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9. ABSTRACT

Presents two macroeconometric models of Thai agriculture. The models constitute a transition phase in a sector analysis project undertaken jointly by the Thai Division of Agricultural Economics and Iowa State University to assess Thailand's economic policies, particularly those related to agriculture. The report opens with a brief history of the overall project and reviews the methodology of large econometric model construction. Special considerations regarding the construction of models for developing countries are also discussed. The report next provides detailed information on the two macroeconomic models. Model I is linear in parameters and in variables; Model II is linear in parameters and nonlinear in variables. Model equations are provided, accompanied by a discussion of equation specification. The report also provides results of a reduced form simulation of Model I and of a Gauss-Seidel simulation of Model II. Suggestions are offered for further research, and appendices give extensive data for each model.

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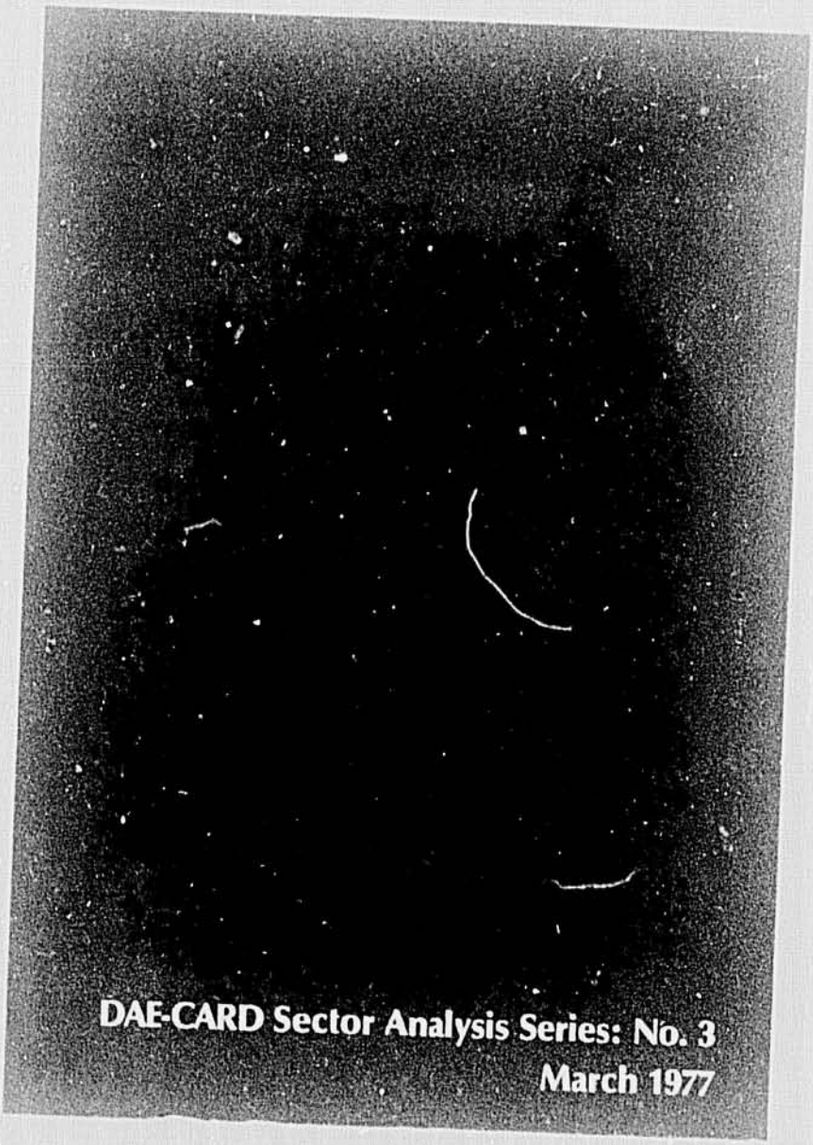

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DAE-CARD Sector Analysis Series: No. 3
March 1977

MACROECONOMETRIC ANALYSIS OF ECONOMIC ACTIVITY IN THAILAND, 1962-1974

by

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FOREWORD

This report summarizes work completed to date on macro models of the Thai economy. The project is a cooperative one conducted by the Division of Agricultural Economics (DAE) of the Ministry of Agriculture and Cooperatives, Royal Thai Government, and the Center for Agricultural and Rural Development (CARD) and the Department of Economics of Iowa State University. Funded by the Agency for International Development and the Royal Thai Government, it is one phase of a sector analysis project being undertaken in the DAE to provide models which can aid development and policies, particularly for Thai agriculture.

A series of macro models for the Thai economy have been undertaken to supplement the various models being developed for the agricultural sector of Thailand. These activities were undertaken not only because of the importance of national economic policies on employment, prices, and other variables in agriculture, but also because various policies enacted in behalf of agriculture also impact on other sectors of the economy.

The model reported is the first generation of a set of macro economic models which may be specified and quantified for the Thai economy. The current model is now being linked with a national programming model developed for the agricultural sector.

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PREFACE

This paper reports the preliminary results of a macroeconometric modeling effort carried out at the Division of Agricultural Economics, Ministry of Agriculture and Co-operatives, Royal Thai Government, over the two-year period from September, 1974 through August, 1976. This effort is part of a Sector Analysis Project being carried out by a team of advisers from Iowa State University in conjunction with the Division of Agricultural Economics under a 5-year contract with AID.

The ultimate purpose of the macroeconometric modeling effort is to link an econometric model of the nonagricultural sector with a linear programming model of Thai agriculture being developed in the project. This report, however, does not reflect this linking process, which at this time has not been completed. It presents two "stand-alone" models that treat the agricultural sector in a fairly aggregative manner. We believe that these models are of interest in themselves even though they represent a transition phase in the overall project. We are presenting them in this form to elicit comments and criticism that may improve future model generations.

This report may be excessively long in some respects, particularly in the discussion of economic and econometric procedure and in the presentation of data sources. We feel, however, that discussing these topics and presenting the sources is desirable in that one of the main functions of this report will be to serve as a basic reference document for future work in this area to be carried out in DAE and will hopefully serve as a self-contained document for the people doing this work.

There are many people, both American and Thai, who have been involved in this work to varying degrees, and we would like here to acknowledge their help without indicting them for what appears here. In DAE, we would like to especially thank Dr. Somnuk Sriplung, Chief of the division, for his great co-operation and assistance. Without his leadership, very little in the project would have been accomplished, if, indeed, it would ever have begun. A very special acknowledgement is made of the leadership of Dr. Earl O. Heady, overall director of the ISU project. In other Thai agencies, thanks go to Dr. Olarn Chaipravat of the Bank of Thailand and to Dr. Virabongsa Ramangkura of Chulalongkorn University. Of course, other members of the ISU team have had great input into this effort, and we would like to express our appreciation to them. They are Dr. Arthur Stoecker (Iowa State University), Dr. Keith Rogers (Western Illinois University), Dr. Leroy Blakeslee (Washington State University), Dr. Dennis Conley (University of Illinois), Dr. Herbert Fullerton (Utah State University), Dr. Charles Framingham (University of Manitoba), and Mr. Larry Kinyon, who provided excellent assistance in computer programming. Finally, we would like to thank Dr. Fletcher Riggs and Mr. David Lundberg of AID, who have provided, and continue to provide, many, many things to the project.

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I. INTRODUCTION

A. A Brief History of the Macro-modeling Effort in the ISU Sector Analysis Project in Thailand

The Iowa State University Sector Analysis Project was started in July 1973. The initial team consisted of three long-term advisors. In the early stages of the project, these three advisors, in conjunction with Thai staff members of the Division of Agricultural Economics in the Ministry of Agriculture, concentrated their efforts in the development of the methodology of constructing linear programming crop models for each of 19 agro-economic zones in Thailand.

Early in 1974 a fourth long-term advisor was added to the team in the area of transportation and marketing. Also, shortly thereafter, with the completion of early solutions of some of the zone LP models, one of the initial team members branched off into the area of statistical demand analysis of important agricultural commodities in Thailand. A second advisor began work on aggregating the zone models into regional LP models to study the differential impacts of agricultural policies on the various regions in Thailand. The third advisor continued the development of the LP models with the ultimate goal being the construction of a national linear programming model of Thai agriculture incorporating the statistical demand analysis and the transportation and marketing analysis.

The initial visualization of the project did not include any explicit and extensive consideration of the nonagricultural sector of the

economy, but as the agricultural modeling proceeded, the ISU and DAE staff began to feel that focusing only on the agricultural sector would give an incomplete picture of the Thai economy for policy simulation purposes. It was felt that identifying and quantifying the linkages between the agricultural and nonagricultural sectors was desirable to analyze properly the effects of nonagricultural policies on the agricultural sector and vice versa. Therefore, a fifth full-time ISU team member was added in September 1974 to investigate these linkages.

B. Some Methodological Considerations

1. The Construction of Macro-econometric Models in Developing Countries

The construction of very large, very sophisticated econometric models has been going on in developed countries, particularly in the United States, for about 15 years, and there is a large and growing literature on the techniques of specification, identification, estimation, forecasting, and simulation of these large models. The application of these techniques to developing countries is still a fairly recent phenomenon, however, and the number of macro-econometric models that has been constructed for developing countries is still small. The reasons for this are fairly obvious; lack of large and disaggregated time series data over a sufficient time period, lack of large-scale computing facilities, lack of a large enough group of well-trained applied econometricians in one place to carry out a major effort of this type, and so on. As time passes, though, these weaknesses are becoming mitigated, and attempts at macro-modeling are becoming more feasible.

The question then arises as to whether the modeling techniques and underlying theoretical specifications of the models in, say, the United States can be carried over to less-developed and, in some cases, quite structurally different economies. One often hears warnings against taking the neo-Keynesian macroeconomic theory underlying most of the large-scale macro-econometric models and applying it to developing countries. This warning is a partially valid one, but not totally. In a basically free-enterprise economy such as Thailand, where economic resources are allocated to some degree by the price system, the levels of the macro-economic variables are determined to a very large extent by the aggregate demands and aggregate supplies of produced goods and factors of production, given various technological and institutional constraints. Therefore, the problem of modeling any such economy necessarily involves the determination of these aggregate demands and supplies. What one must guard against is the blind application of neo-Keynesian macro theory without keeping clearly in mind the special institutional and economic characteristics of the economy being modeled.

In visualizing an economy it is instructive to go back to one of the most basic concepts of macroeconomics, that of the "circular flow." In its simplest and most aggregated form, assuming temporarily the absence of a government sector and an international trade sector, the economy is visualized as being composed of two sectors--the consuming sector and the producing sector. These two sectors interact economically in two ways. The producing sector hires the productive services of the consuming

sector through a factor-of-production market and rewards these services through factor payments (wages, salaries, rents, profits, etc.). Hence, there is a flow of money from the producing sector to the consuming sector and a flow of factor services from the consuming to the producing sector. The flow of money constitutes the money income of the consuming sector. The second interaction between the two sectors is that the members of the consuming sector use their money income to demand the products of the producing sector. In principle, then, in a closed economy which is in equilibrium, the flow of money between the two sectors must be equal, i.e., the amount of money that the consuming sector has to buy goods and services is equal to the amount of money it received in return for its factor services.

This, of course, is a very simplistic view of the world, but it constitutes the basic building block of macroeconomics. What is necessary to make it more realistic is to recognize that in the real world there are other factors at work. For example, in every society, there must be some form of government. The existence of government affects the equilibrium level of GNP in two ways. First, it supports itself by levying taxes on the private sector, which has the effect of decreasing GNP, and it spends money on goods and services, which has the effect of increasing GNP. The payment to government employees becomes income to them, and they in turn buy goods and services. The taxing and spending activities do not have symmetric effects, and therefore government

activity can have the net effect of raising or lowering the equilibrium level of money flowing through the economy.

Other things that must be taken into consideration include the existence of international trade, wherein goods and services produced in the economy are sold abroad, which constitutes an outside injection of money, raising the equilibrium money flow, and wherein goods and services produced abroad are purchased, which brings about a flow of money out of the economy. Secondly, the simplistic view of the economy assumes that individuals spend all of their factor incomes on goods and services in the time period in which they earn it. This, of course, is not true because individuals can save and borrow, thereby altering the time pattern of their demand and further altering the time pattern of the equilibrium level of money in the circular flow. In turn, the desires of individuals and firms to save and borrow necessitates the existence of a financial system, either formal or informal, wherein the money available from saving can be made available to potential borrowers. This financial system may be regulated by economic policy makers to achieve some desired goal in the time pattern of the equilibrium level of money in the circular flow. Also, the existence of foreign trade and a financial system adds further complications in that economic variables such as the aggregate price level and the level of foreign exchange become important.

This is just a thumbnail sketch of a macroeconomic system and is well known. However, it points out that an economic policy

maker must have a considerable amount of knowledge at his disposal in order to evaluate a proposed policy. Not only must he be able to judge the effects of the proposal on the equilibrium level of money in the circular flow, on the aggregate price level, on balance of payments equilibrium, and on the rate of economic growth of the economy, but he must also have some notion as to its effect on income distribution and its differential impacts upon various sectors of the economy. The role of the macroeconomic theorist is to provide hypotheses about the effects of particular policies and the role of the macro-econometrician is, within the institutional and economic structure of a particular economy, to test these hypotheses and to provide the policy maker with a quantitative estimate of the effects of proposed policies.

2. Standard Macro-econometric Methodology

The standard procedure in the construction of macro-econometric models is to begin with a set of national income accounting identities. These accounting identities represent the amount of money flowing through the various parts of the circular flow. For example, an accounting identity that measures the total aggregate demand for goods and services might be written:

Gross Domestic Product = Private Consumption of Goods and Services + Government Consumption Expenditures + Gross Private Fixed Capital Formation + Gross Government Fixed Capital Formation + Total Exports - Total Imports.

An accounting identity measuring the flow of money through the factor of production market might be written:

Gross Domestic Product = Wages and Salaries + Rents + Interest Payments + Indirect Taxes + Capital Consumption Allowances.

There are many variations on these identities, both in terms of defining other economic variables (e.g., national income, personal income, personal disposable income, etc.) and in terms of disaggregating the various components in the identities (which will be seen in the models that will be presented). The form that the disaggregation will take will depend on the purposes of the model builder, data availability, and many other considerations.

In general then, the construction of a macro-econometric model involves the setting up of a system of national income accounting identities appropriate to the model builder's needs, determining which of the economic variables he wishes to explain and forecast, i.e., the jointly dependent variables (JDV), and which economic variables he wishes to take as determined outside the model, i.e., the predetermined variables (PDV). He then attempts to specify the functional relationships among the jointly dependent and predetermined variables. For a model with G jointly dependent variables and K predetermined variables, the general linear presentation of a simultaneous equations econometric system will be:

$$\beta_{11}y_1 + \beta_{12}y_2 + \ldots + \beta_{1G}y_G + \gamma_{11}Z_1 + \gamma_{12}Z_2 + \ldots + \gamma_{1k}Z_K = U_1$$

$$\beta_{21}y_1 + \beta_{22}y_2 + \ldots + \beta_{2G}y_g + \gamma_{21}Z_1 + \gamma_{22}Z_2 + \ldots + \gamma_{GK}Z_K = U_2$$

$$\vdots$$

$$\beta_{G1}y_1 + \beta_{G2}y_2 + \ldots + \beta_{GG}y_G + \gamma_{G1}Z_1 + \gamma_{G2}Z_2 + \ldots + \gamma_{GK}Z_K = U_G$$

where $y_1,\ldots,y_G$ are the jointly dependent variables;

$Z_1,\ldots,Z_k$ are the predetermined variables;

$U_1,\ldots,U_G$ are the stochastic elements in each equation;

β_{ij} are the structural parameters are associated with the JDV;

$(i = 1,\ldots,G;\ j = 1,\ldots,G)$

γ_{il} are the structural parameters associated with the PDV;

$(i = 1,\ldots,G;\ l = 1,\ldots,K)$.

