# A MACRO ECONOMETRIC MODEL FOR IRAN

by

Hamid Nazeman

A THESIS SUBMITTED IN PARTIAL

FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

in the Department

of

Economics & Commerce



SIMON FRASER UNIVERSITY

July 1978

# APPROVAL

NAME: Hamid Nazeman

DEGREE: Master of Arts

TITLE OF THESIS: A Macro-Econometric Model for Iran

EXAMINING COMMITTEE:

Chairperson: Jack L. Knetsch

Peter Kennedy
Senior Supervisor

Richard Holmes

D.M. Eaves
External Examiner
Department of Mathematics
Simon Fraser University

Date Approved: Aug 1/78

Title of Thesis/~~Dissertation~~:

A Macro-Econometric Model for Iran

Author: ______________________

(signature)

Hamid Nazeman

(name)

Aug 1/78

(date)

Abstract

The objective of this study is to develop an econometric model for long-run projections in the oil based economy of Iran. The proposed model is a "Neo-Keynesian" type macro-model that embodies general principles of economic knowledge and also reflects the particular characteristics of the Iranian economy.

In comparison to previous econometric studies related to Iran, this study features a more complete analytical tool in terms of the structure of the model, the statistical technique of estimation and the supporting data. All of the previous models introduced for the Iranian economy are designed to explain aggregate demand (i.e., expenditure) only, treating aggregate supply as exogenous. The model presented here formulates behavioral relationships for the supply side of the economy as well as integrating the supply and demand variables into a complete macro-economic system. Using the two stage least squares technique a simultaneous estimate is obtained for the present model; earlier models' estimates are based on the ordinary least squares technique. Furthermore, the present model covers a longer period of time series data incorporating observations for the 1959 to 1975 period. The model includes 69 variables (44 endogenous, 17 lagged endogenous and 8 exogenous) and there are 44 equations which provide solutions for the 44 endogenous variables.

The reduced from of the estimated model is derived and used to simulate the long-run behavior of the economy. The projections concluded in this study are based on the assumption of a moderate trend of growth for the exogenous oil income variable. This projection indicates a relatively high rate of growth of GNP through the 1980s. However, it also suggests some potential macro-economic problems in the from of trade deficits and government budget deficits.

## Acknowledgements

I would like to thank the members of my supervisory committee: Professor P.E. kennedy and Professor R.A. Holmes; as well as the others who have helped me in the course of writing this dissertation.

Professor Kennedy helped me, not only by providing helpful comments, but also by encouraging me to improve the content and organization of the thesis.

I am in debt to Professor Holmes for his helpful comments.

I would also like to thank my external examiner Professor D.M. Eaves for his interest in the subject and encouraging comments.

Professor R.A.D. Beck of the Economics Department and Professor N.R. Rielly of the Mathematics Department have read an early draft of this dissertation. Their comments are also acknowledged.

I am also thankful to John Yu and Reo Audette for their assistance in using the computer facilites and to Cheryl Scruton for typing the manuscript.

# Table of Contents

## List of Tables



## List of Figures

# Chapter I

# Introduction

Iran's extraordinary economic growth during the last two decades has been matched by very few countries, even among the advanced industrial economies. The Iranian achievement is even more impressive if one considers that a double-digit rate of growth (average annual) was sustained (until recently) with little domestic inflation. The international inflation and world recession of the mid 1970's have, however, created some difficulties for the maintenance of Iran's pace of economic growth of the 1960's and early 1970's.

The study presented here is the result of an effort to analyse the performance of the Iranian economy in the context of a consistent quantitative framework, (i.e. an economic model).

The study involves an econometric model and its application for simulation of the future performance of the Iranian economy. It focuses on the behavior of the economy in a relatively aggregate fashion, and explains the variations in major economic variables. The model is constructed to embody both general theoretical principles and to reflect characteristics peculiar to the Iranian economy.

Theoretically, the Keynesian theory of effective demand constitutes the backbone of our proposed macro-model. Actually, the Hicks-Lange version of the Keynesian model is taken as the structural core of the proposed econometric model. The system, then, is expanded by introducing a more detailed decomposition of national expenditures, (i.e. consumption and investment in various sectors) foreign trade equations, money, supply and credit relationships. Furthermore, inclusion of a supply side to the model (i.e. value added in various sectors of the economy) completes a system of economic relationships which can be used for the analysis of the interaction of aggregate demand and supply in the national economy.

In the expenditure side, the model includes behavioral equations for consumption and investment in both government and private sectors as well as foreign trade relationships and money, credit and tax equations. In the supply side it explains the value added in three major sectors of the economy, namely agriculture, industries and services, while the value added in the oil sector is taken as exogenous. Employment functions in the urban sector (i.e. industries and services) are also included in the supply side of the model and link the behavior of the economy to long-run demographic forces (i.e. population and labor supply).

The model, in it's estimated form is capable of reflecting the dynamic effects of the movements in exogenous variables (either slow variation of sudden shocks) on the performance of the economic system. As a classic case the dynamism of fiscal policies and monetary shocks can be examined.

With respect to the fiscal policy effects, a shock in the form of changes in government spending (either due to oil income or taxation or both) will be represented by changes in the government's consumption expenditure or government investment.

In the demand side of the system, these changes will directly affect the level of national expenditure (i.e. GNP in the present period). The indirect (lagged) effects of a fiscal policy shock will be transmitted to the components of the national expenditure, in the next period, via different paths of interactions: A change in current GNP will affect the level of private consumption in the next period and hence the future GNP. Also the level of current government investment will affect the future level of private investment and hence the future aggregate demand. The current level of GNP is also assumed to affect the next period's stock of money through a central bank reaction function and hence the credit available to the private sector which in turn feeds back to aggregate demand.

In the supply side of the system, a fiscal policy shock can have two different kinds of effects. A direct effect as a result of government investment, which is reflected in the level of aggregate investment and therefore affects the level of output (value added) in all the major sectors of the economy. This, in turn, determines the ex-ante supply of national product. An indirect effect as a result of government consumer expenditures, is reflected in the level of aggregate consumption and hence the aggregate demand which will be followed by an appropriate change in money supply through the central bank's reaction function. This "induced monetary shock" will in turn affect the supply of credit and therefore through the investment functions affect the level of aggregate supply.

As for the monetary policy effects, a shock in the form of an autonomous change in the stock of money will be transmitted via a change in the volume of credit to the private sector, and will affect the level of investment in the private sector which will in turn affect both aggregate demand and aggregate supply. (1)

---

(1) A diagramatic presentation of the dynamism of the model is summarized on page 25.

In the absence of any exogenous monetary shocks the dynamic behavior of the model will be mainly dependent on the trend of the value added in the oil sector since this affects the level of government spending and thus triggers fiscal policy shocks. The long-run trend of demographic forces is also assumed to influence the level of output from the supply side (e.g. employment effects on value added functions).

The sample projection reported in this study is a hypothetical case of "passive monetary policy " where the volume of money supply is determined by the central bank's reaction function. Therefore, the only source of change in the stock of money are the endogenous forces created by the past level of income, which prompts a harmonized gradual growth of money supply in line with and proportionate to the realized level of GNP.

In addition, the reported simulation is subject to the dynamic effects of a continuous fiscal expansion directly financed by a moderately growing revenue from the oil sector.

# Chapter II

## Survey of Existing Macro Models of Iran

Construction of Macro-econometric models for the Iranian economy is a fairly new field of research in the area of applied economic studies in Iran. This is partly because of the so called "infancy" of national accounting in Iran. The national accounts data for the Iranian economy was not prepared in a systematic way until the enactment of new monetary regulations and creation of the Central Bank in 1959. Therefore, a consistent set of time series data on economic variables exists only for a relatively short historical period.

However in 1968 UNCTAD utilized the available data and compiled the first econometric model for the Iranian economy. This was an aggregate model estimated with only 8 observations based on Iran's national accounting data for the 1959-66 period. UNCTAD's model divides the economy into three major sections, namely: oil, agriculture and "the rest of the economy". This is called a "growth-type" model and addresses itself to the following question. "Given the rates of growth of GDP and the agricultural sector, what is the compatible oil sector? In turn given the growth rate of oil what is the implied rate of growth of the rest of the economy and the foreign trade?" This model then projects resource gap and trade gap and some major economic variables on the basis of various target rates assumed for growth of GDP and agriculture.

UNCTAD's 1968 model was followed by few other aggregate models constructed by the national planners. An unpublished model of the Fifth Development Plan (1971) and F. Vakil's macro-economic models(2) of 1972 and 1973 are the major econometric studies carried out in Iran in recent years.

The Econometric Model of the Fifth Plan is an aggregate Keynesian type economic model with 8 behavioral functions and 5 identities that are estimated with 12 observations (1959-70), and used for the gross projections of the major components of the national expenditure (i.e. consumption and investment and foreign trade).

---

(2) Vakil, F., "An Econometric Model for Iran", Bank Markazi Iran Bulletin, July 1972, pp. 115-120, and March 1973, pp. 633-655.

On the other hand, the models built by F. Vakil for the economy of Iran lean towards the Klein-Goldberger type of model in structure. Based on Keynesian-type income-expenditure approach, the structural relationships of the Vakil, 1973 model (and UNCTAD, 1968) are estimated by the ordinary least squares regression technique. While some of the estimated coefficients may suffer from a simultaneity bias due to the correlation between the error term and independent variables, limited numbers of observation (13 in Vakil's and 8 in UNCTAD's model) precluded the use of consistent methods such as two-stage least squares. Moreover, reduced forms of these models are not derived. Therefore, forecasts made from the reduced form are not possible.

In addition to the Econometric models developed by Iranian planners (i.e. Fifth plan's model and Vakil's models), some of the recent studies on Iran's economic development include some basic macro economic relationships designed in the form of econometric models. Among them, Robert E. Looney introduces different versions of a macro economic model in his publications on the future of the Iranian economy.(3) Looney's models both appear in the Appendix of his books as a list of variables and estimated equations with no theoretical justification to support the proposed econometric relationships.

The model in his "Development Strategy for Iran through the 1980's", Prager, 1977 hereafter, "Looney, Prager, 1977 " includes a list of ten estimated behavioral equations and nine identities, which presumably is designed to explain the behavior of the components of the aggregate demand (i.e. consumption, investment, imports and exports). The behavioral equations of "Looney, Prager, 1977" are estimated with 13 observations (1962-74 data) and variables are measured in current prices.

The other set of macro economic equations fitted by Looney is presented in his other study "Iran at the End of the Century", Lexington, 1977 hereafter, "Looney, Lexington, 1977" consists of an alternative set of

---

(3) Looney, R.E., "A Development Strategy for Iran through the 1980's", New York, Prager, 1977, (Appendix F, pp. 177-180).

Looney, R.E., "Iran at the End of the Century", Lexington, Lexington Books, 1977, (Appendix B, pp. 143-144).

hypotheses tested with the same set of time series data measured in 1960 constant prices.

Both Looney's models are estimated by ordinary least squares. All the estimates indicate satisfactory satisfactory statistical fit in terms of high correlation coefficients and high "t" statistics. But Looney does not report "Durbin-Watson" statistics for his estimates. Furthermore, he includes lagged dependent variables in the right hand side of some of his proposed behavioral equations. Therefore, they are not testable for serial auto-correlation with the usual (D.W.) statistics.

Most econometric models built for Iran are estimated with "pre-inflation" time series data of the 1959-72 period and therefore do not include the large scale movements of the economy introduced by the increased oil income after the price jumps of 1973. The model presented in this study, however, covers a longer sample period that includes the "post-inflation" period and makes it possible to examine the impacts of an enlarged oil sector on the performance of the economy from the expenditure point of view. Introduction of the "growth variables" such as growth of oil income (dOIL) and growth of national product (dGNP) makes the model capable of reflecting the impacts of a growth in oil income (either as a shift or as a continuous trend) on the economic system. The direct role of dOIL and dGNP on the aggregate demand is pictured in the consumption functions, investment functions and the trade relationships. At the same time the model links the components of the aggregate supply to the expenditure part and introduces behavioral equations to explain the movements of the supply variables (i.e. values added) endogenously. This is a distinct departure from the conventional pattern of most econometric models for developing economies that tend to consider the sectoral outputs as exogenous variables based on "a priori" given rates of growth.

# Chapter III

## Overview of the Proposed Model

The Macro-economic model proposed for the Iranian economy in this study, is a modified form of the Keynesian basic Macro Model. It is Keynesian in the sense that it explains the basic national-accounting factors of consumption, investment and trade for determination of GNP (total demand). On the other hand it is modified to suit the particular characteristics of the Iranian economy, an oil-exporting economy with a growing industrial sector and accelerating urbanization.

In designing a long-run behavioral system for a developing economy that embodies the practically quantifiable part of the economic theory, one of the major constraints is the availability of data. Our proposed model is therefore the result of a compromise between the theoretically-ideal model and the constraints of available data.

Despite the shortcomings imposed by the non-availability of data, including such theoretically-popular monetary variables as interest rates and foreign exchange rates, or important indexes like wage rates, the model is designed to explain the behavior of the distinct sections of the economy in terms of the urban-rural classification known as conventional dualism(4), as well as the dynamic role of oil revenues, represented directly by government expenditures and referred to as "Oil,Non-Oil" dualism.(5)

Although, the pure Keynesian approach to income determination analysis tends to deal mainly with aggregate demand (expenditures), our model includes in addition some significant properties with an explicit supply magnitude.

All the models designed for Iran are more or less "aggregate demand models" (i.e. they only explain the total expenditure in terms of investment consumption and trade) and ignore the supply (value added) side of the economy. In "Looney, Prager, 1977" and "Looney, Lexington, 1977" there is no variable of supply magnitude i.e. output and therefore both of Looney's models tend to estimate only the trend of expenditures in the Iranian economy. In

---

(4) Fei, J.C.H., and Ranis, G., "A Theory of Economic Development, A.E.R., Sept. 1961, pp. 533-565.

(5) Amuzegar, J. and Fekrat, M.A., " Iran: Economic Development Under Dualisitic Conditions, University of Chicago, 1971, pp. 145-163.

"UNCTAD, 68" the values added variables in the major sectors of the economy are an integrated part of the model, but as exogenous variables predetermined by hypotheses outside the model.

"Vakil, 1973" also has a similar approach, while the values added in agriculture and in manufacturing play their roles as explanatory variables in the behavioral functions of the expenditure part of the model, the values are assumed to be determined outside the model (i.e. exogenous).

The model presented in this study, however, basically consists of the supply side and demand side of the economy (i.e. values added versus expenditures). Therefore, in application of the estimated model for future projections there is the possibility of testing the performance of the economy for potential excess demand (or supply) on an "ex-ante" basis. In other words, the present model not only explains the behavior of the aggregate demand functions, but also, by explaining the behavior of the supply functions endogenously presents a consistent picture of the performance of the economy in its entirety (although simplified). Therefore it can be used to indicate the future trend of the fluctuations in aggregate level (i.e. a macro-equilibrium analysis).

The model as a whole is an integration of the outputs and expenditures. Therefore, it can be analysed with regard to the supply and the demand components of the national income simultaneously. The properties of the supply side, i.e. sectoral values added are required by definition to solve the model for its demand side (expenditures). Furthermore, the supply side of the model (output) is dependent on some properties of aggregate demand (i.e. investment). This feature of the model represents the behavioral interaction between the outputs and expenditures and creates additional interdependence between the properties of aggregate demand and supply, in addition to the definitional identity of the two sides of the national product.

