factors used in the equations for saving, income disbursement, and production, in addition to the previously defined scaling factors. The initial output elasticities of capital and workers (EK, EW) are based on the available empirical studies [4]. The normal fractions of revenue saved (NFRSF, NFRSP) are based on the marginal saving propensity of capitalist farmers reported in empirical studies [5]. Again, the model is relatively insensitive to changes in these parameters.

PARAMETER	DEFINITION	UNITS	VALUE
NFRSF	NORMAL FRACTION OF REVENUE SAVED BY FORMAL SECTOR	DIMENSIONLESS	0.3
NFRSP	NORMAL FRACTION OF REVENUE SAVED BY PEASANT SECTOR	DIMENSIONLESS	0.3
NEK	INITIAL ELASTICITY OF OUTPUT OF CAPITAL	DIMENSIONLESS	0.2
NEW	INITIAL ELASTICITY OF OUTPUT OF WORKERS	DIMENSIONLESS	0.4

Table B.7: Scaling Factors Used in Equations for Saving, Income Disbursement and Production

In addition, the scaling factor for the production functions for both sectors SFPF is computed algebraically on the bases of initial values of factors and the initial output of the economy:

```
SFPF=(NVPF+NVPP)/(EXP(EL*LOGN(NLCF+NLCP))*EXP(NEK*
  LOGN(NKEP+NKEF))*EXP(NEW*LOGN(NWF+NWP)))
    SFPF   - SCALING FACTOR OF PRODUCTION FUNCTION
               (DIMENSIONLESS)
    NVPF   - INITIAL VALUE OF PRODUCTION IN FORMAL
               SECTOR (MONEY UNITS/TIME UNIT)
```

NVPP - INITIAL VALUE OF PRODUCTION IN PEASANT SECTOR (MONEY UNITS/TIME UNIT)
EL - ELASTICITY OF PRODUCTION OF LAND (DIMENSIONLESS)
NLCF - INITIAL LAND CULTIVATED BY FORMAL SECTOR (LAND UNITS)
NLCP - INITIAL LAND CULTIVATED BY PEASANT SECTOR (LAND UNITS)
NEK - INITIAL ELASTICITY OF PRODUCTION OF CAPITAL (DIMENSIONLESS)
NKEP - INITIAL CAPITAL EMPLOYED BY PEASANT SECTOR (CAPITAL UNITS)
NKEF - INITIAL CAPITAL EMPLOYED BY FORMAL SECTOR (CAPITAL UNITS)
NEW - INITIAL ELASTICITY OF PRODUCTION OF WORKERS (DIMENSIONLESS)
NWF - INITIAL WORKERS IN FORMAL SECTOR (PERSONS)
NWP - INITIAL WORKERS IN PEASANT SECTOR (PERSONS)

4.3. Initial Value Parameters

The initial value parameters for this set of equations are based on the same considerations as for earlier sets of equations. The initial value paramets for saving, income disbursement, and production equations are given below:

NIEF=NSEF-NASF/NLASF
NIEF - INITIAL INVESTMENT EXPENDITURE IN FORMAL SECTOR ((MONEY UNITS/TIME UNIT)
NSEF - INITIAL SAVING EXPENDITURE IN FORMAL SECTOR (MONEY UNITS/TIME UNIT)
NASF - INITIAL ACCUMULATED SAVINGS IN FORMAL SECTOR (MONEY UNITS)
NLASF - INITIAL LIFE OF ACCUMULATED SAVINGS IN FORMAL SECTOR (TIME UNITS)

NSEF=NASF/NLASF+NMKOF/ALK+NTKOF/ALK
NSEF - INITIAL SAVING EXPENDITURE IN FORMAL SECTOR (MONEY UNITS/TIME UNIT)
NASF - INITIAL ACCUMULATED SAVINGS IN FORMAL SECTOR (MONEY UNITS)
NLASF - INITIAL LIFE OF ACCUMULATED SAVINGS IN FORMAL SECTOR (TIME UNITS)
NMKOF - INITIAL MODERN CAPITAL OWNED BY FORMAL SECTOR (CAPITAL UNITS)
ALK - AVERAGE LIFE OF CAPITAL (TIME UNITS)

NTKOF - INITIAL TRADITIONAL CAPITAL OWNED BY FORMAL SECTOR (CAPITAL UNITS)

NASF=(NRF*NFRSF-NKOF/ALK)*NLASF

- NASF - INITIAL ACCUMULATED SAVINGS IN FORMAL SECTOR (MONEY UNITS)
- NRF - INITIAL REVENUE IN FORMAL SECTOR (MONEY UNITS/TIME UNIT)
- NFRSF - NORMAL FRACTION REVENUE SAVED IN FORMAL SECTOR (DIMENSIONLESS)
- NKOF - INITIAL CAPITAL OWNED BY FORMAL SECTOR (CAPITAL UNITS)
- ALK - AVERAGE LIFE OF CAPITAL (TIME UNITS)
- NLASF - INITIAL LIFE OF ACCUMULATED SAVINGS IN FORMAL SECTOR (TIME UNITS)

NRF=NVPF+NLRPP+NKRPP-NWF*NAWR

- NRF - INITIAL REVENUE IN FORMAL SECTOR (MONEY UNITS/TIME UNIT)
- NVPF - INITIAL VALUE OF PRODUCTION IN FORMAL SECTOR (MONEY UNITS/TIME UNIT)
- NLRPP - INITIAL LAND RENT PAYMENTS BY PEASANT SECTOR (MONEY UNITS/TIME UNIT)
- NKRPP - INITIAL CAPITAL RENT PAYMENTS BY PEASANT SECTOR (MONEY UNITS/TIME UNIT)
- NWF - INITIAL WORKERS IN FORMAL SECTOR (PERSONS)
- NAWR - INITIAL WAGE RATE (MONEY UNITS/PERSON/TIME UNIT)

NLRPP=NLRF*NALR

- NLRPP - INITIAL LAND RENT PAYMENTS BY PEASANT SECTOR (MONEY UNITS/TIME UNIT)
- NLRF - INITIAL LAND RENTED OUT BY FORMAL SECTOR (LAND UNITS)
- NALR - INITIAL LAND RENT (MONEY UNITS/LAND UNITS/TIME UNIT)

NKRPP=NKRF*NAKR

- NKRPP - INITIAL CAPITAL RENT PAYMENTS BY PEASANT SECTOR (MONEY UNITS/TIME UNIT)
- NKRF - INITIAL CAPITAL RENTED OUT BY FORMAL SECTOR (CAPITAL UNITS)
- NAKR - INITIAL CAPITAL RENT (MONEY UNITS/CAPITAL UNIT/TIME UNIT)

NIEP=NSEP-NASP/NLASP

- NIEP - INITIAL INVESTMENT EXPENDITURE IN PEASANT SECTOR (MONEY UNITS/TIME UNIT)
- NSEP - INITIAL SAVING EXPENDITURE IN PEASANT SECTOR (MONEY UNITS/TIME UNIT)
- NASP - INITIAL ACCUMULATED SAVINGS IN PEASANT SECTOR (MONEY UNITS)
- NLASP - INITIAL LIFE OF ACCUMULATED SAVINGS IN PEASANT SECTOR (TIME UNITS)

NSEP=NASP/NLASP+NMKOP/ALK+NTKOP/ALK

NSEP	- INITIAL SAVING EXPENDITURE IN PEASANT SECTOR (MONEY UNITS/TIME UNIT)
NASP	- INITIAL ACCUMULATED SAVINGS IN PEASANT SECTOR (MONEY UNITS)
NLASP	- INITIAL LIFE OF ACCUMULATED SAVINGS IN PEASANT SECTOR (TIME UNITS)
NMKOP	- INITIAL MODERN CAPITAL OWNED BY PEASANT SECTOR (CAPITAL UNITS)
ALK	- AVERAGE LIFE OF CAPITAL (TIME UNITS)
NTKOP	- INITIAL TRADITIONAL CAPITAL OWNED BY PEASANT SECTOR (CAPITAL UNITS)

NASP=(NRP*NFRSP-NKOP/ALK)*NLASP

NASP	- INITIAL ACCUMULATED SAVINGS IN PEASANT SECTOR (MONEY UNITS)
NRP	- INITIAL REVENUE OF PEASANT SECTOR (MONEY UNITS/TIME UNIT)
NFRSP	- NORMAL FRACTION REVENUE SAVED IN PEASANT SECTOR (DIMENSIONLESS)
NKOP	- INITIAL CAPITAL OWNED BY PEASANT SECTOR (CAPITAL UNITS)
ALK	- AVERAGE LIFE OF CAPITAL (TIME UNITS)
NLASP	- INITIAL LIFE OF ACCUMULATED SAVINGS IN PEASANT SECTOR (TIME UNITS)

NRP=NVPP-NLRPP-NKRPP+NWF*NAWR

NRP	- INITIAL REVENUE OF PEASANT SECTOR (MONEY UNITS/TIME UNIT)
NVPP	- INITIAL VALUE OF PRODUCTION IN PEASANT SECTOR (MONEY UNITS/TIME UNIT)
NLRPP	- INITIAL LAND RENT PAYMENTS BY PEASANT SECTOR (MONEY UNITS/TIME UNIT)
NKRPP	- INITIAL CAPITAL RENT PAYMENTS BY PEASANT SECTOR (MONEY UNITS/TIME UNIT)
NWF	- INITIAL WORKERS IN FORMAL SECTOR (PERSONS)
NAWR	- INITIAL WAGE RATE (MONEY UNITS/PERSON/TIME UNIT)

5. Policy Related Parameters

Two types of simulation experiments are performed with the model: behavior tests involving variation in the assumptions of the model, and policy tests involving exogeneous changes in the values of variables of the model or introducing policy related scaling factors at designated times. These experiments can be performed by using several models each serving a specific test function. More conveniently, a model incorporating all needed assumptions, exogeneous changes and scaling factors can be constructed and switching functions built into it for activating designated mechanisms at will. The model developed in this thesis uses the latter approach.

The policy and testing related parameters consist of designated times, switching constants, and scaling factors that are changed exogeneously over the course of experiments with the model. The values of these parameters given below, therefore, are only for the base run that excludes most of the key feedbacks and all the policy inputs.

```
LTPLR=0
    LTPLR  - LAND TRANSFERED TO PEASANTS DUE TO LAND
             REFORM (LAND UNITS)

TPTST=1960
    TPTST  - TIME FOF POLICY TEST (TIME UNIT)

TPTSTR=4
    TPTSTR - TIME OF POLICY TEST FOR RENTING (TIME UNIT)

TPTSTG=1950
    TPTSTG - TIME OF POLICY TEST FOR GROWTH (TIME UNIT)

TPTSTM=1950
    TPTSTM - TIME FOR POLICY TEST FOR MIGRATION (TIME
             UNIT)

TPTSTW=4
    TPTSTW - TIME OF POLICY TEST FOR WAGE RATE (TIME
             UNIT)

LOT=0
    LOT    - LAND OWNERSHIP TAX (MONEY UNITS/LAND UNITS/
             TIME UNIT)
```

TPTLOT=1950
TPTLOT - TIME FOR POLICY TEST FOR LAND OWNERSHIP TAX (TIME UNIT)

LRT=0
LRT - LAND RENT TEX (MONEY UNITS/MONEY UNIT OF LAND RENT)

TPTLRT=1950
TPTLRT - TIME OF POLICY TEST FOR LAND RENT TEX (TIME UNIT)

LOTP=0
LOTP - LAND OWNERSHIP TAX ON PEASANTS (MONEY UNITS/LAND UNITS/TIME UNIT)

SWR=0
SWR - SWITCH FOR RENTING POLICY (DIMENSIONLESS)

WTTST=0
WTTST - WORKERS TRANSFERED FOR TESTING MODEL (PERSONS)

SWM=0
SWM - SWITCH FOR MIGRATION POLICY (DIMENSIONLESS)

SWW=0
SWW - SWITCH FOR WAGE POLICY (DIMENSIONLESS)

SWCP=0
SWCP - SWITCH FOR COOPERATIVES POLICY (DIMENSIONLESS)

TMCP=1950
TMCP - TIME OF COOPERATIVES POLICY (TIME UNIT)

KRT=0
KRT - CAPITAL RENT TAX (MONEY UNITS/MONEY UNIT CAPITAL RENT)

TPTKRT=1950
TPTKRT - TIME OF POLICY TEST FOR CAPITAL RENT TAX (TIME UNIT)

HTMK=0
HTMK - HEIGHT OF TEST INPUT FOR MODERN CAPITAL SUPPLY (CAPITAL UNITS/TIME UNIT)

TMK=0
TMK - TIME OF MODERN CAPITAL POLICY (TIME UNIT)

SWMKSP=1
SWMKSP - SWITCH FOR MODERN CAPITAL SUPPLY POLICY (DIMENSIONLESS)

MPSK=1
MPSK - MULTIPLIER FOR PRICE SUPPORT OF CAPITAL POLICY DIMENSIONLESS)

SWFP=0
SWFP - SWITCH FOR FINANCIAL POLICY (DIMENSIONLESS)

TFP=1950
TFP - TIME OF FINANCIAL POLICY (DIMENSIONLESS)

CGR=2
CGR - COEFFICIENT FOR GREEN REVOLUTION (DIMENSIONLESS)

SWGR=0
SWGR - SWITCH FOR GREEN REVOLUTION POLICY (DIMENSIONLESS)

TGR=1950
TGR - TIME OF GREEN REVOLUTION POLICY (TIME UNIT)

Each experiment with the model requires re-specification of a given set of the test parameters. Reader familiar with DYNAMO can easily identify changes necessary for each experiment in this study by going over the description of the respective experiments. The rerun files specifying test parameters for the experiments dicussed in chapters four and five are given at the end of the model listing in Appendix C.

NOTES AND REFERENCES

1. For a discussion of how parameters for system dynamics models are estimated, see GRAHM, Alan K., Parameter Estimation in System Dynamics Modelling, Memo # D-2916-3, System Dynamics Group, MIT.

2. See HEADY, E. O., and DILLON, J. L., Agricultural Production Functions, Iowa State University Press, 1961; and HANUMANTHA RAO, C., Agricultural Production Function, Costs, and Returns in India, Asia Publishing House, NY 1965.

3. MELLOR, John W., "The Subsistance Farmer in Traditional Economies", in WHARTON JR., Clifton R., Subsistance Agriculture and Economic Development, Aldine Publishing Co., Chicago, 1969.