This system of equations constitutes a system of <u>structural equations</u> with the β_{ij} and γ_{ij} being <u>structural parameters.</u> In matrix notation, this is written:

1') $BY + GZ = U.$

Of course, the practical problems of specification center around deciding, on economic theory and statistical criteria, which of the jointly dependent and predetermined variables will be included in each of the structural equations and which will be excluded.

Given data on the JDV and PDV, we want to estimate the values of the structural parameters using standard statistical inference procedures, i.e., to describe as well as possible the existing structure of the economy. The description of the structure of the economy provides the model builder and economic policy maker with a static picture of the economy with which he is dealing.

The next step, and perhaps a more important one from a policy point of view, is to use this model (1) for forecasting the effects of changes in the variables that are considered exogenous to the system, and (2) for

forecasting the effects of particular policy actions. This is done by rewriting our structural model, $BY + GZ = U$, as

$$Y = -B^{-1}GZ + B^{-1}U$$

$$= \pi Z + V$$

where $\pi = -B^{-1}G$

$$V = B^{-1}U.$$

This is called the <u>reduced form</u> of the structural model, and it is the form of the model used for forecasting purposes because it expresses each of the JDV as a function of all the PDV. The matrix of reduced form coefficients, π, can be obtained once the matrices of the structural parameters, B and G, have been obtained. Alternatively, they can be obtained directly by regressing each of the JDV on all of the PDV. In either case, the reduced form coefficients constitute impact multipliers, i.e., they indicate what the effect of a change in the value of one of the PDV will be upon the equilibrium values of the jointly dependent variables.

The general question of forecasting with econometric models can be broken into two parts:

1) forecasting under unchanged structure;

2) forecasting under changed structure.

The first of these assumes that for the forecast period the values of the structural parameters will remain unchanged. Hence, all that is necessary to forecast the effect of a change in one of the PDV are estimates of the reduced form parameters. As noted above, these may be obtained directly, so that for forecasting under unchanged structure, it is not necessary to get estimates of the structural parameters.

Forecasting under changed structure poses a more difficult problem. By definition, a change in structure means that the values of at least one of the structural parameters will be different in the forecast period than in the estimation period. Because there is no direct way to estimate the reduced form parameters for the forecast period, i.e., there are no available observations, it is necessary to have estimates of the structural parameters for the sample period. These estimates may be obtained only if the equations in the model are identified, or are over-identified. Structural equations are said to be identified or over-identified if unique estimates of the structural parameters can be obtained given estimates of the reduced form parameters. A great deal of attention is paid in the econometric literature to the ways in which these estimates may be obtained and which we will not discuss here. In any event, once they are obtained, by whatever estimation technique, forecasting under changed structure involves the changing of one or more of the elements in B or G (presumably an informed guess on the part of the model builder), and then recalculating the "new" reduced form matrix (called the "derived reduced form") and then proceeding as before. The reason that forecasting under changed structure is important in macro-econometric modeling is that many policy changes involve changing the economic structure, e.g., changing the tax structure, government expenditure, and taxation patterns, and so on. By applying reduced form analysis to various proposed policy changes, one is able, at least in principle, to forecast the effects of these policy changes on the values of the jointly dependent variables in the system.

This, of course, oversimplifies the problem greatly. It is only the general methodological approach. The real difficulty lies in the appropriate specification of the equations of the model. Moreover, a model is never just specified once and used forever. It must be continuously updated and revised, and thereby, hopefully, improved.

3. The Scope of the Models Presented in this Paper

The macro-econometric modeling effort in the present project must necessarily take on a different form than the standard one just presented. Because of the very great importance of agriculture in the Thai economy, the primary focus of the overall ISU Sector Analysis Project is to describe Thai agriculture in an extensive and disaggregated manner as possible and to investigate the effects of alternative policy proposals with particular emphasis on increasing-agricultural production and income. This means that the macro-modeling of the nonagricultural sector must be geared to the investigation of the interactions between the nonagricultural sector and agricultural sector.

Second, the approach of the national agricultural model is linear programming, whereas that of the macro-econometric model is time series regression analysis, as already discussed. This means that two models involving different techniques must be linked together in order to solve them simultaneously. This poses some difficult problems, both in terms of econometrics and computer programming, but linking the models remains the ultimate purpose of the project.

The models in this paper do not reflect this linking process. They reflect the construction of two "self-contained" models of the Thai economy

which have considerable disaggregation in the nonagricultural sector and a fairly aggregated treatment of the agricultural sector. Model I, presented in Section II, is a 45 equation model that was constructed specifically as linear in both parameters and variables. Moreover, it is a completely "real" model in that there is no consideration of the monetary sector and therefore no consideration of the determination of various aggregate price levels. Model I was constructed in this fashion for the following reasons. Because the national agricultural model is in a totally linear form, the initial methodological problems involved in the linkage of the two models would be reduced if the macro-model was likewise linear in all regards. The monetary and price sector was excluded simply because it is a very difficult sector to model in Thailand (for reasons discussed in Section III) and it was desirable to have a "complete" model to start the linking process, even if incomplete. Model II, presented in Section III, also is a self-contained model that attempts to correct some of the deficiencies in Model I. It represents nonlinearization of variables (though not of parameters) and includes a monetary and price sector.

Although these models may be regarded as transitional models in that they have been constructed in preparation for linking with the national LP model, they are of interest in themselves, and therefore are presented in this report. The discussion of the linking process and the results of this process will be presented in a second report that will be forthcoming in the near future.

II. MODEL I: A MACRO-ECONOMETRIC MODEL LINEAR IN PARAMETERS AND VARIABLES

A. Introduction

As stated above, Model I is a 45-equation model, linear in both parameters and variables. It consists of 36 behavioral equations and 9 identities. The behavioral equations consist of seven general groups of equations:

1) Private Personal Consumption Equations;
2) Government Expenditure Equations;
3) Export Equations;
4) Import Equations;
5) Gross Fixed Capital Formation Equations;
6) Output Equations; and
7) Income Distribution Equations.

In general, the definition of variables and the method of aggregating variables were chosen to match the definition of variables used by National Economic and Social Development Board (NESDB) in the national accounts. Although one would perhaps prefer alternative definitions and would like to have greater disaggregation in some series, these accounts do constitute the primary source of national income data, and it was preferable to align the model to them to as great an extent as possible. (For a detailed description of data sources, see the Data Appendix.)

The equations in the model are estimated by Ordinary Least Squares, using annual data for the sample period, 1962-1974. Two-state Least Squares

cannot be used directly because of the small number of time series observations. An alternative here would be to use principal components to estimate the first stage regressions, but at present there is no principal components program operational at DAE, and so we have stayed with Ordinary Least Squares. Re-estimation of the structural parameters using principal components will be carried out in the near future. In Section B, we present the equations and variables of Model I. The figures in parenthese are t-statistics.

B. Equations of Model I

PRIVATE CONSUMPTION EXPENDITURE EQUATIONS

		$\bar{R}^2$	D.W.
(1)	$FBT_t = \underset{(2.935)}{3138.059} + \underset{(2.860)}{0.106}GDP_t + \underset{(4.934)}{0.667}FBT_{t-1}$	.999	1.686
(2)	$RFLHHO_t = \underset{(3.857)}{1316.057} + \underset{(3.889)}{0.031}GDP_t + \underset{(2.197)}{0.378}RFLHHO_{t-1}$	.998	2.283
(3)	$COPE_t = \underset{(-1.477)}{-591.838} + \underset{(2.355)}{0.049}PDY_t + \underset{(2.118)}{0.501}COPE_{t-1}$	.988	1.249
(4)	$FFHHE_t = \underset{(5.417)}{3361.337} + \underset{(16.509)}{0.031}PDY_t - \underset{(-6.366)}{3742.365}\frac{PFFHHE_t}{P_t}$	.984	1.909
(5)	$SERV_t = \underset{(2.038)}{3498.164} + \underset{(10.049)}{0.038}GDP_{t-1} - \underset{(-1.555)}{2293.702}\frac{PSERV_t}{P_t}$	.967	1.797
(6)	$TC_t = \underset{(1.319)}{1122.582} + \underset{(53.370)}{0.086}PDY_t - \underset{(-3.056)}{2468.667}\frac{PTC_t}{P_t}$	.998	2.840
(7)	$RE_t = \underset{(0.767)}{770.269} + \underset{(58.916)}{0.063}GDP_t - \underset{(-1.771)}{1803.479}\frac{PRE_t}{P_t}$	.997	2.631

GOVERNMENT EXPENDITURE EQUATIONS

		$\bar{R}^2$	D.W.
(8)	$GADJP_t = -426.585 + 0.439GREV_{t-1} + 0.352GADJP_{t-1}$ (-0.842) (3.291) (1.848)	.977	3.068
(9)	$GSERV_t = -321.027 + 0.011GDP_t + 0.759GSERV_{t-1}$ (-2.400) (2.649) (5.416)	.989	2.410
(10)	$GTC_t = 83.626 + 0.908GTC_{t-1}$ (3.110) (17.079)	.960	1.711

EXPORT EQUATIONS

(11)	$XRICE_t = -3397.596 - 0.144XPRICE_t + 0.402RICE_{t-1}$ (-1.574) (-1.403) (3.004) $+ 0.792XRICE_{t-1} - 2786.198D73_t$ (3.064) (-3.380)	.634	1.708
(12)	$XRUB_t = -195.712 + 0.027XPRUB_t + 1.414RUB_t$ (-2.397) (3.662) (18.543) $- 0.380XRUB_{t-1}$ (4.854)	.995	2.455
(13)	$XMZE_t = 228.865 + 1.060MZE_{t-1} + 1.069DXPBPZ_t$ (1.373) (6.286) (1.668) $- 0.252XMZE_{t-1}$ (-1.277)	.876	1.728
(14)	$XTAP_t = -106.297 + 0.405TAP_t + 0.752XTAP_{t-1}$ (-0.897) (2.718) (3.390)	.915	1.917
(15)	$XMFG_t = -1109.251 + 0.146MGDP_t + 0.268XMFG_{t-1}$ (-2.472) (3.188) (1.074)	.962	1.451
(16)	$XOTH_t = -117.471 + 0.015GDP_{t-1} + 0.692XOTH_{t-1}$ (-0.224) (1.745) (2.802)	.828	1.520
(17)	$XSERV_t = -282.921 + 0.246SERGDP_t + 0.307XSERV_{t-1}$ (-0.471) (2.308) (2.171) $+ 2857.120D66^*$ (5.946)	.982	2.588

IMPORT EQUATIONS

		$\bar{R}^2$	D.W.
(18)	$IMP1_t = \underset{(10.478)}{11429.275} + \underset{(3.787)}{0.026PDY_{t-1}} - \underset{(-6.860)}{8553.100}\frac{M1P_t}{PGDP_t}$	.792	2.284
(19)	$IMP2_t = \underset{(4.568)}{1249.538} + \underset{(29.329)}{0.074PDY_t} - \underset{(-9.843)}{3329.708}\frac{M2P_t}{PGDP_t}$	.988	2.197
(20)	$IMP3_t = \underset{(-4.492)}{-975.649} + \underset{(15.807)}{0.038PDY_t}$	.954	1.917
(21)	$IMP4_t = \underset{(8.647)}{10927.00} + \underset{(8.090)}{0.125PDY_{t-1}} - \underset{(-9.400)}{14124.068}\frac{M4P_t}{PGDP_t}$	.982	1.415
	$+ \underset{(2.306)}{0.211IMP4_{t-1}}$		

GROSS FIXED CAPITAL FORMATION EQUATIONS

(22)	$AGINV_t = \underset{(0.054)}{16.762} + \underset{(1.886)}{0.068}(GDP_t - GDP_{t-1})$	.873	2.570
	$+ \underset{(3.056)}{0.124}(GDP_{t-1} - GDP_{t-2}) + \underset{(3.023)}{0.461AGINV_{t-1}}$		
(23)	$NAGINV_t = \underset{(-0.200)}{-209.624} + \underset{(3.069)}{0.405}(GDP_t - GDP_{t-1})$	.987	2.414
	$+ \underset{(3.777)}{0.595}(GDP_{t-1} - GDP_{t-2}) + \underset{(11.357)}{0.732NAGINV_{t-1}}$		

OUTPUT EQUATIONS

(24)	$CROPOUT_t = \underset{(-8.136)}{-41101.648} + \underset{(12.780)}{5.026AGLAB_t}$	.931	2.728
(25)	$OTHAG_t = \underset{(-6.008)}{-14095.125} + \underset{(7.572)}{1.613AGLAB_t} + \underset{(6.268)}{1.240AGINV_{t-1}}$	.986	2.483
(26)	$MGDP_t = \underset{(-2.280)}{-14288.236} + \underset{(2.388)}{7.145NAGLAB_t} + \underset{(1.935)}{0.481MGDP_{t-1}}$	.990	2.123
(27)	$CONSOUT_t = \underset{(8.752)}{21667.660} - \underset{(-7.793)}{119736.281RNATLAB_t}$	.952	1.884
	$+ \underset{(11.344)}{0.432NAGINV_t}$		

		$\bar{R}^2$	D.W.
(28)	$WRTOUT_t = -8183.984 + 0.229\ NAGINV_{t-1} + 6.186\ NAGLAB_t$ (-3.964) (3.020) (6.252)	.988	2.696
(29)	$SERGDP_t = 09364.084 + 61962.344\ RNATLAB_t + 0.701\ SERGDP_{t-1}$ (-3.964) (3.020) (5.145)	.99	2.283
(30)	$TCOUT_t = -3335.865 + 2.914\ NAGLAB_t + 0.022\ NAGINV_{t-1}$ (-5.610) (10.227) (1.026)	.992	1.873
(31)	$OTHOUT_t = -5393.945 + 2.872\ NAGLAB_t + 0.665\ OTHOUT_{t-1} + 0.046\ NAGINV_{t-1}$ (-1.440) (1.490) (3.381) (1.173)	.997	2.994

INCOME DISTRIBUTION EQUATIONS

(32)	$COMP_t = -11929.889 + 2.027\ OTHAG_t + 5.372\ NAGLAB_t$ (-5.875) (4.780) (3.397)	.985	1.104
(33)	$FY_t = 537442.000 - 2.761\ OTHAG_t - 617994.627\ RAGTLAB_t - 0.862\ XRICE_t$ (7.078) (-3.679) (-7.047) (-1.881)	.943	1.808
(34)	$YUE_t = 29541.813 + 0.569\ GDP_t - 17.337\ NAGLAB_t$ (2.302) (3.190) (-1.896)	.972	1.927
(35)	$YPROP_t = -111036.547 + 0.711\ MGDP_t + 135660.782\ RAGTLAB_t$ (-3.381) (7.473) (3.443)	.988	2.489
(36)	$IDTAX_t = -76.798 + 0.115\ GDP_t$ (-0.098) (16.082)	.955	1.755

IDENTITIES

(37) $TPCE_t = FBT_t + RFLHHO_t + COPE_t + FFHHE_t + SERV_t + TC_t + RE_t$

(38) $TGCE_t = GADJP_t + GSERV_t + GTC_t$

(39) $TX_t = XRICE_t + XRUB_t + XMZE_t + XTAP_t + XMFG_t + XOTH_t + XSERV_t$

(40) $TIMP_t = IMP1_t + IMP2_t + IMP3_t + IMP4_t + IMP5_t + IMPSERV_t$

(41) $TINV_t = AGINV_t + NAGINV_t + DINV_t$

(42) $TYUE_t = FY_t + YUE_t$

(43) $2GDP_t = TPCE_t + TGCE_t + TX_t - TIMP_t + SD_t + TINV_t + CROPOUT_t + OTHAG_t + MGDP_t + CONSOUT_t + WRTOUT_t + SERGDP_t + TCOUT_t + OTHOUT_t$

(44) $2NY_t = GDP_t + NFYPROW_t - IDTAX_t - CCA_t + COMP_t + TYUE_t + YPROP_t + CORPSAV_t + DTCORP_t + GGY_t - INTPD_t - INTCD_t$

(45) $PDY_t = NY_t - DTHH_t + TRANIN_t - TRANOUT_t$

LIST OF VARIABLES

(Note: All variables are in millions of baht, 1962 prices, unless otherwise noted.)