The demand side of the model consists of total consumption expenditures total investment expenditures and total exports and imports of goods and services. Taxes, as a part of government revenues are included in the expenditure part of the model, as well as the monetary equations (money supply and credits) which are explained as part of the demand side of the model.

The consumption and investment expenditures are classified in the government and private sectors, and private consumption is subclassified in urban and rural sectors of the economy. The private investment expenditures consist of the investments of two different magnitudes. Total exports are defined as oil exports and non-oil goods exports, and imported goods are also classified in different groups.

On the supply side of the model, national output is defined as the sum of values added in various sectors of the economy, namely the oil sector, the agricultural sector, the industrial and mining and services sectors.

There is a total of sixty nine variables in the model, of which forty four are endogeneous. The remaining twenty five predetermined variables consist of seventeen lagged endogeneous variables and eight exogenous variables.

The model has twenty one behavioral equations and twenty three identities, a total of forty four equations that yield solution values for forty four endogeneous variables at any point of time (with given predetermined variables).

The exogenous variables are chosen from among those that are least likely to be directly influenced by the interaction of the model at any point of time, while the endogeneous variables include all those variables that could be significantly determined within the model, regardless of the importance of their policy roles, i.e. some major policy variables like government investment or growth of money supply are regarded as endogeneous variables.

This approach is justified by our aiming at as high a degree of explanatory and prediction power to the model as possible. Therefore, the model is assumed to explain the behavior of the whole economy, including the government as an economic agent. Otherwise, depending on the degree of a normative planning role assumed for the government, one can eliminate some of the endogeneous variables and replace them by exogenous values coming from outside the model.

Our endogeneous variables, besides the essential Macro targets of the economy (i.e. GNP, consumption, etc.)

include some important policy instruments that are more likely to have the influence of the national policy maker embodied in their variations. Thus, by inclusion of these key variables in the endogeneous part of the model, we have assumed that the policy maker will also follow a consistently rational and therefore a predictable pattern of behavior directly related to the performance of the economy.

On these assumptions the proposed endogeneous policy instruments are likely to follow a structural pattern of behavior consistent with the variation of the other endogeneous variables in the long-run. At the same time, they can accomodate the initiations of the policy-maker in regulating and normalizing short-run fluctuations. On the other hand the exogenous variables determine the long-run range of variation for the other variables without any direct dependence on the short-run behavior of the economy.

With this brief explanation regarding the general form and structure of the model, we introduce the properties of the model by listing the variables and indentities and introducing the hypothetical behavioral relationships. A summary of the organization of the model is shown by the following chart.

**Figure (1)**

(Classification of the Major Endogenous Variables on the basis of National Accounts)

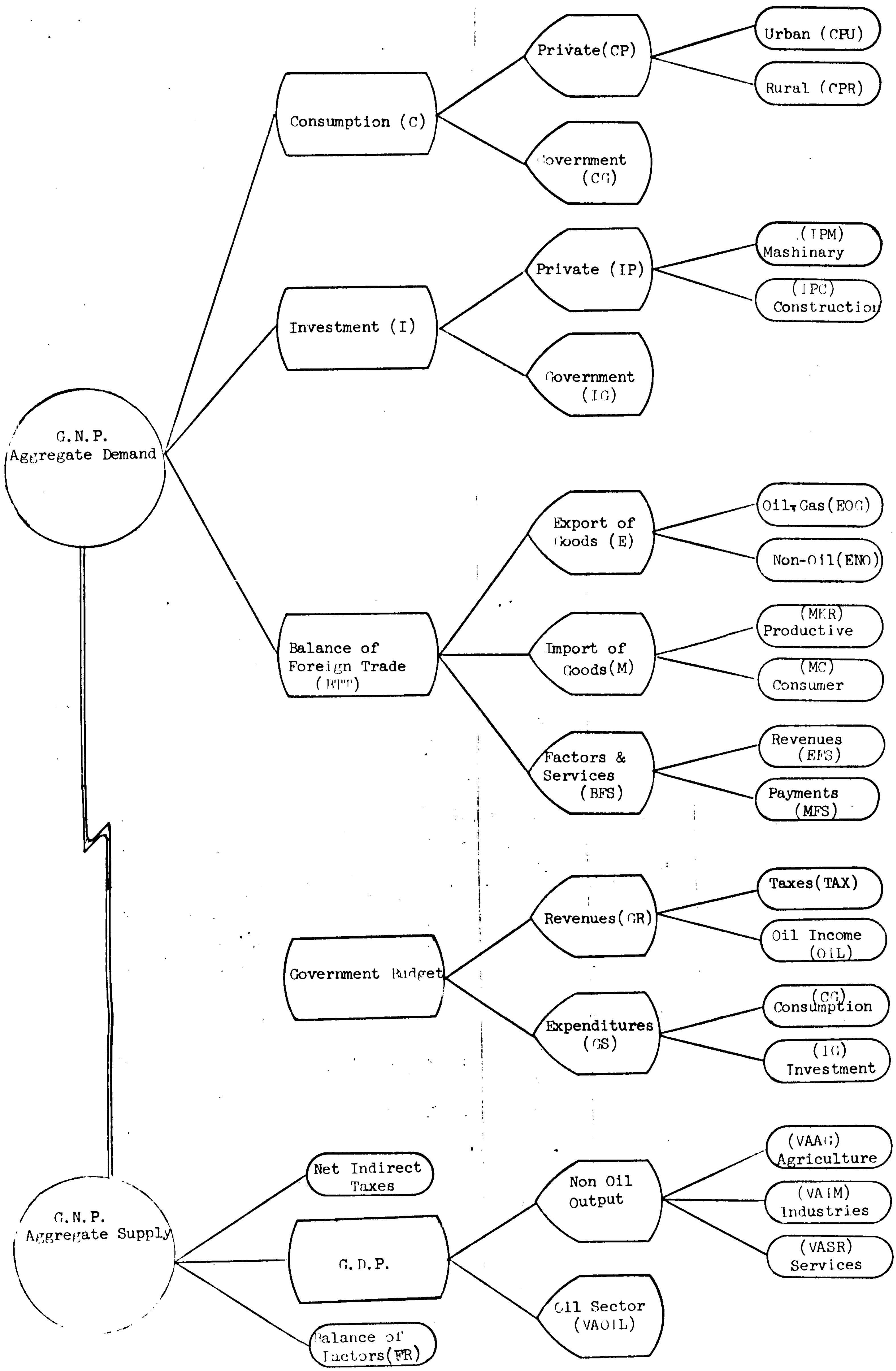


Table 1

List of the Variables of the Model

| Name of the Variable | Code | Class | Type |
|---|---|---|---|
| 1. Gross National Product | GNP | Endog. | target |
| 2. Non-oil GNP | GNPNO | Endog. | target |
| 3. Net Balance of Trade | BTT | Endog. | target |
| 4. Growth of GNP | dGNP | Endog. | target |
| 5. Aggregate consumption | C | Endog. | target |
| 6. Aggregate Investment | I | Endog. | Target |
| 7. National Saving | S | Endog. | Target |
| 8. Private Consumption | CP | Endog. | Irrelevant |
| 9. Rural Private Consumption | CPR | Endog. | Irrelevant |
| 10. Urban Private Consumption | CPU | Endog. | Irrelevant |
| 11. Private Investment | IP | Endog. | Irrelevant |
| 12. Private Investment in Machinery | IPM | Endog. | Irrelevant |
| 13. Private Investment in Construction | IPC | Endog. | Irrelevant |
| 14. Imports of Goods | M | Endog. | Irrelevant |
| 15. Imports of Capital and Intermediate Goods | MKR | Endog. | Irrelevant |
| 16. Imports of Consumer Goods | MC | Endog. | Irrelevant |
| 17. Exports of Goods | E | Endog. | Irrelevant |
| 18. Non-oil Good's Exports | ENO | Endog. | Irrelevant |
| 19. Net Balance of Factors and Services | BFS | Endog. | Irrelevant |
| 20. Payment for Factors and Services | XFS | Endog. | Irrelevant |
| 21. Revenue from Factors and Services | YFS | Endog. | Irrelevant |
| 22. Value Added in Agriculture | VAAG | Endog. | Irrelevant |
| 23. Value Added in Industries and Mines | VAIM | Endog. | Irrelevant |
| 24. Value Added in Services | VASR | Endog. | Irrelevant |
| 25. Net Factor Revenue | FR | Endog. | Irrelevant |
| 26. Urban Employment | EMPT | Endog. | Irrelevant |
| 27. Urban Unemployment | UNEM | Endog. | Irrelevant |
| 28. Rural Population | POPR | Endog. | Irrelevant |
| 29. Employment in Industries and Mines | EMPIM | Endog. | Irrelevant |
| 30. Employment in Services | EMPSR | Endog. | Irrelevant |
| 31. Gross Domestic Product | GDP | Endog. | Irrelevant |
| 32. Total Taxes | TAX | Endog. | Policy |
| 33. Direct Taxes | TAXD | Endog. | Policy |
| 34. Indirect Taxes | TAXI | Endog. | Policy |
| 35. Stock of Money (Broad Definition) | MM | Endog. | Policy |

Table 1 continued

| | | | |
|---|---|---|---|
| 36. Growth of Money ( Broad Definition) | DMM | Endog. | Policy |
| 37. Credits to Private Sector | CR | Endog. | Policy |
| 38. Growth of Credits | dCR | Endog. | Policy |
| 39. Government Revenues | GR | Endog. | Policy |
| 40. Government Expenditures | GX | Endog. | Policy |
| 41. Government Budget Balance | BB | Endog. | Policy |
| 42. Government Investment | IG | Endog. | Policy |
| 43. Government Consumption | CG | Endog. | Policy |
| 44. Value Added in Domestic Oil | VAOIL | Endog. | Policy |
| 45. National Oil | OIL | Exog. | Policy |
| 46. Growth of Oil | dOIL | Exog. | Policy |
| 47. Foreign Factors in Oil Sector | OFF | Exog. | Policy |
| 48. Export of Oil and Gas | EOG | Exog. | Policy |
| 49. Employment in Oil Sector | EMPO | Exog. | Policy |
| 50. Total Population | POP | Exog. | Data |
| 51. Urban Population | POPU | Exog. | Data |
| 52. Urban Active Population | POPUA | Exog. | Data |
| 53. Lagged GNP | GNP(t-1) | Lagged | Data |
| 54. Lagged Value Added in Agriculture | VAAG(t-1) | Lagged | Data |
| 55. Lagged Value Added in Industries | VAIM(t-1) | Lagged | Data |
| 56. Lagged Government Investment | IG(t-1) | Lagged | Data |
| 57. Lagged Government Consumption | CG(t-1) | Lagged | Data |
| 58. Lagged Urban Private Consumption | CPU(t-1) | Lagged | Data |
| 59. Lagged Non-Oil Good's Exports | ENO(t-1) | Lagged | Data |
| 60. Lagged Consumer Good's Imports | MC(t-1) | Lagged | Data |
| 61. Lagged Imports of Goods | M(t-1) | Lagged | Data |
| 62. Lagged Private Investment | IP(t-1) | Lagged | Data |
| 63. Lagged Money Stock | MM(t-1) | Lagged | Data |
| 64. Lagged Credits | CR(t-1) | Lagged | Data |
| 65. Lagged Employment in Industries | EMPIM(t-1) | Lagged | Data |
| 66. lagged Oil Income | OIL(t-1) | Lagged | Data |
| 67. lagged Non-Oil GNP | GNPNO(t-1) | Lagged | Data |
| 68. Lagged Rural Population | POPR(T-1) | Lagged | Data |
| 69. Lagged Employment in Services | EMPSR(T-1) | Lagged | Data |

Table 2

Hypothetical Structure of the Model

| | | |
|---|---|---|
| A. | Aggregate Demand: | |
| 1. | Gross National Product | GNP = C + I + BTT |
| 2. | Non-oil GNP | GNPNO = GNP - OIL |
| B. | Consumer Expenditures: | |
| 3. | Total Consumption | C = CP + CG |
| 4. | Private Consumption | CP = CPU + CPR |
| 5. | Urban Private Consumption | CPU = f1(CPU(t-1),dGNP) |
| 6. | Rural Private Consumption | CPR = f2(VAAG(t-1),dGNP) |
| 7. | Government Consumption | CG = f3(CG(t-1),OIL,TAX) |
| C. | Capital Formation: | |
| 8. | Total Investment | I = IP + IG |
| 9. | Private Investment | IP = IPM + IPC |
| 10. | Private Investment Machinery | IPM = f4(dCR,VAIM(t-1)) |
| 11. | Private Investment in Construction | IPC = f5(IG(t-1),dCR) |
| 12. | Government investment | IG = f6(OIL(t-1),dOIL, IG(t-1)) |
| D. | Foreign Trade: | |
| 13. | Total Exports of Goods | E = EOG + ENO |
| 14. | Exports of Non-oil Goods | ENO = f7(ENO(t-1)) |
| | Exports of Oil and GAS | Exogenous (EOG) |
| 15. | Total Imports of Goods | M = MKR + MC |
| 16. | Imports of Capital and Intermediate Goods | MKR = f8(E,IP(t-1)) |
| 17. | Imports of Consumer Goods | MC = f9(MC(t-1),GNP) |