4. HEADY and DILLON, 1965, op. cit.

5. MELLOR, 1969, op. cit.

APPENDIX C

MODEL LISTING

```
*     RINCOM - RURAL INCOME DISTRIBUTION SYSTEM OF PAKISTAN                00001
NOTE  ------------------------------------------------------------         00002
NOTE                                                                       00003
NOTE        AUTHOR  - KHALID SAEED                                         00004
NOTE        PROJECT - PHD THESIS                                           00005
NOTE        DATE    - SEPTEMBER 1980                                       00006
NOTE  ------------------------------------------------------------         00007
NOTE        THIS MODEL PORTRAYS THE DYNAMICS OF INCOME DISTRIBUTION        00008
NOTE        BETWEEN CAPITALISTS AND CULTIVATORS IN A RURAL AGRARIAN        00009
NOTE        ECONOMY.  THE CAPITALISTS ARE DESIGNATED AS THE FORMAL         00011
NOTE        SECTOR, THE CULTIVATORS AS THE PEASANT SECTOR. THE MODEL       00012
NOTE        FOCUSES ON RESOURCE ALLOCATION AND INCOME DISBURSEMENT         00013
NOTE        PROCESSES IN THE TWO SECTORS.                                  00014
NOTE                                                                       00015
NOTE  ------------------------------------------------------------         00016
NOTE    1.  ACQUISITION OF LAND                                            00017
NOTE                                                                       00018
NOTE        A)  FORMAL SECTOR                                              00019
NOTE                                                                       00021
A LOF.K=TL*FLOF.K-PULSE(LTPLR/DT,TPTST,10000)                              10030
N LOF=NLOF                                                                 10031
A FLOF.K=SMOOTH(DLOF.K/TDLO.K,TSLO)                                        10040
N FLOF=NFLOF                                                               10041
A CLOF.K=(LOF.K-SMOOTH(LOF.K,TALT))/TALT                                   10050
A DLOF.K=ILF.K*ECBALF.K                                                    10060
A ILF.K=ILCF.K+ILRF.K                                                      10070
A ILCF.K=LCF.K*PCLPF.K                                                     10080
A LCF.K=FLCF.K*LOF.K-LOF.K*PULSE(NFLR,TPTSTR,10000)                        10090
N LCF=NLCF                                                                 10091
A FLCF.K=SMOOTH(ILCF.K/ILF.K,TSFLC)                                        10100
N FLCF=NFLCF                                                               10101
A ILRF.K=LRF.K*PRLPF.K                                                     10110
A LRF.K=LOF.K-LCF.K                                                        10120
N LRF=NLRF                                                                 10121
A PCLPF.K=TABHL(TLCP,MRPLF.K/(MFCL.K+STEP(LOT,TPTLOT)),0,4,1)              10130
T TLCP=0/1/1.5/1.8/2                                                       10131
```

```
A PRLPF.K=TABHL(TLRP,(ALR.K-ALR.K*STEP(LRT,TPTLRT))/(MFCL.K+      10140
X   STEP(LOT,TPTLOT)),0,4,1)                                       10141
T TLRP=0/1/1.5/1.8/2                                               10142
A MRPLF.K=EL*AVPF.K/LCF.K                                          10150
A AVPF.K=SMOOTH(VPF.K,TSVP)                                        10160
N AVPF=NVPF                                                        10161
NOTE                                                               10162
NOTE        B)  PEASANT SECTOR                                     10163
NOTE                                                               10164
A LCP.K=LOP.K+LRF.K                                                10170
A LOP.K=TL-LOF.K                                                   10180
N LOP=NLOP                                                         10181
A CLOP.K=(LOP.K-SMOOTH(LOP.K,TALT))/TALT                           10190
A TDLO.K=DLOF.K+DLOP.K                                             10200
A DLOP.K=ILP.K*ECBALP.K                                            10210
A ILP.K=LOP.K*PCLPP.K                                              10220
A PCLPP.K=TABHL(TLCP,MRPLP.K/(MFCL.K+STEP(LOTP,TPTLOT)),0,4,1)     10230
A MRPLP.K=EL*AVPP.K/LCP.K                                          10240
A AVPP.K=SMOOTH(VPP.K,TSVP)                                        10250
N AVPP=NVPP                                                        10251
A DRLP.K=ILCP.K-LOP.K                                              10260
A ILCP.K=EL*AVPP.K/MFCL.K                                          10270
NOTE                                                               10271
L ALR.K=ALR.J+(DT)(CLR.JK)                                         10280
N ALR=NALR                                                         10281
R CLR.KL=(ILR.K-ALR.K)/LRAT                                        10290
A ILR.K=AMRPL.K*FIFGE(1,PDRLLR.K,0,STEP(SWR,TPTSTR))               10300
A PDRLLR.K=TABHL(TDRLLR,DRLP.K/FIFGE(1,LRF.K,0,STEP(SWR,TPTSTR))   10310
X   ,0,4,1)                                                        10311
T TDRLLR=.9/1/1.1/1.15/1.2                                         10312
A MFCL.K=APL.K*NRK                                                 10320
L APL.K=APL.J+(DT/LPAT)(IPL.J-APL.J)                               10330
N APL=NAPL                                                         10331
A IPL.K=AMRPL.K/NRK*PDLO.K                                         10340
A AMRPL.K=(MRPLF.K*LCF.K+MRPLP.K*LCP.K)/(LCF.K+LCP.K)              10350
A PDLO.K=TABHL(TPDLO,TDLO.K/TL,0,4,1)                              10360
T TPDLO=.9/1/1.1/1.15/1.2                                          10361
NOTE                                                               10362
NOTE    2.  ALLOCATION OF WORKERS                                  10363
NOTE                                                               10364
NOTE        A)  FORMAL SECTOR                                      10365
NOTE                                                               10366
L WF.K=WF.J+(DT)(CWF.JK)                                           10370
N WF=NWF                                                           10371
R CWF.KL=(IWF.K-WF.K)/WAT+PULSE(WTTST/DT,TPTST,10000)              10380
A IWF.K=RWF.K*IFWF.K                                               10390
A IFWF.K=TABHL(TFWF,DWF.K/RWF.K,0,1,.25)                           10400
T TFWF=0/.25/.5/.75/.975                                           10401
A DWF.K=EWF.K*AVPF.K/AWR.K                                         10410
A EWF.K=1-EL-EKF.K                                                 10420
```

```
NOTE                                                  10421
NOTE        B)  PEASANT SECTOR                        10422
NOTE                                                  10423
A WP.K=RWF.K-WF.K                                     10430
N WP=NWP                                              10431
A DWP.K=EWP.K*AVPP.K/AWR.K                            10440
A EWP.K=1-EL-EKP.K                                    10450
NOTE                                                  10451
L RWF.K=RWF.J+(DT)(CRWF.JK)                           10460
N RWF=NRWF                                            10461
R CRWF.KL=WNGR.K-RUM.K                                10470
A WNGR.K=RWF.K*STEP(WFGR,TPTSTG)                      10480
A RUM.K=RWF.K*FMR.K                                   10490
A FMR.K=TABHL(TFMR,AWR.K/UWR.K,0,2,.5)                10500
T TFMR=.1/.03/0/-.0035/-.005                          10501
A UWR.K=FIFGE(AWR.K,MUWR.K,0,STEP(SWM,TPTSTM))        10510
A MUWR.K=TABHL(TMUW,TIME.K,1940,2000,10)              10520
T TMUW=700/700/700/700/700/700/700                    10521
NOTE                                                  10522
L AWR.K=AWR.J+(DT/TAWR)(IWR.J-AWR.J)                  10530
N AWR=NAWR                                            10531
A IWR.K=FIFGE(AMRPW.K,ACEW.K,0,STEP(SWW,TPTSTW))*EWDW.K  10540
A EWDW.K=TABHL(TWDW,DWF.K/(RWF.K-DWP.K),0,3,.5)       10550
T TWDW=1/1/1/1.05/1.15/1.25/1.3                       10551
A AMRPW.K=(MRPWF.K*WF.K+MRPWP.K*WP.K)/(WF.K+WP.K)     10560
A MRPWF.K=EWF.K*AVPF.K/WF.K                           10570
A MRPWP.K=EWP.K*AVPP.K/WP.K                           10580
A ACEW.K=SMOOTH((RP.K-SP.JK+ASP.K/LASP.K)/RWF.K,TACEW)  10590
N ACEW=NCEW                                           10591
NOTE                                                  10592
NOTE    3.  ACQUISITION OF CAPITAL                    10593
NOTE                                                  10594
NOTE        A)  FORMAL SECTOR                         10595
NOTE                                                  10596
A KOF.K=MKOF.K+TKOF.K                                 10600
L MKOF.K=MKOF.J+(DT)(MKAF.JK-MKDRF.JK)                10610
N MKOF=NMKOF                                          10611
R MKDRF.KL=MKOF.K/ALK                                 10620
L TKOF.K=TKOF.J+(DT)(TKAF.JK-TKDRF.JK)                10630
N TKOF=NTKOF                                          10631
R TKDRF.KL=TKOF.K/ALK                                 10640
R MKAF.KL=MKDF.K*MKIA.K                               10650
R TKAF.KL=TKDF.K*TKIA.K                               10660
A MKDF.K=KEF.K/ALK*PKEPF.K*ECBAKF.K                   10670
A TKDF.K=DKAF.K-AMKAF.K                               10680
A DKAF.K=(KEF.K/ALK*PKEPF.K+KRF.K/ALK*PKRPF.K)*ECBAKF.K  10690
A KEF.K=FKEF.K*KOF.K-KOF.K*PULSE(NFKR,TPTSTR,10000)   10700
N KEF=NKEF                                            10701
A FKEF.K=SMOOTH(IKEF.K/IKF.K,TSFKE)                   10710
N FKEF=NFKEF                                          10711
A IKEF.K=KEF.K*PKEPF.K                                10720
A IKF.K=IKEF.K+IKRF.K                                 10730
A IKRF.K=KRF.K*PKRPF.K                                10740
```

```
A KRF.K=KOF.K-KEF.K                                            10750
N KRF=NKRF                                                     10751
NOTE                                                           10752
A PKEPF.K=TABHL(TKEP,MRPKF.K/MFCKF.K,0,4,1)                    10760
T TKEP=0/1/1.5/1.8/2                                           10761
A PKRPF.K=TABHL(TKRP,(AKR.K-AKR.K*STEP(KRT,TPTKRT))/MFCKF.K,   10770
X   0,4,1)                                                     10771
T TKRP=0/1/1.5/1.8/2                                           10772
A MRPKF.K=EKF.K*AVPF.K/KEF.K                                   10780
A MFCKF.K=NRK+RCKF.K/ALK                                       10790
A RCKF.K=(MKOF.K*RPMK.K+TKOF.K*RPO.K)/KOF.K                    10800
A EKF.K=TABHL(TEK,KCIF.K,0,1,.25)                              10810
T TEK=.2/.24/.3/.36/.4                                         10811
A KCIF.K=MKOF.K/KEF.K                                          10820
A AMKAF.K=SMOOTH(MKAF.JK,TSKA)                                 10830
N AMKAF=NMKAF                                                  10831
NOTE                                                           10832
NOTE        B)  PEASANT SECTOR                                 10833
NOTE                                                           10834
A KEP.K=KOP.K+KRF.K                                            10840
A KOP.K=MKOP.K+TKOP.K                                          10850
L MKOP.K=MKOP.J+(DT)(MKAP.JK-MKDRP.JK)                         10860
N MKOP=NMKOP                                                   10861
R MKDRP.KL=MKOP.K/ALK                                          10870
L TKOP.K=TKOP.J+(DT)(TKAP.JK-TKDRP.JK)                         10880
N TKOP=NTKOP                                                   10881
R TKDRP.KL=TKOP.K/ALK                                          10890
R MKAP.KL=MKDP.K*MKIA.K                                        10900
R TKAP.KL=TKDP.K*TKIA.K                                        10910
A MKDP.K=DKAP.K*EFSMKP.K                                       10920
A TKDP.K=DKAP.K-AMKAP.K                                        10930
A DKAP.K=KOP.K/ALK*PKEPP.K*ECBAKP.K                            10940
A DRKP.K=IKEP.K-KOP.K                                          10950
A IKEP.K=EKP.K*AVPP.K/MFCKP.K                                  10960
NOTE                                                           10961
A EFSMKP.K=FIFGE(EFSMK1.K,EFSMK2.K,0,STEP(SWCP,TMCP))          10970
A EFSMK1.K=TABHL(TFSMK1,LCP.K/WP.K,0,50,6.25)                  10980
T TFSMK1=.001/.066/.2/.3/.5/.7/.8/.934/1                       10981
A EFSMK2.K=TABHL(TFSMK2,LCP.K/WP.K,0,50,6.25)                  10990
T TFSMK2=1/1/1/1/1/1/1/1/1                                     10991
A PKEPP.K=TABHL(TKEP,MRPKP.K/MFCKP.K,0,4,1)                    11000
A MRPKP.K=EKP.K*AVPP.K/KEP.K                                   11010
A EKP.K=TABHL(TEK,KCIP.K,0,1,.25)                              11020
A KCIP.K=MKOP.K/KEP.K                                          11030
A AMKAP.K=SMOOTH(MKAP.JK,TSKA)                                 11040
N AMKAP=NMKAP                                                  11041
A MFCKP.K=NRK+RCKP.K/ALK                                       11050
A RCKP.K=(MKOP.K*RPMK.K+TKOP.K*RPO.K)/KOP.K                    11060
NOTE                                                           11061
A MKIA.K=TABHL(TMKIA,MKI.K/DMKI.K,0,1,.25)                     11070
T TMKIA=0/.36/.6/.84/1                                         11071
A DMKI.K=SMOOTH(MKDF.K+MKDP.K,TSDKI)*DIC                       11080
N DMKI=NDMKI                                                   11081
```

```
L MKI.K=MKI.J+(DT)(MKS.JK-MKAF.JK-MKAP.JK)                                11090
N MKI=NMKI                                                                11091
R MKS.KL=FIFGE(MKS1.K,MKS2.K,0,SWMKSP)                                    11100
A MKS1.K=TABHL(TMKDM,TIME.K,1940,2000,10)                                 11110
T TMKDM=0/0/0/0/0/0/0                                                     11111
A MKS2.K=STEP(HTMK,TMK)                                                   11120
A TMKD.K=SMOOTH(MKDF.K+MKDP.K+MKDI.K,TSMKD)                                11130
N TMKD=NMKD                                                               11131
A MKDI.K=(DMKI.K-MKI.K)/MKIAT                                             11140
NOTE                                                                      11141
A TKIA.K=TABHL(TTKIA,TKI.K/DTKI.K,0,1,.25)                                11150
T TTKIA=0/.36/.6/.84/1                                                    11151
A DTKI.K=SMOOTH(TKDF.K+TKDP.K,TSDKI)*DIC                                  11160
N DTKI=NTKI                                                               11161
L TKI.K=TKI.J+(DT)(TKS.JK-TKAF.JK-TKAP.JK)                                11170
N TKI=NTKI                                                                11171
R TKS.KL=TTKD.K/TDP.K*TP.K                                                11180
A TTKD.K=SMOOTH(TKDF.K+TKDP.K+TKDI.K,TATKD)                               11190
N TTKD=NTKD                                                               11191
A TKDI.K=(DTKI.K-TKI.K)/TKIAT                                             11200
A TP.K=PP.K+PF.K                                                          11210
NOTE                                                                      11211
A TDP.K=TTKD.K+APD.K+TCSD.K                                               11220
A TCSD.K=SMOOTH(CSDF.K+CSDP.K,TSCSD)                                      11230
N TCSD=NCSD                                                               11231