(1) AGINV = Fixed Capital Formation in Agriculture

(2) AGLAB = Number of Workers in Agriculture (1,000's of workers)

(3) CCA = Capital Consumption Allowance

(4) COMP = Compensation of Employees

(5) CONSOUT = Construction Output

(6) COPE = Consumption of Clothing and Other Personal Effects

(7) CORPSAV = Saving of Corporations and Government Enterprises

(8) CROPOUT = Crop Output

(9) D66* Dummy Variable, 1962-65 = 0; 1966-1974 = 1

(10) D73 = Dummy Variable, 1973 = 1; all other years = 0

(11) DINV = Change in Inventories

(12) DTCORP = Direct Taxes on Corporations

(13) DTHH = Direct Taxes on Households

(14) DXPBPMZ = Difference Between Export Price and Bangkok Wholesale Price of Maize (number of baht)

(15) FBT = Consumption of Food, Beverages, and Tobacco

(16) FFHHE = Consumption of Furniture, Furnishings, and Household Equipment

(17) FY = Farm Income

(18) GADJP = Government Expenditures on Administration, Defense, Justice and Police

(19) GDP = Gross Domestic Product

(20) GGY = General Government Income From Property and Entrepreneurship

(21) GREV = Government Revenue

(22) GSERV = Government Expenditures on Services

(23) GTC = Government Expenditures on Transportation and Communication

(24) IDTAX = Indirect Taxes

(25) IMP1 = Imports of Consumer Goods, Passenger Cars and Tires

(26) IMP2 = Imports of Intermediate Goods (Chiefly for Consumer Goods), Chassis and Bodies, and Fertilizers and Pesticides

(27) IMP3 = Imports of Fuel and Lubricants

(28) IMP4 = Imports of Capital Goods (not including Fertilizers and Pesticides), Buses and Trucks, and Intermediate Goods (Chiefly for Capital Goods)

(29) IMP5 = Total Merchandise Imports in Balance of Payments-(IMP1 + IMP2 + IMP3 + IMP4)

(30) IMPSERV = Imports of Services

(31) INTCD = Interest on Consumer Debt

(32) INTPD = Interest on Public Debt

(33) M1P/PGDP = Ratio of Price Deflator for IMP1 to the GDP Price Deflator

(34) M2P/PGDP = Ratio of Price Deflator for IMP2 to the GDP Price Deflator

(35) M4P/PGDP = Ratio of Price Deflator for IMP4 to the GDP Price Deflator

(36) MGDP = Manufacturing Output

(37) MZE = Output of Maize

(38) NAGLAB = Number of Workers in Nonagriculture (1,000's of workers)

(39) NAGINV = Fixed Capital Formation on Nonagriculture

(40) NFYPROW = Net Factor Income Payment from the Rest of the World

(41) NY = National Income

(42) OTHAG = Output of Agricultural Products, other than Crops

(43) OTHOUT = Output of other Products

(44) PDY = Personal Disposable Income

(45) PFFHHE/P = Ratio of Price Deflator for FFHHE to the Price Deflator for All Consumption

(46) PRE/P = Ratio of Price Deflator for RE to the Price Deflator for All Consumption

(47) PSERV/P = Ratio of Price Deflator for SERV to the Price Deflator for All Consumption

(48) PTC/P = Ratio of Price Deflator for TC to the Price Deflator for All Consumption

(49) RAGTLAB = Ratio of Agricultural Labor to Total Labor Force

(50) RE = Consumption Expenditures on Recreation and Entertainment

(51) RFLHHO = Consumption Expenditures on Rent, Fuel, Light, and Household Operation

(52) RICE = Output of Rice

(53) RNATLAB = Ratio of Nonagricultural Labor to Total Labor Force

(54) RUB = Output of Rubber

(55) SD = Statistical Discrepancy

(56) SERGDP = Output of Services

(57) SERV = Consumption Expenditures on Services

(58) TAP = Output of Tapioca

(59) TC = Consumption Expenditures of Transportation and Communication

(60) TCOUT = Output of Transportation and Communication

(61) TGCE = Total Government Consumption Expenditures

(62) TIMP = Total Imports

(63) TINV = Total Fixed Capital Formation

(64) TPCE = Total Personal Consumption Expenditures

(65) TRANIN = Net Transfers to Households from Government and ROW

(66) TRANOUT = Net Transfers From Households to Government and ROW

(67) TX = Total Exports

(68) TYUE = Total Income for Unincorporated Enterprises

(69) WRTOUT = Output of Wholesale and Retail Trade

(70) XMFG = Exports of Manufactured Goods

(71) XMZE = Exports of Maize

(72) XOTH = Exports of Other Goods

(73) XPRICE = Export Price of Rice (Baht per Metric Ton)

(74) XPRUB = Export Price of Rubber (Baht per Metric Ton)

(75) XRICE = Exports of Rice

(76) XRUB = Exports of Rubber

(77) XSERV = Exports of Services

(78) XTAP = Exports of Tapioca

(79) YPROP = Income from Property

(80) YUE = Income from Unincorporated Enterprises Other than Farms

C. Discussion of Equation Specification

1. Private Personal Consumption Equations

The equations in this sector have two general patterns. First, to as great an extent as possible in this sector as in other sectors, we have tried to include the effect of prices on the endogenous variables. In some cases a specification with a significant price effect was selected rather than one which might have predicted better. This is because, with the inclusion of a monetary sector which explains prices, the direct effect of monetary policy on the endogenous variables can be measured. Where a price effect is found to be unimportant, the specification of the consumption equations follows that of the permanent income hypothesis, where the lagged value of the consumption variable captures the permanent income effect.

2. Government Expenditure Equations

Here is a sector where one would prefer a much more disaggregated set of data to capture the differential effects of government spending more successfully. In any event, there does not seem to be a great deal of discretionary anti-cyclical fiscal policy with respect to government expenditures in Thailand. Therefore, the pattern of government expenditures follows a fairly smooth upward trend in response to the growth of the economy, reflected in the income variables, and to the growth of the population, reflected in the lagged values of the endogenous variable.

3. Export Equations

The volume of exports for a particular country is difficult to capture in just one equation because the volume of any commodity that is exported in a year depends on both domestic and international economic conditions. More desirable would be to have a structural model for each commodity that would model world demands and supplies and thereby world prices. Models of this sort constitute a very major research effort in themselves, so this approach becomes infeasible at this point. Any sort of single equation expression of the exports of an economy really is a reduced form equation in its own right. It reflects a series of equilibrium positions over the time period with the amount exported being a function of many demand and supply factors that are not explicitly specified or modeled. Because of this, it is difficult *a priori* even to say whether a single equation will be primarily a demand function, expressing world demand for Thai exports, or primarily a supply function, expressing Thai production reaction, say, to the world export price that it faces.

This is a familiar problem in statistical time series demand analysis in determining whether or not a set of price-quantity points reflect primarily a demand curve, primarily a supply curve, or some combination of shifts in the demand and supply curves. If we have a complete structural model with all equations identified, then it is possible to define the demand and supply functions explicitly. Working only with reduced form equations, as we are doing here, it is difficult, if not impossible, to do

this. Therefore, given the nature of the product being exported and the place that a country plays in the world market for this commodity, a single equation approach may show a strongly negative price effect, which would indicate that the equation is basically a demand relationship. Alternatively, we may observe a strongly positive price effect, indicating a supply relationship, or finally, no significant price effect at all, indicating, possibly, simultaneous demand and supply shifts.

Therefore, the export equations that are presented in Model I should be considered in this light. They really constitute reduced form equations of underlying structural models, and therefore, do not describe the underlying structure in the international market for these commodities. In the context of a macro-econometric model, they do constitute structural equations in the sense of explaining (and forecasting) the monetary value of the exports of a particular commodity on the basis of the exogenous and other endogenous variables of the model.

Specifically, we observe in the rice export equation a negative export price effect that would seem to indicate primarily a demand relationship for Thai rice. In the rubber export equation, we observe a positive price effect, indicating primarily a supply relationship. For maize, where the price variable is the difference between the export price of maize and the Bangkok Wholesale Price, we observe a positive effect, again indicating a supply relationship. For tapioca, manufactured goods, services, and other (a residual category), no significant price effect is observed.

With respect to the above discussion, it is argued that these apparently contradictory results are plausible from an economic theory point of view.

Aside from the price effects, we see that the primary explanatory variables are output variables and lagged values of exports, indicating evidence of trend in the export of the various commodity groups. Also, in the equations for rice and services we have included dummy variables to capture what we consider to be either a discrete shift in the intercept of the regression equation or a condition which does not reflect the basic economic conditions in the market we are trying to describe. In the rice export equation, the dummy variable, D73, is introduced to reflect the placing of an export quota on rice for 1973. In the service export equation, the dummy variable, D66*, is introduced to show an intercept shift resulting from the large-scale introduction of U.S. troops into Thailand during the Vietnam War.

4. Import Equations

Because import equations have many of the same characteristics as consumption expenditure equations, many of the same considerations apply as discussed above. In three of the four import groups we see a strong price effect on the level of imports.

It is noted that the classification of imports used is that of NESDB. There are perhaps other breakdowns and aggregations of imports that might be used, which might be more economically interesting if one were to expand this sector. But, as mentioned above, wherever it seemed appropriate the data classifications were selected to coincide with the national income data employed and published by NESDB.

5. Gross Fixed Capital Formation Equations

The specification of these investment equations follows a standard accelerator formulation in explaining levels of investment in terms of past changes in output or GDP. The level of aggregation in these equations, i.e., agricultural investment and nonagricultural investment, is perhaps excessive but was chosen only because of data availability. New, more disaggregated data, by industry group is now available but only for the period beginning in 1967. Because we wished to simulate Model I for the 1962-1974 period using actual data, the more aggregated equations were used in this model. In Model II, as will be discussed in Section III, using the disaggregated investment data, we "forecast" these data back to 1962. Then we used these data in disaggregating the investment sector and in generating capital stock series for the output equations. (See Section B of the Data Appendix for a detailed description of this process.)

6. Output Equations

In most macroeconometric models the general form of the output equations is that of an aggregate production function, i.e., Output = f (Capital, Labor). It is difficult to use this form of function in Thailand because of the lack of any capital stock or capital services time series data. As mentioned above, only investment data are available. Therefore the equations that appear are not really aggregate production functions in the strictest sense of the term; they are regression equations that attempt to predict the monetary value of output for the various output groups.

One possible approach, which uses only investment data and which preserves in part the production function nature of the relationship, is to employ a transformation of the following sort, which was used by Dr. Chinnawoot Soonthornsima in his Ph.D. dissertation at the University of Michigan.

This assumes that the effect of capital stock on real output takes place in one year, i.e., $k_{t-1} = k_{t-2} + i_{t-1}$ where i = investment

$$y_t = f\ (k_{t-2} + i_{t-1})$$

But $y_{t-1} = f\ (k_{t-2})$

$k_{t-2} = \emptyset\ (y_{t-1})$ where $\emptyset = f^{-1}$

So that $y_t = f[\emptyset\ (y_{t-1}) + i_{t-1}]$

or $y_t = f(y_{t-1}, i_{t-1})$

With the addition of some labor variable, the general form of the output equations investigated then becomes

$$\text{Output}_t = (\text{Labor}_t, \text{Investment}_{t-1}, \text{Output}_{t-1})$$

and the choice of which of these variables that appears in each equation was determined on the criterion of statistical significance.

The use of disaggregated investment data discussed before would be quite desirable in these equations. Again, however, in order to use the longer sample period, 1962-1974, for simulation purposes, we restricted our investment data in Model I to the level of aggregation of agricultural and nonagricultural investment. In Model II, we use the "estimated" capital stock data.

7. Income Distribution Equations

The degree of disaggregation is most unsatisfactory in this group of equations. To capture the effects of the interactions between the agricultural and nonagricultural sector in terms of income variables, it would be most desirable to have a much more detailed breakdown into ag and nonag income. Generating such data and expanding this sector will be one of the most important priorities in future model generations.

D. Results of a Reduced Form Simulation of Model I

As discussed in Section I.B.2, our structural model is written as $BY + GZ = U$, and by rewriting the model as

$$Y = -B^{-1}GZ + B^{-1}U$$
$$= \pi Z + V,$$

we obtain the reduced form of the model, where the jointly dependent variables Y are expressed as a function of the predetermined variables Z. Once the matrices of structural coefficients are obtained, the matrix of reduced form coefficients, π, may be calculated. Multiplying π by Z, the matrix of predetermined variables, we obtain predictions of each of the jointly dependent variables, which can then be compared with the actual values of these variables to evaluate the predictive capability of the entire structural model.

There are two possible ways this can be done. We note that the list of predetermined variables includes two kinds of variables; 1) exogenous variables, and 2) lagged values of the jointly dependent variables. In the first approach, we use the actual values of the lagged jointly dependent

(endogenous) variables. In the second, the value for each of the endogenous variables is calculated for the first observation, 1962. Then, wherever lagged values of the endogenous variables appear, say, for 1963, the calculated 1962 values are used, and so on for the rest of the simulation period. This second method is a much more stringent one for evaluating the model because it reflects the dynamic stability of the model. For example, if the predictions of the endogenous variables are poor in the early years, in a dynamically unstable model, the errors will tend to cumulated in the later years, and the predictions in these later years will tend to be very large. If the model is dynamically stable, these errors will be offset in other equations and predictions in the later years will not tend to wander off.

In Table 1 we present the results of the simulation of Model I. For each of the jointly dependent variables we show the actual value of the variable, denoted by the superscript A, the forecast value of the variable using the actual values of the lagged endogenous variables, denoted by the superscript * and the forecast values of the variable, using the calculated values of the endogenous variables, denoted by the superscript **.

$$U = \frac{\sqrt{\sum_t (\text{Predicted}_t - \text{Actual}_t)^2}}{\sqrt{\sum_t \text{Predicted}_t^2} \quad \sqrt{\sum_t \text{Actual}_t^2}}$$

This statistic is a measure of the accuracy of the forecast, and is approximately the average percent error of forecast.

In general, we see that the U - Statistic is higher, as would be expected, for the forecast series using the calculated values of the lagged endogenous variables, though this is not universally true. For both cases the forecasts seem to follow the actual values fairly, successfully as reflected in the U-Statistics. Two exceptions to this are those of Agricultural Investment and Construction Output, using the calculated values of the lagged endogenous variables, which indicate some dynamic instability in these equations. For the case where the actual value of the lagged endogenous variables is used, the U-Statistics range from 0.003 to 0.064 indicating forecasts that are close to the actual values.

As stated in the Introduction, Model I is designed specifically to be linear in both parameters and variables to describe the real sector of the Thai economy. We argue that, in terms of explaining and forecasting the monetary levels of aggregate economic variables, it is a fairly effective model. In Section III we present a modified version of Model I that allows for nonlinearities in the variables, which disaggregates Model I further and introduces explicitly a monetary and price sector.