Table 2 continued

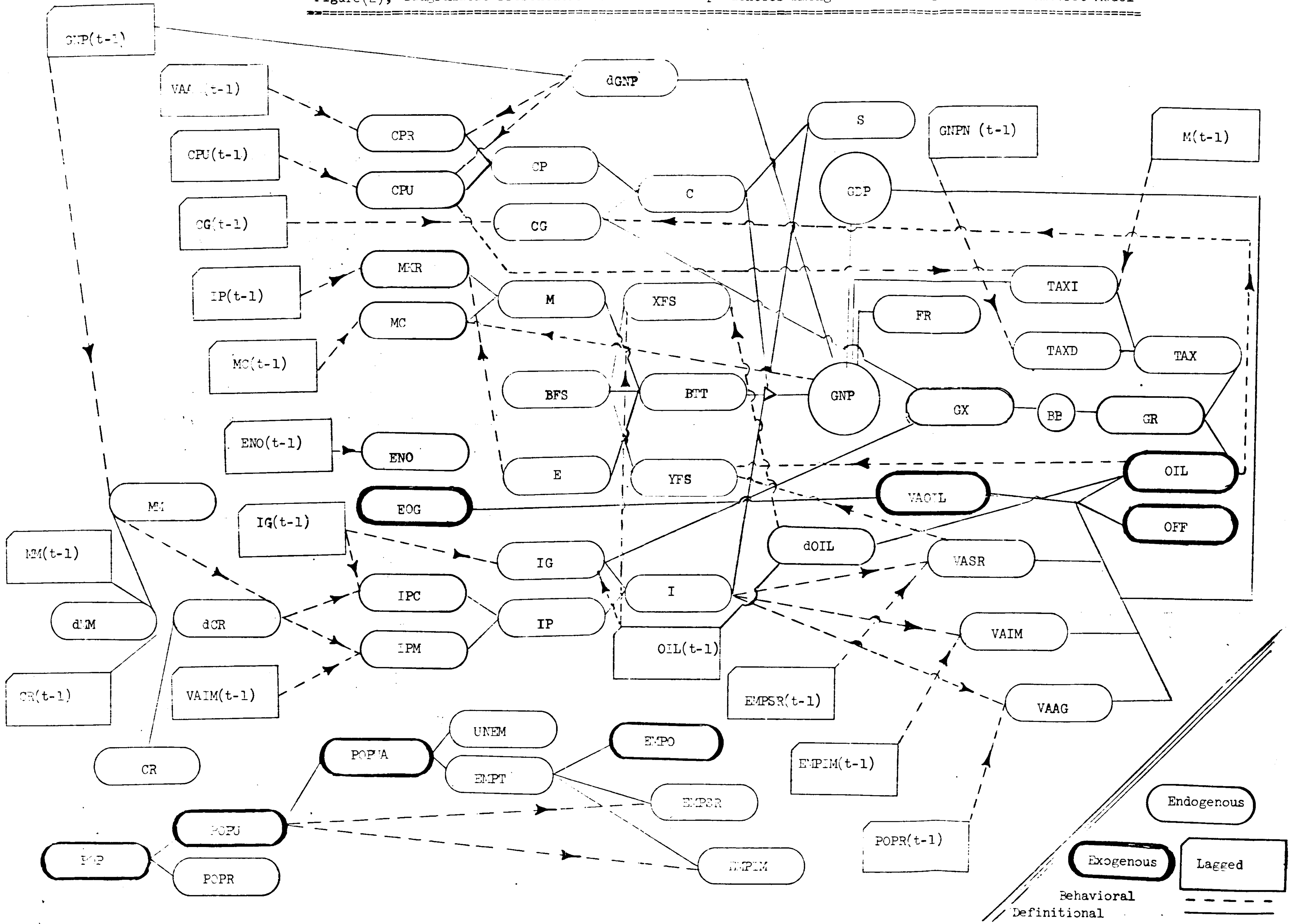
| | | |
|---|---|---|
| 18. | Net Balance of Factors and Services | BFS = YFS - XFS - FR |
| 19. | Income from Factors and Services | YFS = f10(VASR,OIL) |
| 20. | Payment for Factors and Services | XFS = f11(VAOIL(t-1),dOIL) |
| 21. | Net Balance of Trade | BTT = BFS + E - M |
| E. | Government Budget: | |
| 22. | Net Budget Balance | BB = GR - GX |
| 23. | Government Revenues | GR = TAX + OIL |
| 24. | Total Taxes | TAX = TAXD + TAXI |
| 25. | Direct Taxes | TAXD = f12(GNPNO(t-1)) |
| 26. | Indirect Taxes | TAXI = f13(CPU,M(t-1)) |
| | National Oil Income | Exogenous (OIL) |
| 27. | Government Expenditures | GX = CG + IG |
| F. | Money and Credit: | |
| 28. | Stock of Money | MM = f14(GNP(t-1)) |
| 29. | Growth of Money Stock | dMM = MM - MM(t-1) |
| 30. | Credits to Private Sector | CR = CR(t-1) + dCR |
| 31. | Growth of Credits | dCR = f15(MM) |
| G. | Aggregate Supply: | |
| 32. | National Product at Market Price | GNP = GDP + FR + TAXI |
| 33. | Gross Domestic Product | GDP = VAOIL + VAAG + VAIM + VASR |
| 34. | Value Added in Agriculture | VAAG = f16(I,POPR(t-1)) |
| 35. | Value Added in Industries and Mines | VAIM = f17(I,EMPIM(t-1)) |

Table 2 continued

| | | |
|---|---|---|
| 36. | Value Added in Services | VASR = f18(I,EMPSR(t-1)) |
| 37. | Value Added in Oil | VAOIL = OIL + OFF |
| 38. | Growth of National Product | dGNP = GNP - GNP(t-1) |
| 39. | National Saving | S = GNP - C |
| | Growth of Oil | Exogenous (dOIL) |
| | Foreign Factors in Oil Sector | Exogenous (OFF) |
| I. | Population and Employment | |
| 40. | Rural Population | POPR = POP - POPU |
| | Total Population | Exogenous (POP) |
| | Urban Population | Exogenous (POPU) |
| 41. | Total Urban Employment | EMPU = EMPIM + EMPSR + EMPO |
| 42. | Employment in Industries and Mines | EMPIM = f19(POPU,VAIM) |
| 43. | Employment in Services | EMPSR = f20(POPU) |
| | Employment in Oil | Exogenous (EMPO) |
| 44. | Urban Unemployment | UNEM = POPUA - EMPU |
| | Urban Active Population | Exogenous (POPUA) |

The above system of 44 equations (24 identities and 20 behavioral equations) constitutes the general structure of the model. In the next section we will estimate the behavioral functions and analyse the implications of the specified equations in the context of relevant economic theory and the structural characteristics of the Iranian economy. The following chart features a diagramatic presentation of the structural interdependencies among the variables of the model.

Figure(2); Diagramatic Presentation of the Interdependencies among the Variables of the Econometric Model



# Chapter IV

# Estimation and Testing of the Model

## 4.1 Method of Estimation:

In order to test and specify the hypothesized behavioral equations of the model we use the time series data of the National Accounts of Iran prepared for the 1958 - 75 period.(6)

All the variables are measured in billions of Iranian Rials in current prices. By using the time series data in current prices, we are actually formulating the interaction of the economy without filtering out the effects of the inflationary prices embodied in the variables of the model. At the same time, by using the variables in current prices, we can easily account for the substantial inflow of "purchasing power" caused by the appreciation of oil exports (i.e. price shifts of the 1970s). Whereas using

---

(6) The National Accounts Data are published annually by the Central Bank of Iran (Bank Markazi Iran) starting in 1958. The series used in this study is the recent revised version of the Central Bank's data compiled by the Plan and Budget Organization. (Economic Statistics and Trends of Iran), Tehran, Sept. 1976.

data in constant terms would require either employing different price deflators for various sectors of the economy or using an implicit GNP price deflator (i.e. a weighted index of different prices). The first method would produce a complicated accounting system with different price indexes and the latter would fail to indicate the full impact of the oil prices. Therefore, our analysis is simply carried out in observed nominal values.

All the alternative hypotheses of the model were first statistically tested and analyzed by using the ordinary least squares method(7). Application of (OLSQ) would however estimate single equations from a simultaneous system of equations, thereby encountering the simultaneity bias (i.e. correlation of the error terms with the endogeneous variables of the system).

The 2SLSQ estimates of our model is based on five principal components which explain about 99 percent of the total variation in the predetermined variables of the model. A set of principal components will be created and used along with the predetermined variables of each single equation as instrumental variables in the first stage of that equation's 2SLSQ regression.(8)

---

(7) Carter, R.A.L., "Least Squares As An Explanatory Estimator", Canadian Journal of Economis, Feb. 1973, pp. 108-114.

(8) McCarthy, M.D., "Notes on the Selection of Instruments for Two Stage Least Squares and K Class Type Estimation of Large Models", Southern Economic Journal, 1971, pp. 251-259.

By using the 2SLSQ technique, we can treat the simultaneity bias and get a consistent simultaneous estimate for the model. However, there are some other econometric difficulties that have to be considered. Among these difficulties, multicollinearity and autocorrelation could represent major problems in estimating an aggregate economic model like ours. The equations of the model were likely to indicate the existence of serial correlation in the residuals, due to the hypothesized dynamic trend of the function (i.e. inclusion of the lagged dependent variable as an explanatory variable of the corresponding function). The presence of serial correlation in the error terms means that the least squares estimate is not the minimum-variance estimate and the estimators are not efficient. In order to correct the autocorrelated regression, we have to search for a suitable linear transformation that satisfies the condition of serially independent error terms. For example, in the following linear model;

$$Y(t) = A + B.X(t) + U(t)$$

where, the error terms are serially correlated:

$$U(t) = R.U(t-1) + V(t)$$

By subtracting R.Y(t-1) from Y(t) we have:

$$Y(t) - R.y(t-1) = A.(1-R) + (X(t)-RX(t-1)) + V(t)$$

The value of R that presents serially independent error terms V(t), determines the suitable transformed equation which has the most efficient (minimum variance) estimates.(9) There are different methods of searching for the optimum value of R. In the estimation of our hypothesized model, we have used an iterative "TSCORC" method provided in our computing facility.(10)

In the following section we will explain the economic basis of the hypothesized behavioral functions of the model and present the estimated equations. This presentation will include the regression analysis by two stage least squares (2SLSQ) techniques. Whenever relevent, we will compare our findings with "Vakil, 73" and "Looney, 77" models.

---

(9) Fair, R.C., "The Estimation of Simulation Equation Models with Lagged Endogenous Variables and First Order Serially Correlated Errors", Econometrica, May 1970, pp. 507-516.

(10) "TSCORC" is a modified version of the "Cochrane-Orcutt" method utilizing R.C. Fair's technique in simultaneous estimation, provided in "Econometric Software Package", Synergy Inc., Washington, D.C.

## 4.2 Consumption Functions

As presented earlier, total consumer expenditure is disaggregated into consumption by the private sector and consumption by the government. Private consumption is then disaggregated into urban consumption and rural consumption. Therefore, we have three behavioral equations representing these three sections of consumer expenditures.

The fundamental economic principle behind the consumption behavior is the Keynesian theory of aggregate consumption, that assumes a positive relationship between aggregate income and consumption. This basic principle together with the dynamic trend of consumption (i.e. the tendency to advance the consumption standards) are the major pivots in explaining the consumption behavior of the economy.

### Urban Private Consumption (CPU):

The hypothetical function representing the consumer behavior of the Urban community was defined as:

$CPU(t) = f(CPU(t-1), dGNP)$

This function assumes that the volume of urban consumption at any period can be explained by two factors; 1) The consumption of the previous period, which in itself indicates the effect of the previous income (retained level of consumer expenditure) and 2) The growth in GNP, that indicates the relative effect of the variation in purchasing power ( the dynamic role of income in consumption).

By this hypothesis we assume that the consumers tend to retain a certain trend in consumption based on past experiences and habits (which is simply presented by a lagged consumption varible). At the same time the consumer behavior is assumed to be subject to changes in current income, i.e. a growing income is likely to promote consumption while a declining income is likely to lower the expected level of consumption. Thus at any period of time the actual consumption is determined by adjusting the expected trend of consumption in line with the direction and the amount of growth in income.

The regression analysis of this function produced the following estimates:

2SLSQ;

CPU(t) = -18.6 + 1.185 CPU(t-1) + .142 dGNP(t)

(9.92) (54.7)

(R-squared) = .9985

D.W. = 3.09 (H = -2.15)

The 2SLSQ regression after correction for first order serial correlation presented a more efficient estimate.

2SLSQ - TRNS; (RHO = -.6141)

CPU(t) = -17.87 + 1.175 CPU(t-1) + 0.150 dGNP

(11.9) (59.1)

(R-squared) = .9991

D.W. = 2.24 (H = -.39)

H = (1-.5(D.W.)) N/(1-N(VB)) , N is the number of observations and VB indicates the variance of the coefficient for the lagged variable. H has a normal distribution with mean zero and variance unity.(11) For the 95 percent level of confidence the critical values are +,-1.645 (-1.645 < H < 1.645).

---

(11) the (H) statistic is presented as an alternative for D.W., because of the presence of lagged dependent variable among the regressors.

See; Durbin, J., "Testing for Serial Correlation in Least Square Regression When Some of the Regressors are lagged Dependent Variables", Econometrica, 38, May 1970, pp. 410-21.

In the "Vakil, 73" modelwe find an alternative function for private urban consumption in the form of:

CPU = f(GNP,MKR(t-1))

where the lagged imports of capital and intermediate goods (MKR) is assumed to represent the availability of consumer goods (which is assumed to be affected by the imports of productive goods). Although the idea of correlation between the productive capacity of consumer goods industry and imports of productive goods may be justifiable, the assumption of "supply induced demand" for this section of expenditures presents an indirect approach to the explanation of the consumer's behavior.

On the other hand, the "Looney, Lexington, 77" model assumes another function in the form of:

CU = 10.4 + .084 IG(t-1) + .0076 GNP(t-1)

presumably the inclusion of the lagged government expenditure in this consumption function is to indicate the impact of public spending on private income, and therefore, on consumption. As mentioned, there is no explanation presented in theoretical support of Looney's proposed behavioral functions. Despite the high value of correlation coefficient presented for the above function (.9944), the function is likely to suffer from a high degree of collinearity between the investment and income variables.

Our proposed function, as presented, takes a more direct approach in explanation of the consumer's behavior and also presents good statistical properties.

Rural Private Consumption:

The rural sector of the Iranian economy can still be identified as a subsistence economy that has little connection with the dynamic urban sector. Therefore, the hypothesized function for the rural consumption behavior includes the value added in agriculture instead of the national output.

The assumption is that, since agriculture is the major field of activity in the rural sector, the agricultural income naturally constitutes the basis for consumption in this sector. At the same time growth of the dynamic sector of the economy is expected to have some contribution to the growth of the rural income and therefore, growth of rural consumption.

Although the contribution of the rest of the economy in the rural sector has not had a large impact in the past, the indications are that the modern sector is gradually contributing to the growth of the traditional sector of the economy. Inclusion of (dGNP) in the rural consumption function is based on the idea of reflecting the impacts of the national economic growth in the growth of consumer expenditures of the rural sector.

The regression analysis indicated that the lagged agricultural income has more significance in explaining the rural consumption than the present income. The results of the regression analysis are as follows:

2SLSQ - TRNS; (RHO = .5642)

$$CPR(t) = 0.07 + \underset{(2.16)}{1.20\ VAAG(t-1)} + \underset{(19.9)}{.0166\ dGNP}$$

(R-squared) = .9905

D.W. = 1.81

The existence of high correlation between the agricultural income and rual consumption confirms the validity of the hypothesis that the rural sector still has a traditional subsistence economy that has little economic input from the other sectors. The fitted values from the estimated equation are very close to the actual observations of the sample, which indicates a satisfactory predicting power for the estimates.

Comparison of the coefficients of dGNP in consumption functions for urban and rural sectors indicates that the growth of income has an important role in influencing the urban consumption, while its effect on the consumption of traditional sector is relatively small. An alternative estimate presented for this function is "Vakil, 73" equation for rural consumption which includes (VAAG) along with rural population index as independent variables explaining the rural sector's consumption (CPR=F(VAAG,POPR)). "Looney, Lexington, 77" also includes rural population, lagged rural consumption and lagged private investment in construction as independent variables for this function (i.e. CPR=f(CPR(t-1),POPR,IPC(t-1)).

We could not rationalize any economic reason for the effect of IPC on rural consumer behavior in Looney's proposed function. Obviously a mere statistical correlation between two variables can not justify any meaningful economic relationship. However, inclusion of population variables in both "Vakil, 73" and "Looney, Lexington, 77" is an acceptable alternative in explaining the rural sector's consumption behavior. The estimated function in our proposed model, as presented instead of the demographic factor tends to reflect the dynamic role of the growth of the GNP on adjusting the trend of the consumption in the rural sector, which clearly indicates the growing contribution of the modern sectors of the economy in the so called "subsistence economy" of the rural sector.

Government Consumption:

The consumer expenditures of the government consist of all the purchases of the public sector for purposes other than productive investment. Although public expenditure can be regarded as an autonomous factor determined by the policy maker, it is assumed that the behavior of the government like the other economic agents is subject to economic rationality. Therefore, in explaining the consumption behavior of the government we assume that the volume of the government's income is the major determining factor.