A CSDF.K=(RF.K-SF.JK+SSRF.JK)*(1-FSCEF)/RPO.K                             11240
A CSDP.K=(RP.K-SP.JK+SSRP.JK)*(1-FSCEP)/RPO.K                             11250
A APD.K=P.K*NAPCD                                                         11260
L P.K=P.J+(DT)(CP.JK)                                                     11270
N P=NP                                                                    11271
R CP.KL=P.K*STEP(FPGR,TPTSTG)                                             11280
A TAP.K=APD.K/TDP.K*TP.K                                                  11290
NOTE                                                                      11291
L AKR.K=AKR.J+(DT)(DT/TAKR)(IKR.J-AKR.J)                                  11300
N AKR=NAKR                                                                11301
A IKR.K=AMRPK.K*FIFGE(1,PDRKKR.K,0,STEP(SWR,TPTSTR))                      11310
A AMRPK.K=(MRPKF.K*KEF.K+MRPKP.K*KEP.K)/(KEF.K+KEP.K)                     11320
A PDRKKR.K=TABHL(TDRKKR,DRKP.K/FIFGE(1,KRF.K,0,STEP(SWR,TPTSTR))          11330
X    ,0,4,1)                                                              11331
T TDRKKR=.9/1/1.1/1.15/1.2                                                11332
NOTE                                                                      11333
A RPMK.K=RPO.K*MPSK                                                       11340
L RPO.K=RPO.J+(DT/RPAT)(IRPO.J-RPO.J)                                     11350
N RPO=NRPO                                                                11351
A IRPO.K=NRPO*MDSR.K                                                      11360
A MDSR.K=TABHL(TDSRP,TDP.K/TP.K,0,4,1)                                    11370
T TDSRP=0/1/1.5/1.8/2                                                     11371
```

```
NOTE                                                                      11372
NOTE    4.  SAVINGS, INCOME DISBURSEMENT, AND PRODUCTION                  11373
NOTE                                                                      11374
NOTE        A)  FORMAL SECTOR                                             11375
NOTE                                                                      11376
A ECBALF.K=FIFGE(ECBLF1.K,ECBLF2.K,0,STEP(SWFP,TFP))                      11380
A ECBLF1.K=TABHL(TCBL1,((ASRF.K-AIEF.K))/(ASF.K/LASF.K),0,4,.5)           11390
T TCBL1=.2/.4/1/1.3/1.5/1.57/1.6/1.65/1.68                                11391
A ECBLF2.K=TABHL(TCBL2,((ASRF.K-AIEF.K))/(ASF.K/LASF.K),0,4,.5)           11400
T TCBL2=.2/.4/1/1.3/1.5/1.57/1.6/1.65/1.68                                11401
A ECBAKF.K=FIFGE(ECBKF1.K,ECBKF2.K,0,STEP(SWFP,TFP))                      11410
A ECBKF1.K=TABHL(TCBK1,(ASRF.K-AIEF.K)/(ASF.K/LASF.K),0,4,.5)             11420
T TCBK1=0/.3/1/1.5/1.8/2/2.1/2.15/2.18                                    11421
A ECBKF2.K=TABHL(TCBK2,(ASRF.K-AIEF.K)/(ASF.K/LASF.K),0,4,.5)             11430
T TCBK2=0/.3/1/1.5/1.8/2/2.1/2.15/2.18                                    11431
A ASRF.K=SMOOTH(SF.JK,TSS)                                                11440
A AIEF.K=SMOOTH(ELTF.JK+EKAF.JK,TAIE)                                     11450
N AIEF=NIEF                                                               11451
L ASF.K=ASF.J+(DT)(SF.JK-EKAF.JK-ELTF.JK-SSRF.JK)                         11460
N ASF=NASF                                                                11461
R SF.KL=ARF.K*FRSF.K                                                      11470
A ARF.K=SMOOTH(RF.K,TSR)                                                  11480
N ARF=NRF                                                                 11481
A RF.K=VPF.K+LRPP.K+KRPP.K-WDF.K-LOF.K*LOT-LRPP.K*LRT-KRPP.K*KRT          11490
A VPF.K=PF.K*RPO.K                                                        11500
A PF.K=SFPF*EXP(EL*LOGN(LCF.K))*EXP(EWF.K*LOGN(WF.K))*                    11510
X   EXP(EKF.K*LOGN(KEF.K))*CPYF.K*                                        11511
X   FIFGE(1,CGR,0,STEP(SWGR,TGR))                                         11512
A CPYF.K=TABHL(TCPY,KCIF.K,0,1,.25)                                       11520
T TCPY=1/1.5/1.7/1.9/2                                                    11521
R EKAF.KL=MKAF.JK*RPMK.K+TKAF.JK*RPO.K                                    11530
R ELTF.KL=CLOF.K*APL.K                                                    11540
R SSRF.KL=ASF.K/LASF.K                                                    11550
A LASF.K=NLASF                                                            11560
A WDF.K=WF.K*AWR.K                                                        11570
A LRPP.K=LRF.K*ALR.K                                                      11580
A KRPP.K=KRF.K*AKR.K                                                      11590
A FRSF.K=NFRSF                                                            11600
NOTE                                                                      11601
NOTE        B)  PEASANT SECTOR                                            11602
NOTE                                                                      11603
A ECBALP.K=FIFGE(ECBLP1.K,ECBLP2.K,0,STEP(SWFP,TFP))                      11610
A ECBLP1.K=TABHL(TCBL1,(ASRP.K-AIEP.K)/(ASP.K/LASP.K),0,4,.5)             11620
A ECBLP2.K=TABHL(TCBL2,(ASRP.K-AIEP.K)/(ASP.K/LASP.K),0,4,.5)             11630
A ECBAKP.K=FIFGE(ECBKP1.K,ECBKP2.K,0,STEP(SWFP,TFP))                      11640
A ECBKP1.K=TABHL(TCBK1,(ASRP.K-AIEP.K)/(ASP.K/LASP.K),0,4,.5)             11650
A ECBKP2.K=TABHL(TCBK2,(ASRP.K-AIEP.K)/(ASP.K/LASP.K),0,4,.5)             11660
A ASRP.K=SMOOTH(SP.JK,TSS)                                                11670
A AIEP.K=SMOOTH(ELTP.JK+EKAP.JK,TAIE)                                     11680
N AIEP=NIEP                                                               11681
L ASP.K=ASP.J+(DT)(SP.JK-EKAP.JK-ELTP.JK-SSRP.JK)                         11690
N ASP=NASP                                                                11691
R SP.KL=ARP.K*FRSP.K                                                      11700
```

```
A ARP.K=SMOOTH(RP.K,TSR)                                        11710
N ARP=NRP                                                       11711
A RP.K=VPP.K-LRPP.K-KRPP.K+WDF.K-LOP.K*LOTP                     11720
A VPP.K=PP.K*RPO.K                                              11730
A PP.K=SFPF*EXP(EL*LOGN(LCP.K))*EXP(EKP.K*LOGN(KEP.K))          11740
X    *EXP(EWP.K*LOGN(WP.K))*CPYP.K*                             11741
X    FIFGE(1,CGR,0,STEP(SWGR,TGR))                              11742
A CPYP.K=TABHL(TCPY,KCIP.K,0,1,.25)                             11750
R SSRP.KL=ASP.K/LASP.K                                          11760
A LASP.K=NLASP                                                  11770
A FRSP.K=NFRSP*EUISP.K*ERPSP.K                                  11780
A EUISP.K=TABHL(TSWS,DWP.K/WP.K,0,2,.25)                        11790
T TSWS=.1/.15/.3/.55/1/1.45/1.7/1.85/1.9                        11791
A ERPSP.K=TABHL(TRPS,(LRPP.K+KRPP.K)/(AVPP.K-WP.K*AMRPW.K),0,1,.25) 11800
T TRPS=1/.55/.3/.15/.1                                          11801
R EKAP.KL=MKAP.JK*RPMK.K+TKAP.JK*RPO.K                          11810
R ELTP.KL=(CLOP.K-PULSE(LTPLR/DT,TPTST,10000))*APL.K            11820
NOTE                                                            11821
NOTE    SUPPLEMENTARY EQUATIONS                                 11822
NOTE                                                            11823
S LWRF.K=LCF.K/WF.K                                             11830
S LWRP.K=LCP.K/WP.K                                             11840
S TR.K=RF.K+RP.K                                                11850
S TOL.K=LOF.K+LOP.K                                             11860
S TOK.K=KOF.K+KOP.K                                             11870
S TREF.K=TRPP.K+VPF.K                                           11880
S TRPP.K=LRPP.K+KRPP.K                                          11890
S TREP.K=WDF.K+VPP.K                                            11900
S RELRPP.K=TREP.K-LRPP.K                                        11910
NOTE                                                            11911
NOTE    PARAMETERS AND INITIAL CONDITIONS                       11912
NOTE                                                            11913
NOTE         1.   QUISITION OF LAND                             11914
NOTE                                                            11915
N NLOF=FIFGE(NLOF1,NLOF2,0,SWN)                                 11920
C NLOF1=25E6                                                    11930
C NLOF2=10E6                                                    11940
C SWN=0                                                         11950
C LTPLR=0                                                       11960
N NFLOF=NLOF/TL                                                 11970
C TALT=.5                                                       11980
C TSLO=5                                                        11990
C TPTST=1960                                                    12000
C TPTSTR=4                                                      12010
C TPTSTG=1950                                                   12020
C TPTSTM=1950                                                   12030
C TPTSTW=4                                                      12040
N NLCF=FIFGE(NLCF1,NLCF2,0,SWN)                                 12050
C NLCF1=25E6                                                    12060
C NLCF2=10E6                                                    12070
C TSFLC=.5                                                      12080
C NFLCF=1                                                       12090
C NFLR=0                                                        12100
N NLRF=NLOF-NLCF                                                12110
```

```
C LOT=0
C TPTLOT=1950
C LRT=0
C TPTLRT=1950
C EL=.4
C TSVP=1
N NVPF=FIFGE(NVPF1,NVPF2,0,SWN)
C NVPF1=4000E6
C NVPF2=1600E6
NOTE
N NLCP=TL-NLCF
N NLOP=NLCP-NLRF
C LOTP=0
N NVPP=TVP-NVPF
C TVP=8000E6
NOTE
N NALR=NMPL
N NAPL=NMPL/NRK
C NMPL=EL*(NVPF+NVPP)/(NLCF+NLCP)
C LRAT=1
C SWR=0
C LPAT=1
C NRK=.2
C TL=50E6
NOTE
NOTE     2.  ALLOCATION OF WORKERS
NOTE
N NWF=FIFGE(NWF1,NWF2,0,SWN)
C NWF1=3.4E6
C NWF2=1.36E6
C WAT=1
C WTTST=0
N NWP=NRWF-NWF
C NRWF=6.8E6
C SWM=0
C FPGR=0
C WFGR=0
C TAWR=.5
N AWR=NMPW
N NMPW=(NEW*NVPF+NEW*NVPP)/NRWF
C SWW=0
N NCEW=(NRP*(1-NFRSP)+NASP/NLASP)/NRWF
C ACEW=.5
NOTE
NOTE     3.  ACQUISITION OF CAPITAL
NOTE
N NMKOF=NKOF*NFMKF
N NTKOF=NKOF*NFTKF
C NFMKF=0
N NFTKF=1-NFMKF
N NKOF=(NKEF+NKEP)*NFKOF
N NFKOF=NFLOF
N NKEF=NEK*NVPF/NMPK
C TSFKE=.5
```

```
C NFKEF=1
N NKRF=NKOF-NKEF
C NFKR=0
C SWCP=0
C MCP=1950
C KRT=0
C TPTKRT=1950
C TSKA=.5
C NMKAF=0
C ALK=5
NOTE
N NMKOP=NKOP*NFMKP
N NTKOP=NKOP*NFTKP
C NFMKP=0
N NFTKP=1-NFMKP
N NKOP=(NKEP+NKEF)*(1-NFKOF)
N NKEP=NEK*NVPP/NMPK
C NMKAP=0
NOTE
C TSDKI=1
C DIC=1
N NDMK=NTKOF/ALK+NTKOP/ALK*EFSMKP)*DIC
C NMKI=0
C HTMK=0
C TMK=0
C SWMKSP=1
C TSMKD=1
C MKIAT=1
C TKIAT=1
N NTKI=(NTKOP+NTKOF)/ALK*DIC
C TATKD=1
N NTKD=NTKI/DIC
N NMKD=NDMKI/DIC+(NDMKI-NMKI)/MKIAT
C TSCSD=1
N CSD=(NRF*(1-NFRSF)+NASF/NLASF)*(1-FSCEF)+
X   (NRP*(1-NFRSP)+NASP/NLASP)*(1-FSCEP)
C FSCEF=.5
C FSCEP=.5
N NAPCD=NAP/NP
C NP=50E6
N NAP=NVPP+NVPF-NCSP-NKSP
N NCSP=NCSD
N NKSP=(NTKOP+NTKOF)/ALK
C TAKR=1
N NAKR=NMPK
N NMPK=NRK+1/ALK
C MPSK=1
C RPAT=1
C NRPO=1
NOTE
```

```
NOTE    4.  INCOME DISBURSEMENT, SAVINGS, PRODUCTION
NOTE
C SWFP=0
C TFP=1950
C TSS=1
N NIEF=NSEF-NASF/NLASF
C TAIE=1
N NSEF=NASF/NLASF+NMKOF/ALK+NTKOF/ALK
N NASF=(NRF*NFRSF-NKOF/ALK)*NLASF
C NFRSF=.3
C TSR=1
N NRF=NVPF+NLRPP+NKRPP-NWF*NAWR
N NLRPP=NLRF*NALR
N NKRPP=NKRF*NAKR
N SFPF=(NVPF+NVPP)/(EXP(EL*LOGN(NLCF+NLCP))
X    *EXP(NEK*LOGN(NKEP+NKEF))*EXP(NEW*LOGN(NWF+NWP)))
C NEK=.2
C NEW=.4
C CGR=2
C SWGR=0
C TGR=1950
C NLASF=2.5
NOTE
N NIEP=NSEP-NASP/NLASP
N NSEP=NASP/NLASP+NMKOP/ALK+NTKOP/ALK
N NASP=(NRP*NFRSP-NKOP/ALK)*NLASP
N NRP=NVPP-NLRPP-NKRPP+NWF*NAWR
C NLASP=2.5
C NFRSP=.3
NOTE
NOTE    MODEL SPECIFICATIONS
NOTE
A PLTPER.K=FIFGE(FPL,SUBPL,TCPL,TIME.K)
C FPL=0
C SUBPL=0
C TCPL=1949.75
N TIME=YEAR-NYEARS
C YEAR=1950
C NYEARS=80
C DT=.25
C LENGTH=0
C PRTPER=0
NOTE
NOTE    OUTPUT STATEMENTS
NOTE
PRINT NCSD,NRP,NRF,NAP,NAPCD,SFPF,SF,SP,SSRF,SSRP,
X   ERPSP,ECBALF,ECBALF
PRINT LOF,LCF,CLOF,FLOF,DLOF,ILF,ILCF,ILRF,LCF,LRF,MRPLF,
X   AVPF,APL,AMRPL
PRINT LOP,LCP,CLOP,DLOP,ILP,ILCP,DRLP,MRPLP,AVPP,ALR,
X   MFCL,APL
PRINT WF,DWF,IWF,EWF,WP,DWP,EWP,RWF,AWR,MRPWF,MRPWP,ACEW,AMRPW
PRINT KOF,MKAF,TKAF,MKDRF,TKDRF,MKDF,TKDF,IKF,IKEF,IKRF,
X   KEF,KRF
```

```
PRINT KOP,KEP,MKAP,TKAP,MKDRP,TKDRP,MKDP,TKDP,DRKP,IKEP
PRINT PKEPF,PKRPF,MRPKF,MFCKF,EKF,KCIF,PKEPP,MRPKP,
X   EKP,KCIP,MFCKP
PRINT MKIA,DMKI,MKI,MKS,TMKD,TKIA,DTKI,TKI,TKS,TTKD,TKDI,TR
PRINT TP,TDP,APD,TCSD,CSDF,CSDP,P,TAP,AKR,AMRPK,RPMK,RPO,RUM
PRINT AIEF,ASF,SF,WDF,LRPP,KRPP,RF,VPF,PF,EKAF,ELTF,
X   SSRF,FRSF
PRINT AIEP,ASP,SP,RP,VPP,PP,EKAP,ELTP,SSRP,FRSP,ECBALP,ECBALP
NOTE
PLOT LWRF,LWRP (0,16)
PLOT LCF,LOF,TOL(0,60E6)
PLOT WF,RWF(0,8E6)
PLOT KEF,KOF,TOK(0,8000E6)
PLOT RF,TR
PLOT LRPP,TRPP,RF,TREF(0,9000E6)
PLOT WDF,TREP,RP,RELRPP(0,9000E6)
PLOT AWR/ALR/FRSP/ACEW
PLOT MRPWP,MRPWF/MRPLP,MRPLF
PLOT AWR,ACEW,MRPWF,MRPWP(250,1200)
PLOT ALR,MRPLF,MRPLP(40,80)
NOTE
NOTE     RERUN FILE FOR SIMULATION EXPERIMENTS OF CHAPTER FOUR
NOTE
MINDYN RUN RINCOM
NOTE
CP LENGTH=75
CP FPL=3
CP SUBPL=3
CP TCPL=100
CP YEAR=0
CP NYEARS=0
CP TPTST=4
CP TPTSTW=4
CP TPTSTR=4
CP SWW=1
TP TCBL1=1/1/1/1/1/1/1/1/1
TP TCBK1=1/1/1/1/1/1/1/1/1
TP TSWS=1/1/1/1/1/1/1/1/1
TP TRPS=1/1/1/1/1
CP SWN=0
CP SWMKSP=1
RUN TWO
CP SWR=1
CP NFLR=.025
CP NFKR=.025
RUN THREE
TP TCBL1=.2/.4/1/1.3/1.5/1.57/1.6/1.65/1.68
TP TCBK1=0/.3/1/1.5/1.8/2/2.1/2.15/2.18
RUN FOUR
TP TSWS=.1/.15/.3/.55/1/1.45/1.7/1.85/1.9
RUN FIVE
TP TRPS=1/.55/.3/.15/.1
RUN SIX
```

```
C SWN=1
C RUN SIX-B
C HTMK=12.5E6
C TMK=4
T TFSMK1=0/0/0/0/0/0/0/0/0/0
C LENGTH=100
C FPL=4
C SUBPL=4
RUN SEVEN
C LENGTH=150
C FPL=0
C SUBPL=3
C TCPL=74.75
C TPTSTG=75
C WFGR=.02
C FPGR=.02
PLOT ACEW,AWR/ALR
RUN SIX-A
C LENGTH=20
C SWW=0
C SWR=0
C FPL=1
C SUBPL=1
C HTW=-2E6
T TCBL1=1/1/1/1/1/1/1/1/1/1
T TCBK1=1/1/1/1/1/1/1/1/1/1
T TSWS=1/1/1/1/1/1/1/1/1
T TRPS=1/1/1/1/1
C NFLR=0
C NFKR=0
PLOT WF,WP
PLOT LOF,LOP
PLOT MRPWF,MRPWP
PLOT LWRF,LWRP
PLOT MRPLF,MRPLP
RUN ONE
QUIT
NOTE
NOTE    RERUN FILE FOR SIMULATION EXPERIMENTS OF CHASPTER FIVE
NOTE
MINDYN RUN RINCOM
NOTE
CP LENGTH=2000
CP FPL=0
CP FPR=1950
CP SUBPR=5
CP SUBPL=0
CP TCPL=1949.75
CP NYEARS=65
CP YEAR=1950
CP SWW=1
CP SWR=1
CP NFLR=.025
CP NFKR=.025
```

```
CP WFGR=.02
CP TPTSTG=1950
CP FPGR=.02
PLOT LCF,LOF,TOL(0,60E6)
PLOT WF,RWF(0,20E6)
PLOT RF,TR(0,25E9)
PRINT LOF,LCF,LRF,LOP,LCP
PRINT WF,WP,AWR,RF,RP,ALR,APL,LRPP,TRPP,WDF,ACEW
PRINT TR,RP,RF,RWF,WP,WF,ZRPW,ZLSW,ZRW,ZRF,AWR,ACEW
PLOT AWR(400,900)/ALR(50,200)/RUM
RUN BASE
C HTL=1E6
C TPTST=1960
RUN LAND REFORM
TP TMKDM=0/0/30E6/30E6/30E6/30E6/30E6
CP SWMKSP=0
TP TFSMK1=0/0/0/0/0/0/0/0/0
RUN ONE
C SWGR=1
C TGR=1960
CP CGR=1.5
RUN GREEN REVOLUTION
T TCBL2=.8/.85/1/1.1/1.15/1.175/1.1825/1.183/1.1835
T TCBK2=.8/.85/1/1.1/1.15/1.175/1.1825/1.183/1.1835
C SWFP=1
C TFP=1950
RUN TWO
C SWCP=1
T TCBL2=.8/.85/1/1.1/1.15/1.175/1.1825/1.183/1.1835
T TCBK2=.8/.85/1/1.1/1.15/1.175/1.1825/1.183/1.1835
C SWFP=1
C TMCP=1950
C TFP=1950
RUN THREE
C LOT=20
C TPTLOT=1950
RUN FOUR
C LRT=.25
C KRT=.25
C TPTLRT=1950
RUN FIVE
C SWM=1
C TPTSTM=1950
RUN SIX
C SWCP=1
T TCBL2=.8/.85/1/1.1/1.15/1.175/1.1825/1.183/1.1835
T TCBK2=.8/.85/1/1.1/1.15/1.175/1.1825/1.183/1.1835
C SWFP=1
C LRT=.25
C KRT=.25
C TPTLRT=1950
C TFP=1950
C TMCP=1950
C SWGR=1
```

```
C TGR=1960
RUN SEVEN
QUIT
```