TABLE 1

Actual and Forecast Values of Endogenous Variables from Reduced Form Analysis

	FBT_t^A	FBT_t^*	FBT_t^{**}	$RFLHHO_t^A$	$RFLHHO_t^*$	$RELHHO_t^{**}$	$COPE_t^A$	$COPE_t^*$	$COPE_t^{**}$
1962	26767	26735	26734	5160	5146	5146	3751	3801	3801
1963	28315	28468	28338	5392	5450	5413	4139	4184	4169
1964	29655	29761	29899	5657	5614	5658	4542	4471	4526
1965	31339	31279	31438	5893	5897	5896	4933	4876	4880
1966	33723	33316	33196	6233	6253	6200	5617	5404	5337
1967	36002	35836	35113	6565	6654	6532	6032	6097	5838
1968	38287	38332	37432	6928	7064	6962	6224	6649	6464
1969	40614	40734	40129	7526	7458	7461	6606	7033	7154
1970	42806	43351	43228	7903	7996	8030	7283	7563	7901
1971	44843	45306	46465	8170	8283	8587	8567	8062	8646
1972	47493	74297	49360	8611	8568	9013	9167	8948	9289
1973	50559	50036	51968	9151	9019	9372	10016	9753	10015
1974	53269	53416	53929	9453	9614	9572	10331	10768	10602
U		0.003	0.011		0.006	0.012		0.020	0.019

	$FFHHE_t^A$	$FFHHE_t^*$	$FFHHE_t^{**}$	$SERV_t^A$	$SERV_t^*$	$SERV_t^{**}$	TC_t^A	TC_t^*	TC_t^{**}
1962	1391	1280	1280	3480	3448	3448	3235	3263	3262
1963	1523	1530	1505	3683	3612	3594	3649	3734	3666
1964	1809	1742	1767	4023	3831	3842	4017	3905	3974
1965	2052	2032	2039	4260	4032	4046	4451	4277	4298
1966	2449	2492	2466	4219	268	4240	5094	4974	4901
1967	2861	2901	2826	4447	553	4519	5833	5708	5500
1968	3090	3122	3067	5045	4933	4802	6237	6322	6168
1969	3331	3309	3309	4962	5270	5202	6589	6858	6858
1970	3697	3451	3492	5284	5587	5617	7420	7429	7541
1971	3159	3235	3408	6221	5861	6046	7661	7619	8100
1972	3450	3489	3680	6354	6210	6500	8235	8114	8642
1973	4164	3973	4100	6958	6695	7041	9603	9008	9362
1974	4359	4331	4226	7459	7440	7493	9581	9880	9591
U		0.016	0.020		0.019	0.016		0.016	0.017

1) *Series - Forecast Values of Endogenous Variables Using Actual Values of Lagged Endogenous Variables
**Series - Forecast Values of Endogenous Variables Using Calculated Values of Lagged Endogenous Variables

TABLE 1 (Cont'd)

	RE_t^A	RE_t^*	RE_t^{**}	$GADJP_t^A$	$GADJP_t^*$	$GADJP_t^{**}$	$GSERV_t^A$	$GSERV_t^*$	$GSERV_t^{**}$
1962	2968	2956	2955	4268	4213	4213	1792	1663	1663
1963	3212	3408	3343	4773	4618	4599	1822	1814	1704
1964	3490	3508	3582	5048	5247	5185	1913	1864	1787
1965	3993	3889	3886	5712	5715	5764	1981	1998	1902
1966	4592	4432	4321	6156	6259	6278	2125	2144	2064
1967	5100	5033	4812	6654	6757	6800	2248	2350	2265
1968	5465	5590	5408	7997	7685	7736	2766	2544	2526
1969	5833	6101	6080	8731	8976	8884	2932	3029	2843
1970	6584	6727	6845	9695	9905	9959	3161	3265	3218
1971	6799	6875	7397	10495	10319	10412	3608	3490	3625
1972	7379	7283	7866	10375	10742	10712	3983	3895	4009
1973	8114	7951	8359	11557	10589	10707	4483	4280	4372
1974	8634	8802	8548	10896	11287	10988	4749	4798	4670
U		0.012	0.023		0.020	0.017		0.018	0.017

	GTC_t^A	GTC_t^*	GTC_t^{**}	$XRICE_t^A$	$XRICE_t^*$	$XRICE_t^{**}$	$XRUB_t^A$	$XRUB_t^*$	$XRUB_t^{**}$
1962	220	233	233	3240	3391	3391	2111	2098	2098
1963	274	283	296	3614	3240	3359	2032	2081	2086
1964	323	332	352	4834	3788	3587	2359	2266	2246
1965	354	377	403	4831	4669	3681	2293	2238	2281
1966	400	405	450	3843	4460	3549	2201	2265	2270
1967	449	447	492	3778	3997	3764	2295	2270	2244
1968	567	491	530	2723	2955	2944	2742	2778	2797
1969	651	598	565	2608	2504	2679	3005	3054	3033
1970	641	675	597	2711	3718	3774	2996	2967	2957
1971	669	666	626	4018	3939	4781	3347	3329	3344
1972	673	691	652	5384	5007	5612	3454	3456	3457
1973	724	695	675	2163	2161	2342	4245	4224	4222
1974	693	741	697	2666	2551	2692	3945	3939	3948
U		0.030	0.040		0.064	0.083		0.007	0.008

TABLE 1 (Cont'd)

	$XMZE_t^A$	$XMZE_t^*$	$XMZE_t^{**}$	$XTAP_t^A$	$XTAP_t^*$	$XTAP_t^{**}$	$XMFG_t^A$	$XMFG_t^*$	$XMFG_t^{**}$
1962	516	792	792	423	575	575	186	163	163
1963	818	900	830	451	547	662	225	353	307
1964	1233	1112	1109	780	480	638	219	540	533
1965	886	917	946	759	714	608	633	725	812
1966	1345	1221	1206	726	765	651	1552	1100	1135
1967	1222	1169	1204	824	767	711	2075	1580	1474
1968	1661	1407	1411	938	928	843	1804	1997	1846
1969	1647	1450	1513	1029	1088	1017	2093	2152	2230
1970	1544	1784	1817	1400	1212	1203	2253	2555	2639
1971	1997	1927	1858	1185	1441	1293	2749	2902	3073
1972	1965	2133	2168	1383	1571	1652	3826	3459	3536
1973	1478	1509	1458	1937	1934	2136	4358	4128	4028
1974	2443	2426	2432	2525	2341	2490	4433	4757	4551
U		0.050	0.052		0.061	0.060		0.056	0.060

	$XOTH_t^A$	$XOTH_t^*$	$XOTH_t^{**}$	$XSERV_t^A$	$XSERV_t^*$	$XSERV_t^{**}$	$IMP1_t^A$	$IMP1_t^*$	$IMP1_t^{**}$
1962	2958	2508	2508	1404	1540	1540	4061	4178	4180
1963	2594	2886	2567	1570	1771	1800	4262	4210	4201
1964	2850	2714	2700	1824	1953	2023	4423	4391	4401
1965	3199	2960	2862	2647	2175	2253	4595	4827	4851
1966	3695	3288	3044	5181	5489	5370	5341	5610	5603
1967	3251	3777	3274	7115	6445	6506	6234	5860	5777
1968	3051	3574	3538	7372	7241	7057	6768	6282	6229
1969	3091	3558	3868	7290	7562	7443	7292	6625	6625
1970	3309	3710	4259	7628	7736	7791	6154	6401	6439
1971	4098	3983	4714	7521	8056	8135	4729	5609	5695
1972	5587	4654	5194	8751	8274	8483	4569	3887	4010
1973	5598	5766	5631	9098	8917	8852	5189	5520	5658
1974	6025	5985	6029	9128	9332	9241	4161	4091	4060
U		0.054	0.060		0.026	0.024		0.040	0.042

TABLE 1 (Cont'd)

	$IMP2_t^A$	$IMP2_t^*$	$IMP2_t^{**}$	$IMP3_t^A$	$IMP3_t^*$	$IMP3_t^{**}$	$IMP4_t^A$	$IMP4_t^*$	$IMP4_t^{**}$
1962	1862	1886	1885	1224	1061	1060	3976	3721	3732
1963	2160	2310	2251	1251	1270	1240	4893	4257	4161
1964	2675	2510	2570	1563	1342	1373	5373	5472	5365
1965	2970	2928	2946	1440	1500	1510	5993	6425	6537
1966	3540	3642	3580	2052	1758	1726	7567	8400	8476
1967	4313	4187	4009	1733	2029	1937	9997	9807	9597
1968	4786	4790	4658	2161	2296	2228	11998	11745	11404
1969	5337	5269	5269	2159	2520	2520	13418	13346	13222
1970	5046	5463	5559	2760	2782	2831	12703	12824	12969
1971	5343	5399	5813	3100	2906	3119	9805	10083	10550
1972	5486	5356	5810	3359	3094	3328	10401	11014	11763
1973	6589	6174	6478	3951	3485	3641	13652	13420	14373
1974	5542	5812	5563	3698	3942	3814	14316	13992	13992
U		0.022	0.026		0.049	0.037		0.019	0.031

	$AGINV_t^A$	$AGINV_t^*$	$AGINV_t^{**}$	$NAGINV_t^A$	$NAGINV_t^*$	$NAGINV_t^{**}$	$CROPOUT_t^A$	$CROPOUT_t^*$	$CROPOUT_t^{**}$
1962	1286	1085	1085	8807	8848	8843	17674	17627	17627
1963	1346	1652	1462	10673	11761	11281	19302	18527	18527
1964	1414	1555	1765	13320	12302	13566	19146	19447	19447
1965	1883	1582	1725	14133	14320	14382	19581	20376	20376
1966	1907	2142	1863	17670	16789	15904	23056	21321	21321
1967	2830	2574	2209	21226	21329	18383	21033	22281	22281
1968	2916	2812	2574	23283	23207	21403	22856	23251	23251
1969	2805	3010	3159	26652	25483	25694	24542	24241	24241
1970	3157	3094	3652	26405	28738	30018	25139	25247	25247
1971	3306	3006	3972	26558	27080	33532	26291	26267	26267
1972	2673	2930	3689	27127	26313	33716	25343	27302	27302
1973	2810	2539	3012	28523	26546	31187	29489	28353	28353
1974	3256	3571	2340	30677	32102	27267	30169	29423	29423
U		0.047	0.098		0.025	0.071		0.020	0.020

TABLE 1 (Cont'd)

	$OTHAG_t^A$	$OTHAG_t^*$	$OTHAG_t^{**}$	$MGDP_t^A$	$MGDP_t^*$	$MGDP_t^{**}$	$CONSOUT_t^A$	$CONSOUT_t^*$	$CONSOUT_t^{**}$
1962	6015	5856	5856	8997	8422	8422	3270	3459	3456
1963	6495	6636	6386	9810	9674	9397	3614	4238	4031
1964	6977	7006	7150	10654	10887	10688	4152	3992	4539
1965	7480	7390	7823	12355	12164	12180	4612	4386	4412
1966	7729	8273	8077	13795	13968	13884	5604	4853	4471
1967	8871	8611	8556	15465	15568	15611	6640	6456	5183
1968	9943	10067	9297	16594	17465	17535	6944	6668	5889
1969	10715	10491	10067	18821	19030	19482	7046	7053	7144
1970	11035	10676	11115	20607	21258	21576	7019	7860	8413
1971	11431	11440	12054	23941	23339	23805	6210	6545	9332
1972	11764	11957	12783	26496	26243	26178	5782	5615	8813
1973	11403	11509	12769	30375	28851	28698	5845	4998	7002
1974	12019	12023	12274	31137	32182	31375	6124	6679	4590
U		0.011	0.030		0.016	0.016		0.042	0.125

	$WRTOUT_t^A$	$WRTOUT_t^*$	$WRTOUT_t^{**}$	$SERGDP_t^A$	$SERGDP_t^*$	$SERGDP_t^{**}$	$TCOUT_t^A$	$TCOUT_t^*$	$TCOUT_t^{**}$
1962	9898	9881	9881	6142	6068	6068	4633	4521	4521
1963	10883	10832	10840	6548	6597	6544	4795	4866	4866
1964	12095	11971	12110	7030	7129	7127	5348	5242	5255
1965	12824	13332	13388	7771	7716	7784	5608	5655	5661
1966	14132	14371	14428	8539	8546	8554	6013	6075	6081
1967	16686	15967	15563	9266	9271	9281	6633	6523	6485
1968	17722	17728	17077	10227	10091	10102	6818	7047	6985
1969	18754	19083	18653	10941	11075	10987	7289	7509	7468
1970	20995	20857	20638	11753	11886	11919	8241	8056	8035
1971	21628	21858	22686	12761	12766	12882	8623	8548	8628
1972	22742	23019	24616	13770	13784	13869	9335	9082	9236
1973	25624	24343	25852	15025	14864	14933	9721	9657	9802
1974	25108	25931	26541	16030	16116	16052	10115	10285	10344
U		0.013	0.022		0.004	0.003		0.010	0.008

TABLE 1 (Cont'd)

	$OTHOUT_t^A$	$OTHOUT_t^*$	$OTHOUT_t^{**}$	$COMP_t^A$	$COMP_t^*$	$COMP_t^{**}$	FY_t^A	FY_t^*	FY_t^{**}
1962	7164	6943	6943	14927	14118	14118	13122	14065	14065
1963	7678	7667	7522	16510	16284	15778	13834	14515	15101
1964	8290	8425	8350	17742	17651	17943	14473	15493	15270
1965	9255	9305	9356	18757	19085	19963	15984	16146	15801
1966	10320	10380	10458	20217	21617	21219	18188	16359	17686
1967	11542	11616	11626	22974	22984	22873	19448	18915	19267
1968	13182	13031	12957	25806	26757	25196	20276	18883	21019
1969	14438	14627	14391	27904	28385	27525	21497	20572	21594
1970	15939	16083	16007	30243	29630	30519	19864	22105	20846
1971	18131	17561	17772	33834	32098	33341	20848	22896	20476
1972	19243	19548	19630	34659	34123	35796	25607	24255	21456
1973	21088	20868	21429	34672	34252	36806	32444	31034	27401
1974	22653	22748	23097	35062	36394	36903	32135	32989	32175
U		0.007	0.008		0.016	0.019		0.030	0.045

	YUE_t^A	YUE_t^*	YUE_t^{**}	$YPROP_t^A$	$YPROP_t^*$	$YPROP_t^{**}$	$IDTAX_t^A$	$IDTAX_t^*$	$IDTAX_t^{**}$
1962	19684	19814	19807	5926	5650	5650	7002	7204	7203
1963	20750	21976	21396	6374	5998	5801	7765	8023	7906
1964	21709	21382	22044	6334	6318	6176	8713	8306	8440
1965	23976	22619	22597	6402	6683	6695	9166	8983	8979
1966	27282	25130	24133	7630	7424	7364	9791	9974	9773
1967	27373	27923	25926	7790	7883	7914	11150	10984	10580
1968	28828	30508	28862	7891	8553	8603	12641	12042	11710
1969	31459	32742	32555	8594	9123	9445	13492	12995	12957
1970	36642	35650	36723	9392	10029	10255	13867	14150	14367
1971	35474	35331	40041	11841	10830	11162	14457	14685	15637
1972	34350	35568	40835	12262	12081	12035	14724	15371	16435
1973	39689	37436	41123	14006	13257	13148	15673	16424	17170
1974	40195	41052	38759	14308	14811	14238	19174	17874	17410
U		0.020	0.040		0.026	0.028		0.021	0.037

TABLE 1 (Cont'd)

	$TPCE_t^A$	$TPCE_t^*$	$TPCE_t^{**}$	$TGCE_t^A$	$TGCE_t^*$	$TGCE_t^{**}$	TX_t^A	TX_t^*	TX_t^{**}
1962	46752	46629	46625	6280	6109	6109	10838	11068	11068
1963	49912	50385	50028	6869	6715	6599	11304	11778	11611
1964	53193	52832	53248	7283	7443	7325	14099	12854	12836
1965	56920	56282	56484	8048	8090	8069	15248	14399	13443
1966	69128	61140	60662	8681	8808	8792	18544	18588	17226
1967	66840	66883	65141	9351	9554	9557	20560	20005	19177
1968	71276	72014	70303	11330	10721	10792	20290	20879	20435
1969	75461	76764	76194	12314	12603	12292	20762	21370	21784
1970	80977	82104	82654	13497	13845	13774	21841	23683	24441
1971	85420	85242	88650	14772	14474	14662	24915	25578	27199
1972	90689	89910	94350	15031	15327	15373	30350	28553	30102
1973	98565	96435	100219	16764	15564	15755	28878	28640	28670
1974	103086	104252	103963	16338	16827	16355	31165	31332	31383
U		0.006	0.011		0.018	0.015		0.020	0.029