Major sources of government income in the Iranian economy are oil revenues and taxes. So, we assume that the volume of the public sector's revenues from oil and taxes constitutes the basis for the consumption expenditures of the government's budget. At the same time, continuation and expansion of the public services is often the significant basis in preparation of the government budget. This fact suggests that besides the sources of the revenue, the previous level of the government's consumption may be considered as an explanatory variable in the corresponding consumption function.

In our initial hypothesis we defined the government's consumption as:

$$CG(t) = f\ (CG(t-1), OIL, TAX)$$

Regression analysis of this function indicated that by excluding the TAX variable we can have a better estimate for the consumption expenditure of the government. The insignificant coefficient estimated for the tax variable indicates that the consumer expenditures of the government are not strongly dependent on the tax revenues.

Examination of the observations indicates that the relative share of the taxes in total revenue has declined due to the large increase in the other sources of public revenues(12) (i.e. oil income). In fact, the enormous expansion of the public services in the recent years has been financed mainly by oil revenues.

After excluding the tax variable from the regression, we obtained the following esimates:

---

(12) It was also found that with the increasing GNP the average tax ratio has declined (relative share of taxes from total output has decreased).

2SLSQ;

$$CG(t) = 7.82 + .903\ CG(t-1) + .192\ OIL$$
$$\qquad\qquad\qquad (9.65) \qquad\qquad (15.1)$$

$(R\text{-squared}) = .9963$

D.W. = 1.73 $\quad$ (H = .55)

The estimate indicates that the government consumer expenditures at any period is likely to be as much as 90 percent of the last period's expenditures plus about one-fifth of the oil revenues in the present period.

The fitted values of CG from the estimation are quite close to the observed values in the 1959-75 period. Therefore, on the basis of the "ex-post" performance of the estimated function we can assume a satisfactory prediction power for it.

An alternative hypothesis tested for government consumption in "Looney, Prager, 77" is in the form of:

$$CG = f(CRG(t-1), OR(t-1), GNP(t-1))$$

where CRG indicates credits of the banking system to the public sector and OR stands for the oil revenue. On the other hand, "Looney, Lexington, 77" presents another equation in the form of:

$$CG = f(M(t-1), GNP(t-1))$$

In this function lagged imports M(t-1) is suggested as an independent variable for the explanation of the public consumer expenditures. Although Looney's proposed equations both produce good statistical fit there is no theoretical explanation on the economic significance of these functions.

"Vakil, 73" assumes that the revenue sources of the public treasury is the main factor affecting the volume of government consumption and presents the following function:

$$CG = f(TD, TA, VAOIL)$$

where TD and TA indicate the direct and indirect taxes respectively. This function yields good statistical properties and may be considered as an alternative hypothesis for our proposed function.

## 4.3 The Investment Functions

Using the classification of Iranian national accounts, we assumed the sources of capital formation are: government investment, private investment in machinery and equipment and private investment in construction. Therefore, we have three behavioral functions for the investment expenditures of the economy.

Considering the fact that government investment and government supported investment are the major sources of capital formation, it would be irrelevant to try to explain the investment behavior by means of comparing the cost of capital (i.e. the interest rate) with the marginal efficiency of investment. The irrelevance of the theoretical stock adjustment approach is not limited to the public sector's investment. But, the factors affecting private investment are also different from those prevailing in a western type developed economy.

In fact, the lack of an organized capital market and the possibility for many promising investment opportunities identifies an entirely different condition, where the interest rates do not necessarily represent the cost of capital(13), and extensive use of theoretical marginal "cost-efficiency" analysis is not likely to provide a practical tool for explanation of the investment behavior of the economy.

---

(13) Kooros, A., "How to Pay for Economic Development in Iran", Bank Markazi Iran Bulletin, March-April 1969, p. 788.

Private Investment in Machinery (IPM):

We assumed that the private investment in machinery and equipment is a function of lagged value added in industries and mines, and the availability of the new sources of credit in the private sector

IPM(t) = f(VAIM(t-1), dCR(t))

In this function by using industrial production (VAIM) as an explanatory variable, we assume that the theory of the correlation between the present level of output and future investment(14) can be applied to the modern industrial sector of the economy. it is assumed that a one period (i.e. one year) lag can reflect the normal decision making process in time. So the volume of industial production at any period affects the volume of industrial investment (i.e. investment in machinery) in the following period.

---

(14) Evans, M.K., "Macroeconomic Activity", New York, Harper and Row, 1969, pp. 133-142

The other variable (dCR) features the role of the banking system's credits in financing the investment in any period of time.

Although the function does not include the interest rate or any explicit indicator for evaluation of the role of the investment productivity, it can be argued that the volume of new credits provided by the banking system is an indicator for the relative efficiency of the investments. And thus the credit variable not only represents the effect of the availability of finance but also it indicates the role of the banking and monetary factors in the performance of the industrial investment function With the 2SLSQ regression corrected for the first order serial correlation we obtained a more efficient (minimum variance) estimate for IPM.

2SLSQ - TRNS; (RHO = -.1992)

$$IPM(t) = 3.60 + .118\ VAIM(t-1) + .379\ dCR(t)$$
$$\qquad\qquad\qquad (1.43) \qquad\qquad\qquad (3.92)$$

(R-squared) = .9718

D.W. = 2.15

The fitted values of (IPM) from the above estimates are reasonably close to the observed values in the sample.

Although a relatively high standard error for the coefficient of VAIM in the OLSQ estimate indicates a low level of significance for that variable, we include the estimated function in our proposed model on a theoretical basis (i.e. the particular importance of the role of the industrial output in this sector's investment decisions). It must be noted that further growth and maturity of the industrial sector is expected to create a greater reliance on industrial value added for financing of private investment.

The alternative functions suggested in "Vakil, 73" is in the form of:

IPM = f(GNP(t-1))

which assumes that the investment in machinery is a function of lagged GNP only. The estimated function presents a relatively lower correlation coefficient (.755), but a highly significant t-statistic (t=5.9).

"Looney, Lexington, 77" includes an alternative function in the form of:

IPM = f(VAOIL(t-1), IP(t-1))

The estimated equation for this hypothesis presents a high correlation coefficient (.96) and significant t-statistics. However, inclusion of lagged oil output and lagged investment is likely to present a disturbing case of multicollinearity. Also the presence of lagged investment variable in the right hand side of the equation could have contributed to the strength of fit, while there is no Durbin-Watson statistics to test the estimate for serial auto correlation. In comparing the alternative value added variables, as explanatory factors for investment in machinery, it is clear that our proposed variable (VAIM) is directly related to the specific sector (industries and mines). On the other hand, inclusion of the credit variable in our equation indicates the role of the monetary dynamism in the investment function.

Private Investment in Construction (IPC):

The total private capital formation in construction consists of the investments in residential construction and non-residential construction. The residential construction activities are sensitive to the supply of credit. Therefore, we included the growth of the private sector's credits as an explanatory variable in the hypothesized function.

On the other hand, the investment of the government is an important factor for both residential and non-residential construction industries. The volume of public investment can affect residential construction by influencing the purchasing power of the households and thus promoting the demand for housing. It also influences the non-residential construction industry directly by sub-contracting the construction projects to the private sector, and indirectly by promoting the market through the multiplier-accelerator mechanism.

We assumed that there is a time lag between the initiation of investment by the government and realization of its effects on the activities of the private sector. Therefore, by using a one year lagged government investment in our proposed investment function, we assumed that the private sector's investment decision in the construction field are lagged by one year behind the autonomous investment decision by the government.

We obtained the following results for the 2SLSQ estimations:

2SLSQ:

$$IPC(t) = 16.45 + .188\ IG(t-1) + .247\ dCr(t)$$

$$\qquad\qquad\qquad (4.09) \qquad\qquad\quad (5.97)$$

(R-squared) = .9947

D.W. = 1.51

The alternative hypothesis proposed for this function in "Vakil, 73" is in the form of:

IPC = f(dCR,dPI)

i.e. a function of the growth of credits to the private sector and the change in wholesale price index regression analysis of this function presents relatively good statistical results. The coefficient of the price variable has a negative sign which indicates the negative role of the inflation on investment decisions.

"Looney, Lexington, 77" presents a function in the form of:

IPC = f(M(t-1),IPC(t-1))

Inclusion of the lagged IPC as an explanatory variable yields a high explanatory power for this function, but the presence of lagged imports M(t-1) as an independent variable is not theoretically justified.

Although "Vakil, 73" has a fairly good alternative for the investment function in construction, we tend to support our propsed function both on theoretical grounds and statistical findings.

Government Investment (IG):

Government investment is one of the major policy variables of the model, that is used as an explanatory variable in some of the behavioral equations of the model. Therefore, IG has a direct and also an indirect multiplier effect on the GNP. The relative importance of the public sector's investment has increased over time. In recent years it has constituted more than 60 percent of the gross national capital formation.

The government's investment decisions depends on the availability of resources and the target rate of growth of the economy. However the planned targets of growth normally have to be adjusted on the basis of the expected changes in the revenues of the government. Thus, we can assume that the total volume of government investment in any period depends on the realized levels of financial resources (i.e. oil revenues, taxes and net balance of foreign loans) and the current variations (positive or negative changes) in the flow of those revenues. Our assumptions not only explain the actual behavior of the administration, but it also relects the theoretical foundations of the dynamic investment analysis, i.e.

present investment can be related to the previous period's income, the previous period's investment and variations in present income.(15)

On the basis of these assumptions, our hypothetical function included the lagged oil revenue (major source of government's income), the variation in oil revenues and the lagged government investment.

The regression analysis presented the following estimates:

2SLSQ:

$$IG(t) = -2.8 + .887\ IG(t-1) + .258\ OIL(t-1) + .059\ dOIL(t)$$
$$(11.9) \qquad (13.4) \qquad (5.9)$$

(R-squared) = .9985

D.W. = 2.42

The alternative function presented in "Vakil, 73" is in the form of:

IG = f(VAOIL)

This function simply takes the value added in oil as the only explanatory variable for government investment.

---

(15) Koyck, L.M., "Distributed Lags and Investment Analysis", Amsterdam, North Holland Co., 1954, p. 36.

"Looney, Lexington, 77" has two separate functions for government investment (investment in machinery and investment in construction). These functions are presented in the following forms:

IGM(t) = f(IGM(t-1),IP(t-1),GNP(t-1))

IGC(t) = f(IGC(t-1),IP(t-1),VAOIL(t-1))

Besides the lagged investment variables that are present in both equations and presumably improve the explanation power (probably at the cost of multicollinearity), there are also GNP and OIL output appearing as independent variables. It is hard to find a reasonable explanation for government investments in two different types being functions of two different levels of income (i.e. GNP and OIL output). Our perception of the government's behavior is consistent with our proposed function that explains the total government investment in one equation in the context of a clear economic theory, which also presents a good estimate.

## 4.4 Foreign Trade Functions

The foreign trade section of the model includes the following behavioral relations:

- Exports of Non-oil goods
- Imports of capital and intermediate goods
- Imports of consumer goods
- Payments for factors and services
- Revenues from factors and services

Non-Oil Exports (ENO):

Export of oil and gas constitutes the major portion of Iran's total export of goods. The residual of total exports is called non-oil export (i.e. non oil and gas), which includes two different groups of products: a traditional section that consists of primary products like fruits, fish, cotton, woolen carpets, minerals, etc. and a modern section that consists of manufactured consumer goods like textiles, clothing, footwear, household applicances, etc.. (16)

---

(16) Iran has exported some automobiles, busses and other durable consumer goods through bilateral trade agreements, while the country is a net importer of these items.

Although non-oil exports have grown to some extent in the last two decades, the relative importance of non-oil exports has declined due to the enormous growth in the value of the oil sector's exports i.e. the total non-oil exports in 1975 was about 3.1 percent of the total export of goods.

Considering the content of the non-oil exports we tested a few alternative assumptions for the export function of non-oil goods. The explanatory variables included value added in agriculture, in industries and mines and the GNP. Although all the above variables indicated positive correlation with ENO, none of the estimates presented a sufficiently good statistical fit.

Finally, we assumed that the export of non-oil goods has a simple growth trend over time and that no single variable or combination of variables can significantly explain it (probably because of the wide range of factors affecting this relatively small magnitude). Therefore, we assumed that the total non-oil exports at any period is simply a function of the last period's exports.

$$ENO(t) = f(ENO(t-1))$$

The regression analysis confirmed the validity of this assumption and presented satisfactory estimates.

2SLSQ:

ENO(t) = .964 + 1.052 ENO(t-1)

(13.9)

(R-squared) = .9330

D.W. = 2.02 (H = .042)

Imports of Capital and Intermediate Goods (MKR):

The total imports of goods are divided into three different categories capital, intermediate and consumer goods. Assuming that the first two categories are affiliated in terms of their functional variations as well as the economic magnitude we made a simpler classification for the purpose of this study, (i.e. the imports of the productive goods versus consumer goods).

In order to explain the variation of the imports of the productive goods we tested various alternative assumptions. A simple hypothesis was to assume that MKR is a function of national product or, in a more precise relationship, the value added in the industrial sector. This assumption indicated a significant correlation. However, besides the conventional income variables that are usually used to explain the trend of imports, we wanted to consider the objective magnitude of the import substitution policies that are likely to influence the long run trend of imports.

Considering the fact that the investment decisions in the private sector, through a system of incentives and regulations (i.e. taxes, tariffs, etc.), are guided and steered towards a national target of industrialization we assumed that the domestic investment in general, and industrial capital formation in particular, would indicate the import substitution effects of the development of the domestic industries.

Therefore our hypothetical function was based on the assumption that the growth of the industrial sector requires imported machinery and semi-finished materials (Productive imports). But at the same time, the expansion of national productive capacity (i.e. growth of the capital stock) is supposed to supply domestic manufactured products competitive with, and a substitute for some of the imported items.

However, it is obvious that the growth of productive capacity in the industrial sector is positively related to the volume of capital formation. Therefore, the above hypothesized function, among the other problems, would be likely to suffer from collinearity among its independent variables. Also the regression analysis of that function does not present a significant estimate.

We proposed an alternative hypothesis which does not reflect the effects of import substitution directly. However, it links the productive imports to the total exports of the economy, and therefore represents the idea of "balanced trade" embodied in Iranian bilateral trade agreements in recent years.

Considering the need for imported capital and intermediate goods in the process of industrialization, we assumed that the private capital formation will create demand for imported productive goods. Thus, the hypothesized function is:

$$MKR(t) = f(E(t), IP(t-1))$$

The assumption of a lagged investment variable is to accommodate the effect of the adjustment lag in conveying the trend of domestic market to foreign trade.

The regression analysis presented the following estimates for this function:

2SLSQ:

$$MKR(t) = -41.9 + .218\ E(t) + 1.718\ IP(t-1)$$
$$\qquad\qquad\qquad (2.32) \qquad\quad (2.15)$$

$(R\text{-squared}) = .9270$

$D.W. = 1.56$

By including this function in the model, the potential import substitution process is not directly embodied in the model. Therefore, it is likely to overestimate the volume of imports, if the model is employed for projection under the condition of domestic industries' competition in imported goods' market.

An alternative function estimated for the import of productive goods is presented in "Vakil, 73" in the form of:

$$MKR = f(VAIM(t-1), GNP)$$

Both explanatory variables in this function are income variables which are commonly used in import functions.