APPENDIX D

MODEL ANALYZER

The model Analyser gives variable definitions in alphabatic order, and indicates the equations where each variable is used. Model analyzer is a useful aid for understanding the equation listing of the model. The analyzer identifies the following characteristics of the model variables:

1. NAME - VARIABLE NAME
2. NO - NUMBER OF EQUATION FOR THE VARIABLE
3. T - TYPE OF EQUATION FOR THE VARIABLE
4. DEFINITION - DEFINITION AND DIMENSIONS OF THE VARIABLE
5. WHERE USED - EQUATIONS IN WHICH THE VARIABLE IS USED (NAME,T,NO)

```
NAME      NO    T  DEFINITION
   WHERE USED

ACEW      59    A  AVERAGE CONSUMPTION EXPENDITURE PER WORKER
          59.1  N     (MONEY UNITS/PERSON/TIME UNIT)
   IWR,A,54/PRINT,339.1/PLOT,341.2/PLOT,341.4
AIEF      145   A   AVERAGE INVESTMENT EXPENDITURE IN FORMAL
          145.1 N     SECTOR (MONEY UNITS/TIME UNIT)
   ECBLF1,A,139/ECBLF2,A,140/ECBKF1,A,142/ECBKF2,A,143/PRINT
     ,339.9
AIEP      168   A  AVERAGE INVESTMENT EXPENDITURE IN PEASANT
          168.1 N     SECTOR (MONEY UNITS/TIME UNIT)
   ECBLP1,A,162/ECBLP2,A,163/ECBKP1,A,165/ECBKP2,A,166/PRINT
     ,340.2
AKR       130   L  AVERAGE CAPITAL RENT (MONEY UNITS/CAPITAL
          130.1 N     UNIT/TIME UNIT)
   PKRPF,A,77/KRPP,A,159/PRINT,339.8
ALK       267   C  AVERAGE LIFE OF CAPITAL (TIME UNITS)
   MKDRF,R,62/TKDRF,R,64/MKDF,A,67/DKAF,A,69/MFCKF,A,79
     MKDRP,R,87/TKDRP,R,89/DKAP,A,94/MFCKP,A,105/NDMKI,N,277
     NTKI,N,285/NKSP,N,297/NMPK,N,300/NSEF,N,309/NASF,N,310
     NSEP,N,324/NASP,N,325
```

```
ALR      28    L  AVERAGE LAND RENT (MONEY UNITS/LAND UNITS/
         28.1  N     TIME UNIT)
   PRLPF,A,14/CLR,R,29/LRPP,A,158/PRINT,338.8/PLOT,341.2
     PLOT,341.5
AMKAF    83    A  AVERAGE MODERN CAPITAL ACQUISITIONS IN
         83.1  N     FORMAL SECTOR (CAPITAL UNITS/TIME UNIT)
   TKDF,A,68
AMKAP    104   A  AVERAGE MODERN CAPITAL ACQUISITIONS IN
         104.1 N     PEASANT SECTOR (CAPITAL UNITS/TIME UNIT)
   TKDP,A,93
AMRPK    132   A  AVERAGE MARGINAL REVENUE PRODUCT OF CAPITAL
                     (MONEY UNITS/CAPITAL UNIT/TIME UNIT)
   IKR,A,131/PRINT,339.8
AMRPL    35    A  AVERAGE MARGINAL REVENUE PRODUCT OF LAND
                     (MONEY UNITS/LAND UNITS/TIME UNIT)
   ILR,A,30/IPL,A,34/PRINT,338.6
AMRPW    56    A  AVERAGE MARGINAL REVENUE PRODUCT OF WORKERS
                     (MONEY UNITS/PERSON/TIME UNIT)
   IWR,A,54/ERPSP,A,180/PRINT,339.1
APD      126   A  AGRICULTURAL PRODUCT DEMAND (PRODUCT UNITS/
                     TIME UNIT)
   TDP,A,122/TAP,A,129/PRINT,339.8
APL      33    L  AVERAGE PRICE OF LAND (MONEY UNITS/LAND
         33.1  N     UNITS)
   MFCL,A,32/ELTF,R,154/ELTP,R,182/PRINT,338.6/PRINT,338.8
ARF      148   A  AVERAGE REVENUE IN FORMAL SECTOR (MONEY
         148.1 N     UNITS/TIME UNIT)
   SF,R,147
ARP      171   A  AVERAGE REVENUE IN PEASANT SECTOR (MONEY
         171.1 N     UNITS/TIME UNIT)
   SP,R,170
ASF      146   L  ACCUMULATED SAVINGS IN FORMAL SECTOR (MONEY
         146.1 N     UNITS)
   ECBLF1,A,139/ECBLF2,A,140/ECBKF1,A,142/ECBKF2,A,143/SSRF,
     R,155/PRINT,339.9
ASP      169   L  ACCUMULATED SAVINGS IN PEASANT SECTOR
         169.1 N     (MONEY UNITS)
   ACEW,A,59/ECBLP1,A,162/ECBLP2,A,163/ECBKP1,A,165/ECBKP2,A
     ,166/SSRP,R,176/PRINT,340.2
ASRF     144   A  AVERAGE SAVING RATE IN FORMAL SECTOR (MONEY
                     UNITS/TIME UNIT)
   ECBLF1,A,139/ECBLF2,A,140/ECBKF1,A,142/ECBKF2,A,143
ASRP     167   A  AVERAGE SAVING RATE IN PEASANT SECTOR
                     (MONEY UNITS/TIME UNIT)
   ECBLP1,A,162/ECBLP2,A,163/ECBKP1,A,165/ECBKP2,A,166
AVPF     16    A  AVERAGE VALUE OF PRODUCTION IN FORMAL
         16.1  N     SECTOR (MONEY UNITS/TIME UNIT)
   MRPLF,A,15/DWF,A,41/MRPWF,A,57/MRPKF,A,78/PRINT,338.6
AVPP     25    A  AVERAGE VALUE OF PRODUCTION IN PEASANT
         25.1  N     SECTOR (MONEY UNITS/TIME UNIT)
   MRPLP,A,24/ILCP,A,27/DWP,A,44/MRPWP,A,58/IKEP,A,96/MRPKP,
     A,101/ERPSP,A,180/PRINT,338.8
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AWR      53   L  AVERAGE WAGE RATE (MONEY UNITS/PERSON/TIME
         53.1 N    UNIT)
   DWF,A,41/DWP,A,44/FMR,A,50/UWR,A,51/WDF,A,157/PRINT,339.1
     PLOT,341.2/PLOT,341.4
CGR     319   C  COEFFICIENT FOR GREEN REVOLUTION
                   (DIMENSIONLESS)
   PF,A,151/PP,A,174
CLOF      5   A  CHANGE IN LAND OWNED BY FORMAL SECTOR (LAND
                   UNITS/TIME UNIT)
   ELTF,R,154/PRINT,338.6
CLOP     19   A  CHANGE IN LAND OWNED BY PEASANT SECTOR
                   (LAND UNITS)
   ELTP,R,182/PRINT,338.8
CLR      29   R  CHANGE IN LAND RENT (MONEY UNITS/LAND
                   UNITS/TIME UNIT/TIME UNIT)
   ALR,L,28
CP      128   R  CHANGE IN POPULATION (PERSONS/TIME UNIT)
   P,L,127
CPYF    152   A  CROPS PER YEAR IN FORMAL SECTOR (NUMBER)
   PF,A,151
CPYP    175   A  CROPS PER YEAR IN PEASANT SECTOR (NUMBER)
   PP,A,174
CRWF     47   R  CHANGE IN RURAL WORKFORCE (PERSONS/TIME
                   UNIT)
   RWF,L,46
CSDF    124   A  CONSUMPTION SERVICES DEMAND FROM FORMAL
                   SECTOR (PRODUCT UNITS/TIME UNIT)
   TCSD,A,123/PRINT,339.8
CSDP    125   A  CONSUMPTION SERVICES DEMAND FROM PEASANT
                   SECTOR (PRODUCT UNITS/TIME UNIT)
   TCSD,A,123/PRINT,339.8
CWF      38   R  CHANGE IN WORKERS IN FORMAL SECTOR
                   (PERSONS/TIME UNIT)
   WF,L,37
DIC     276   C  DESIRED INVENTORY COVERAGE (TIME UNITS)
   DMKI,A,108/DTKI,A,116/NDMKI,N,277/NTKI,N,285/NTKD,N,287
     NMKD,N,288
DKAF     69   A  DESIRED CAPITAL ACQUISITIONS IN FORMAL
                   SECTOR (CAPITAL UNITS/TIME UNIT)
   TKDF,A,68
DKAP     94   A  DESIRED CAPITAL ACQUISITIONS IN PEASANT
                   SECTOR (CAPITAL UNITS /TIME UNIT)
   MKDP,A,92/TKDP,A,93
DLOF      6   A  DESIRED LAND OWNERSHIP BY FORMAL SECTOR
                   (LAND UNITS)
   FLOF,A,4/TDLO,A,20/PRINT,338.6
DLOP     21   A  DESIRED LAND OWNERSHIP BY PEASANT SECTOR
                   (LAND UNITS)
   TDLO,A,20/PRINT,338.8
DMKI    108   A  DESIRED MODERN CAPITAL INVENTORY (CAPITAL
        108.1 N    UNITS)
   MKIA,A,107/MKDI,A,114/PRINT,339.7
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DRKP     95   A  DESIRED RENTED CAPITAL IN PEASANT SECTOR
                   (CAPITAL UNITS)
   PDRKKR,A,133/PRINT,339.4
DRLP     26   A  DESIRED RENTED LAND IN PEASANT SECTOR (LAND
                   UNITS)
   PDRLLR,A,31/PRINT,338.8
DT      336   C  SIMULATION SOLUTION INTERVAL (TIME UNITS)
   LOF,A,3/ALR,L,28/APL,L,33/WF,L,37/CWF,R,38/RWF,L,46/AWR,L
     ,53/MKOF,L,61/TKOF,L,63/MKOP,L,86/TKOP,L,88/MKI,L,109
     TKI,L,117/P,L,127/AKR,L,130/RPO,L,135/ASF,L,146/ASP,L,
     169/ELTP,R,182
DTKI    116   A  DESIRED TRADITIONAL CAPITAL INVENTORY
        116.1 N    (CAPITAL UNITS)
   TKIA,A,115/TKDI,A,120/PRINT,339.7
DWF      41   A  DESIRED WORKERS IN FORMAL SECTOR (PERSONS)
   IFWF,A,40/EWDW,A,55/PRINT,339.1
DWP      44   A  DESIRED WORKERS IN PEASANT SECTOR (PERSONS)
   EWDW,A,55/EUISP,A,179/PRINT,339.1
ECBAKF  141   A  EFFECT OF CASH BALANCE AVAILABILITY ON
                   CAPITAL DEMAND IN FORMAL SECTOR
                   (DIMENSIONLESS)
   MKDF,A,67/DKAF,A,69
ECBAKP  164   A  EFFECT OF CASH BALANCE AVAILABILITY ON
                   CAPITAL DEMAND IN PEASANT SECTOR
                   (DIMENSIONLESS)
   DKAP,A,94
ECBALF  138   A  EFFECT OF CASH BALANCE AVAILABILITY ON LAND
                   DEMAND IN FORMAL SECTOR (DIMENSIONLESS)
   DLOF,A,6/PRINT,338.4
ECBALP  161   A  EFFECT OF CASH BALANCE AVAILABILITY ON LAND
                   DEMAND IN PEASANT SECTOR (DIMENSIONLESS)
   DLOP,A,21/PRINT,340.2
ECBKF1  142   A  FUNCTION ONE FOR ECBAKF (DIMENSIONLESS)
   ECBAKF,A,141
ECBKF2  143   A  FUNCTION TWO FOR ECBAKF (DIMENSIONLESS)
   ECBAKF,A,141
ECBKP1  165   A  FUNCTION ONE FOR ECBAKP (DIMENSIONLESS)
   ECBAKP,A,164
ECBKP2  166   A  FUNCTION TWO FOR ECBAKP (DIMENSIONLESS)
   ECBAKP,A,164
ECBLF1  139   A  FUNCTION ONE FOR ECBALF (DIMENSIONLESS)
   ECBALF,A,138
ECBLF2  140   A  FUNCTION TWO FOR ECBALF (DIMENSIONLESS)
   ECBALF,A,138
ECBLP1  162   A  FUNCTION ONE FOR ECBALP (DIMENSIONLESS)
   ECBALP,A,161
ECBLP2  163   A  FUNCTION TWO FOR ECBALP (DIMENSIONLESS)
   ECBALP,A,161
EFSMKP   97   A  EFFECT OF PEASANT FARM SIZE ON MODERN
                   CAPITAL DEMAND IN PEASANT SECTOR
                   (DIMENSIONLESS)
   MKDP,A,92/NDMKI,N,277
EFSMK1   98   A  FUNCTION ONE FOR EFSMKP (DIMENSIONLESS)
   EFSMKP,A,97
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EFSMK2   99   A  FUNCTION TWO FOR EFSMKP (DIMENSIONLESS)
  EFSMKP,A,97
EKAF    153   R  EXPENDITURE ON CAPITAL ACQUISITIONS IN
                   FORMAL SECTOR (MONEY UNITS/TIME UNIT)
  AIEF,A,145/ASF,L,146/PRINT,339.9
EKAP    181   R  EXPENDITURE ON CAPITAL ACQUISITIONS IN
                   PEASANT SECTOR (MONEY UNITS/TIME UNIT)
  AIEP,A,168/ASP,L,169/PRINT,340.2
EKF      81   A  ELASTICITY OF PRODUCTION OF CAPITAL IN
                   FORMAL SECTOR (DIMENSIONLESS)
  EWF,A,42/MRPKF,A,78/PF,A,151/PRINT,339.5
EKP     102   A  ELASTICITY OF PRODUCTION OF CAPITAL IN
                   PEASANT SECTOR (DIMENSIONLESS)
  EWP,A,45/IKEP,A,96/MRPKP,A,101/PP,A,174/PRINT,339.5
EL      216   C  ELASTICITY OF PRODUCTION OF LAND
                   (DIMENSIONLESS)
  MRPLF,A,15/MRPLP,A,24/ILCP,A,27/EWF,A,42/EWP,A,45/PF,A,