	$TIMP_t^A$	$TIMP_t^*$	$TIMP_t^{**}$	$TINV_t^A$	$TINV_t^*$	$TINV_t^{**}$	$TYUE_t^A$	$TYUE_t^*$	$TYUE_t^{**}$
1962	12039	11761	11774	11737	11578	11572	32806	33878	33870
1963	13539	13021	12826	14802	16195	15525	34584	36488	36495
1964	15226	14907	14901	15286	14407	15882	36182	36873	37311
1965	16384	17067	17229	17144	17030	17235	39960	38763	38396
1966	20012	20923	20897	22654	22007	20844	45471	41487	41816
1967	24293	23900	23335	24800	24647	21336	46822	46836	45191
1968	28268	27669	27074	27725	27544	25502	49104	49389	49879
1969	30871	30424	30301	33113	32149	32508	52956	53312	54146
1970	29945	30751	31081	33290	35560	37398	56506	57754	57568
1971	26327	27348	28527	31795	32017	39434	56322	58225	60516
1972	26890	26426	27986	27799	27242	35404	59957	59821	62289
1973	32596	31813	33365	36126	33878	38993	72133	68468	68523
1974	30088	30208	29800	37477	39217	33151	72330	74039	70932
U		0.012	0.020		0.021	0.067		0.017	0.021

TABLE 1 (Cont'd)

	GDP_t^A	GDP_t^*	GDP_t^{**}	NY_t^A	NY_t^*	NY_t^{**}	PDY_t^A	PDY_t^*	PDY_t^{**}
1962	63793	63313	63300	54333	53985	53976	53938	53590	53581
1963	69125	70433	69414	58372	59548	58749	57928	59104	58305
1964	73693	72893	74056	61405	61500	62310	60905	61000	61810
1965	79486	78784	78746	66278	65725	65970	65708	65155	65400
1966	89190	87402	85649	74802	72422	71582	74314	71934	71094
1967	96136	96180	92671	79568	79733	77317	78907	79072	76656
1968	104286	105385	102492	85130	86928	85138	84298	86096	84306
1969	112546	113669	113339	91510	93003	93005	90487	91980	91982
1970	120728	123716	125601	98064	100052	101351	96891	98879	100178
1971	129016	128365	136643	104269	103408	109004	103014	102153	107749
1972	134475	134326	143584	108846	108023	114166	107923	107100	113243
1973	148570	143490	149971	122466	117134	121252	122718	117386	121504
1974	153355	156091	152062	124680	128472	125103	125630	129422	126053
U		0.009	0.017		0.012	0.013		0.012	0.013

III. MODEL II: A MACROECONOMETRIC MODEL LINEAR IN PARAMETERS AND NONLINEAR IN VARIABLES

A. Specification of the Equations in Model II

Model II is a 55-equation model, that remains linear in the parameters but allows for nonlinearities in the variables. It varies from Model I in the following ways:

1) the private consumption expenditure equations are now specified in per capita figures rather than in levels;
2) three of the four import equations are specified in per capita terms rather than in levels;
3) the gross fixed capital formation equations have been disaggregated from two to seven equations;
4) six of the seven output equations are specified in a modified Cobb-Douglas production function form and the seventh in an output per worker form;
5) a fairly simple monetary and price sector has been added to monetize the model and to capture the effects of changes on the real sectors of the model.

The government expenditure, export, and income distribution equations remain unchanged from Model I.

The reason for changing from looking at levels for the cases of private consumption expenditures and for three of the import equations is that per capita consumption (and also imports) provides a better measure of the welfare of the people in the economy than does just consumption

level. Obviously, we can observe the levels of consumption increasing but if population is rising faster, we will observe a net decrease in per capita consumption. Therefore, if the level of consumption goods obtainable by each person in the economy is used as a welfare measure, as it often is, per capita consumption is preferable as the dependent variable in these equations. The reason for remaining with the level in the case of IMP1 is simply that a satisfactory specification for this import group was not found. Trying to do so remains an area for future research.

Note that in general, as might be expected, the goodness-of-fit statistics for the per capita specifications in Model II are a bit worse than those for the level case in Model I. Nevertheless, they remain strong, and so, given the additional economic content of the per capita specification, this specification is retained in Model II.

The Gross Fixed Capital Formation Equation Sector has been disaggregated from 2 to 7 equations, reflecting the same level of industry origin disaggregation as appears in the output equations. To achieve this degree of disaggregation, it was necessary to take the NESDB disaggregated data for the period 1967-1974, and estimate the 1961-1966 figures. The estimation method used here is described in detail in Section B of the Data Appendix. Of course the results in this sector must be considered in light of the fact that this data estimation has been carried out, but we assert that the estimation process is a reasonable one and that the benefits gained from the additional disaggregation merit this approach. The reader must judge for himself if this is true, but one further

thing to keep in mind is that the 1967-1974 data are "hard" data, and since we are interested in using the model for forecasting the period after 1974, the forecast will be based for the most part on this "hard" data in the latter years of the sample period.

The output equations have been respecified in a modified Cobb-Douglas form. Our original intention was to specify an unrestricted Cobb-Douglas form, but as often happens in estimating time-series production functions, the multicollinearity between the labor and capital series makes the estimated elasticities very unreliable. In fact, in almost all cases the capital coefficient turns significantly negative, which is an unacceptable result. Therefore, we decided to fit a general functional form of $\ln(\frac{\text{Output}}{\text{Labor}}) = f\ (\ln \text{Capital})$. This specification assumes that the elasticity of labor is unity, which is no doubt an excessive restriction, but it does allow us to get an unrestricted estimate of the capital elasticity. It also allows us to generate multipliers for labor in the various industry groups. Multipliers such as these can have important policy implications for programs of moving labor from one industry to another on overall GDP and other endogenous variables of the system.

This specification was used in six of the seven industry groups, the exception being that of Construction Output. This industry group exhibits the unusual characteristic that output per worker increases through 1968 and then declines very sharply. With an increasing capital stock, this leads to a negative sign for capital in construction. Why output per worker should be declining is not easy to explain, but it certainly asks for further analysis of this sector. Note also that the

D-W Statistics for some of these productions are unacceptably low. This also suggests further research in the whole output sector.

Finally, a rather rudimentary monetary and price sector has been added to Model II. The monetary sector in Thailand is a very difficult sector to model on the basis of traditional macro theory for a couple of reasons. First, the bulk of the money supply is held in currency and not in Demand Deposits. Second, the historical pattern of interest rates has been one of rigidity. Therefore, any sort of interest rate monetary mechanism is extremely hard to capture, and the traditional concept of monetary policy working through commercial bank reserves and thereby through demand deposit creation is very much weakened.

Therefore, we concentrated on the determination of M1, the narrowly defined money supply, and on the determination of the GDP and the Consumption Price Indexes (the latter not being the published Consumer Price Index). The effects of these price indexes feed back through the model through the consumption and import equations. One interesting result here is the very strong effect of the Import Price Index of Fuel & Lubricants on domestic price levels.

In summary, Model II is very similar in overall structure to that of Model I, but the additional flexibility of allowing nonlinearities in the variables allows us to ask some further economic questions in terms of the effects of particular variables. As will be seen, the simulation results of Model II remain very good, which is a very positive result, given the greater complexity and flexibility of this second model.

THE EQUATIONS OF MODEL II

PRIVATE CONSUMPTION EXPENDITURE EQUATIONS

		$\bar{R}^2$	D.W.
(1)	$\frac{FBT_t}{N_t} = \underset{(4.139)}{235.490} + \underset{(4.010)}{0.174}\frac{PDY_t}{N_t} + \underset{(2.886)}{0.418}\frac{FBT_{t-1}}{N_{t-1}}$	.991	2.196
(2)	$\frac{RFLHHO_t}{N_t} = \underset{(3.606)}{67.160} + \underset{(3.476)}{0.029}\frac{PDY_t}{N_t} + \underset{(1.740)}{0.328}\frac{RFLHHO_{t-1}}{N_{t-1}}$	.979	2.083
(3)	$\frac{COPE_t}{N_t} = \underset{(-0.688)}{-16.213} + \underset{(1.409)}{0.039}\frac{PDY_t}{N_t} + \underset{(2.236)}{0.608}\frac{COPE_{t-1}}{N_{t-1}}$	.963	1.455
(4)	$\frac{FFHHE_t}{N_t} = \underset{(5.123)}{111.567} + \underset{(4.432)}{0.025}\frac{PDY_t}{N_t} + \underset{(1.027)}{0.122}\frac{FFHHE_{t-1}}{N_{t-1}} - \underset{(-5.998)}{117.789}\frac{PFFHHE_t}{P_t}$	.970	2.187
(5)	$\frac{SERV_t}{N_t} = \underset{(2.830)}{140.900} + \underset{(4.709)}{0.026}\frac{GDP_t}{N_t} - \underset{(-2.003)}{76.005}\frac{PSERV_t}{P_t}$	.881	1.778
(6)	$\frac{TC_t}{N_t} = \underset{(0.026)}{0.891} + \underset{(27.580)}{0.097}\frac{PDY_t}{N_t} - \underset{(-2.324)}{68.402}\frac{PTC_t}{P_t}$	.993	2.701
(7)	$\frac{RE_t}{N_t} = \underset{(-0.453)}{-14.220} + \underset{(35.427)}{0.069}\frac{GDP_t}{N_t} - \underset{(-1.157)}{37.394}\frac{PRE_t}{P_t}$	.992	2.613

GOVERNMENT CONSUMPTION EQUATIONS

(8)	$GADJP_t = \underset{(-0.842)}{-426.585} + \underset{(3.291)}{0.439}\,GREV_{t-1} + \underset{(1.848)}{0.352}\,GADJP_{t-1}$	.977	3.068
(9)	$GSERV_t = \underset{(-2.400)}{-321.027} + \underset{(2.649)}{0.011}\,GDP_t + \underset{(5.416)}{0.759}\,GSERV_{t-1}$	.989	2.410
(10)	$GTC_t = \underset{(3.110)}{83.626} + \underset{(17.079)}{0.908}\,GTC_{t-1}$	.960	1.711

EXPORT EQUATIONS

		$\bar{R}^2$	D.W.
(11)	$XRICE_t = -3397.596 - 0.144\ XPRICE_t + 0.402\ RICE_{t-1} + 0.792\ XRICE_{t-1} - 2786.198\ D73_t$ (-1.574) (-1.403) (3.004) (3.064) (-3.380)	.634	1.708
(12)	$XRUB_t = -195.712 + 0.027\ XPRUB_t + 1.414\ RUB_t - .380\ XRUB_{t-1}$ (-2.397) (3.662) (18.543) (-4.854)	.995	2.455
(13)	$XMZE_t = 228.865 + 1.060\ MZE_{t-1} + 1.069\ DXPBPZ_t - 0.252\ XMZE_{t-1}$ (1.373) (6.286) (1.668) (-1.277)	.876	1.728
(14)	$XTAP_t = -106.297 + 0.405\ TAP_t + 0.752\ XTAP_{t-1}$ (-0.897) (2.718) (3.390)	.915	1.917
(15)	$XMFG_t = -1109.251 + 0.146\ MGDP_t + 0.268\ XMFG_{t-1}$ (-2.472) (3.188) (1.074)	.962	1.451
(16)	$XOTH_t = -117.471 + 0.015\ GDP_{t-1} + 0.692\ XOTH_{t-1}$ (-0.224) (1.745) (2.802)	.828	1.620
(17)	$XSERV_t = -282.921 + 0.246\ SERGDP_t + 0.307\ XSERV_{t-1} + 2857.120\ D666^*_t$ (-0.471) (2.308) (2.171) (5.946)	.982	2.588

IMPORT EQUATIONS

		$\bar{R}^2$	D.W.
(18)	$IMP1_t = 11429.275 + 0.026\ PDY_{t-1} - 8553.100\ \frac{M1P_t}{PGDP_t}$ (10.478) (3.787) (-6.860)	.792	2.284
(19)	$\frac{IMP2_t}{N_t} = -19.7 + .0909\ \frac{PDY_t}{N_t} - 82.000\ \frac{M2P_t}{PGDP_t}$ (-1.755) (17.586) (-8.024)	.966	2.336
(20)	$\frac{IMP3_t}{N_t} = -51.100 + 0.0471\ \frac{PDY_t}{N_t}$ (-3.936) (9.327)	.887	1.937
(21)	$\frac{IMP4_t}{N_t} = 241.400 + 0.1556\ \frac{PDY_{t-1}}{N_{t-1}} - 400.000\ \frac{M4P_t}{PGDP_t} + 0.1629\ \frac{IMP4_{t-1}}{N_{t-1}}$ (6.029) (6.996) (-9.139) (1.699)	.967	1.624

GROSS FIXED CAPITAL FORMATION EQUATIONS

		$\bar{R}^2$	D.W.
(22)	$AGINV_t = \underset{(0.464)}{126.607} + \underset{(2.707)}{0.071}\ (GDP_t - GDP_{t-1}) + \underset{(3.726)}{0.114}\ (GDP_{t-1} - GDP_{t-2}) + \underset{(3.619)}{0.451}\ AGINV_{t-1}$	.895	2.033
(23)	$MANINV_t = \underset{(-1.603)}{-589.457} + \underset{(2.167)}{0.073}\ (GDP_t - GDP_{t-1}) + \underset{(3.124)}{0.130}\ (GDP_{t-1} - GDP_{t-2}) + \underset{(13.826)}{0.872}\ MANINV_{t-1}$	.986	1.833
(24)	$CONSINV_t = \underset{(-0.578)}{-75.999} + \underset{(2.397)}{0.035}\ (GDP_t - GDP_{t-1}) + \underset{(3.142)}{0.056}\ (GDP_{t-1} - GDP_{t-2}) + \underset{(4.423)}{0.575}\ CONSTNV_{t-1}$	.937	3.251
(25)	$TCINV_t = \underset{(1.751)}{749.259} + \underset{(2.060)}{0.087}\ (GDP_t - GDP_{t-1}) + \underset{(8.309)}{0.744}\ TCINV_{t-1}$	.895	2.047
(26)	$WRTINV_t = \underset{(1.840)}{386.916} + \underset{(1.707)}{0.118}\ (WRTOUT_t - WRTOUT_{t-1}) + \underset{(2.295)}{0.208}\ (WRTOUT_{t-1} - WRTOUT_{t-2}) + 0.770\ WRTINV_{t-1}$	.940	2.449
(27)	$SERVINV_t = \underset{(-0.434)}{-156.963} + \underset{(1.281)}{0.046}\ (GDP_t - GDP_{t-1}) + \underset{(2.111)}{0.088}\ (GDP_{t-1} - GDP_{t-2}) + \underset{(6.602)}{0.746}\ SERVINV_{t-1}$	.942	2.720
(28)	$OTHINV_t = \underset{(0.372)}{184.627} + \underset{(1.555)}{0.087}\ (GDP_t - GDP_{t-1}) + \underset{(3.588)}{0.228}\ (GDP_{t-1} - GDP_{t-2}) + \underset{(7.703)}{0.679}\ OTHINV_{t-1}$	.967	2.401

OUTPUT EQUATIONS

(29)	$\ln \left(\frac{AGOUT_t}{AGLAB_t}\right) = \underset{(10.559)}{3.385} + \underset{(13.872)}{0.427}\ \ln KAG_t$	.941	2.393
(30)	$\ln \left(\frac{MGDP_t}{MANLAB_t}\right) = \underset{(13.258)}{3.606} + \underset{(24.244)}{0.644}\ \ln KMAN_t$	.980	0.979