Looney's models do not classify imports in different groups. "Looney, Prager, 77" has a function in the form of:

$M(t) = f(OIL, OIL(t-1), M(t-1))$

which explains the total imports as a function of oil income and lagged dependent variable.

However, it must be noted that the trend of the import substitution in the past has not been strong enough to present a significant statistical estimate. Thus, in order to accommodate the impact of future industialization on trends of the imports, suitable adjustments in the model can be initiated exogenously (i.e. introduction of exogenous coefficients to reflect the future impact of import substitution policy).

Imports of Consumer Goods (MC):

Imported consumer goods in Iran consist of many different items. The major groups of imported consumer goods are foodstuffs, chemical and pharmaceutical products and durable consumer goods. The total value of consumer goods imports in 1975 was 151.7 billion Rials (2.25 billion Dollars), which was equal to about 6.5 percent of the total consumer expenditure.

In order to specify the import function for consumer goods, we assume that imported consumer goods constitute part of total private consumption and therefore is a function of income. At the same time, we assumed that consumer habit and the concept of "maintaining consumption standards" suggests the relevance of lagged imports as an explanatory variable for the consumer goods import function For example:

$$MC(t) = f(MC(t-1), GNP)$$

The regression analysis supported our assumptions and we obtained the following estimates.

2SLSQ:

$$MC(t) = -6.51 + .614\ MC(t-1) + .024\ GNP(t)$$
$$\qquad\qquad\qquad (1.91) \qquad\qquad (3.51)$$

(R-squared) = .9074

D.W. = 1.70

Revenue from Factors and Services (YFS):

This variable, in fact, represents invisible exports which include the exports of services and revenues from factors abroad. The explanatory variables chosen to explain the variations of YFS are the value added in the services sector and oil income.

For the first regressor (VASR), the assumption is that the larger the services sector the greater the opportunity for the export of services. The latter regressor (OIL) is assumed to explain the factor income from the investments abroad and the foreign companies' expenditures in Iran (both related to the volume of oil revenues).

The regression analysis displayed reasonably good estimates for the hypothesized function.

2SLSQ - TRNS: (RHO = .9378)

$$YFS(t) = -73.58 + \underset{(8.83)}{.164}\ VASR(t) + \underset{(2.21)}{.0186}\ OIL(t)$$

(R-squared) = .9858

D.W. = 1.82

Payments for Factors and Services (XFS)

This variable refers to the invisible imports and includes the import of services and payments for the foreign factors. Prior to the nationalization arragements of 1973 in the oil sector, payments for the international oil consortium was one of the major items accounted for by this variable. But following 1973 only services purchased by the nationalized oil industry were included in this account.

Assuming that the major components of the payments to foreign factors are either government's spending abroad or the payments for foreign factors engaged in Iran. We found that oil income is a significant variable in explaining their variations. i.e. government expenditure, especially that requiring foreign exchange is directly determined by the volume of oil revenues and the foreign factors and services purchased through private business activities are also mainly dependent on the availability of foreign exchange, which in turn is mainly provided by oil revenues.

As with the government investment expenditures, we assumed that a lagged OIL variable along with the dOIL, i.e. growth of the oil income, could represent a dynamic pattern of the oil revenues' effect on the payments abroad. The 2SLSQ regression after correction for first order serial correlation presented the following estimate:

2SLSQ - TRNS: (RHO = .6729)

$$XFS(t) = 57.00 + .236\ OIL(t-1) + .069\ dOIL(t)$$
$$(11.9) \qquad (3.29)$$

(R-squared) = .9696

D.W. = 2.40

Both Vakil and Looney take the net factor payments as a function of cil export, therefore, their simple equation can be regarded as the estimated reduced form of YFS and XFS functions in our model.

Balance of Total Trade (BTT)

Balance of total trade is derived from an identity equation:

$$BTT = E - M + BFS$$

which is the sum of net export of commodities (E -M) and balance of factors and services (BFS). The net balance of factors and services is also defined as the product of another identity equaticn:

$$BFS = YFS - XFS - FR$$

where, FR is the net factor revenue. hence FR is defined as part of the national product and already accounted for in GNP, the above equation determines BFS as the net balance of factors and services (i.e. net balance of non-visible trade). As the net factor revenue (FR) has varied randomly (negative or positive) over the sample period as a small fraction of the GNP, model does not include any behavioral equation for FR. It is simply defined as the difference between national and domestic product at market prices.

## 4.5 Money Supply, Credit and Price Equations

As we mentioned earlier it would not be a realistic analysis if we were to explain the structural dynamics of a developing economy in the context of a purely monetarist approach. However, we did include some major monetary variables such as money supply and credits, and their growth, as explanatory variables in some of the behavioral equations. Thus, we assumed that the variations in the monetary variables would be implicitly embodied in the model.

At this stage we will specify the long-run trend of the monetary variables in terms of their relationships with the other variables of the model.

It is obvious that for a short run analysis, the money supply or credit levels could be assumed as exogenous variables controlled directly by the monetary authorities. But, having designed the model for a long-run structural analysis, we assumed that the long-run trend of variations of the monetary variables should also be explained in the context of a rational relationship based on the principles of economic theory.

In our definitional equations about this section of the model, we assumed that the initial level of money (stock of money, MM) and also the initial cumulative balance of credits (CR) are known, and the values of MM and CR for the next period would be determined by the volume of the growth of money supply (dMM) and the growth of credits (dCR) i.e. a simple stock-flow mechanism.

$$MM(t+1) = MM(t) + dMM(t+1)$$

$$CR(t+1) = CR(t) + dCR(t+1)$$

Therefore, we need to specify the functions of the growth of credits. Furthermore, in order to analyze the monetary magnitude of a general price index, we included an aggregate price deflator as a function of money supply. This index will enable us to convert (i.e. deflate) the monetary value of GNP in current prices to the real value of GNP in terms of constant prices.

Money Supply and Demand (MM)

The broad definition of money stock (MM) is assumed to be the one which includes cash and demand deposits (M1), savings and time deposits of the private sector (M2) and government deposits (M3). So, our money stock (MM) refers to the total stock of money, quasi money, and government deposits. The inclusion of government deposits in money stock is because of the importance of the government funds in the total deposits of the banking system.

Our hypothesis for the growth of money stock is based on the principles of monetary management, i.e. control of the growth of money supply in line with the growth of the economy. Both Fisher's basic "quantitative theory of money" and the modern monetary theory relate the variaton of prices to the variation in money supply (i.e. growth of money stock) and therefore, an optimal monetary policy in this context can be defined as a steady moderate rate of growth in money supply carefully managed and harmonized with the real growth of the economy. (17)

Assuming that the monetary authorities are aware of the inflationary effects of the excess growth of money supply, we hypothesize that the growth of the money depends on the real requirements of the economic growth that to some extent reflects the variations in non-monetary phenomena.

On the basis of such a basic assumption we expressed the hypothetical functions for money supply and demand as:

$$MD(t) = f(GNP(t-1))$$
$$MS(t) = MD(t) = MM$$

The first function assumes that the demand for money supply in a given period depends on the volume of GNP in the preceding period. The assumption of a lag for the income variable reflects the idea that the money at any period is a function of the realized (past) income, rather

---

(17) Friedman, M., "Monetary Policy for a Developing Society", Central Bank of Iran's Bulletin, March-April 1971, pp. 700-712.

than the expected (current) income.(18) The second function defines the equilibrium condition in the money market (supply = demand).

The regression analysis of the above function resulted in the following estimates:

2SLSQ:

MM(t) = -91.48 + .599 GNP(t-1)

(-3.51) (24.8)

(R-squared) = .9778

D.W. = 1.78

In "Vakil, 73" there is no behavioral function for money stock, while "Looney, Prager, 77" presents a function in the form of:

MS = f(MS(t-1),OIL(t-1))

However, our proposed simple function is directly in line with monetary theory and also indicates good statistical fit.

Growth of Credits (dCR):

The growth of credits (dCR) indicates the changes in outstanding credits provided by the banking system to the private sector. As we showed, the availability of credit is a significant factor in the private sector's investment decisions.

---

(18) Assumption of an adjustment lag is common in simple monetary models and rational expectation models.

In recent years there has been a large expansion in Iran's banking industry which has resulted in a substantial growth of the credits to the private sector. Beside the commercial credits the new waves of growth in the banking industry has also influenced the supply of credits to the manufacturing and construction industries.

Our hypothetical function for the availability of credits (dCR) assumes that the money supply is the original factor in determining the level of credits, i.e. a variation in the money supply can affect the volume of deposits in the banking system, which in turn can affect the credit creation potential of the banks. Therefore, an increase in the money supply is likely to increase the level of credits to the private sector, "CETERIS PARIBUS".

Therefore, we assumed that the volume of new credits granted to the private sector (DCR) at any period is a function of the growth of money stock in that period.

$$dCR(t) = f(dMM(t))$$

The regression analysis presented the following 2SLSQ estimate:

dCR(t) = 3.09 + .631 dMM(t)

(11.1)

R-squared = .8978

D.W. = 2.54

Alternative functions proposed in "Looney, Prager, 77" include two credit functions one for the government sector and one for the private sector in the following forms:

CRG = f(CRG(t-1),MS(t))

CRP = f(CRP(t-1),MS(t),MS(t-1),CRG(t-1))

inclusion of lagged dependent variables yields a high explanation power for these functions which could be good alternatives for a detailed credit creation analysis. "Vakil, 73" also presents an alternative function in the form of:

dCR = f(VAIM,MS(t-1))

which presents good statistical properties.

In an alternative hypothesis we assumed that the nominal stock of money supply has an exponential growth path, where the rate of growth as in Friedman's framework is the sum of the rate of growth of real income and the rate of growth of prices. On the basis of this assumption, stock of money at any period can be taken as a linear function of the money stock in the past period, i.e.

$$MM(t) = (m + 1).MM(t-1)$$

where m is the anticipated rate of growth of money.

With this definition we can now write:

$$dMM(t) = MM(t) - MM(t-1)$$

$$dMM(t) = MM(t) - (1/(1+m)).MM(t)$$

$$dMM(t) = g(MM(t))$$

Thus our proposed function for growth of credits can be rewritten as:

$$dCR = f(dMM) = f(g(MM(t)))$$

$$dCR = h(MM(t))$$

Regression analysis of the above hypothesis presented the following estimates:

2SLSQ:

$$dCR(t) = -20.51 + .222\ MM(t)$$
$$(23.0)$$

(R-squared) = .9743

D.W. = 1.50

The above estimated function presents a better statistical fit than previously suggested function for dCR. This indicates that the new credits granted to the private sector, under the condition of steady growth of money, can be taken as a function of the stock of money.

Prices and Inflation:

According to monetarist theory, growth of the money supply is the major source of inflation. We tested this theory by assuming that the implicit price deflator of GNP as an index for the rate of inflation is a function of the money supply (money in the broad definition).

We regressed the price index on the same year's money supply to test this hypothesis. The regression analysis supported the hypothesis and produced the following estimates;

2SLSQ:

$$PR(t) = \underset{(20.8)}{88.4} + \underset{(16.9)}{.124}\, MM(t)$$

(R-squared) = .9538

D.W. = 1.89

The estimated function for the price index indicates that the assumption of a money induced inflation, which is a typical phenomenon for the western industrial economies is not totally irrelevant for the developing economy of Iran.

Furthermore, a cross-sectoral analysis in the Iranian economy might reveal that the recent inflationary pressures have been induced through the advanced industrial sector of the economy which has substantial inter-relationships with the foreign sector. Therefore, it can be argued that the recent leaps in domestic prices are mainly related to the rise in world prices (i.e. the imported inflation).

This argument can be supported by the fact that the rise in Iranian prices was fairly small during the 1959-71 period, while the major waves of inflation hit the Iranian economy in the 1970s following the industrial world's inflation.

In order to test the hypothesis of "Imported Inflation" in the Iranian economy we regressed the annual rate of change in the GNP price index (rdPR) on the annual rate of change in import prices (rdPX) and the annual rate of change in money supply (rdMM). The regression analysis presented the following estimate:

OLSQ:

$$rdPR = -2.56 + \underset{(1.18)}{.194}\ rdMM + \underset{(3.67)}{.976}\ rdPX$$

$(R\text{-squared}) = .81$

D.W. = 1.86

A relatively insignificant coefficient reported for the money variable in the above equation supports the hypothesis of the determinant role for "world inflation" in the Iranian economy. This equation is not included in our model. However, it may be referred to as a crude estimator of the price path. Neither Vakil nor Looney include a behavioral price function in their models. Looney's model does not indicate any price variable and "Vakil, 73" takes the wholesale price index as an exogenous.

## 4.6 Taxes

Government revenues consist of oil income and taxes. The volume of oil income depends on the oil prices and the quantity of production which are determined outside the present model (exogenous). Taxes are classified into direct taxes and indirect taxes.

Direct Taxes (TAXD)

Direct taxes constitute a relatively small proportion of the government revenues. Direct taxes consist of personal income tax, corporate taxes and property taxes. In recent years due to a large increase in corporate and personal revenues the total volume of direct taxes has also increased significantly, i.e. in 1975 direct taxes accounted for almost 6.5 percent of non-oil GNP, compared to 1.5 percent in 1959.

For estimation of the direct tax equation, we assumed that the volume of direct taxes is a function of lagged non-oil GNP. The correlation of taxes and income is an obviously clear hypothesis, while the assumption of a one year lag for the income variable is to indicate the time lags involved in the collection procedure.

The regression analysis produced the following estimates for our assumed direct tax equation:

2SLSQ - TRNS: (RHO = .8829)

$$TAXD(t) = -68.23 + \underset{(9.5)}{.126}\ GNPNO(t-1)$$

(R-squared) = .9582

D.W. = 1.58

Looney's models do not include any tax variable while "Vakil, 73" presents a direct tax function in the following form:

$$TD = f(GNP)$$

our assumed tax function excludes the oil income from GNP and as presented takes the lagged non-oil GNP as a basis for direct taxes.

Indirect Taxes (TAXI):

Indirect taxes consist of custom revenues and sales tax. Formerly indirect taxes were the major source of the government's non-oil revenues, but recently the relative importance of direct taxes has increased. Although the availability of large oil revenues has resulted in the adoption of a more liberal tariff structure for consumer goods, custom revenues still constitute the major proportion of indirect taxes.

In estimating a behavioral equation for indirect taxes, we made them a function of lagged imports and urban private consumption; the two major sources of indirect taxes.

In this function we assumed that urban consumer expenditure represents the major source of consumer indirect taxes, while the rural consumption expenditures are not significantly taxable. The total value of imports was included to represent the custom revenues, which is collected from most of the imported items, though mainly from the consumer goods. We assumed a one year lag for the import variable to indicate the time interval in the collection of tariff revenues.

The 2SLSQ regression after correction for serial correlation presented a more efficient estimate;

2SLSQ - TRNS: (RHO = .93)

$$TAXI(t) = 41.33 + \underset{(4.38)}{.1072}\, M(t-1) + \underset{(1.54)}{.0249}\, CPU(t)$$

(R-squared) = .9850

D.W. = 2.44

## 4.7 The Aggregate Supply

The present model is designed to explain the components of the aggregate supply, i.e. the values added in different sectors of the economy, in addition to the aggregate demand (i.e. expenditures). Furthermore, the values added are used as explanatory variables in the other functions of the model.

Considering the limitations of a consistent time series data, disaggregation of the total supply is limited to the four major sectors of the economy; oil, agriculture, industries and services. The gross domestic product (GDP) is defined as the sum of the gross values added in these four sectors.