    151/PP,A,174/NMPL,N,228/SFPF,N,316
ELTF    154   R  EXPENDITURE ON LAND TRANSACTIONS IN FORMAL
                   SECTOR (MONEY UNITS/TIME UNIT)
  AIEF,A,145/ASF,L,146/PRINT,339.9
ELTP    182   R  EXPENDITURE ON LAND TRANSACTIONS IN PEASANT
                   SECTOR (MONEY UNITS/TIME UNIT)
  AIEP,A,168/ASP,L,169/PRINT,340.2
ERPSP   180   A  EFFECT OF RENT PRESSURES ON SAVINGS IN
                   PEASANT SECTOR (DIMENSIONLESS)
  FRSP,A,178/PRINT,338.4
EUISP   179   A  EFFECT OF UTILITY OF INVESTMENT ON SAVINGS
                   IN PEASANT SECTOR (DIMENSIONLESS)
  FRSP,A,178
EWDW     55   A  EFFECT OF WORKER DEMAND ON WAGE RATE
                   (DIMENSIONLESS)
  IWR,A,54
EWF      42   A  ELASTICITY OF PRODUCTION OF WORKERS IN
                   FORMAL SECTOR (DIMENSIONLESS)
  DWF,A,41/MRPWF,A,57/PF,A,151/PRINT,339.1
EWP      45   A  ELASTICITY OF PRODUCTION OF WORKERS IN
                   PEASANT SECTOR (DIMENSIONLESS)
  DWP,A,44/MRPWP,A,58/PP,A,174/PRINT,339.1
FIFGE            SWITCHING FUNCTION FROM DYNAMO
  ILR,A,30/PDRLLR,A,31/UWR,A,51/IWR,A,54/EFSMKP,A,97/MKS,R,
    110/IKR,A,131/PDRKKR,A,133/ECBALF,A,138/ECBAKF,A,141/PF
    ,A,151/ECBALP,A,161/ECBAKP,A,164/PP,A,174/NLOF,N,192
    NLCF,N,205/NVPF,N,218/NWF,N,234/PLTPER,A,329
FKEF     71   A  FRACTION CAPITAL EMPLOYED IN FORMAL SECTOR
         71.1 N    (DIMENSIONLESS)
  KEF,A,70
FLCF     10   A  FRACTION LAND CULTIVATED BY FORMAL SECTOR
         10.1 N    (DIMENSIONLESS)
  LCF,A,9
FLOF      4   A  FRACTION LAND OWNED BY FORMAL SECTOR
          4.1 N    (DIMENSIONLESS)
  LOF,A,3/PRINT,338.6
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FMR       50   A  FRACTIONAL MIGRATION RATE (FRACTION/TIME
                    UNIT)
   RUM,A,49
FPGR     242   C  FRACTIONAL POPULATION GROWTH RATE (1/TIME
                    UNITS)
   CP,R,128
FPL      330   C  FIRST PLOT PERIOD (TIME UNITS)
   PLTPER,A,329
FRSF     160   A  FRACTION REVENUE SAVED IN FORMAL SECTOR
                    (DIMENSIONLESS)
   SF,R,147/PRINT,339.9
FRSP     178   A  FRACTION REVENUE SAVED IN PEASANT SECTOR
                    (DIMENSIONLESS)
   SP,R,170/PRINT,340.2/PLOT,341.2
FSCEF    291   C  FRACTION SELF CONSUMPTION EXPENDITURE IN
                    FORMAL SECTOR (DIMENSIONLESS)
   CSDF,A,124/NCSD,N,290
FSCEP    292   C  FRACTION SELF CONSUMPTION EXPENDITURE IN
                    PEASANT SECTOR (DIMENSIONLESS)
   CSDP,A,125/NCSD,N,290
HTMK     279   C  HEIGHT OF TEST INPUT FOR MODERN CAPITAL
                    SUPPLY (CAPITAL UNITS/TIME UNIT)
   MKS2,A,112
IFWF      40   A  INDICATED FRACTION OF WORKERS IN FORMAL
                    SECTOR (DIMENSIONLESS)
   IWF,A,39
IKEF      72   A  INDICATED CAPITAL EMPLOYMENT IN FORMAL
                    SECTOR (CAPITAL UNITS)
   FKEF,A,71/IKF,A,73/PRINT,339.2
IKEP      96   A  INDICATED CAPITAL EMPLOYMENT IN PEASANT
                    SECTOR (CAPITAL UNITS)
   DRKP,A,95/PRINT,339.4
IKF       73   A  INDICATED CAPITAL OWNERSHIP IN FORMAL
                    SECTOR (CAPITAL UNITS)
   FKEF,A,71/PRINT,339.2
IKR      131   A  INDICATED CAPITAL RENT (MONEY UNITS/CAPITAL
                    UNIT/TIME UNIT)
   AKR,L,130
IKRF      74   A  INDICATED CAPITAL FOR RENT IN FORMAL SECTOR
                    (CAPITAL UNITS)
   IKF,A,73/PRINT,339.2
ILCF       8   A  INDICATED LAND CULTIVATION IN FORMAL SECTOR
                    (LAND UNITS)
   ILF,A,7/FLCF,A,10/PRINT,338.6
ILCP      27   A  INDICATED LAND CULTIVATION BY PEASANT
                    SECTOR (LAND UNITS)
   DRLP,A,26/PRINT,338.8
ILF        7   A  INDICATED LAND OWNERSHIP BY FORMAL SECTOR
                    (LAND UNITS)
   DLOF,A,6/FLCF,A,10/PRINT,338.6
ILP       22   A  INDICATED LAND OWNERSHIP BY PEASANT SECTOR
                    (LAND UNITS)
   DLOP,A,21/PRINT,338.8
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ILR       30    A  INDICATED LAND RENT (MONEY UNITS/LAND
                     UNITS/TIME UNIT)
   CLR,R,29
ILRF      11    A  INDICATED LAND FOR RENT IN FORMAL SECTOR
                     (LAND UNITS)
   ILF,A,7/PRINT,338.6
IPL       34    A  INDICATED PRICE OF LAND (MONEY UNITS/LAND
                     UNITS)
   APL,L,33
IRPO     136    A  INDICATED RELATIVE PRICE OF OUTPUT (MONEY
                     UNITS/PRODUCT UNIT)
   RPO,L,135
IWF       39    A  INDICATED WORKERS IN FORMAL SECTOR
                     (PERSONS)
   CWF,R,38/PRINT,339.1
IWR       54    A  INDICATED WAGE RATE (MONEY UNITS/PERSON/
                     TIME UNIT)
   AWR,L,53
KCIF      82    A  CAPITAL COMPOSITION INDICATOR IN FORMAL
                     SECTOR (DIMENSIONLESS)
   EKF,A,81/CPYF,A,152/PRINT,339.5
KCIP     103    A  CAPITAL COMPOSITION INDICATOR IN PEASANT
                     SECTOR (DIMENSIONLESS)
   EKP,A,102/CPYP,A,175/PRINT,339.5
KEF       70    A  CAPITAL EMPLOYED BY FORMAL SECTOR (CAPITAL
          70.1 N     UNITS)
   MKDF,A,67/DKAF,A,69/IKEF,A,72/KRF,A,75/MRPKF,A,78/KCIF,A,
     82/AMRPK,A,132/PF,A,151/PRINT,339.2/PLOT,340.7
KEP       84    A  CAPITAL EMPLOYED BY PEASANT SECTOR (CAPITAL
                     UNITS)
   MRPKP,A,101/KCIP,A,103/AMRPK,A,132/PP,A,174/PRINT,339.4
KOF       60    A  CAPITAL OWNED BY FORMAL SECTOR (CAPITAL
                     UNITS)
   KEF,A,70/KRF,A,75/RCKF,A,80/TOK,S,187/PRINT,339.2/PLOT,
     340.7
KOP       85    A  CAPITAL OWNED BY PEASANT SECTOR (CAPITAL
                     UNITS)
   KEP,A,84/DKAP,A,94/DRKP,A,95/RCKP,A,106/TOK,S,187/PRINT,
     339.4
KRF       75    A  CAPITAL RENTED OUT BY FORMAL SECTOR
          75.1 N     (CAPITAL UNITS)
   DKAF,A,69/IKRF,A,74/KEP,A,84/PDRKKR,A,133/KRPP,A,159
     PRINT,339.2
KRPP     159    A  CAPITAL RENT PAYMENTS BY PEASANT SECTOR
                     (MONEY UNITS/TIME UNIT)
   RF,A,149/RP,A,172/ERPSP,A,180/TRPP,S,189/PRINT,339.9
KRT      263    C  CAPITAL RENT TAX (MONEY UNITS/MONEY UNIT
                     CAPITAL RENT)
   PKRPF,A,77/RF,A,149
LASF     156    A  LIFE OF ACCUMULATED SAVINGS IN FORMAL
                     SECTOR (TIME UNITS)
   ECBLF1,A,139/ECBLF2,A,140/ECBKF1,A,142/ECBKF2,A,143/SSRF,
     R,155
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LASP     177   A  LIFE OF ACCUMULATED SAVINGS IN PEASANT
                     SECTOR (TIME UNITS)
   ACEW,A,59/ECBLP1,A,162/ECBLP2,A,163/ECBKP1,A,165/ECBKP2,A
     ,166/SSRP,R,176
LCF        9   A  LAND CULTIVATED BY FORMAL SECTOR (LAND
          9.1 N      UNITS)
   ILCF,A,8/LRF,A,12/MRPLF,A,15/AMRPL,A,35/PF,A,151/LWRF,S,
     183/PRINT,338.6/PLOT,340.5
LCP       17   A  LAND CULTIVATED BY PEASANT SECTOR (LAND
                     UNITS)
   MRPLP,A,24/AMRPL,A,35/EFSMK1,A,98/EFSMK2,A,99/PP,A,174
     LWRP,S,184/PRINT,338.8
LENGTH   337   C  LENGTH OF SIMULATION RUN (TIME UNITS)
LOF        3   A  LAND OWNED BY FORMAL SECTOR (LAND UNITS)
           3.1 N
   CLOF,A,5/LCF,A,9/LRF,A,12/LOP,A,18/RF,A,149/TOL,S,186
     PRINT,338.6/PLOT,340.5
LOP       18   A  LAND OWNED BY PEASANT SECTOR (LAND UNITS)
          18.1 N
   LCP,A,17/CLOP,A,19/ILP,A,22/DRLP,A,26/RP,A,172/TOL,S,186
     PRINT,338.8
LOT      212   C  LAND OWNERSHIP TAX (MONEY UNITS/LAND UNITS/
                     TIME UNIT)
   PCLPF,A,13/PRLPF,A,14/RF,A,149
LOTP     223   C  LAND OWNERSHIP TAX ON PEASANTS (MONEY
                     UNITS/LAND UNITS/TIME UNIT)
   PCLPP,A,23/RP,A,172
LPAT     231   C  LAND PRICE ADJUSTMENT TIME (TIME UNITS)
   APL,L,33
LRAT     229   C  LAND RENT ADJUSTMENT TIME (TIME UNITS)
   CLR,R,29
LRF       12   A  LAND RENTED OUT BY FORMAL SECTOR (LAND
          12.1 N     UNITS)
   ILRF,A,11/LCP,A,17/PDRLLR,A,31/LRPP,A,158/PRINT,338.6
LRPP     158   A  LAND RENT PAYMENTS BY PEASANT SECTOR (MONEY
                     UNITS/TIME UNIT)
   RF,A,149/RP,A,172/ERPSP,A,180/TRPP,S,189/RELRPP,S,191
     PRINT,339.9/PLOT,340.9
LRT      214   C  LAND RENT TAX (MONEY UNITS/MONEY UNIT OF
                     LAND RENT)
   PRLPF,A,14/RF,A,149
LTPLR    196   C  LAND TRANSFERED TO PEASANTS DUE TO LAND
                     REFORM (LAND UNITS)
   LOF,A,3/ELTP,R,182
LWRF     183   S  LAND WORKER RATIO IN FORMAL SECTOR (LAND
                     UNITSS/WORKER)
   PLOT,340.4
LWRP     184   S  LAND WORKER RATIO IN PEASANT SECTOR (LAND
                     UNITSS/WORKER)
   PLOT,340.4
MDSR     137   A  MULTIPLIER FROM DEMAND SUPPLY RATIO ON
                     RELATIVE PRICE (DIMENSIONLESS)
   IRPO,A,136
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MFCKF    79   A  MARGINAL FACTOR COST OF CAPITAL IN FORMAL
                   SECTOR (MONEY UNITS/CAPITAL UNIT/TIME
                   UNIT)
   PKEPF,A,76/PKRPF,A,77/PRINT,339.5
MFCKP    105  A  MARGINAL FACTOR COST OF CAPITAL IN PEASANT
                   SECTOR (MONEY UNITS/CAPITAL UNIT/TIME
                   UNIT)
   IKEP,A,96/PKEPP,A,100/PRINT,339.5
MFCL     32   A  MARGINAL FACTOR COST OF LAND (MONEY UNITS/
                   LAND UNITS/TIME UNIT)
   PCLPF,A,13/PRLPF,A,14/PCLPP,A,23/ILCP,A,27/PRINT,338.8
MKAF     65   R  MODERN CAPITAL ACQUISITIONS IN FORMAL
                   SECTOR (CAPITAL UNITS/TIME UNIT)
   MKOF,L,61/AMKAF,A,83/MKI,L,109/EKAF,R,153/PRINT,339.2
MKAP     90   R  MODERN CAPITAL ACQUISITIONS IN PEASANT
                   SECTOR (CAPITAL UNITS/TIME UNIT)
   MKOP,L,86/AMKAP,A,104/MKI,L,109/EKAP,R,181/PRINT,339.4
MKDF     67   A  MODERN CAPITAL DEMAND IN FORMAL SECTOR