		$\bar{R}^2$	D.W.
(31)	$\frac{CONSOUT_t}{CONLAB_t} = 19780.387 - 0.726\ KCONS_t + 0.779\ \frac{CONSOUT_{t-1}}{CONLAB_{t-1}}$ (2.141)(-2.896) (5.331)	.908	1.030
(32)	$\ln \frac{(WRTOUT_t)}{(WRTLAB_t)} = -1.329 + 1.059\ \ln KWRT_t$ (-2.146)(18.164)	.965	0.904
(33)	$\ln \frac{(SERGDP_t)}{(SERLAB_t)} = 6.441 + 0.266\ \ln KSERV_t$ (41.185)(17.378)	.962	0.553
(34)	$\ln \frac{(TCOUT_t)}{(TCLAB_t)} = 6.726 + 0.318\ \ln KTC_t$ (24.977)(13.148)	.935	2.110
(35)	$\ln \frac{(OTHOUT_t)}{(OTHLAB_t)} = 3.162 + 0.616\ \ln KOTH_t$ (11.266)(25.007)	.981	0.718

INCOME DISTRIBUTION EQUATIONS

(36)	$COMP_t = -11929.889 + 2.027\ OTHAG_t + 5.372\ NAGLAB_t$ (-5.875) (4.780) (3.397)	.985	1.104
(37)	$FY_t = 537442.001 - 2.761\ OTHAG_t - 617994.000\ RAGTLAB_t - 0.862\ XRICE_t$ (7.078)(-3.679) (-7.047) (-1.881)	.943	1.808
(38)	$YUE_t = 29541.813 + 0.569\ GDP_t - 17.337\ NAGLAB_t$ (2.302) (3.190) (-1.896)	.972	1.927
(39)	$YPROP_t = -111036.547 + 0.711\ MGDP_t + 135660.782\ RAGTLAB_t$ (-3 381) (7.473) (3.443)	.988	2.489
(40)	$IDTAX_t = -76.798 + 0.115\ GDP_t$ (-0.098)(16.082)	.955	1.755

MONETARY AND PRICE EQUATIONS

(41)	$CHP_t = 2057.450 + 0.073\ GDPCP_t$ (4.404)(21.992)	.976	1.314
(42)	$DDHP_t = 1162.477 + 0.067\ XNAGCP_t$ (3.037)(16.696)	.959	0.962

	$\bar{R}^2$	D.W.
(43) $TDHP_t = -12844.045 + 0.238\ GDPCP_t$ $(-7.993)(20.887)$	.973	0.940
(44) $PGDP_t = 0.676 + 0.000018\ M1_t + 0.141\ M3P_t$ $(23.111)\ (9.353)\ (6.841)$	.969	1.738
(45) $P_t = 0.423 + 0.00001\ M1 + 0.408\ PGDP_t$ $(3.713)\ (3.126)\ (2.446)$ $+ 0.068\ M3P_t$ (2.610)	.990	1.812

IDENTITIES

(46) $$\frac{TPCE_t}{N_t} = \frac{FBT_t}{N_t} + \frac{RFLHHO_t}{N_t} + \frac{COPE_t}{N_t} + \frac{FFHHE_t}{N_t} + \frac{SERV_t}{N_t} + \frac{TC_t}{N_t} + \frac{RE_t}{N_t}$$

(47) $TGCE_t = GADJP_t + GSERV_t + GTC_t$

(48) $TX_t = XRICE_t + XRUB_t + XMZE_t + XTAP_t + XMFG_t + XOTH_t + XSERV_t$

(49) $$\frac{TIMP_t}{N_t} = \frac{IMP1_t}{N_t} + \frac{IMP2_t}{N_t} + \frac{IMP3_t}{N_t} + \frac{IMP4_t}{N_t} + \frac{IMP5_t}{N_t} + \frac{IMPSERV_t}{N_t}$$

(50) $TINV_t = AGINV_t + MANINV_t + CONSINV_t + TCINV_t + WRTINV_t + SERVINV_t$
$+ OTHINV_t + DINV_t$

(51) $TYUE_t = FY_t + YUE_t$

(52) $M1_t = CHP_t + DDHP_t$

(53) $2GDP_t = TPCE_t + TGCE_t + TX_t - TIMP_t + TINV_t + SD_t + AGOUT_t + MGDP_t$
$+ CONSOUT_t + WRTOUT_t + SERGDP_t + TCOUT_t + OTHOUT_t$

(54) $2NY = GDP_t + NFYPROW_t - IDTAX_t - CCA_t + COMP_t + TYUE_t + YROP_t$
$+ CORPSAV_t + DTCORP_t + GGY_t - INTPD_t - INTCD_t$

(55) $PDY_t = NY_t - DTHH_t + TRANIN_t - TRANOUT_t$

LIST OF VARIABLES IN MODEL II, NOT IN MODEL I

(1) AGOUT = Total Output in Agriculture

(2) CHP = Currency in Hands of the Public

(3) CONLAB = Workers in Construction (millions of workers)

(4) CONSINV = Gross Fixed Capital Formation in Construction

(5) DDH = Demand Deposits in Hands of the Public

(6) GDPCP = Gross Domestic Product in Current Prices

(7) KAG = Capital Stock in Agriculture

(8) KCONS = Capital Stock in Construction

(9) KMAN = Capital Stock in Manufacturing

(10) KOTH = Capital Stock in Other

(11) KSERV = Capital Stock in Services

(12) KTC = Capital Stock in Transportation and Communication

(13) KWRT = Capital Stock in Wholesale and Retail Trade

(14) M3P = Price Deflator for Fuel and Lubricants

(15) MANINV = Gross Fixed Capital Formation in Manufacturing

(16) MANLAB = Workers in Manufacturing (millions of workers)

(17) N = Population (millions of workers)

(18) OTHINV = Gross Fixed Capital Formation in Other

(19) OTHLAB = Workers in Other (millions of workers)

(20) SERVINV = Gross Fixed Capital Formation in Services

(21) SERLAB = Workers in Services (millions of workers)

(22) TCINV = Gross Fixed Capital Formation in Transportation and Communication

(23) TCLAB = Workers in Transportation and Communication (millions of workers)

(24) TDH = Time Deposits in Hands of the Public

(25) WRTINV = Gross Fixed Capital Formation in Wholesale and Retail Trade

(26) WRTLAB = Workers in Wholesale and Retail Trade (millions of workers)

(27) XNAGCP = Non-Agricultural Output in Current Prices

B. Results of a Gauss-Seidel Simulation of Model II

In Table 2 we present the results of simulating Model II with a Gauss-Seidel simulation algorithm. The Gauss-Seidel routine is an iterative one, wherein the structural equations may be nonlinear in either the variables, parameters, or both. In contrast to the reduced form approach used for simulating Model I, where the equations of the reduced form of the structural model are solved simultaneously, the Gauss-Seidel algorithm solves the system of simultaneous structural equations directly for each year of the simulation period. The first year's values of the jointly dependent variables are read in as estimated values to begin the iteration for the solution of the model for the first year (1962). Then the solution values for 1962 are taken as the estimated values for 1963, and so on. Ultimately, we get a set of solution values for the jointly dependent variables for each year.

This approach varies from the reduced form approach in two ways. First, since the reduced form matrix of multipliers is not generated directly, multiplier analysis with the model must be carried out step-by-step by changing the value of one of the predetermined variables, resolving the system, then comparing the two solutions to get the implicit multiplier for that variable. Second, it is not possible to get a simulation of the model using the actual values of the lagged endogenous variables as we were able to do with Model I. Therefore, in Table 2 we present only one set of predicted values. These predicted values correspond to the second set shown in Table I, viz., the ** variables.

The main thing to note in comparing Tables 1 and 2 is that for the jointly dependent variables that are common to both models, the predictive performance, as reflected in the Theil U-Statistic, is very close. The U-Statistic is slightly lower in some cases and slightly higher in others. For the two cases that were the poorest for Model I, Agricultural Investment and Construction Output, we note the following. In the case of Agricultural Investment, the U-Statistic declines from .098 to .073. For the case of Construction Output, the change in the U-Statistic is very small, from .125 to .122, but the major errors in Model I appear in the later years, while those in Model II appear in the earlier years. From a forecasting point of view, the latter problem would seem to be less severe. Nonetheless, this equation continues to be a weak one in Model II, as it was in Model I. The rest of the equations perform very satisfactorily.

In short, the predictive performance of the more complex and flexible Model II remains good. This robustness in the general overall structure is encouraging in indicating that future and even more complex forms of the model will continue to fit and forecast successfully.

TABLE 2

Actual and Forecast Values of Endogenous Variables of Model II from Gauss-Seidel Analysis

	$\frac{FBT_t^A}{N_t}$	$\frac{FBT_t^{**}}{N_t}$	$\frac{RFLHHO_t^A}{N_t}$	$\frac{RFLHHO_t^{**}}{N_t}$	$\frac{COPE_t^A}{N_t}$	$\frac{COPE_t^{**}}{N_t}$	$\frac{FFHHE_t^A}{N_t}$	$\frac{FFHHE_t^{**}}{N_t}$
1962	938	948	181	181	131	136	49	48
1963	967	981	184	185	141	144	52	54
1964	987	1000	188	187	151	151	60	60
1965	1016	1016	191	189	160	157	66	67
1966	1066	1047	197	194	178	166	77	77
1967	1109	1072	202	197	186	174	88	84
1968	1149	1108	208	202	188	185	93	89
1969	1188	1147	220	208	193	197	97	94
1970	1177	1173	217	212	200	206	102	95
1971	1196	1201	218	216	228	215	84	90
1972	1231	1226	223	219	238	224	89	92
1973	1274	1282	230	228	252	240	105	100
1974	1306	1329	232	235	253	255	106	110
U		0.010		0.010		0.021		0.021

	$\frac{SERV_t^A}{N_t}$	$\frac{SERV_t^{**}}{N_t}$	$\frac{TC_t^A}{N_t}$	$\frac{TC_t^{**}}{N_t}$	$\frac{RE_t^A}{N_t}$	$\frac{RE_t^{**}}{N_t}$	$GADJP^A$	$GADJP^{**}$
1962	122	124	113	118	104	104	4268	4213
1963	126	127	125	128	110	113	4773	4599
1964	134	129	134	131	116	115	5048	5185
1965	138	132	144	136	130	120	5712	5764
1966	133	135	161	152	145	132	6156	6278
1967	137	137	180	160	157	140	6654	6800
1968	151	143	187	175	164	153	7997	7736
1969	145	150	193	190	170	167	8731	8884
1970	145	154	204	195	181	173	9695	9959
1971	166	158	204	203	181	183	10495	10411
1972	165	160	213	212	191	189	10375	10712
1973	175	173	242	235	204	205	11557	10707
1974	183	186	235	247	212	217	10896	10988
U		0.017		0.024		0.024		0.018

TABLE 2 (Cont'd)

	GSERV[A]	GSERV**	GTC[A]	GTC**	XRICE[A]	XRICE**	XRUB[A]	XRUB**
1962	1792	1671	220	233	3240	3391	2111	2098
1963	1822	1714	274	296	3614	3359	2032	2086
1964	1913	1781	323	352	4834	3587	2359	2246
1965	1981	1878	354	403	4831	3681	2293	2281
1966	2125	2033	400	450	3843	3549	2201	2270
1967	2242	2219	449	493	3778	3764	2295	2244
1968	2776	2457	567	530	2723	2944	2742	2797
1969	2932	2741	651	565	2608	2679	3005	3033
1970	3161	3075	641	597	2711	3774	2996	2957
1971	3608	3431	669	626	4018	4781	3347	3344
1972	3983	3784	673	652	5384	5612	3454	3457
1973	4483	4192	724	675	2163	2342	4245	4222
1974	4749	4602	693	697	2666	2692	3945	3948
U		0.029		0.040		0.084		0.008

	$XMZE_t^A$	$XMZE_t^{**}$	XTAP[A]	XTAP**	XMFG[A]	XMFG**	XOTH[A]	XOTH**
1962	516	792	423	575	186	329	2958	2508
1963	818	830	451	662	225	472	2594	2579
1964	1233	1110	780	638	219	629	2850	2712
1965	886	946	759	608	633	815	3199	2852
1966	1345	1206	726	651	1552	1037	3695	3011
1967	1222	1204	824	711	2075	1308	3251	3233
1968	1661	1411	938	843	1804	1645	3051	3479
1969	1647	1513	1029	1017	2093	2038	3091	3781
1970	1544	1817	1400	1203	2253	2514	3309	4132
1971	1997	1858	1185	1293	2749	3044	4098	4536
1972	1965	2168	1383	1652	3826	3603	5587	4955
1973	1478	1458	1937	2136	4358	4203	5598	5358
1974	2443	2432	2525	2491	4433	4863	6025	5828
U		0.052		0.061		0.070		0.059

TABLE 2 (Cont'd)

	$XSERV^A$	$XSERV^{**}$	$IMP1_t^A$	$IMP1_t^{**}$	$\frac{IMP2_t^A}{N_t}$	$\frac{IMP2_t^{**}}{N_t}$	$\frac{IMP3_t^A}{N_t}$	$\frac{IMP3_t^{**}}{N_t}$
1962	1404	1578	4061	4238	65	72	43	39
1963	1570	1846	4262	4466	74	83	43	43
1964	1824	2053	4423	4499	89	86	52	45
1965	2647	2259	4595	4699	96	91	47	47
1966	5181	5335	5341	5123	112	106	65	54
1967	7115	6453	6234	5536	133	115	53	57
1968	7372	6998	6768	6134	144	132	65	64
1969	7290	7375	7292	6463	156	145	63	70
1970	7628	7726	6154	6485	139	144	76	73
1971	7521	8086	4729	5999	143	149	83	76
1972	8751	8474	4569	4704	142	142	87	81
1973	9098	8819	5189	4926	166	160	100	93
1974	9128	9331	4161	4236	136	150	91	100
U		0.025		0.049		0.037		0.044

	$\frac{IMP4_t^A}{N_t}$	$\frac{IMP4_t^{**}}{N_t}$	$AGINV^A$	$AGINV^{**}$	$MANINV^A$	$MANINV^{**}$	$CONSINV^A$	$CONSINV^{**}$
1962	139	143	1312	1333	787	669	535	531
1963	167	170	1515	1700	1057	1058	638	707
1964	179	196	1813	1755	1444	1290	781	754
1965	194	209	1922	1578	1745	1255	849	682
1966	239	239	2291	1839	2329	1586	1018	809
1967	308	277	2830	2245	3017	2215	1298	1023
1968	360	327	2916	2463	3559	2782	1470	1164
1969	392	369	2805	2912	4567	3671	1354	1417
1970	349	363	3157	3280	4935	4625	1535	1644
1971	262	289	3306	3489	5017	5516	1461	1795
1972	270	296	2673	3297	5267	5982	1438	1742
1973	344	327	2810	3371	5848	6529	1592	1790
1974	351	350	3256	3749	6822	7428	1820	1987
U		0.035		0.073		0.073		0.078

TABLE 2 (Cont'd)

	TCINV[A]	TCINV**	WRTINV[A]	WRTINV**	SERVINV[A]	SERVINV**	OTHINV[A]	OTHINV**
1962	2321	2675	1363	1546	858	856	2917	2977
1963	2705	3222	1598	1891	1057	1183	3450	3845
1964	3226	3427	1915	2072	1341	1362	4214	4341
1965	3396	3657	2050	2252	1506	1332	4549	4226
1966	4092	4121	2467	2430	1879	1543	5501	4643
1967	4820	4350	2792	2607	2555	1936	6740	5579
1968	5230	4749	3454	2806	2443	2232	7127	6137
1969	5951	5108	3443	3034	2988	2717	8347	7180
1970	5401	5480	3497	3277	2995	3196	8043	8152
1971	5166	5640	3306	3480	3630	3599	7978	8972
1972	5312	5595	3279	3649	3633	3694	8199	9059
1973	5877	6022	3465	3768	3614	3843	8128	9149
1974	5393	6023	3638	3877	3811	4252	9193	10099
U		0.045		0.052		0.050		0.058