Value added in the domestic oil (VAOIL) consists of the national value added in oil, which we refer to as the total oil revenue (OIL) and the foreign factors in the oil sector (OFF). These two variables are both treated as exogenous variables in the present model, i.e. with a given price for oil and the total volume of oil production, which is determined by the government, the national oil income and the share of the foreign factors in the oil industry can be determined outside the model.

It must be noted that the share of the foreign factors in the domestic VAOIL has decreased substantially after the 1973 sales agreement which replaced the former consortium agreement and nationalized the oil industry in economic terms. Under the new arrangement the foreign factors constitute an insignificant proportion of the domestic value added in the oil sector. Our proposed function for XFS (payments for factors and services) integrates both payments for factors and purchase of services. Thus, the above change in the oil sector's payments does not affect our estimation.

The behavioral equations explained in the supply section of the model includes the functions of values added in agriculture, industries and services. The functions of employment in these sectors are also presented in this section.

In order to estimate the value added functions in three major sectors of the economy, we adopt the common hypothesis for the production function, and define the output as a function of major inputs (i.e. capital and labor).

$$Y = f(K,L)$$

or in its linear form we have:

$$Y = a + b.K + c.L$$

Due to the lack of data for capital stock, the direct estimation of this production function faces some difficulty. Furthermore, the investment figures disaggregated at sectoral level does not constitute a consistent time series for the entire observation period. Thus, it would not be feasible to use the investment figures for simulation of the capital stocks data. In the presence of these data restrictions our proposed equations for the values added in various sectors of the economy are based on a set of "Average Ratios" assumptions that would make it possible to use the aggregate investment data along with sectoral employment figures in the estimation of sectoral production functions.

By assuming that (i) the average capital-labor ratio in each sector is constant during the observation period (i.e. $K/L = G$), and (ii) the investment in each sector is dependent on the level of aggregate investment, we can express our linear production function in the following form:

$$Y(t) = a + b.K(t-1) + b.I(t) + c.L(t-1) + c.dL(t)$$

assuming that $K/L = G$, we can write

$$Y(t) = a + b.G.L(t-1) + b.I(t) + c.L(t-1) + (c/G)I(t)$$

$$Y(t) = a + (b.G + c)\ L(t-1) + (\ b + c/G)I(t)$$

$$Y(t) = A + B.L(t-1) + D.I(t);\ \text{where}\ B = b.G+c, D = b+c/G$$

Thus, we can reduce our proposed production function to a linear function of the $(L(t-1))$ and $(I(t))$. This hypothesis assumes that under the conditions of constant capital-labor ratio and homogenous distribution of national capital formation among the various sectors of the economy, the sectoral output can be defined in terms of the lagged input of labor force (which also represents the impact of initial capital input) and the current volume of investment (which also represents the impact of current labor input).

It is obvious that the validity of the above made assumptions can be challenged from a theoretical point of view. However the assumption of a constant capital-labor ratio on an aggregate level is not much different from the assumption of a fixed capital-output ratio, which is a fairly common practical assumption in economic investigations. Regarding the assumption of the fixed linear dependency of sectoral capital formations to the aggregate investment it must be noted that in a long-run analysis the principle of balanced growth requires a harmonized pattern of resource allocation that would establish a reasonably stable trend for the distribution of capital among the various sectors of the economy.

Furthermore, it must be noted that the proposed hypothetical function is only a tentative function that is suggested under the condition of limited statistical data.

In the following section we will test the proposed function statistically for three major sectors of the Iranian economy.

Value Added in Agriculture (VAAG):

Agriculture is the largest sector of the Iranian economy in terms of population and the smallest sector in terms of output. This sector mainly consists of farming, forestry, fishing and hunting. Traditional farming is the major source of activity in this sector, which represents a subsistance economy.

The behavioral function assumed for the agricultural output included the rural population and government investment. Inclusion of the rural population indicates the role of manpower in the traditional sector which is contrary to the famous assumption of zero or negligible marginal productivity of labor in some theoretical models of economic development.(19)

---

(19) - Lewis, W.A., "Development with Unlimited Supply of Labour", Manchester School of Economics, May 1954, pp. 139-192.

- Fei, J. and Ranis, G, " A Theory of Economic Development", A.E.R., Sept. 1961, pp. 553-565.

The hypothesis of zero productivity in these theoretical analysis is based on the assumption of "Unlimited Supply of Labour". This general assumption appears to be unrealistic under the traditional conditions of a farming sector dependent on the labor force. In fact, one of the causes for slower growth of agriculture in Iran's recent development plans is argued to be related to the large scale migration of young farmers to the urban sector.

Our assumption is that the total level of output in a traditional agriculture is not completely independent of the labor input. However, long-run development can introduce structural adjustments in technical and social aspects of traditional relationships with less dependency on labor.

The hypothetical function for agriculture production in the form of the general function already introduced is as follows:

$$VAAG(t) = f(POPR(t-1), I(t))$$

The rural population in this function is assumed to represent the labor input in agriculture, where under the traditional rural conditions the formal employment figures can not be considered as a meaningful index for labor participation.

The regression analysis resulted in the following estimates for our hypothesized function:

2SLSQ:

VAAG(t) = -310.2 + .163 I(t) + .0268 POPR(t-1)

(7.17) (5.52)

(R-squared) = .9647

D.W. = 1.69

In an alternative hypothesis for the agricultural value added, we consider the volume of change in output as a function of change in productive inputs, i.e.:

d VAAG(t) = f(dPOPR(t), I(t))

The regression analysis of this function presented the following results:

$$dVAAG(t) = -120. + .471\ dPOPR(t) + .076\ I(t)$$
$$(.95) \qquad (2.3)$$

R-squared = .66

D.W. = 2.24

In another estimation we replaced total investment by government investment, which is assumed to have a greater contribution to the agricultural development programs. This hypothesis presented the following regression results:

$$dVAAG(t) = -168.5 + .671\ dPOPR(t) + .094\ IG(t)$$
$$(1.31) \qquad (1.8)$$

R-squared = .62

D.W. = 1.99

After testing several different hypothesies we concluded that the variation in agricultural output is likely to be affected by some other factors and that some of these are not easily quantifiable (like climatic conditions and so on). Therefore, the estimated functions mostly present a relatively low prediction power.

Value Added in Industries and Mines (VAIM):

The industrial sector which is referred to as "the Industries and Mines" consists of manufacturing and mining, construction, water and electricity. Where the manufacturing and construction industries constitute the major proportion of the value added in this sector. Although government has made a substantial contribution in the development of the industrial sector, it is still the largest sector (in terms of the value added) for the private investment.

The production function hypothesized for this sector is also in the form of the function already introduced, i.e. it relates the level of output to the lagged empoyment and current investment:

VAIM(t) = f(EMPIM(t-1), I(t))

The regression analysis of this function produced the following estimates;

2SLSQ:

VAIM(t) = -95.58 + .484 I + .0874 EMPIM(t-1)
(14.16) (5.56)

R-squared = .9913

D.W. = 1.64

In alternative hypothesis we analysed the change of output in this sector as a function of changes in the inputs of the factors of production, i.e.:

dVAIM = f (dEMPIM, IP)

The regression analysis of this function produced the following estimates:

OLSQ:

$$dVAIM(t) = -25.5 + .598\ IP(t) + .0764\ dEMPIM(t)$$

s.e; (.032) (.036)

R-squared = .9635

D.W. = 1.34

Value Added in Services (VASR):

The services sector is the largest sector of the Iranian economy in terms of the value added. This sector consists of various service industries including the public services, private services, banking domestic trade and transportation.

The public services constitutes the largest proportion of the value added in this sector and the total government investment is considered to be the most significant factor affecting the growth of the services sector as a whole. The regression analysis did not indicate a significant role for private investment.

Our hypothetical function included the aggregate investment and employment in the services sector as explanatory variables. The regression analysis of this function produced the following estimates:

2SLSQ:

VASR(t) = -288.5 + .870 I(t) + .218 EMPSR(t-1)

(12.8) (5.4)

R-squared = .9859

D.W. = 1.41

In an alternative hypothesis we analysed the change in services value added as a function of changes in inputs (capital and labor) but did not succeed to regress a significant estimate.

After dropping the employment variable we regressed the following function that presents the growth of service's output as a function of government investment:

OLSQ:

dVASR(t) = -2.26 + .515 IG(t)

(11.7)

R-squared = .9072

D.W. = 1.91

4.8 Employment Equations

As there is no precise definition for employment under the traditional conditions of the rural sector, it would be irrelevant to apply the modern concepts of formal employment and unemployment to the labor force in the rural sector. Therefore, we assumed that the total active population (i.e. population in the labor market) of the rural sector, regardless of the level of productivity are fully employed. Thus the analysis would be limited to the urban sector of the economy where the labor market is relatively organized.

Total urban employment was defined as the sum of employment in the non-agricultural sectors of the economy (i.e. oil, industries, and services). The total urban unemployment, therefore, would be equal to the active urban population minus the total employment.

Employment in the oil sector (i.e. oil and gas) was assumed to be determined by the exogenous factors in the oil sector. Therefore, employment in the oil sector was assumed as an exogenous variable independent from the rest of the model. Futhermore, oil is a capital intensive industry and employment in the oil sector does not constitute a large proportion of the total urban employment.

The major sources of employment in the urban sector are industries and services, which are expected to absorb the surplus labor released from the agricultural sector in the long-run.

In order to determine the behavioral functions of employment in industries and services, it was assumed that the migration of rural population to the urban sector is efficiently adjusted and balanced by the availability of urban employment. Therefore, the size of the urban population can be regarded as a significant factor in estimation of the employment in urban sectors of the economy.

This assumption does not specify a structural relationship based on the explicit role of economic factors in the labor market. But, considering the relative size of urbanization as an implicit index of industrial development, the above assumption, indicates the proportionate weight of the various sources of employment in the urban sector.

Employment in Industries and Mines (EMPIM):

In a regression analysis based on the assumption of the existence of correlation between the size of the urban population and industrial employment, we obtained the following results:

2SLSQ - TRNS: (RHO = .3332)

$$EMPIM(t) = -743.8 + \underset{(23.5)}{.264}\ POPU(t)$$

(R-squared) = .9891

D.W. = 2.02

In an alternative approach we assumed different supply and demand functions for the employment in the industrial sector and estimated the function for the reduced form of the employment market, i.e. if;

Supply EMPIM = f(POPU)

Demand EMPIM = f(VAIM)

we have the reduced form as;

EMPIM = f(VAIM, POPU)

Regression analysis of this function presented the following estimates:

2SLSQ:

$$EMPIM(t) = -495.4 + \underset{(13.7)}{.238}\ POPU(t) + \underset{(1.19)}{.279}\ VAIM(t)$$

R-squared = .9863

D.W. = 1.41

In the above estimated function a relatively large standard error for the VAIM variable suggests a low level of significance for this variable in determination of industrial employment. This might be taken as an indication of the imperfection of the employment market in Iran, where subsidized industries may expand employment with little consideration of productivity. However, it is expected that development of more competitive industries will gradually establish a more significant role for the output variable in this function.

Employment In Services (EMPSR)

The employment market in the services sector under the conditions of the Iranian economy can be regarded as a "supplier's market". This hypothesis can be supported by the fact that the public services, the largest field of employment in this sector, similar to many developed economies, acts as a redistribution agency that directly provides welfare to civil servants and indirectly promotes affiliated service industries in the private sector. In recent years availability of large sources of income to the Iranian Public Treasury has enabled the government to undertake a wide range of welfare programs that, among other effects on the economy, has resulted in a growing employment opportunity in the urban sector. At the same time, a rapid growth in the manufacturing, construction, transportaion and other fields of industry has created even larger demand for the services sector and in many areas shortages developed for services of skilled labous.

On the basis of these developments,we assume that the trend of migration to the Iranian urban employment market is directly linked to the long-run "anticipated" rate of demand for employment in the urban sector and therefore the labor market is in a full employment state.

Having assumed a "supplier's market" in the services sector our hypothesis is formulated as:

EMPSR(t) = f(POPU(t))

Regression analysis of this function produced the following estimates:

2SLSQ - TRNS: (RHO = .6122)

EMPSR(t) = -262.1 + .223 POPU(t)

(19.1)

(R-squared) = .9932

D.W. = 1.67

# Chapter V

# Simulation and Conclusions

The behavioral functions estimated in the last chapter together with the definitional equations of the model constitute a complete set of structural equations that can be employed for future projections.

In the following section, the estimated equations will be used to compute the reduced form of the model and apply it for a sample ex-ante prediction on the basis of given future values for the excgenous variables of the model.

A complete list of estimated behavioral equations of the model is presented in the Appendix. The reduced form matrix of the model used for the sample prediction is presented on the following page.