                   (CAPITAL UNITS/TIME UNIT)
   MKAF,R,65/DMKI,A,108/TMKD,A,113/PRINT,339.2
MKDI     114  A  MODERN CAPITAL DEMAND FOR INVENTORY
                   (CAPITAL UNITS/TIME UNIT)
   TMKD,A,113
MKDP     92   A  MODERN CAPITAL DEMAND IN PEASANT SECTOR
                   (CAPITAL UNITS/TIME UNIT)
   MKAP,R,90/DMKI,A,108/TMKD,A,113/PRINT,339.4
MKDRF    62   R  MODERN CAPITAL DEPRECIATION RATE IN FORMAL
                   SECTOR (CAPITAL UNITS/TIME UNIT)
   MKOF,L,61/PRINT,339.2
MKDRP    87   R  MODERN CAPITAL DEPRECIATION RATE IN PEASANT
                   SECTOR (CAPITAL UNITS/TIME UNIT)
   MKOP,L,86/PRINT,339.4
MKI      109  L  MODERN CAPITAL INVENTORY (CAPITAL UNITS)
         109.1 N
   MKIA,A,107/MKDI,A,114/PRINT,339.7
MKIA     107  A  MODERN CAPITAL INVENTORY AVAILABILITY
                   (DIMENSIONLESS)
   MKAF,R,65/MKAP,R,90/PRINT,339.7
MKIAT    283  C  MODERN CAPITAL INVENTORY ADJUSTMENT TIME
                   (TIME UNITS)
   MKDI,A,114/NMKD,N,288
MKOF     61   L  MODERN CAPITAL OWNED BY FORMAL SECTOR
         61.1 N    (CAPITAL UNITS)
   KOF,A,60/MKDRF,R,62/RCKF,A,80/KCIF,A,82
MKOP     86   L  MODERN CAPITAL OWNED BY PEASANT SECTOR
         86.1 N    (CAPITAL UNITS)
   KOP,A,85/MKDRP,R,87/KCIP,A,103/RCKP,A,106
MKS      110  R  MODERN CAPITAL SERVICES PRODUCTION (CAPITAL
                   UNITS/TIME UNIT)
   MKI,L,109/PRINT,339.7
MKS1     111  A  FUNCTION ONE FOR MKS (CAPITAL UNITS/TIME
                   UNIT)
   MKS,R,110
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MKS2 112 A FUNCTION TWO FOR MKS (CAPITAL UNITS/TIME UNIT)

MKS,R,110

MPSK 301 C MULTIPLIER FOR PRICE SUPPORT OF CAPITAL POLICY (DIMENSIONLESS)

RPMK,A,134

MRPKF 78 A MARGINAL REVENUE PRODUCT OF CAPITAL IN FORMAL SECTOR (MONEY UNITS/CAPITAL UNIT/ TIME UNIT)

PKEPF,A,76/AMRPK,A,132/PRINT,339.5

MRPKP 101 A MARGINAL REVENUE PRODUCT OF CAPITAL IN PEASANT SECTOR (MONEY UNITS/CAPITAL UNIT/ TIME UNIT)

PKEPP,A,100/AMRPK,A,132/PRINT,339.5

MRPLF 15 A MARGINAL REVENUE PRODUCT OF LAND IN FORMAL SECTOR (MONEY UNITS/LAND UNITS/TIME UNIT)

PCLPF,A,13/AMRPL,A,35/PRINT,338.6/PLOT,341.3/PLOT,341.5

MRPLP 24 A MARGINAL REVENUE PRODUCT OF LAND IN PEASANT SECTOR (MONEY UNITS/LAND UNITS/TIME UNIT)

PCLPP,A,23/AMRPL,A,35/PRINT,338.8/PLOT,341.3/PLOT,341.5

MRPWF 57 A MARGINAL REVENUE PRODUCT OF WORKERS IN FORMAL SECTOR (MONEY UNITS/PERSON/TIME UNIT)

AMRPW,A,56/PRINT,339.1/PLOT,341.3/PLOT,341.4

MRPWP 58 A MARGINAL REVENUE PRODUCT OF WORKERS IN PEASANT SECTOR (MONEY UNITS/PERSON/TIME UNIT)

AMRPW,A,56/PRINT,339.1/PLOT,341.3/PLOT,341.4

MUWR 52 A MINIMUM URBAN WAGE RATE (MONEY UNITS/ PERSON/TIME UNIT)

UWR,A,51

NAKR 299 N INITIAL CAPITAL RENT (MONEY UNITS/CAPITAL UNIT/TIME UNIT)

AKR,N,130.1/NKRPP,N,315

NALR 226 N INITIAL LAND RENT (MONEY UNITS/LAND UNITS/ TIME UNIT)

ALR,N,28.1/NLRPP,N,314

NAP 295 N INITIAL AGRICULTURAL PRODUCTION (PRODUCT UNITS/TIME UNIT)

NAPCD,N,293/PRINT,338.4

NAPCD 293 N INITIAL AGRICULTURAL PRODUCTION PER CAPITA DEMAND (PRODUCT UNITS/PERSON/TIME UNIT)

APD,A,126/PRINT,338.4

NAPL 227 N INITIAL AVERAGE PRICE OF LAND (MONEY UNITS/ LAND UNITS)

APL,N,33.1

NASF 310 N INITIAL ACCUMULATED SAVINGS IN FORMAL SECTOR (MONEY UNITS)

ASF,N,146.1/NCSD,N,290/NIEF,N,307/NSEF,N,309

NASP 325 N INITIAL ACCUMULATED SAVINGS IN PEASANT SECTOR (MONEY UNITS)

ASP,N,169.1/NCEW,N,248/NCSD,N,290/NIEP,N,323/NSEP,N,324

NAWR 245 N INITIAL WAGE RATE (MONEY UNITS/PERSON/TIME UNIT)
AWR,N,53.1/NRF,N,313/NRP,N,326
NCEW 248 N INITIAL CONSUMPTION EXPENDITURE PER WORKER (MONEY UNITS/WORKER/TIME UNIT)
ACEW,N,59.1
NCSD 290 N INITIAL CONSUMPTION SERVICES DEMAND (SERVICE UNITS/TIME UNIT)
TCSD,N,123.1/NCSP,N,296/PRINT,338.4
NCSP 296 N INITIAL CONSUMPTION SERVICES PRODUCTION (PRODUCT UNITS/TIME UNIT)
NAP,N,295
NDMKI 277 N INITIAL DESIRED MODERN CAPITAL INVENTORY (CAPITAL UNITS)
DMKI,N,108.1/NMKD,N,288
NEK 317 C INITIAL ELASTICITY OF PRODUCTION OF CAPITAL (DIMENSIONLESS)
NKEF,N,256/NKEP,N,273/SFPF,N,316
NEW 318 C INITIAL ELASTICITY OF PRODUCTION OF WORKERS (DIMENSIONLESS)
NMPW,N,246/SFPF,N,316
NFKEF 258 C INITIAL FRACTION OF CAPITAL EMPLOYED IN FORMAL SECTOR (DIMENSIONLESS)
FKEF,N,71.1
NFKOF 255 N INITIAL FRACTION OF CAPITAL OWNED BY FORMAL SECTOR (DIMENSIONLESS)
NKOF,N,254/NKOP,N,272
NFKR 260 C INITIAL FRACTION OF CAPITAL RENTED OUT BY FORMAL SECTOR (CAPITAL UNITS)
KEF,A,70
NFLCF 209 C INITIAL FRACTION LAND CULTIVATED IN FORMAL SECTOR (DIMENSIONLESS)
FLCF,N,10.1
NFLOF 197 N INITIAL FRACTION LAND OWNED BY FORMAL SECTOR (DIMENSIONLESS)
FLOF,N,4.1/NFKOF,N,255
NFLR 210 C INITIAL FRACTION OF LAND RENTED OUT BY FORMAL SECTOR (DIMENSIONLESS)
LCF,A,9
NFMKF 252 C INITIAL FRACTION MODERN CAPITAL IN FORMAL SECTOR (DIMENSIONLESS)
NMKOF,N,250/NFTKF,N,253
NFMKP 270 C INITIAL FRACTION MODERN CAPITAL IN PEASANT SECTOR (DIMENSIONLESS)
NMKOP,N,268/NFTKP,N,271
NFRSF 311 C NORMAL FRACTION REVENUE SAVED IN FORMAL SECTOR (DIMENSIONLESS)
FRSF,A,160/NCSD,N,290/NASF,N,310
NFRSP 328 C NORMAL FRACTION REVENUE SAVED IN PEASANT SECTOR (DIMENSIONLESS)
FRSP,A,178/NCEW,N,248/NCSD,N,290/NASP,N,325
NFTKF 253 N INITIAL FRACTION TRADITIONAL CAPITAL IN FORMAL SECTOR (DIMENSIONLESS)
NTKOF,N,251

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NFTKP   271   N  INITIAL FRACTION TRADITIONAL CAPITAL IN
                   PEASANT SECTOR (DIMENSIONLESS)
   NTKOP,N,269
NIEF    307   N  INITIAL INVESTMENT EXPENDITURE IN FORMAL
                   SECTOR (MONEY UNITS/TIME UNIT)
   AIEF,N,145.1
NIEP    323   N  INITIAL INVESTMENT EXPENDITURE IN PEASANT
                   SECTOR (MONEY UNITS/TIME UNIT)
   AIEP,N,168.1
NKEF    256   N  INITIAL CAPITAL EMPLOYED BY FORMAL SECTOR
                   (CAPITAL UNITS)
   KEF,N,70.1/NKOF,N,254/NKRF,N,259/NKOP,N,272/SFPF,N,316
NKEP    273   N  INITIAL CAPITAL EMPLOYED BY PEASANT SECTOR
                   (CAPITAL UNITS)
   NKOF,N,254/NKOP,N,272/SFPF,N,316
NKOF    254   N  INITIAL CAPITAL OWNED BY FORMAL SECTOR
                   (CAPITAL UNITS)
   NMKOF,N,250/NTKOF,N,251/NKRF,N,259/NASF,N,310
NKOP    272   N  INITIAL CAPITAL OWNED BY PEASANT SECTOR
                   (CAPITAL UNITS)
   NMKOP,N,268/NTKOP,N,269/NASP,N,325
NKRF    259   N  INITIAL CAPITAL RENTED OUT BY FORMAL SECTOR
                   (CAPITAL UNITS)
   KRF,N,75.1/NKRPP,N,315
NKRPP   315   N  INITIAL CAPITAL RENT PAYMENTS BY PEASANT
                   SECTOR (MONEY UNITS/TIME UNIT)
   NRF,N,313/NRP,N,326
NKSP    297   N  INITIAL CAPITAL SERVICES PRODUCTION
                   (CAPITAL UNITS/TIME UNIT)
   NAP,N,295
NLASF   322   C  INITIAL LIFE OF ACCUMULATED SAVINGS IN
                   FORMAL SECTOR (TIME UNITS)
   LASF,A,156/NCSD,N,290/NIEF,N,307/NSEF,N,309/NASF,N,310
NLASP   327   C  INITIAL LIFE OF ACCUMULATED SAVINGS IN
                   PEASANT SECTOR (TIME UNITS)
   LASP,A,177/NCEW,N,248/NCSD,N,290/NIEP,N,323/NSEP,N,324
     NASP,N,325
NLCF    205   N  INITIAL LAND CULTIVATED BY FORMAL SECTOR
                   (LAND UNITS)
   LCF,N,9.1/NLRF,N,211/NLCP,N,221/NMPL,N,228/SFPF,N,316
NLCF1   206   C  VALUE ONE FOR NLCF (LAND UNITS)
   NLCF,N,205
NLCF2   207   C  VALUE TWO FOR NLCF (LAND UNITS)
   NLCF,N,205
NLCP    221   N  INITIAL LAND CULTIVATED BY PEASANT SECTOR
                   (LAND UNITS)
   NLOP,N,222/NMPL,N,228/SFPF,N,316
NLOF    192   N  INITIAL LAND OWNED BY FORMAL SECTOR (LAND
                   UNITS)
   LOF,N,3.1/NFLOF,N,197/NLRF,N,211
NLOF1   193   C  VALUE ONE FOR NLOF (LAND UNITS)
   NLOF,N,192
NLOF2   194   C  VALUE TWO FOR NLOF (LAND UNITS)
   NLOF,N,192
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NLOP     222    N  INITIAL LAND OWNED BY PEASANT SECTOR (LAND
                     UNITS)
   LOP,N,18.1
NLRF     211    N  INITIAL LAND RENTED OUT BY FORMAL SECTOR
                     (LAND UNITS)
   LRF,N,12.1/NLOP,N,222/NLRPP,N,314
NLRPP    314    N  INITIAL LAND RENT PAYMENTS BY PEASANT
                     SECTOR (MONEY UNITS/TIME UNIT)
   NRF,N,313/NRP,N,326
NMKAF    266    C  INITAIL MODERN CAPITAL ACQUISITIONS IN
                     FORMAL SECTOR (CAPITAL UNITS/TIME UNIT)
   AMKAF,N,83.1
NMKAP    274    C  INITIAL MODERN CAPITAL ACQUISITIONS IN
                     PEASANT SECTOR (CAPITAL UNITS/TIME UNIT)
   AMKAP,N,104.1
NMKD     288    N  INITIAL MODERN CAPITAL DEMAND (CAPITAL
                     UNITS/TIME UNIT)
   TMKD,N,113.1
NMKI     278    C  INITIAL MODERN CAPITAL INVENTORY (CAPITAL
                     UNITS)
   MKI,N,109.1/NMKD,N,288
NMKOF    250    N  INITIAL MODERN CAPITAL OWNED BY FORMAL
                     SECTOR (CAPITAL UNITS)
   MKOF,N,61.1/NSEF,N,309
NMKOP    268    N  INITIAL MODERN CAPITAL OWNED BY PEASANT
                     SECTOR (CAPITAL UNITS)
   MKOP,N,86.1/NSEP,N,324
NMPK     300    N  INITIAL MARGINAL REVENUE PRODUCT OF CAPITAL
                     (MONEY UNITS/CAPITAL UNIT/TIME UNIT)
   NKEF,N,256/NKEP,N,273/NAKR,N,299
NMPL     228    N  INITIAL MARGINAL REVENUE PRODUCT OF LAND
                     (MONEY UNITS/LAND UNITS/TIME UNIT)
   NALR,N,226/NAPL,N,227
NMPW     246    N  INITIAL MARGINAL REVENUE PRODUCT OF WORKERS
                     (MONEY UNITS/PERSON/TIME UNIT)
   NAWR,N,245
NP       294    C  INITIAL POPULATION OF COUNTRY (PERSONS)
   P,N,127.1/NAPCD,N,293
NRF      313    N  INITIAL REVENUE IN FORMAL SECTOR (MONEY
                     UNITS/TIME UNIT)