	AGOUT[A]	AGOUT**	MGDP[A]	MGDP**	CONSOUT[A]	CONSOUT**	WRTOUT[A]	WRTOUT**
1962	23689	24301	8997	9558	3270	982	9898	10604
1963	25797	25299	9810	10226	3614	1901	10883	11267
1964	26123	26334	10654	11038	4152	2734	12095	12040
1965	27061	27402	12355	12026	4612	3528	12824	12961
1966	30785	28689	13795	13207	5604	4223	14132	13958
1967	29904	29986	15465	14655	6640	4870	16686	15155
1968	32799	31676	16694	16465	6944	5365	17722	16537
1969	35257	33386	18821	18534	7046	5791	18754	18224
1970	36174	35039	20607	21074	7019	6046	20995	19941
1971	37722	36822	23941	23837	6210	6195	21628	21744
1972	37107	38653	26496	26687	5782	6164	22742	23499
1973	40892	40244	30375	29770	5845	5995	25624	25250
1974	42188	41895	31137	33190	6124	5604	25108	27153
U		0.016		0.018		0.122		0.025

TABLE 2 (Cont'd)

	SERGDP[A]	SERGDP**	TCOUT[A]	TCOUT**	OTHOUT[A]	OTHOUT**	COMP[A]	COMP**
1962	6142	6220	4633	4634	7164	7150	14927	14439
1963	6548	6684	4795	4938	7678	7767	16510	15998
1964	7030	7192	5348	5260	8290	8490	17742	17592
1965	7771	7771	5608	5630	9255	9322	18757	19267
1966	8539	8402	6013	6011	10320	10260	20217	20513
1967	9266	9109	6633	6449	11542	11338	22974	23511
1968	10227	9931	6818	6917	13182	12880	25806	26505
1969	10941	10783	7289	7435	14438	14039	27904	28838
1970	11753	11740	8241	8013	15939	15658	30243	30357
1971	12761	12763	8623	8583	18131	17401	33834	32079
1972	13770	13893	9335	9154	19243	19299	34659	33731
1973	15025	15102	9721	9769	21088	21359	34672	34036
1974	16030	16372	10115	10446	22653	23593	35062	36386
U		0.007		0.010		0.041		0.015

	FY[A]	FY**	YUE[A]	YUE**	YPROP[A]	YPROP**	IDTAX[A]	IDTAX**
1962	13122	13628	19684	20262	5926	6458	7002	7294
1963	13834	14803	20750	21529	6374	6390	7765	7933
1964	14473	15748	21709	21371	6334	6425	8713	8304
1965	15984	16749	23976	21598	6402	6586	9166	8777
1966	18188	19266	27282	23464	7630	6746	9791	9638
1967	19448	17781	27373	24758	7790	7369	11150	10344
1968	20276	18619	28828	27103	7891	7978	12641	11354
1969	21497	19805	31459	30021	8594	8770	13492	12445
1970	19864	21068	36642	33297	9392	9898	13867	13675
1971	20848	22196	35474	35654	11841	11184	14457	14750
1972	25607	23651	34350	36750	12262	12532	14724	15610
1973	32444	31174	39689	40663	14006	13910	15673	17077
1974	32135	32879	40195	42303	14308	15528	19174	18126
U		0.031		0.034		0.027		0.031

TABLE 2 (Cont'd)

	CHP[A]	CHP**	DDHP[A]	DDHP**	TDHP[A]	TDHP**	PGDP[A]	PGDP**
1962	6573	6714	4520	3849	3149	2339	1.000	1.007
1963	6660	7027	3541	4078	4255	3358	0.985	1.013
1964	7266	7508	3672	4490	5368	4927	1.013	1.023
1965	8125	8212	4792	4842	6407	7220	1.061	1.043
1966	9371	9458	5286	5475	8826	11283	1.137	1.073
1967	9824	9963	5882	6097	10979	12930	1.126	1.094
1968	10641	10582	6645	6533	13241	14948	1.120	1.114
1969	10950	11443	7039	7075	16100	17755	1.142	1.129
1970	11864	11981	7584	7672	19490	19509	1.126	1.149
1971	13053	12563	8393	8118	24172	21406	1.115	1.174
1972	15279	13889	9552	8718	31379	25729	1.205	1.214
1973	18645	17767	11291	10691	38643	38372	1.448	1.355
1974	20450	21769	12475	13476	49436	51420	1.761	1.790
U		0.026		0.035		0.048		0.017

	P[A]	P**	TPCE/N[A]	TPCE/N**	TGCE[A]	TGCE**	TX[A]	TX**
1962	1.000	1.007	1639	1658	6280	6118	10838	11271
1963	0.999	1.014	1705	1732	6869	6608	11304	11834
1964	1.008	1.024	1770	1773	7283	7318	14099	12974
1965	1.029	1.043	1846	1816	8048	8045	15248	13442
1966	1.076	1.072	1957	1903	8681	8761	18544	17059
1967	1.126	1.092	2059	1964	9351	9511	20560	18917
1968	1.135	1.111	2139	2055	11330	10723	20290	20118
1969	1.146	1.126	2207	2152	12314	12190	20762	21437
1970	1.142	1.146	2226	2208	13497	13631	21841	24124
1971	1.150	1.170	2279	2266	14772	14468	24915	26943
1972	1.203	1.207	2350	2324	15031	15148	30350	29920
1973	1.395	1.340	2484	2463	16764	15574	28878	28610
1974	1.709	1.737	2528	2579	16338	16286	31165	31584
U		0.010		0.011		0.017		0.029

TABLE 2 (Cont'd)

	TIMP/N[A]	TIMP/N**	TINV[A]	TINV**	TYUE[A]	TYUE**	M1[A]	M1**
1962	422	435	11737	12230	32806	33890	11093	10564
1963	462	482	14802	16388	34584	36332	10201	11105
1964	507	516	15286	15552	36182	37119	10938	11998
1965	531	544	17144	16110	39960	38347	12917	13054
1966	632	609	22654	20049	45471	42730	14657	14933
1967	748	681	24800	20699	46822	42539	15706	16060
1968	848	783	27725	23859	49104	45722	17286	17115
1969	903	851	33113	29694	52956	49826	17989	18518
1970	823	849	33290	33382	56506	54364	19448	19653
1971	702	765	31795	34422	56322	57850	18446	20681
1972	697	720	27799	31016	59957	60401	24831	22607
1973	821	786	36126	39265	72133	71837	29936	28458
1974	738	762	37477	40961	72330	75182	32925	35245
U		0.028		0.049		0.022		0.032

	GDP[A]	GDP**	NY[A]	NY**	PDY[A]	PDY**
1962	63793	64100	54333	54904	53938	54509
1963	69125	69648	58372	59178	57928	58729
1964	73693	72874	61405	61639	60905	61139
1965	79486	76990	66278	64765	65708	64195
1966	89190	84476	74802	70858	74314	70370
1967	96136	90619	79568	75129	78907	74468
1968	104236	99403	85130	82034	84298	81202
1969	112546	108887	91510	89194	90487	88171
1970	120728	119581	98064	96826	96891	95652
1971	129016	128934	104269	103640	103014	102385
1972	134475	136406	108846	109262	107923	108338
1973	148570	149163	122466	121547	122718	121799
1974	153355	158287	124680	129868	125630	130818
U		0.014		0.014		0.014

IV. SUGGESTION FOR FURTHER RESEARCH IN THE MACRO-MODELING EFFORT AND SUMMARY AND CONCLUSIONS

A. Suggestions for Further Research

Anyone who engages in trying to construct a macroeconometric model is aware of many weaknesses and shortcomings in his product. This is particularly true for modeling efforts in developing countries because of some of the difficulties mentioned in the introduction of this report. In many ways, a modeling effort is a never-ending process, with the model needing to be constantly updated, revised, and hopefully improved. Nevertheless, it is necessary at some point to make the current version (or versions) of the model available in order to solicit discussion, criticism, and recommendations. The models in this paper are presented in that spirit.

We see several areas in which further research is necessary; no doubt there are many others. In this section we discuss briefly a partial list of these areas to provide the reader with some notion as to the direction the current modeling effort will take.

1) The estimation of these models by Ordinary Least Squares is not satisfactory on grounds that are well known. We plan to reestimate the model by two Stage Least Squares by using Principal Components as the first-stage regressors.

2) In light of the overall purpose of the project, probably the major research that must be undertaken is that of the linkage of the macroeconometric model to the national linear programming model of Thai agriculture. This research is currently underway.

There are two possible ways that the macro-model of the nonagricultural sector may be linked to the linear-programming model of the agricultural equations of the macro-model to the equations of the linear programming model and to solve the combined system of equations simultaneously. From a dynamic standpoint, such solutions could be obtained for successive time periods under alternative policy assumptions.

This method, however, provides some difficulties. First, given the present set of computer programs and computer resources at our disposal, it forces the macro-model of the nonagricultural sector to be linear such as Model I, both in the parameters and in the variables. This is a very severe restriction on the specification of the macro model. The reason that it imposes a linearity constraint is that for a very large system of simultaneous equations, the only algorithm that we currently have that can solve such a large system is the linear programming algorithm, which is unable at present to handle nonlinearities. Solving the combined system simultaneously would require either a modification of the L-P algorithm to allow for nonlinearities or the use of an alternative algorithm for solving systems of nonlinear equations, such as the Gauss-Seidel technique. Either approach would entail a major programming effort in terms of computer size and solution time.

An alternative approach is to treat the combined ag and non-ag sector models in a block-recursive manner and therefore solve the two sector models separately. Because of the much smaller size of the non-ag macro model, a non-linear specification such as Model II will pose many fewer difficulties

in its solution. The linkage would then be recursive by temporal periods in the sense that a solution to the linear programming model of agriculture would be obtained subject to previous solved-for values of the non-ag macro variables. The resulting values of the agricultural variables which influence the non-agricultural sector of the economy will be fed into the macro model, which will then be re-solved, and so on.

Whether this recursive approach will prove satisfactory for simulating various policy proposals remains to be seen, but because of its greater computational simplicity, this will be our initial approach in the linkage of the two sector models. If it turns out that it appears necessary that a simultaneous solution technique be used, the programming effort to make this possible will then be undertaken.

3) The monetary and price sector, as mentioned above, is very rudimentary and really does not capture the workings of the financial sector satisfactorily. We plan to expand this sector considerably, including financial variables as explanatory variables in various sectors of the model, most particularly the investment sector. Also, we plan to expand this sector to analyze the Balance of Payments and foreign exchange position of Thailand. This would be of obvious interest because of the open nature of the Thai economy.

4) It is possible that having a model specification that is linear in the parameters is too restrictive and that improved performance might be gained by using nonlinear specifications. In the future, we plan to explore some possible nonlinear forms.

5) Because of the very important political and social implications of the distribution of income, one of the prime weaknesses in the present models in the level of aggregation of the income distribution sector. One of the most important areas for further research lies in the disaggregation of this sector and analysis of the underlying causes of the present distribution of income and policies that might change it in a way that is felt desirable by the Royal Thai Government.

6) As mentioned in Section III, some of the statistical measures reflecting the output equations are not particularly satisfactory, and further research in this area is called for.

7) Since a reduced form matrix of multipliers is not directly forthcoming from the Gauss-Seidel simulation of Model II, a rather extensive multiplier analysis of Model II will be carried out by changing the values of important predetermined variables and studying the comparative solutions of the model.

8) The construction of sub-models of the export commodities will be undertaken so as to gain a more complete (and less ambiguous) picture of these export markets. These structural sub-models may then be incorporated directly into the larger model.

9) Though the data base is very meager, clearly regional disaggregation of the macro-model would be of great interest. To the extent allowed by data availability, this area will be explored.

B. Summary and Conclusions

This paper presents two macroeconometric models of the Thai economy. As stated, they are transitional models in a larger modelling effort in

the Division of Agricultural Economics and should not be considered "completed" models. No model is ever "complete." Nevertheless, they provide a picture of the Thai economy for the period 1962-1974 and hopefully will serve as a building block for future model generations and as a stimulus to further macroeconometric modelling effort in Thailand.

V. Data Appendix

A. Data in Model I.

1. AGINV = Fixed Capital Formation in Agriculture.

sources: 1. Fixed Capital Formation in Agriculture in current prices.

1962-1974, Unpublished data from NESDB.

2. Total investment in current price.

1962-1966, table 5, pp. 28-29, NA 1968-69 edition;

1967-1968, table 5, p. 11, NA 1970-71 edition;

1969, table 5, p. 11, NA 1972-73 edition;

1970-1974, table 5, p. 15, NA 1974-75 edition;

3. Total investment in 1962 prices.

1962-1966, table 9, pp. 36-37, NA 1968-69 edition;

1967-1968, table 9, p. 15, NA 1970-71 edition;

1969, table 9, p. 15, NA 1972-73 edition;

1970-1974, table 9, p. 19, NA 1974-75 edition.

2. AGLAB = Number of Workers in Agriculture.

sources: 1960, table 19, Population and Housing Census;

1970, table 21, Population and Housing Census;

1961-1969 and 1971-1974 Estimation by using growth rate.

3. CCA = Capital Consumption Allowance.

sources: 1. Capital Consumption Allowance in current prices.

1962-1966, Account 1, pp. 6-7, NA 1968-69 edition;

1967-1968, Account 1, p. 1, NA 1970-71 edition;

1969, Account 1, p. 1, NA 1972-73 edition;

1970-1974, Account 1, p. 3, NA 1974-75 edition.

2. Gross Domestic Produt in Current Prices.

1962-1966, Table 2, pp. 22-23, NA 1968-69 edition;

1967-1968, Table 2, p. 8, NA 1970-71 edition;

1969, Table 2, p. 8, NA 1972-73 edition;

1970-1974, Table 2, p. 12, NA 1974-75 edition.

3. Gross Domestic Product in 1962 prices.

1962-1966, Table 7, pp. 32-33, NA 1968-69 edition;

1967-1968 Table 7, p. 13, NA 1970-71 edition;

1969, Table 7,p. 13, NA 1972-73 edition;

1970-1974, Table 7, p. 17, NA 1974-75 edition.

4. COMP = Compensation of Employees.

sources: 1. Compensation of Employees in Current Prices.

1962-1966, Account 2, pp. 8-9, NA 1968-69 edition;

1967-1968, Account 2, p. 2, NA 1970-71 edition;

1969, Account 2, p. 2, NA 1972-73 edition;

1970-1974, Account 2, p. 4, NA 1974-75 edition.

2. Gross Domestic Product in current prices and 1962 prices.

1962-1974, the same as CCA.

5. CONSOUT = Construction Output.

sources: 1962-1966, Table 7, pp. 32-22, NA 1968-69 edition;

1967-1968, Table 7, p. 13, NA 1970-71 edition;

1969, Table 7, p. 13, NA 1972-73 edition;

1970-1974, Table 7, p. 17, NA 1974-75 edition.

6. CORPSAV = Saving of Corporations and Government Enterprises.

sources: 1962-1974, the same as COMP.

7. CROPOUT = Crop Output.

   sources: 1962-1974, the same as CONSOUT.

8. D66* = Dummy Variable.

   sources: 1962-1965 = 0;

   1966-1974 = 1.

9. D 73 = Dummy Variable.

   sources: 1973 = 1;

   all other years = 0.

10. DINV = Change in Inventories.

    sources: 1962-1966, Table 9, pp. 36-37, NA 1968-69 edition;

    1967-1968, Table 9, p. 15, NA 1970-71 edition;

    1969, Table 9, p. 15, NA 1972-73 edition;

    1970-1974, Table 9, p. 19, NA 1974-75 edition.

11. DTCORP = Direct Taxes on Corporations.

    sources: 1962-1974, the same as COMP.

12. DTHH = Direct taxes on Households.

    sources: 1. Direct taxes on Household in current prices.