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.26612 | -0.02307 | 0.0 | 0.90518 | 0.0 | 0.0 | 0.0 | 0.0 | -0.07177 | 1.32833 | 0.08698 | 1.34290 | -1.98970 | 1.04622 | 1.37234 | 0.59570 | 0.00000 | -0.71154 | 0.0 | 0.0 | 0.0 | 0.03455 | -0.00000 | 0.0 | 0.02275 | -55.216 |
| -0.73188 | -0.02307 | 0.0 | 0.90518 | 0.0 | 0.0 | 0.0 | 0.0 | -0.07177 | 1.32833 | 0.08698 | 1.34290 | -1.98970 | 1.04622 | 1.37236 | 0.59570 | 0.00000 | -0.71154 | 0.0 | 0.0 | 0.0 | 0.03455 | -0.00000 | 0.0 | 0.02275 | -55.216 |
| 0.03310 | -0.07928 | 0.0 | 0.75985 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00890 | -0.03189 | 0.00338 | 0.05220 | -1.67034 | -0.02512 | -0.03295 | 0.83588 | -0.00000 | -0.59734 | 0.0 | 0.0 | 0.0 | -0.22900 | 0.00000 | 0.0 | 0.01910 | -36.27 |
| 0.26612 | -0.02307 | 0.00000 | 0.90518 | 0.0 | 0.0 | 0.0 | 0.0 | -1.07177 | 1.32833 | 0.08698 | 1.34290 | -1.98970 | 1.04622 | 1.37238 | 0.59570 | 0.00000 | -0.71154 | 0.0 | 0.0 | 0.00000 | 0.03455 | -0.00000 | 0.00000 | 0.02275 | -55.21 |
| 0.23502 | -0.00370 | 0.0 | 0.14529 | 0.0 | 0.0 | 0.0 | 0.0 | -0.17203 | 1.36022 | 0.01396 | 0.21555 | -0.31936 | 1.07134 | 1.40533 | 0.15982 | 0.00000 | -0.11421 | 0.0 | 0.0 | 0.0 | 0.00555 | -0.00000 | 0.0 | 0.00365 | -11.776 |
| 0.0 | 0.05991 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.09136 | 0.0 | 0.06964 | 1.07516 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.25800 | 0.0 | 0.0 | 0.0 | -7.162 |
| 0.03310 | -0.01937 | 0.0 | 0.75989 | 0.0 | 0.0 | 0.0 | 0.0 | 0.10025 | -0.03189 | 0.07402 | 1.12735 | -1.67034 | -0.02512 | -0.03295 | 0.83588 | -0.00000 | -0.59734 | 0.0 | 0.0 | 0.0 | 0.02901 | 0.00000 | 0.0 | 0.01910 | -43.437 |
| 0.04303 | -0.00370 | 0.0 | 0.14529 | 0.0 | 0.0 | 0.0 | 0.0 | -0.17203 | 1.36022 | 0.01396 | 0.21555 | -0.31936 | 0.16793 | 1.40533 | 0.15982 | 0.00000 | -0.11421 | 0.0 | 0.0 | 0.0 | 0.00555 | -0.00000 | 0.0 | 0.00365 | -19.596 |
| 0.00478 | -0.00041 | 0.0 | 0.01615 | 0.0 | 0.0 | 0.0 | 0.0 | -0.01912 | 1.17070 | 0.00155 | 0.02395 | -0.03549 | 0.01666 | 0.02448 | 0.01776 | -0.00000 | -0.01269 | 0.0 | 0.0 | 0.0 | 0.00062 | -0.00000 | 0.0 | 0.00041 | 6.981 |
| 0.03825 | -0.00329 | 0.0 | 0.12914 | 0.0 | 0.0 | 0.0 | 0.0 | -0.15291 | 0.18951 | 0.01741 | 0.19159 | -0.28387 | 0.14927 | 1.38085 | 0.14206 | 0.00000 | -0.10152 | 0.0 | 0.0 | 0.0 | 0.00493 | -0.00000 | 0.0 | 0.00325 | -26.477 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.09136 | 0.0 | 0.06964 | 0.18772 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -4.379 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.05847 | 0.0 | 0.06964 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -10.739 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.03289 | 0.0 | 0.0 | 0.18772 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 6.361 |
| 0.00644 | -0.00055 | 0.0 | 0.24011 | 0.0 | 0.0 | 0.0 | 0.0 | -0.00172 | 0.03189 | 0.00209 | 0.03224 | 1.67034 | 0.02512 | 0.03295 | 0.26412 | 0.00000 | 0.59734 | 0.0 | 0.0 | 0.0 | 0.00083 | -0.00000 | 0.0 | 0.00055 | -49.701 |
| 0.0 | 0.0 | 0.0 | 0.21838 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.71811 | 0.0 | 0.0 | 0.24022 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -41.858 |
| 0.00644 | -0.00055 | 0.0 | 0.02173 | 0.0 | 0.0 | 0.0 | 0.0 | -0.00172 | 0.03189 | 0.00209 | 0.03224 | -0.04777 | 0.02512 | 0.03295 | 0.02390 | 0.00000 | 0.59734 | 0.0 | 0.0 | 0.0 | 0.00083 | -0.00000 | 0.0 | 0.00055 | -7.843 |
| 0.0 | 0.0 | 0.0 | 1.00000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.10000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.10000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.03954 | -0.07983 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00717 | 0.0 | 0.00547 | 0.08444 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.22817 | 0.0 | 0.0 | 0.01964 | -85.976 |
| 0.0 | 0.08454 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.24843 | 0.0 | 0.0 | 0.0 | 46.800 |
| 0.03954 | 0.00471 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00717 | 0.0 | 0.00547 | 0.08444 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.02026 | 0.0 | 0.0 | 0.01964 | -39.176 |
| 0.0 | 0.00980 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.01494 | 0.0 | 0.01179 | 0.17578 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.04218 | 0.0 | 0.02689 | 0.0 | -311.429 |
| 0.0 | 0.02902 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.04425 | 0.0 | 0.03773 | 0.52077 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.08736 | 0.12497 | 0.0 | 0.0 | 0.0 | -99.059 |
| 0.0 | 0.05212 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.07948 | 0.0 | 0.06058 | 0.93541 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.22447 | 0.0 | 0.0 | 0.21762 | -294.757 |
| -0.73423 | -0.11381 | -1.00000 | 0.89725 | 0.0 | 0.0 | 0.0 | 0.0 | -0.20105 | 1.71669 | -0.01948 | -0.30083 | -1.97227 | 1.03706 | 1.28759 | 0.98697 | -0.04149 | -0.70531 | 0.0 | 0.0 | -0.08736 | -0.35737 | 0.01761 | -0.02689 | -0.19507 | 541.416 |
| 0.0 | 0.00798 | 0.0 | 0.0 | 0.0 | 0.44205 | 0.0 | 1.00000 | 0.01217 | 0.0 | 0.00927 | 0.14320 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.02402 | 0.03436 | 0.0 | 0.0 | 0.0 | -531.012 |
| 0.0 | -0.00798 | 0.0 | 0.0 | 0.0 | -0.44205 | 1.00000 | -1.00000 | -0.01217 | 0.0 | -0.00927 | -0.14320 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.02402 | -0.03436 | 0.0 | 0.0 | 0.0 | 531.012 |
| 0.0 | 0.0 | 0.0 | 0.0 | 1.00000 | -1.00000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.00798 | 0.0 | 0.0 | 0.0 | 0.23839 | 0.0 | 0.0 | 0.01217 | 0.0 | 0.00927 | 0.14320 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.02402 | 0.03436 | 0.0 | 0.0 | 0.0 | -525.375 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.20306 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -5.637 |
| 1.00000 | 0.09094 | 1.00000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.13857 | 0.0 | 0.10570 | 1.63197 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.08736 | 0.39162 | 0.0 | 0.02689 | 0.21762 | -705.245 |
| 0.00294 | -0.00025 | 0.0 | 0.00991 | 0.0 | 0.0 | 0.0 | 0.0 | -0.01174 | 0.01455 | 0.00095 | 0.01471 | -0.02179 | 0.01146 | 0.10598 | 0.01090 | 0.05187 | -0.00779 | 0.0 | 0.0 | 0.0 | 0.00038 | 0.08803 | 0.0 | 0.00025 | -20.280 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.08803 | 0.0 | 0.0 | -24.834 |
| 0.00244 | -0.00025 | 0.0 | 0.00991 | 0.0 | 0.0 | 0.0 | 0.0 | -0.01174 | 0.01455 | 0.00095 | 0.01471 | -0.02179 | 0.01146 | 0.10598 | 0.01090 | 0.05187 | -0.00779 | 0.0 | 0.0 | 0.0 | 0.00038 | -0.00000 | 0.0 | 0.00025 | 4.554 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.59874 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -91.480 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.59874 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -1.00000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -91.480 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.13311 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.00000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -40.934 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.13311 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -40.834 |
| 1.00244 | -0.00025 | 0.0 | 0.00991 | 0.0 | 0.0 | 0.0 | 0.0 | -0.01174 | 0.01455 | 0.00095 | 0.01471 | -0.02179 | 0.01146 | 0.10598 | 0.01090 | 0.05187 | -0.00779 | 0.0 | 0.0 | 0.0 | 0.00038 | 0.08803 | 0.0 | 0.00025 | -20.28 |
| 0.19196 | 0.05991 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.98744 | 0.0 | 0.90341 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.25800 | 0.0 | 0.0 | 0.0 | 5.03 |
| 0.81095 | -0.06016 | 0.0 | 0.00991 | 0.0 | 0.0 | 0.0 | 0.0 | -0.01174 | 0.01455 | 0.00095 | -0.97273 | -0.02179 | -0.89196 | 0.10598 | 0.01090 | 0.05187 | -0.00779 | 0.0 | 0.0 | 0.0 | -0.25763 | 0.08803 | 0.0 | 0.00025 | -25.31 |
| 0.0 | 0.05991 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.98744 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.25800 | 0.0 | 0.0 | 0.0 | -2.784 |
| 0.19199 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.90341 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 7.81 |
| 1.00000 | 0.0 | 1.00000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Having specified the reduced form of the model, we can introduce data for exogeneous variables and project the future trends of the endogenous variables. The exogenous variables of the model as introduced consist of the population variables (i.e. total population urban population and active urban population) and the variables related to the oil sector (i.e. oil export, net oil income, variation in oil income, and employment in the oil sector). It is obvious that alternative assumptions about the future trend of these exogenous variables would create alternative projected values for the endogenous variables of the model. In sample projections introduced in this study, the exogenous variables are determined in the following manner:

a) Determination of the population variables is based on the assumption of the continuation of present demographic trends in the future. Thus, the total population figure is produced by using a slowly declining rate of growth of population, consistent with the findings of the last two censuses.(20) The urban population figures are also produced by applying the increasing rate of growth of urban population (i.e. rural - urban migration) observed in

---

(20) It is assumed that the rate of growth of Iran's population will gradually decline from approximately 2.7 percent per annum in 1975 to about 2 percent per annum by the year 2000.

recent years. For the active urban population it is assumed that the rate of activity is slowly increasing due to the increasing participation of the female population in the labor force.(21)

b) The values of the exogenous variables related to the oil sector are determined on the basis of a fixed annual rate of growth for the value of output and export in this sector. In our sample projection the rate of growth is assumed to be 15 percent in current prices.(22) Knowing the fact that oil variables are the primary policy variables of the model, there is no economic justification for the assumption of a certain rate of growth for the value added in the oil sector. Therefore, the present projection has to be considered solely as a "sample projection" under the hypothetical condition of the particular growth rate assigned for these values. However, it must be noted that a 15 percent annual rate of growth in current prices is a

---

(21) It is assumed the rate of activity for urban population will increase from about 41.8 percent in 1975 to about 46 percent in 1985.

(22) e.g. a 5-10 percent annual price rise along with a 5-10 percent rise in oil production can present an average annual growth rate cf 15 percent in oil income.

moderate rate of growth which would enable us to examine the projected performance of the economy without speculating on the effects of drastic changes in the oil sector's variables.

The result of the sample projection for a ten year period (1975-85) is presented in the following table:

# Table (4)

Simulated Values of the Endogenous Variables of the Econometric Model

With the Assumption of a 15% Per Annum Growth in the Oil Sector (Nominal)

( Billions of Rials, Current Prices )

| | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|---|
| . Gross National Product | 4554.4 | 5672.3 | 6852.9 | 8194.5 | 9739.1 | 11523.5 | 13591.6 | 15997.3 | 18802.8 | 22291.9 |
| . Non-Oil G.N.P. | 3078.9 | 3937.6 | 4857.9 | 5900.3 | 7100.8 | 8489.4 | 10102.4 | 11954.8 | 14198.4 | 16775.3 |
| . Net Balance of Trade | 234.3 | 114.4 | -62.7 | -283.6 | -554.3 | -891.5 | -1313.4 | -1840.3 | -2497.8 | -3316.7 |
| . Growth of G.N.P. | 959.7 | 1087.9 | 1180.6 | 1341.6 | 1544.6 | 1784.4 | 2068.1 | 2405.7 | 2905.5 | 3279.1 |
| . National Consumption | 2903.6 | 3665.9 | 4531.0 | 5553.0 | 6765.0 | 8207.6 | 9929.3 | 11955.4 | 14454.9 | 17412.4 |
| . National Investment | 1446.4 | 1892.1 | 2384.5 | 2925.1 | 3528.4 | 4207.4 | 4975.7 | 5849.2 | 6845.5 | 7996.2 |
| . National Saving | 1650.7 | 2006.5 | 2321.9 | 2641.5 | 2974.1 | 3315.9 | 3652.4 | 4008.9 | 4347.9 | 4669.5 |
| . Private Consumption, Total | 1911.5 | 2428.7 | 3022.6 | 3742.1 | 4614.6 | 5674.6 | 6963.2 | 8530.7 | 10437.4 | 12756.4 |
| . Private Consumption, Rural | 408.0 | 510.4 | 599.4 | 697.8 | 805.2 | 924.3 | 1057.4 | 1207.4 | 1377.3 | 1570.5 |
| . Private Consumption, Urban | 1503.5 | 1918.3 | 2423.1 | 3044.3 | 3809.4 | 4750.3 | 5905.8 | 7323.3 | 9060.1 | 11145.9 |
| . Private Investment, Total | 500.9 | 653.0 | 824.6 | 1010.8 | 1219.7 | 1457.0 | 1727.6 | 2037.9 | 2395.0 | 2907.2 |
| . Private Investment, Mashinery | 248.8 | 318.3 | 399.1 | 486.2 | 594.5 | 696.9 | 826.0 | 974.8 | 1147.0 | 1346.9 |
| . Private Investment, Construction | 252.1 | 334.7 | 425.5 | 524.6 | 635.2 | 760.1 | 901.7 | 1063.1 | 1248.0 | 1450.3 |
| . Import of Goods, Total | 1135.3 | 1462.2 | 1844.4 | 2275.3 | 2752.3 | 3291.9 | 3907.6 | 4612.6 | 5423.2 | 6357.8 |
| . Import of Productive Goods | 998.6 | 1211.7 | 1532.5 | 1893.4 | 2290.4 | 2738.0 | 3247.5 | 3829.5 | 4497.1 | 5265.3 |
| . Import of Consumer Goods | 136.7 | 250.5 | 311.9 | 381.8 | 461.9 | 553.9 | 660.1 | 783.1 | 926.0 | 1092.6 |
| Export of Goods, Total | 1566.8 | 1799.5 | 2067.0 | 2374.4 | 2727.5 | 3133.3 | 3599.7 | 4135.7 | 4751.6 | 5459.6 |
| Export of Non-Oil Goods | 45.1 | 49.6 | 54.6 | 60.1 | 66.1 | 72.7 | 80.0 | 89.0 | 96.9 | 106.5 |
| Balance of Factors & Services | -147.2 | -222.9 | -285.2 | -382.7 | -529.5 | -732.9 | -1005.4 | -1363.4 | -1826.3 | -2418.4 |
| . Payment for Factors & Services | 399.3 | 440.7 | 499.7 | 567.7 | 646.0 | 735.7 | 839.0 | 957.9 | 1094.5 | 1251.6 |
| . Income from Factors & Services | 194.1 | 240.7 | 292.8 | 350.3 | 414.8 | 497.3 | 569.5 | 652.7 | 769.9 | 890.3 |
| . Value Added in Agriculture | 421.2 | 497.4 | 580.6 | 671.1 | 771.2 | 882.9 | 1008.4 | 1150.3 | 1311.4 | 1495.0 |
| . Value Added in Industries | 876.3 | 1122.5 | 1393.1 | 1668.2 | 1985.2 | 2340.4 | 2740.8 | 3194.2 | 3709.5 | 4297.1 |
| . Value Added in Services | 1629.3 | 2046.1 | 2509.0 | 3015.5 | 3578.4 | 4209.1 | 4919.5 | 5723.4 | 6636.6 | 7677.3 |
| . Net Factor Revenue | -48.0 | 22.9 | 78.3 | 165.3 | 298.2 | 494.6 | 735.9 | 1058.2 | 1500.7 | 2057.1 |
| . Urban Employment, Total | 6678.4 | 7092.5 | 7527.9 | 7987.8 | 8476.1 | 8994.8 | 9547.0 | 10135.4 | 10764.4 | 11437.7 |
| . Urban Unemployment, Total | -80.5 | -99.4 | -118.5 | -134.1 | -153.9 | -177.0 | 83874.0 | -238.9 | -281.0 | -333.4 |
| . Rural Population | 18529.0 | 18530.0 | 18709.0 | 18763.0 | 18788.0 | 18795.0 | 18750.0 | 18693.0 | 18578.0 | 18434.0 |
| . Employment in Industries | 3452.4 | 3705.6 | 3972.0 | 4254.7 | 4556.7 | 4879.9 | 5226.7 | 5599.8 | 6002.5 | 6438.2 |
| . Employment in Services | 3163.5 | 3327.0 | 3488.4 | 3662.9 | 3846.4 | 4039.1 | 4241.3 | 4453.5 | 4676.5 | 4910.7 |
| . Gross Domestic Product | 4444.3 | 5438.1 | 6506.1 | 7693.3 | 9023.9 | 10529.9 | 12225.2 | 14157.7 | 16350.9 | 18878.4 |
| Taxes, Total | 346.8 | 461.2 | 590.2 | 738.7 | 911.6 | 1114.2 | 1353.1 | 1635.8 | 1971.4 | 2370.6 |
| Direct Taxes | 178.8 | 245.9 | 321.8 | 402.8 | 494.6 | 600.3 | 722.5 | 864.5 | 1030.2 | 1224.2 |
| . Indirect Taxes | 168.0 | 215.3 | 268.4 | 335.9 | 417.0 | 513.9 | 630.6 | 771.3 | 941.2 | 1146.4 |
| . Money Stock | 2078.8 | 2653.4 | 3304.7 | 4011.6 | 4814.9 | 5739.7 | 6808.1 | 8046.3 | 9486.7 | 11166.4 |
| . Growth of Money Stock | 411.4 | 574.6 | 651.3 | 706.9 | 803.3 | 924.8 | 1068.4 | 1238.2 | 1440.4 | 1679.7 |
| Balance of Banking Credits | 1534.1 | 2103.5 | 2817.6 | 3688.9 | 4738.8 | 5994.3 | 7487.3 | 9255.6 | 11344.1 | 13896.0 |
| . Growth of Banking Credits | 441.6 | 569.4 | 714.2 | 871.3 | 1049.9 | 1255.5 | 1493.0 | 1749.3 | 2098.5 | 2461.9 |
| . Government Revenue | 1855.3 | 2195.9 | 2585.1 | 3032.9 | 3549.9 | 4148.3 | 4842.1 | 5648.3 | 6585.8 | 7677.2 |
| . Government Expenditure | 1937.7 | 2476.3 | 3068.4 | 3725.2 | 4459.1 | 5283.4 | 6214.1 | 7269.9 | 8468.2 | 9835.0 |
| Balance of Government Budget | -82.4 | -280.3 | -483.3 | -692.3 | -909.2 | -1135.1 | -1371.4 | -1620.6 | -1882.4 | -2157.9 |
| Government Investment | 945.6 | 1239.1 | 1560.0 | 1914.2 | 2308.7 | 2750.4 | 3248.1 | 3811.3 | 4450.9 | 5179.0 |
| Government Consumption | 992.1 | 1237.1 | 1508.4 | 1811.0 | 2150.4 | 2533.0 | 2966.0 | 3457.7 | 4017.4 | 4656.0 |
| Value Added in Oil & Gas | 1517.6 | 1768.2 | 2033.4 | 2338.5 | 2689.2 | 3092.6 | 3556.2 | 4089.0 | 4703.4 | 5409.0 |