   ARF,N,148.1/NCSD,N,290/NASF,N,310/PRINT,338.4
NRK      232    C  NET RETURN ON CAPITAL INVESTMENT/INTEREST
                     RATE (MONEY UNITS/TIME UNIT/MONEY UNIT)
   MFCL,A,32/IPL,A,34/MFCKF,A,79/MFCKP,A,105/NAPL,N,227/NMPK
      ,N,300
NRP      326    N  INITIAL REVENUE OF PEASANT SECTOR (MONEY
                     UNITS/TIME UNIT)
   ARP,N,171.1/NCEW,N,248/NCSD,N,290/NASP,N,325/PRINT,338.4
NRPO     303    C  INITIAL RELATIVE PRICE OF OUTPUT (MONEY
                     UNITS/OUTPUT UNIT)
   RPO,N,135.1/IRPO,A,136
NRWF     240    C  INITAIL RURAL WORKFORCE (PERSONS)
   RWF,N,46.1/NWP,N,239/NMPW,N,246/NCEW,N,248
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NSEF    309   N  INITIAL SAVING EXPENDITURE IN FORMAL SECTOR
                   (MONEY UNITS/TIME UNIT)
   NIEF,N,307
NSEP    324   N  INITIAL SAVING EXPENDITURE IN PEASANT
                   SECTOR (MONEY UNITS/TIME UNIT)
   NIEP,N,323
NTKD    287   N  INITIAL TRADITIONAL CAPITAL DEMAND (CAPITAL
                   UNITS/TIME UNIT)
   TTKD,N,119.1
NTKI    285   N  INITIAL TRADITIONAL CAPITAL INVENTORY
                   (CAPITAL UNITS)
   DTKI,N,116.1/TKI,N,117.1/NTKD,N,287
NTKOF   251   N  INITIAL TRADITIONAL CAPITAL OWNED BY FORMAL
                   SECTOR (CAPITAL UNITS)
   TKOF,N,63.1/NDMKI,N,277/NTKI,N,285/NKSP,N,297/NSEF,N,309
NTKOP   269   N  INITIAL TRADITIONAL CAPITAL OWNED BY
                   PEASANT SECTOR (CAPITAL UNITS)
   TKOP,N,88.1/NDMKI,N,277/NTKI,N,285/NKSP,N,297/NSEP,N,324
NVPF    218   N  INITIAL VALUE OF PRODUCTION IN FORMAL
                   SECTOR (MONEY UNITS/TIME UNIT)
   AVPF,N,16.1/NVPP,N,224/NMPL,N,228/NMPW,N,246/NKEF,N,256
     NAP,N,295/NRF,N,313/SFPF,N,316
NVPF1   219   C  VALUE ONE FOR NVPF (MONEY UNITS/TIME UNIT)
   NVPF,N,218
NVPF2   220   C  VALUE TWO FOR NVPF (MONEY UNITS/TIME UNIT)
   NVPF,N,218
NVPP    224   N  INITIAL VALUE OF PRODUCTION IN PEASANT
                   SECTOR (MONEY UNITS/TIME UNIT)
   AVPP,N,25.1/NMPL,N,228/NMPW,N,246/NKEP,N,273/NAP,N,295
     SFPF,N,316/NRP,N,326
NWF     234   N  INITIAL WORKERS IN FORMAL SECTOR (PERSONS)
   WF,N,37.1/NWP,N,239/NRF,N,313/SFPF,N,316/NRP,N,326
NWF1    235   C  VALUE ONE FOR NWF (PERSONS)
   NWF,N,234
NWF2    236   C  VALUE TWO FOR NWF (PERSONS)
   NWF,N,234
NWP     239   N  INITIAL WORKERS IN PEASANT SECTOR (PERSONS)
   WP,N,43.1/SFPF,N,316
NYEARS  335   C  YEARS OF SIMULATION BEFORE INITIAL VALUE OF
                   TIME (TIME UNITS)
   TIME,N,333
P       127   L  POPULATION OF COUNTRY (PERSONS)
        127.1 N
   APD,A,126/CP,R,128/PRINT,339.8
PCLPF    13   A  PROPENSITY TO CULTIVATE LAND FROM
                   PROFITABILITY IN FORMAL SECTOR
                   (DIMENSIONLESS)
   ILCF,A,8
PCLPP    23   A  PROPENSITY TO CULTIVATE LAND FROM
                   PROFITABILITY IN PEASANT SECTOR
                   (DIMENSIONLESS)
   ILP,A,22
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PDLO      36    A  PRESSURE FROM DESIRED LAND OWNERSHIP ON
                     PRICE OF LAND (DIMENSIONLESS)
   IPL,A,34
PDRKKR   133    A  PRESSURE FROM DEMAND FOR RENTED CAPITAL ON
                     CAPITAL RENT (DIMENSIONLESS)
   IKR,A,131
PDRLLR    31    A  PRESSURE FROM DEMAND FOR RENTED LAND ON
                     LAND RENT (DIMENSIONLESS)
   ILR,A,30
PF       151    A  PRODUCTION OF FORMAL SECTOR (PRODUCT UNITS/
                     TIME UNIT)
   TP,A,121/VPF,A,150/PRINT,339.9
PKEPF     76    A  PROPENSITY TO EMPLOY CAPITAL FROM
                     PROFITABILITY IN FORMAL SECTOR
                     (DIMENSIONLESS)
   MKDF,A,67/DKAF,A,69/IKEF,A,72/PRINT,339.5
PKEPP    100    A  PROPENSITY TO EMPLOY CAPITAL FROM
                     PROFITABILITY IN PEASANT SECTOR
                     (DIMENSIONLESS)
   DKAP,A,94/PRINT,339.5
PKRPF     77    A  PROPENSITY TO RENT OUT CAPITAL FROM
                     PROFITABILITY IN FORMAL SECTOR
                     (DIMENSIONLESS)
   DKAF,A,69/IKRF,A,74/PRINT,339.5
PLTPER   329    A  PLOT PERIOD (TIME UNITS)
PP       174    A  PRODUCTION OF PEASANT SECTOR (PRODUCT
                     UNITS/TIME UNIT)
   TP,A,121/VPP,A,173/PRINT,340.2
PRLPF     14    A  PROPENSITY TO RENT OUT LAND FROM
                     PROFITABILITY IN FORMAL SECTOR
                     (DIMENSIONLESS)
   ILRF,A,11
PRTPER   338    C  PRINTING PERIOD OF SIMULATED RUN (TIME
                     UNITS)
RCKF      80    A  REPLACEMENT COST OF CAPITAL IN FORMAL
                     SECTOR (MONEY UNITS /CAPITAL UNIT/TIME
                     UNIT)
   MFCKF,A,79
RCKP     106    A  REPLACEMENT COST OF CAPITAL IN PEASANT
                     SECTOR (MONEY UNITS /CAPITAL UNIT/TIME
                     UNIT)
   MFCKP,A,105
RELRPP   191    S  RECEIPTS LESS LAND RENT PAYMENTS IN PEASANT
                     SECTOR (MONEY UNITS/TIME UNIT)
   PLOT,341.1
RF       149    A  REVENUE IN FORMAL SECTOR (MONEY UNITS/TIME
                     UNIT)
   CSDF,A,124/ARF,A,148/TR,S,185/PRINT,339.9/PLOT,340.8/PLOT
     ,340.9
RP       172    A  REVENUE IN PEASANT SECTOR (MONEY UNITS/TIME
                     UNIT)
   ACEW,A,59/CSDP,A,125/ARP,A,171/TR,S,185/PRINT,340.2/PLOT,
     341.1
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RPAT     302    C  RELATIVE PRICE ADJUSTMENT TIME (TIME UNITS)
   RPO,L,135
RPMK     134    A  RELATIVE PRICE OF MODERN CAPITAL (MONEY
                     UNITS/CAPITAL UNIT)
   RCKF,A,80/RCKP,A,106/EKAF,R,153/EKAP,R,181/PRINT,339.8
RPO      135    L  RELATIVE PRICE OF OUTPUT (MONEY UNITS/
         135.1 N     PRODUCT UNIT)
   RCKF,A,80/RCKP,A,106/CSDF,A,124/CSDP,A,125/RPMK,A,134/VPF
     ,A,150/EKAF,R,153/VPP,A,173/EKAP,R,181/PRINT,339.8
RUM       49    A  RURAL URBAN MIGRATION (PERSONS/TIME UNIT)
   CRWF,R,47/PRINT,339.8
RWF       46    L  RURAL WORKFORCE (PERSONS)
          46.1 N
   IWF,A,39/IFWF,A,40/WP,A,43/WNGR,A,48/RUM,A,49/EWDW,A,55
     ACEW,A,59/PRINT,339.1/PLOT,340.6
SF       147    R  SAVINGS IN FORMAL SECTOR (MONEY UNITS/TIME
                     UNIT)
   CSDF,A,124/ASRF,A,144/ASF,L,146/PRINT,338.4/PRINT,339.9
SFPF     316    N  SCALING FACTOR OF PRODUCTION FUNCTION
                     (DIMENSIONLESS)
   PF,A,151/PP,A,174/PRINT,338.4
SP       170    R  SAVINGS IN PEASANT SECTOR (MONEY UNITS/TIME
                     UNIT)
   ACEW,A,59/CSDP,A,125/ASRP,A,167/ASP,L,169/PRINT,338.4
     PRINT,340.2
SSRF     155    R  SAVING SPENDING RATE IN FORMAL SECTOR
                     (MONEY UNITS/TIME UNIT)
   CSDF,A,124/ASF,L,146/PRINT,338.4/PRINT,339.9
SSRP     176    R  SAVING SPENDING RATE IN PEASANT SECTOR
                     (MONEY UNITS/TIME UNIT)
   CSDP,A,125/ASP,L,169/PRINT,338.4/PRINT,340.2
STEP               SWITCHING FUNCTION FROM DYNAMO
   PCLPF,A,13/PRLPF,A,14/PCLPP,A,23/ILR,A,30/PDRLLR,A,31
     WNGR,A,48/UWR,A,51/IWR,A,54/PKRPF,A,77/EFSMKP,A,97/MKS2
     ,A,112/CP,R,128/IKR,A,131/PDRKKR,A,133/ECBALF,A,138
     ECBAKF,A,141/PF,A,151/ECBALP,A,161/ECBAKP,A,164/PP,A,
     174
SUBPL    331    C  SUBSEQUENT PLOT PERIOD (TIME UNITS)
   PLTPER,A,329
SWCP     261    C  SWITCH FOR COOPERATIVES POLICY
                     (DIMENSIONLESS)
   EFSMKP,A,97
SWFP     304    C  SWITCH FOR FINANCIAL POLICY (DIMENSIONLESS)
   ECBALF,A,138/ECBAKF,A,141/ECBALP,A,161/ECBAKP,A,164
SWGR     320    C  SWITCH FOR GREEN REVOLUTION POLICY
                     (DIMENSIONLESS)
   PF,A,151/PP,A,174
SWM      241    C  SWITCH FOR MIGRATION POLICY (DIMENSIONLESS)
   UWR,A,51
SWMKSP   281    C  SWITCH FOR MODERN CAPITAL SUPPLY POLICY
                     (DIMENSIONLESS)
   MKS,R,110
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SWN     195   C  SWITCH FOR CHANGING INITIAL CONDITIONS
                   (DIMENSIONLESS)
   NLOF,N,192/NLCF,N,205/NVPF,N,218/NWF,N,234
SWR     230   C  SWITCH FOR RENTING POLICY (DIMENSIONLESS)
   ILR,A,30/PDRLLR,A,31/IKR,A,131/PDRKKR,A,133
SWW     247   C  SWITCH FOR WAGE POLICY (DIMENSIONLESS)
   IWR,A,54
TACEW   249   C  TIME TO AVERAGE CONSUMPTION EXPENDITURE PER
                   WORKER (TIME UNIT)
   ACEW,A,59
TAIE    308   C  TIME TO AVERAGE INVESTMENT EXPENDITURE
                   (TIME UNITS)
   AIEF,A,145/AIEP,A,168
TAKR    298   C  TIME TO AVERAGE CAPITAL RENT (TIME UNITS)
   AKR,L,130
TALT    198   C  TIME TO AVERAGE LAND TRANSACTIONS (TIME
                   UNITS)
   CLOF,A,5/CLOP,A,19
TAP     129   A  TOTAL AGRICULTURAL PRODUCTION (PRODUCT
                   UNITS/TIME UNIT)
   PRINT,339.8
TATKD   286   C  TIME TO AVERAGE TRADITIONAL CAPITAL DEMAND
                   (TIME UNITS)
   TTKD,A,119
TAWR    244   C  TIME TO ADJUST WAGE RATE (TIME UNITS)
   AWR,L,53
TCBK1   142.1 T  TABLE1 FOR EFFECT OF CASH BALANCE
                   AVAILABILITY ON DEMAND FOR CAPITAL
                   (DIMENSIONLESS)
   ECBKF1,A,142/ECBKP1,A,165
TCBK2   143.1 T  TABLE2 FOR EFFECT OF CASH BALANCE
                   AVAILABILITY ON DEMAND FOR CAPITAL
                   (DIMENSIONLESS)
   ECBKF2,A,143/ECBKP2,A,166
TCBL1   139.1 T  TABLE1 FOR EFFECT OF CASH BALANCE
                   AVAILABILITY ON DEMAND FOR LAND
                   (DIMENSIONLESS)
   ECBLF1,A,139/ECBLP1,A,162
TCBL2   140.1 T  TABLE2 FOR EFFECT OF CASH BALANCE
                   AVAILABILITY ON DEMAND FOR LAND
                   (DIMENSIONLESS)
   ECBLF2,A,140/ECBLP2,A,163