    1962-1966, Account 4, pp. 12-14, NA 1968-69 edition;

    1967-1968, Account 4, p. 4, NA 1970-71 edition;

    1969, Account 4, p. 4, NA 1972-73 edition;

    1970-1974, Account 4, p. 6, NA 1974-75 edition.

    2. Gross Domestic Product in current price and 1962 prices.

    1962-1974, the same as CCA.

13. DXPBPMZ = Difference Between Export Prices and Bangkok Wholesale Price of Maize.

    sources: 1. Export price of Maize = $\frac{\text{Total value of export}}{\text{Total quantity}}$.

1962-1974, Total III 7, pp. 50-51, Bank of Thailand April 2518.

2. Bangkok Wholesale Price of Maize.

1962-1974, Table V9, p. 97, Bank of Thailand April 2518.

14. FBT = Consumption of Food, Beverages, and Tobacco.

sources: 1962-1966, Table 8, pp. 34-35, NA 1968-69 edition;

1967-1968, Table 8, p. 14, NA 1970-71 edition;

1969, Table 8, p. 14, NA 1972-73 edition;

1970-1974, Table 8, p. 18, NA 1974-75 edition.

15. FFHHE = Consumption of Furniture, Furnishings and Household Equipment.

sources: 1962-1974, the same as FBT.

16. FY = Farm Income.

sources: 1962-1966, Table 6, pp. 30-31, NA 1968-69 edition;

using 4% of Income from farms, professions and other unincorporated enterprises received by households.

1967-1968, Table 6, p. 12, NA 1970-71 edition;

1969, Table 6, p. 12, NA 1972-73 edition;

1970-1974, Table 6, p. 16, NA 1974-75 edition.

17. GADJP = Government Expenditures on Administration, Defense, Justice and Police.

sources: 1962-1974, the same as FBT.

18. GDP = Gross Domestic Product.

sources: 1962-1966, Table 7, pp. 32-33, NA 1968-69 edition;

1967-1968, Table 7, p. 13, NA 1970-71 edition;

1969, Table 7, p. 13, NA 1972-73 edition;

1970-1974, Table 7, p. 17, NA 1974-75 edition.

19. GGY = General Government Income From Property and Entrepreneurship.

sources: 1962-1974, the same as COMP.

20. GREV = Government Revenue.

sources: 1. Government Revenue in current prices.

1962-1966, Account 5, pp. 14-15, NA 1968-69 edition;

1967-1968, Account 5, p. 5, NA 1970-71 edition;

1969, Account 5, p. 5, NA 1972-73 edition;

1970-1974, Account 5, p. 5, NA 1974-75 edition.

2. Gross Domestic Product in current prices and 1962 prices.

1962-1974, the same as CCA.

21. GSERV = Government Expenditures on Services.

= Education and research + health services + special welfare services + other services.

sources: 1962-1974, the same as FBT.

22. GTC = Government Expenditures on Transportation and Communication.

sources: 1962-1974, the same as FBT.

23. IDTAX = Indirect Taxes.

sources: 1962-1974, the same as CCA.

24. IMP 1 = Imports of Consumer Goods, Passenger Cars and Tires.

sources: 1962-1974, Unpublished data from NESDB.

25. IMP 2 = Imports of Intermediate Goods (Chiefly for Consumer Goods), Chassis and Bodies, and Fertilizers and Pesticides.

sources: 1962-1974, the same as IMP 1.

26. IMP 3 = Imports of Fuel and Lubricants.

sources: 1962-1974, the same as IMP 1.

27. IMP 4 = Imports of Capital Goods (not including Fertilizers and Pesticides), Buses and Trucks, and Intermediate Goods.

(Chiefly for Capital Goods)

sources: 1962-1974, the same as IMP 1.

28. IMP 5 = Total Merchandise Imports in Balance of Payments.

(IMP 1 + IMP 2 + IMP 3 + IMP 4)

sources: 1962-1974, the same as IMP 1.

29. IMPSERV = Imports of Services.

sources: 1962-1974, the same as IMP 1.

30. INTCD = Interest on Consumer Debt.

sources: 1962-1974, the same as COMP.

31. INTPD = Interest on Public Debt.

sources: 1962-1974, the same as COMP.

32. M 1 P/PGDP = Ratio of Price Deflator for IMP 1 to the GDP Price Deflator.

sources: 1. Price Deflator for IMP 1.

1962-1974, Unpublished data from NESDB.

2. GDP Price Deflator.

1962-1974, Unpublished data from NESDB.

33. M 2 P/PGDP = Ratio of Price Deflator for IMP 2 to the GDP Price Deflator.

    sources: 1962-1974, same as M 1 P/PGDP.

34. M 4 P/PGDP = Ratio of Price Deflator for IMP 4 to the GDP Price Deflator.

    sources: 1962-1974, the same as M 1 P/PGDP.

35. MGDP = Manufacturing Output.

    sources: 1962-1974, the same as GDP.

36. MZE = Output of Maize.

    sources: 1962-1972, Table 15, p. 54, Agri. Stat. of Thailand (DAE), 1972-73 edition;

    1973-1974, Unpublished data from DAE.

37. NAGLAB = Number of Workers in Non-Agriculture (1,000's of workers).

    sources: 1962-1974, the same AGLAB.

38. NAGINV = Fixed Capital Formation in Non-Agriculture.

    sources: 1962-1974, the same as AGINV.

39. NFYPROW = Net Factor Income Payment From the Rest of the World

    = NY - GDP + IDTAX + CCA.

40. NY = National Income.

    = COMP + YUE + YPROP + DTCORP + GGY - INTCD - INTPD.

41. OTHAG = Output of Agricultural Products other than Crops.

    sources: 1962-1974, the same as CONSOUT.

42. OTHOUT = Output of other Non-Agricultural Products.

    sources: 1962-1974, the same as CONSOUT.

43. PDY = Personal Disposable Income

= NY - DTHH + TRANIN - TRANOUT.

44. PFFHHE/P = Ratio of Price Deflator for the FFHHE to the Price Deflator for All Consumption.

sources: 1. Price Deflator for the FFHHE = $\frac{\text{FFHHE in current price}}{\text{FFHHE in 1962 price}}$.

a. FFHHE in current prices.

1962-1966, Table 4, pp. 26-27, NA 1968-69 edition;

1967-1968, Table 4, p. 10, NA 1970-71 edition;

1969, Table 4, p. 10, NA 1972-73 edition;

1970-1974, Table 4, P. 14, NA 1974-75 edition.

b. FFHHE in 1962 prices.

1962-1974, the same as FFHHE.

2. Price Deflator for All Consumption.

$= \frac{\text{Total Private Consumption in current prices}}{\text{Total Private Consumption in 1962 prices}}$

a. Total Private Consumption in current prices.

1962-1974, the same as FFHHE in current prices.

3. Total Private Consumption in 1962 prices.

1962-1974, the same as FFHHE.

45. PRE/P = Ratio of Price Deflator for RE to the Price Deflator for All Consumption.

sources: 1962-1974, the same as PFFHHE/P.

46. PSERV/P = Ratio of Price Deflator for SERV to the Price Deflator for All Consumption.

sources: 1962-1974, the same as PFFHHE/P.

47. PTC/P = Ratio of Price Deflator for TC to the Price Deflator for All Consumption.

sources: 1962-1974, the same as PFFHHE/P.

48. RAGTLAB = Ratio of Agricultural Labor to Total Labor Force.

sources: 1962-1974, the same as AGLAB.

49. RE = Consumption Expenditure on Recreation and Entertainment.

sources: 1962-1974, the same as FBT.

50. RFLHHO = Consumption Expenditure on Rent, Fuel, Light and Household Operation.

sources: 1962-1974, the same as FBT.

51. Rice = Output of Rice

sources: 1962-1972, Table 17, p. 48, Agri. Stat. of Thailand(DAE) 1972-73 edition;

1973-1974, Unpublished data from DAE.

52. RNATLAB = Ratio of Non-Agricultural Labor to total Labor Force.

sources: 1962-1974, the same as AGLAB.

53. RUB = Output of Rubber.

sources: 1962-1974, Unpublished data from Division of Rubber.

54. SD = Statistical Discrepancy.

= GDP - TPCE - TGCE - TX + TIMP - TINV.

55. SERGDP = Output of Sercices.

sources: 1962-1974, the same as CONSOUT.

56. SERV = Consumption Expenditures on Services.

sources: 1962-1974, the same as FBT.

57. TAP = Output of Tapioca (Cassava meals).

sources: 1962-1972, Table 17, p. 56, Agri. Stat. of Thailand, 1972-73 edition;
1973-1974, Unpublished data from DAE.
(Converted at 392 kgs meals per ton of roots)

58. TC = Consumption Expenditure on Transportation and Communication.
sources: 1962-1974, the same as FBT.

59. TCOUT = Output of Transportation and Communication.
sources: 1962-1974, the same as CONSOUT.

60. TGCE = Total Government Consumption Expenditures.
sources: 1962-1974, the same as FBT.

61. TIMP = Total Imports.
sources: 1962-1974, Unpublished data from NESDB.

62. TINV = Total Fixed Capital Formation.
sources: 1962-1974, the same as DINV.

63. TPCE = Total Personal Consumption Expenditures.
sources: 1962-1974, the same as FBT.

64. TRANIN = Net Transfers to Households from Government and the Rest of the World.
= Current transfers from general government + Current transfers from the rest of the world.
sources: 1962-1974, the same as DTHH.

65. TRANOUT = Net Transfers from Households to Government and ROW
= Other current transfers to general government + transfers to the rest of the world.
sources: 1962-1974, the same as DTHH.

66. TX = Total Exports.

sources: 1962-1974, Unpublished data from NESDB.

67. TYUE = Total Income From Unincorporated Enterprises.

sources: 1962-1974, the same as DTHH.

68. WRTOUT = Output of Wholesale and Retail Trade.

sources: 1962-1974, the same as CONSOUT.

69. XMFG = Exports of Manufactured Goods.

$$= \frac{\text{Export of manufactured goods + machinery + misc. man. goods}}{\text{Export of merchandise price deflator}}$$

sources: 1. Export of manufacture goods + machinery + misc. man goods.

1962-1974, Table III 4 col. 7+8+9, p. 43, BOT April 2518.

2. Export of merchandise price deflator.

1962-1974, Unpublished data from NESDB.

70. XMZE = Exports of Maize.

= Quantity of export x 1962 price.

sources: 1962-1974, Table III 7, pp. 50-51, BOT April 2518.

71. XOTH = Exports of Other Goods.

= Total of Export - (ΣXRICE + XRUB + MZE + XTAP) - XMFG - XSERV.

sources: 1. Total of Export and XSERV.

1962-1974, Unpublished data from NESDB.

2. ΣXRICE + XRUB + XMZE + XTAP.

1962-1974, the same as XMZE.

72. XPRICE = Export Price of Rice (Baht per Metric Ton).

$$= \frac{\text{Value of Price Export}}{\text{Export Quantity}}$$

sources: 1962-1974, Table III 7, pp. 50-51, BOT April 2518.

73. XPRUB = Export Price of Rubber (Baht per Metric Ton).

$$= \frac{\text{Value of Rubber Export}}{\text{Export Quantity}}$$

sources: 1961-1974, the same as XPRICE.

74. XRICE = Exports of Rice.

= Quantity of Export x 1962 price.

sources: 1962-1974, the same as XPRICE.

75. XRUB = Exports of Rubber.

= Quantity of Export x 1962 price.

sources: 1962-1974, the same as XPRICE.

76. XSERV = Export of Services.

sources: 1962-1974, Unpublished data from NESDB.

77. XTAP = Exports of Tapioca.

= Quantity of Export x 1962 price.

sources: 1962-1974, the same as XPRICE.

78. YPROP = Income from Property

sources: 1962-1974, the same as COMP.

79. YUE = Income from Unincorporated Enterprizes other than Farms.

sources: 1962-1974, the same as FY.

B. Data in Model II.

1. AGOUT = Total Output in Agriculture.

Sources: 1962-1966, Table 7, pp. 32-33, NA 1968-69 edition;

1967-1968, Table 7, p. 13, NA 1970-71 edition;

1969, Table 7, p. 13, NA 1972-73 edition;

1970-1974, Table 7, p. 17, NA 1974-75 edition.

2. CHP = Currency in Hands of the Public.

sources: 1962-1974, Table I. 3, p. 6, Bank of Thailand April 2518.

3. CONLAB = Workers in Construction (millions of workers).

sources: 1960, Table 19, Population and Housing Census;

1970, Table 21, Population and Housing Census;

1961-1969 and 1971-1974 Estimation by using growth rate.

4. DDH = Demand Deposits in Hands of the Public.

sources: 1962-1974, the same as CHP.

5. GDPCP = Gross Domestic Product.

sources: 1962-1966, Table 2, pp. 22-23, NA 1968-69 edition;

1967-1968, Table 2, p. 8, NA 1970-71 edition;

1969, Table 2, p. 8, NA 1972-73 edition;

1970-1974, Table 2, p. 12, NA 1974-75 edition.

6. M 3 P = Price Deflator for Fuel and Lubricants

sources: 1962-1974, Unpublished data from NESDB.

7. MANLAB = Workers in Manufacturing (millions of workers).

sources: 1962-1974, the same as CONLAB.

8. N = Population.

sources: 1960 and 1970, Dr. Leroy Blakeslee adjusted then from 1960 and 1970 Population and Housing Census;

1962-1969 Estimation by using growth rate;

1970-1974, Unpublished data from Population Projection Working Group (NSO, Institute of Population Studies and NESDB).

9. OTHLAB = Workers in Other (millions of workers)

   sources: 1962-1974, the same as CONLAB.

10. SERLAB = Workers in Services (millions of workers)

    sources: 1962-1974, the same as CONLAB.

11. TCLAB = Workers in Transportation and Communication (millions of workers).

    sources: 1962-1974, the same as TCLAB.

12. TDH = Time Deposits in Hands of the Public.

    sources: 1962-1974, Table I. 6. b., pp. 12-13, column 31, Bank of Thailand April 2518.

13. WRTLAB = Workers in Wholesale and Retail Trade.

    sources: 1962-1974, the same as CONLAB.

14. XNAGCP = Non-Agricultural Output in Current Prices.

    sources: 1962-1974, the same as GDPCP.

15. CONSINV = Gross Fixed Capital Formation in Construction.

    MANINV = Gross Fixed Capital Formation in Manufacturing.

    OTHINV = Gross fixed Capital Formation in Other.

    SERVINV = Gross Fixed Capital Formation in Services.

    TCINV = Gross Fixed Capital Formation in Transportation and Communication.

    WRTINV = Gross Fixed Capital Formation in Wholesale and Retail Trade.

The variables which are mentioned above are derived as follows:

1. Proportions of Total Gross Fixed Capital Formation for each Industry group for the 1967-1974 Investment data were computed.
2. A regression was run with these proportions regressed on time, and then were extrapolated back to 1961.
3. The extrapolated proportions were then multiplied by actual Total Gross Fixed Capital Formation for the 1961-1966 period to get industry investment figures.

16. KAG = Capital Stock in Agriculture.

KCONS = Capital Stock in Construction.

KMAN = Capital Stock in Manufacturing.

KOTH = Capital stock in Other.

KSERV = Capital Stock in Services.

KTC = Capital Stock in Transportation.

KWRT = Capital Stock in Wholesale and Retail Trade.

The variables which are mentioned above are derived as follows:

1. It was assumed that the output - capital ratio is approximately equal to the marginal output-capital ratio.
2. For the aggregate groups, Agriculture and Non-Agriculture, the average of the marginal output-capital ratios for 1962-1974 was computed.
3. For the base year 1962, it was assumed that the actual output-capital ratio was equal to this average ratio and the capital stock for agriculture and non-agriculture was estimated for 1962.

4. The capital stocks for the industry groups were then calculated using the same proportions used in calculating the investment data.
5. Capital stock for later years was calculated simply by adding the investment figures to the 1962 benchmark capital figure.