As shown in the above table, the projected figure for GNP in 1985 is approximately 22,000 billion rials (about 326.5 billion dollars) (23) which indicates an average annual growth of 19.8 percent in nominal terms (i.e. current prices). Considering the recent trend of growth in the Iranian economy, the above projected growth should not be considered unexpectedly high. On the other hand our sample projection indicates an increasing deficit in the balance of trade and, also, a growing deficit in the government's budget. As for the trade deficit, it is likely that we are ignoring the import substitution effects in the model, our projection overestimates total imports and indicates a persistent trade deficit. Therefore, it is not remote from reality to expect a slower trend of growth in imports because of the expansion of the domestic industry and its consequent import substitution effects. This might improve the trade balance over the period of projection. On the other hand, given the present tax strucutre formalized in the model it is likely to expect a substantial deficit in the government budget, which is mainly dependent on the oil income. Therefore, a structural improvement in taxing

---

(23) with the average 1975 exchange rate of 67.64 Rials per U.S. dollar.

policy might be considered as an alternative source of finance for public spending. This would secure a lower rate of inflation and produce a more stable perspective for the future growth of the economy.

According to the above simulation the average annual rate of growth of money supply is about 21.2 percent. Using this ratio along with a given rate of rise in import prices can lead us to a crude estimation of the expected rate of inflation during the above projection period. The estimated price equation which is not included in the structural model, explains the rate of change in the aggregate price index (rdPR) as a function of the rate of growth of the money supply (rdMM) and rate of change in import prices (rdPX). The estimated function is:

$$rdPR = -2.56 + .194\ rdMM + .976\ rdPX$$

With this function, an assumed 5 percent annual rise in import prices would estimate an average 6.4 percent inflation rate, while a 10 percent rise in import prices is likely to indicate an inflation rate higher than 11.3 percent in the Iranian economy.

Regarding the employment projection, there is an increasing shortage of labor presented in the above simulation (i.e. negative unemployment), which reaches a figure above three hundred thousand by 1985. This would indicate an increase in demand for the foreign labor force in part, and more productive employment opportunities for the domestic labor force (particularly in the services sector).

The prediction power of the model can be tested by comparing its projections with the actual observations. We can also test the efficiency of the model's projections by comparing them to the outcome of a "naive forecast". In order to do these comparisons we chose a group of major endogenous variables and for each variable we estimated a simple time trend in the linear form of:

$$y(t) = a + b.y(t-1)$$

Using these estimated time trends we introduced the last observed value of the sample (1975) and obtained a naive forecast for the value of selected variables in 1976.

On the other hand, we grouped the projected values of the same variables for 1976 from the econometric model. Thus for a group of major endogenous variables we obtained two sets of different forecasts. These alternative forecasts can be compared with the actual observations of 1976 as follows:

Table 5

Comparison of the Actual and Forecasted Values of the Major Variables for 1976 (Billion Rials)

| Variable | Actual Observation | Model's Forecast | Naive Forecast |
|---|---|---|---|
| GDP | 4589.2 | 4584.4 | 4569.4 |
| MM | 2116.1 | 2078.8 | 2433.7 |
| C | 2778.1 | 2903.8 | 3093.6 |
| I | 1402.7 | 1446.4 | 1886.7 |
| BT | 508.4 | 234.3 | 85.5 |
| CP | 1799.4 | 1911.5 | 2005.9 |
| CG | 978.2 | 992.1 | 1087.7 |
| IP | 530.8 | 500.9 | 673.4 |
| IG | 871.9 | 945.6 | 1213.3 |
| GR | 1802.0 | 1855.3 | 1916.7 |
| GX | 1850.1 | 1937.7 | 2301.0 |
| E | 1694.2 | 1566.8 | 1579.4 |
| M | 1078.6 | 1185.3 | 1493.9 |

In order to have a standard criteria for comparison of these two forecasts we regressed the actual 1976 observations against each group of forecasted values. The results of these two regressions are as follows:

ACTUAL = 20.55 + .986 MODEL

t: (0.32) (31.7)

(R-squared) = .9892

D.W. = 2.31

Standard Error = 120.3

ACTUAL = -95.46 + .959 TREND

t: (-0.63) (13.8)

(R-squared) = .9452

D.W. = 2.28

Standard Error = 271.3

As presented by the above regressions, forecasts of the macro-model produce a closer fit with the actual observations and indicate a relatively high prediction power for the mddel.

The above sample projection also indicates a growing inflow of factor revenue which by the end of the projection period accounts for a significant proportion of national income. It must be noted that such a diverging trend in balance of factor revenues is contrary to our "a priori" hypothesis of randomly fluctuating factor balance which has had a relatively small value throughout the observation period.

This phenomena can be explained by the fact that under arbitrary assumption of a 15 percent annual growth for the oil revenues, the model indicates a widening gap between the national expenditure and domestic income which is presented as an increasing inflow of resources (i.e. factor income) required to maintain the structural macro equilibrium assumed in the model. However, in reality these resources could be assumed to be provided by a greater volume of oil production which would also result in an improved balance of trade. Comparison of these regressions supports the relative efficiency of the model's projections.

As we noted earlier this sample projection is solely an academic experiment which presents a simulation on the basis of the observed trend of the behavior of major economic variables under given assumptions and therefore it can not be considered as a comprehensive plan for the prediction of the future developments of the economy and the relevant policy analysis.

APPENDIX

A list of the estimated behavioral equations of the model:

CPU(t) = -17.87 + 1.175 CPU(t-1) + 0.150 dGNP

CPR(t) = 0.07 + 1.20 VAAG(t-1) + .0166 dGNP

CG(t) = 7.82 + .903 CG(t-1) + .192 OIL

IPM(t) = 3.60 + .118 VAIM(t-1) + .379 dCR(t)

IPC(t) = 16.45 + .188 IG(t-1) + .247 dCr(t)

IG(t) = -2.8 + .887 IG(t-1) + .258 OIL(t-1) + .059 dOIL(t)

ENO(t) = .964 + 1.052 ENO(t-1)

MKR(t) = -41.9 + .218 E(t) + 1.718 IP(t-1)

MC(t) = -6.51 + .614 MC(t-1) + .024 GNP(t)

YFS(t) = -73.58 + .164 VASR(t) + .0186 OIL(t)

XFS(t) = 57.00 + .236 OIL(t-1) + .069 dOIL(t)

TAXD(t) = -68.23 + .126 GNPNO(t-1)

TAXI(t) = 41.33 + .1072 M(t-1) + .0249 CPU(t)

MM(t) = -91.48 + .599 GNP(t-1)

dCR(t) = -20.51 + .222 MM(t)

VAAG(t) = -310.2 + .163 I(t) + .0268 POPR(t-1)

VAIM(t) = -95.58 + .484 I + .0874 EMPIM(t-1)

VASR(t) = -288.5 + .870 I(t) + .218 EMPSR(t-1)

EMPIM(t) = -495.4 + .238 POPU(t) + .279 VAIM(t)

EMPSR(t) = -262.1 + .223 POPU(t)

Bibliography

Adelman, I. and Adelman F., "The Dynamic Properties of the Klein-Goldberger Model," in A. Zellner, ed., Reading in Economic Statistics and Econometrics, Boston, Little Brown and Co., 1968, pp. 630-660.

Almon, S., "The Distributed Lag Between Capital Appropriation and Expenditures", Econometrica, Jan. 1965, pp. 178-196.

Amemiya, T., "On the Use of Principal Components of Independent Variables in TSLS Estimations", International Economic Review, Vol. 30, 1966, pp. 280-303.

Amuzegar, J. and Fekrat, M.A., Iran: Economic Development Under Dualistic Conditions, Chicago, University of Chicago Press, 1971.

Ball, R.J., ed., The International Linkage of National Economic Models, Amsterdam, North Holland Co., 1973.

Bank Markazi Iran, Annual Report and Balance Sheet, Tehran, 1965-1975.

Bank Markazi Iran, National Income of Iran (1959-72), Tehran, 1974.

Bank Markazi Iran, Bulletin, Tehran, 1963-1974.

Bridge, J.L, Applied Econometrics, Amsterdam, North Holland Co., 1971.

Carter, R.A.L., "Least Squares As An Explanatory Estimators", Canadian Journal of Economics, Feb. 1973, pp. 108-114.

Christ, C.F. "Aggregative Econometric Models: A Review Article", American Economic Review, June 1956, pp. 385-408.

Dhrymes, P.J., Econometrics, Statistical Foundations and Applications", New York, Harper and Row, 1970.

Duesenberry, J.S., et.al., eds., The Brookings Quarterly Econometric Model of the United States, Chicago, Rand McNally and Co., 1966.

Evans, M.K., Macro Economic Activity: Theory, Forecasting and Control, New York, Harper and Row, 1969.

Evans, M.K., "An Econometric Model of the Israeli Economy: 1952-1965", Econometrica, Sept. 1970, pp. 624-660.

Evans, M.K., et.al., The Wharton Econometric Forecasting Model, Philadelphia, University of Pennsylvania, 1967.

Fair, R.C., "The Estimation of Simulation Equation Models with Lagged Endogenous Variables and First Order Serially Correlated Errors", Econometrica, May 1970, pp. 507 - 516.

Fei, J. and Ranis, G., "A Theory of Economic Development", American Economic Review, Sept. 1961, pp. 533-565.

Friedman, M., "Monetary Policy for a Developing Society", Bank Markazi Iran Bulletin, March-April, 1971, pp. 700-712.

Friedman, M., "A Monetary Theory of the National Income", The Journal of Political Economy, March, April, 1971, pp. 323-337.

Goldberger, A.S., Impact Multipliers and Dynamic Properties of the Klein-Goldberger Model, Amsterdam, North Holland Co., 1959.

Hickman, B.G., ed., Quantitiative Planning of Economic Policy, Washington, D.C., The Brookings Institute, 1965.

Institute for Economic Research, University of Tehran, Tahqiqat-e- Eqtesadi, (Quarterly Journal of Economic Research), Tehran, 1967-1974.

International Monetary Fund, International Financial Statistics, Washington, D.C., 1958-1975.

Johnson, J. Econometric Methods, New York, McGraw Hill, 1972.

Khan, M.S., "Experiments with a Monetary Model for the Venezulan Economy", IMF, Staff Papers, July, 1974, pp. 389-413.

Klein, L.R., "What Kind of Econometric Model for Developing Economies", The Indian Economic Journal, Sept. 1965, pp. 313-324.

Klein, L.R., "Single Equation vs. Equation System Method for Estimation in Econometrics", Econometrica, Oct. 1960, pp. 866.871.

Klein, L.R., and Goldberger, A.S., An Econometric Model of the U.S.A. 1929-1952, Amsterdam, North Holland Co., 1955.

Kooros, A., "How to Pay for Economic Development in Iran", Bank Markazi Iran Bulletin, March-April 1969, pp. 786-791.

Koyck, L.M., Distributed Lags and Investment Analysis, Amsterdam, North Holland Co., 1954.

Lewis, W.A., "Development with Unlimited Supply of Labor", The Manchester School of Economics and Social Studies, May, 1954, pp. 139-192.

McCarthy, M.D., "Notes on the Selection of Instruments for Two Stage Least Squares and K Class Type Estimations of Large Models", Southern Economic Journal, 1971, pp. 251 - 259.

Plan Organization of Iran, Fifth Development Plan 1973-1978, A Summary, Tehran, 1973.

Plan Organization of Iran, Economic Statistics and Trends of Iran, Tehran, Sept. 1976.

Sastry, V.K., "The Use of Macroeconomic Regression Models of Developing Countries, A Comment", Oxford Economic Papers, March 1975, pp. 156-165.

Shaheen, A.S., 1965 Input-Output Table for the Iranian Economy, Tehran, Minstry of Economy.

Tinbergen, J., On the Theory of Economic Policy, Amsterdam, North Holland Co., 1952.

United Nations, Macro-Economic Models for Planning and Policy Making, Geneva, 1967.

United Nations, Feasible Growth and Trade Gap Projections in the ECAFE Region, Bangkok, ECAFE, 1968.

United Nations, Trade Prospects and Capital Needs of Developing Countries, New York, UNCTAD, 1968.

Vakil, F., "An Econometric Model for Iran", Bank Markzi Iran Bulletin, July-Aug. 1972, pp. 115-120.

Vakil, F., "An Econometric Model for Iran: Estimated Structural Equations", Bank Markazi Iran Bulletin, March-April 1973, pp. 633-655.

Wallis, K., "Some Recent Developments in Applied Econometrics: Dynamic Models and Simultaneous Equations System", The Journal of Economic Literature, Sept. 1969, pp. 771-796.