TCPL    332   C  TIME FOR CHANGING PLOT PERIOD (TIME UNIT)
   PLTPER,A,329
TCPY    152.1 T  TABLE FOR CROPS PER YEAR (NUMBER)
   CPYF,A,152/CPYP,A,175
TCSD    123   A  TRADITIONAL CONSUMPTION SERVICES DEMAND
        123.1 N    (PRODUCT UNITS/TIME UNIT)
   TDP,A,122/PRINT,339.8
TDLO     20   A  TOTAL DESIRED LAND OWNERSHIP (LAND UNITS)
   FLOF,A,4/PDLO,A,36
TDP     122   A  TOTAL DESIRED PRODUCTION (PRODUCT UNITS/
                   TIME UNIT)
   TKS,R,118/TAP,A,129/MDSR,A,137/PRINT,339.8
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TDRKKR  133.2 T  TABLE FOR EFFECT OF DEMAND FOR RENTED
                   CAPITAL ON CAPITAL RENT (DIMENSIONLESS)
   PDRKKR,A,133
TDRLLR   31.2 T  TABLE FOR PRESSURE FROM DEMAND FOR RENTED
                   LAND ON LAND RENT (DIMENSIONLESS)
   PDRLLR,A,31
TDSRP   137.1 T  TABLE FOR EFFECT OF DEMAND SUPPLY RATIO ON
                   RELATIVE PRICE (DIMENSIONLESS)
   MDSR,A,137
TEK      81.1 T  TABLE FOR ELASTICITY OF PRODUCTION OF
                   CAPITAL (DIMENSIONLESS)
   EKF,A,81/EKP,A,102
TFMR     50.1 T  TABLE FOR FRACTIONAL MIGRATION RATE
                   (DIMENSIONLESS)
    FMR,A,50
TFP     305   C  TIME OF FINANCIAL POLICY (DIMENSIONLESS)
   ECBALF,A,138/ECBAKF,A,141/ECBALP,A,161/ECBAKP,A,164
TFSMK1   98.1 T  TABLE1 FOR EFFECT OF PEASANT FARM SIZE ON
                   MODERN CAPITAL DEMAND (DIMENSIONLESS)
   EFSMK1,A,98
TFSMK2   99.1 T  TABLE2 FOR EFFECT OF PEASANT FARM SIZE ON
                   MODERN CAPITAL DEMAND (DIMENSIONLESS)
   EFSMK2,A,99
TFWF     40.1 T  TABLE FOR FRACTION OF WORKERS IN FORMAL
                   SECTOR (DIMENSIONLESS)
   IFWF,A,40
TGR     321   C  TIME OF GREEN REVOLUTION POLICY (TIME UNIT)
   PF,A,151/PP,A,174
TIME    333   N  SIMULATION TIME (TIME UNIT)
   MUWR,A,52/MKS1,A,111/PLTPER,A,329
TKAF     66   R  TRADITIONAL CAPITAL ACQUISITIONS IN FORMAL
                   SECTOR (CAPITAL UNITS/TIME UNIT)
   TKOF,L,63/TKI,L,117/EKAF,R,153/PRINT,339.2
TKAP     91   R  TRADITION CAPITAL UNITS IN PEASANT SECTOR
                   (CAPITAL UNITS/TIME UNIT)
   TKOP,L,88/TKI,L,117/EKAP,R,181/PRINT,339.4
TKDF     68   A  TRADITIONAL CAPITAL DEMAND IN FORMAL SECTOR
                   (CAPITAL UNITS /TIME UNIT)
   TKAF,R,66/DTKI,A,116/TTKD,A,119/PRINT,339.2
TKDI    120   A  TRADITIONAL CAPITAL DEMAND FOR INVENTORY
                   (CAPITAL UNITS/TIME UNIT)
   TTKD,A,119/PRINT,339.7
TKDP     93   A  TRADITIONAL CAPITAL DEMAND IN PEASANT
                   SECTOR (CAPITAL UNITS/TIME UNIT)
   TKAP,R,91/DTKI,A,116/TTKD,A,119/PRINT,339.4
TKDRF    64   R  TRADITIONAL CAPITAL DEPRECIATION RATE IN
                   FORMAL SECTOR (CAPITAL UNITS/TIME UNIT)
   TKOF,L,63/PRINT,339.2
TKDRP    89   R  TRADITIONAL CAPITAL DEPRECIATION RATE IN
                   PEASANT SECTOR (CAPITAL UNITS/TIME UNIT)
   TKOP,L,88/PRINT,339.4
TKEP     76.1 T  TABLE FOR PROPENSITY TO EMPLOY CAPITAL FROM
                   PROFITABILITY (DIMENSIONLESS)
   PKEPF,A,76/PKEPP,A,100
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TKI      117   L  TRADITIONAL CAPITAL INVENTORY (CAPITAL
         117.1 N    UNITS)
   TKIA,A,115/TKDI,A,120/PRINT,339.7
TKIA     115   A  TRADITIONAL CAPITAL INVENTORY AVAILABILITY
                    (DIMENSIONLESS)
   TKAF,R,66/TKAP,R,91/PRINT,339.7
TKIAT    284   C  TRADITIONAL CAPITAL INVENTORY ADJUSTMENT
                    TIME (TIME UNITS)
   TKDI,A,120
TKOF      63   L  TRADITIONAL CAPITAL OWNED BY FORMAL SECTOR
          63.1 N    (CAPITAL UNITS)
   KOF,A,60/TKDRF,R,64/RCKF,A,80
TKOP      88   L  TRADITIONAL CAPITAL OWNED BY PEASANT SECTOR
          88.1 N    (CAPITAL UNITS)
   KOP,A,85/TKDRP,R,89/RCKP,A,106
TKRP      77.2 T  TABLE FOR PROPENSITY TO RENT OUT CAPITAL
                    FROM PROFITABILITY (DIMENSIONLESS)
   PKRPF,A,77
TKS      118   R  TRADITIONAL CAPITAL SERVICES PRODUCTION
                    (CAPITAL UNITS/TIME UNIT)
   TKI,L,117/PRINT,339.7
TL       233   C  TOTAL LAND (LAND UNITS)
   LOF,A,3/LOP,A,18/PDLO,A,36/NFLOF,N,197/NLCP,N,221
TLCP      13.1 T  TABLE FOR PROPENSITY TO CULTIVATE LAND FROM
                    PROFITABILITY (DIMENSIONLESS)
   PCLPF,A,13/PCLPP,A,23
TLRP      14.2 T  TABLE FOR PROPENSITY TO RENT OUT LAND FROM
                    PROFITABILITY (DIMENSIONLESS)
   PRLPF,A,14
TMCP     262   C  TIME OF COOPERATIVES POLICY (TIME UNIT)
   EFSMKP,A,97
TMK      280   C  TIME OF MODERN CAPITAL POLICY (TIME UNIT)
   MKS2,A,112
TMKD     113   A  TOTAL MODERN CAPITAL DEMAND (CAPITAL UNITS/
         113.1 N    TIME UNIT)
   PRINT,339.7
TMKDM    111.1 T  TABLE FOR MODERN CAPITAL DEMAND MET
                    (CAPITAL UNITS/TIME UNIT)
   MKS1,A,111
TMKIA    107.1 T  TABLE FOR MODERN CAPITAL INVENTORY
                    AVAILABILITY (DIMENSIONLESS)
   MKIA,A,107
TMUW      52.1 T  TABLE FOR MINIMUM URBAN WAGE (MONEY UNITS/
                    PERSON/TIME UNIT)
   MUWR,A,52
TOK      187   S  TOTAL OWNED CAPITAL (CAPITAL UNITS)
   PLOT,340.7
TOL      186   S  TOTAL OWNED LAND (LAND UNITS)
   PLOT,340.5
TP       121   A  TOTAL PRODUCTION (PRODUCT UNITS/TIME UNIT)
   TKS,R,118/TAP,A,129/MDSR,A,137/PRINT,339.8
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TPDLO 36.1 T TABLE FOR PRESSURE FOR DESIRED LAND OWNERSHIP ON PRICE OF LAND (DIMENSIONLESS)
PDLO,A,36
TPTKRT 264 C TIME OF POLICY TEST FOR CAPITAL RENT TAX (TIME UNIT)
PKRPF,A,77
TPTLOT 213 C TIME FOR POLICY TEST FOR LAND OWNERSHIP TAX (TIME UNIT)
PCLPF,A,13/PRLPF,A,14/PCLPP,A,23
TPTLRT 215 C TIME OF POLICY TEST FOR LAND RENT TAX (TIME UNIT)
PRLPF,A,14
TPTST 200 C TIME OF POLICY TEST (TIME UNIT)
LOF,A,3/CWF,R,38/ELTP,R,182
TPTSTG 202 C TIME OF POLICY TEST FOR GROWTH (TIME UNIT)
WNGR,A,48/CP,R,128
TPTSTM 203 C TIME FOR POLICY TEST FOR MIGRATION (TIME UNIT)
UWR,A,51
TPTSTR 201 C TIME OF POLICY TEST FOR RENTING (TIME UNIT)
LCF,A,9/ILR,A,30/PDRLLR,A,31/KEF,A,70/IKR,A,131/PDRKKR,A,133
TPTSTW 204 C TIME OF POLICY TEST FOR WAGE RATE (TIME UNIT)
IWR,A,54
TR 185 S TOTAL REVENUE (MONEY UNITS/TIME UNIT)
PRINT,339.7/PLOT,340.8
TREF 188 S TOTAL RECEIPTS IN FORMAL SECTOR (MONEY UNITS/TIME UNIT)
PLOT,340.9
TREP 190 S TOTAL RECEIPTS IN PEASANT SECTOR (MONEY UNITS/TIME UNIT)
RELRPP,S,191/PLOT,341.1
TRPP 189 S TOTAL RENT PAYMENTS BY PEASANT SECTOR (MONEY UNITS/TIME UNIT)
TREF,S,188/PLOT,340.9
TRPS 180.1 T TABLE FOR RENT PRESSURES ON SAVINGS (DIMENSIONLESS)
ERPSP,A,180
TSCSD 289 C TIME TO SMOOTH CONSUMPTION SERVICES DEMAND (TIME UNITS)
TCSD,A,123
TSDKI 275 C TIME TO SMOOTH DESIRED CAPITAL INVENTORY (TIME UNITS)
DMKI,A,108/DTKI,A,116
TSFKE 257 C TIME TO SMOOTH FRACTION OF CAPITAL EMPLOYED (TIME UNITS)
FKEF,A,71
TSFLC 208 C TIME TO SMOOTH FRACTION OF LAND CULTIVATED (TIME UNITS)
FLCF,A,10

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TSKA    265    C  TIME TO SMOOTH CAPITAL ACQUISITIONS (TIME
                    UNITS)
   AMKAF,A,83/AMKAP,A,104
TSLO    199    C  TIME TO SMOOTH LAND OWNERSHIP (TIME UNITS)
   FLOF,A,4
TSMKD   282    C  TIME TO SMOOTH MODERN CAPITAL DEMAND (TIME
                    UNITS)
   TMKD,A,113
TSR     312    C  TIME TO SMOOTH REVENUE (TIME UNITS)
   ARF,A,148/ARP,A,171
TSS     306    C  TIME TO SMOOTH SAVINGS (TIME UNITS)
   ASRF,A,144/ASRP,A,167
TSVP    217    C  TIME TO SMOOTH VALUE OF PRODUCTION (TIME
                    UNITS)
   AVPF,A,16/AVPP,A,25
TSWS    179.1 T   TABLE FOR EFFECT OF SURPLUS WORKERS ON
                    SAVINGS IN PEASANT SECTOR (DIMENSIONLESS)
   ESWSP,A,179
TTKD    119    A  TOTAL TRADITIONAL CAPITAL DEMAND (CAPITAL
        119.1  N    UNITS/TIME UNIT)
   TKS,R,118/TDP,A,122/PRINT,339.7
TTKIA   115.1 T   TABLE FOR TRADITIONAAL CAPITAL INVENTORY
                    AVAILABILITY (DIMENSIONLESS)
   TKIA,A,115
TVP     225    C  TOTAL VALUE OF PRODUCTION (MONEY UNITS/TIME
                    UNIT)
   NVPP,N,224
TWDW     55.1 T   TABLE EFFECT OF WORKER DEMAND ON WAGE RATE
                    (DIMENSIONLESS)
   EWDW,A,55
UWR      51    A  URBAN WAGE RATE (MONEY UNITS/PERSON/TIME
                    UNIT)
   FMR,A,50
VPF     150    A  VALUE OF PRODUCTION IN FORMAL SECTOR (MONEY
                    UNITS/TIME UNIT)
   AVPF,A,16/RF,A,149/TREF,S,188/PRINT,339.9
VPP     173    A  VALUE OF PRODUCTION IN PEASANT SECTOR
                    (MONEY UNITS/TIME UNIT)
   AVPP,A,25/RP,A,172/TREP,S,190/PRINT,340.2
WAT     237    C  WORKER ADJUSTMENT TIME (TIME UNITS)
   CWF,R,38
WDF     157    A  WAGE DISBURSEMENT IN FORMAL SECTOR (MONEY
                    UNITS/TIME UNIT)
   RF,A,149/RP,A,172/TREP,S,190/PRINT,339.9/PLOT,341.1
WF       37    L  WORKERS IN FORMAL SECTOR (PERSONS)
         37.1  N
   CWF,R,38/WP,A,43/AMRPW,A,56/MRPWF,A,57/PF,A,151/WDF,A,157
      LWRF,S,183/PRINT,339.1/PLOT,340.6
WFGR    243    C  WORKFORCE GROWTH RATE (FRACTION/TIME UNIT)
   WNGR,A,48
WNGR     48    A  WORKFORCE NATURAL GROWTH RATE (PERSONS/TIME
                    UNIT)
   CRWF,R,47
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WP       43   A  WORKERS IN PEASANT SECTOR (PERSONS)
         43.1 N
   AMRPW,A,56/MRPWP,A,58/EFSMK1,A,98/EFSMK2,A,99/PP,A,174
     ESWSP,A,179/ERPSP,A,180/LWRP,S,184/PRINT,339.1
WTTST   238   C  WORKERS TRANSFERED FOR TESTING MODEL
                   (PERSONS)
   CWF,R,38
YEAR    334   C  INITIAL VALUE OF TIME (TIME UNIT)
   TIME,N,333
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