POPULATION AND DEVELOPMENT

ASIAN POPULATION STUDIES SERIES NO. 88

Demographic-Economic Models and Policy Simulations for

MALAYSIA, THE PHILIPPINES AND THAILAND:

A Comparative Study

ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC
BANGKOK, THAILAND

UNITED NATIONS
1988

POPULATION AND DEVELOPMENT

ASIAN POPULATION STUDIES SERIES NO. 88

Demographic-Economic Models and Policy Simulations for

MALAYSIA, THE PHILIPPINES AND THAILAND:

A Comparative Study

ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC
BANGKOK, THAILAND

UNITED NATIONS
1988

ST/ESCAP/625

PREFACE

The need for integrating population considerations into development plans has long been recognized and repeatedly emphasized at various international forums including the International Conference on Population held at Mexico in 1984. In the Declaration on Population and Development adopted at that Conference it was noted that over the past decade population issues had been recognized increasingly as a fundamental element of development planning and that, to be realistic, development activities must reflect the inextricable links between population and development. The Conference therefore recommended that national development policies, plans and programmes, as well as international development strategies, should be formulated on the basis of an integrated approach that took into account the interrelationships between population and development.

In order to improve policies and programmes which integrate demographic considerations into national development planning it will be beneficial to have models of development that more accurately reflect the role of population change. Demographic-economic models, although still at an early stage of development, can, if developed and applied properly, not only assist policy makers and planners in gauging the direct and indirect effects of population policies but also provide decision makers with quantitative estimates of the impact of those policies, thereby promoting the integration of population factors into the planning process.

The Population Division of the Economic and Social Commission for Asia and the Pacific (ESCAP) is fully aware of the need to foster the development of appropriate models and to facilitate their introduction into the planning process. In this connection, the Division organized, *inter alia,* an expert group meeting on population and development at Bangkok in July 1977 to review the application and development of demographic-economic models for the ESCAP region. Then, during 1979-1981, the Division undertook a research project entitled "Comparative study on demographic-economic model-building for three selected countries of the ESCAP region". An important outcome of the project was demographic-economic models for Indonesia, Japan and the Republic of Korea. Thanks are due to the Government of Japan for its generous financial support of the project.

Malaysia, the Philippines and Thailand participated in the present project, entitled "Comparative study on demographic-economic interrelationships for selected ESCAP countries". It may be considered another step on the part of the ESCAP secretariat towards furthering knowledge in these fields with a view to improving understanding of the interrelationships between demographic and socio-economic factors. It is hoped that this publication provides a more complete conceptual framework for the formulation of population and development policies. The principal objective of this project is to investigate quantitatively the process of population change and socio-economic development and thereby identify policy recommendations which could be applied by the three participating countries, and by other countries of the region.

The present publication is the result of the study conducted under this project. The study directors and experts who collaborated on this publication are:

Malaysia

Mr. Fong Chan Onn	Professor Faculty of Economics and Administration University of Malaya Kuala Lumpur

The Philippines

Mr. Vicent B. Paqueo	Staff Economist The World Bank Washington, D.C. (Formerly, Associate Professor School of Economics University of the Philippines)

Thailand

Ms. Mathana Phananiramai	Assistant Professor Faculty of Economics Thammasart University Bangkok
Mr. Yongyuth Chalamwong	Assistant Professor Faculty of Economics and Business Administration Kasetsart University Bangkok

Comparative reviewers

Mr. Naohiro Ogawa	Professor Deputy Director Nihon University Population Research Institute Nihon University Tokyo

Mr. David Demery	Department of Economics University of Bristol Bristol, United Kingdom
Mr. Francis J.M. Harrigan	The Fraser of Allander Institute University of Strathclyde United Kingdom

The assistance of these experts is gratefully acknowledged. In addition, the secretariat wishes to take this opportunity to express its deep appreciation to the United Nations Population Fund (UNFPA) for its continued interest in and generous support of the secretariat's work programme in the field of population, including this project.

CONTENTS

CONTENTS *(Continued)*

Page

Annexes

PART TWO. A CGE-BASED ECONOMIC-DEMOGRAPHIC MODEL OF THE PHILIPPINES
by Vicente B. Paqueo

CONTENTS *(Continued)*

Page

CONTENTS *(Continued)*

INTRODUCTION

A. Background of the Project

This publication is the final report of an ESCAP project entitled "Comparative Study on Demographic-economic Interrelationships for Selected Countries". The project, funded by the United Nations Population Fund (UNFPA) was commenced on 1 April 1984 and completed in December 1987.

The basic premises on which the economic-demographic modelling activities of ESCAP are based include: (1) there exist interrelationships between population and socio-economic variables; (2) there is a growing interest in the role of population in the process of economic change and the consequent need for integrating population considerations into development plans; (3) there is a need for improved knowledge of the interrelationships between the process of population change and the process of economic change; and (4) there is a need for a quantitative policy analysis which systematically and scientifically integrates population factors into development planning with a view to improving population and development plans and policies.

In addition to the fact that more than 50 per cent of the world population is in the ESCAP region, population changes and related problems continue to be causes of great concern to most countries of the region. In the attempt to slow down the rate of population increase, the importance of the interrelationships between population and socio-economic development has become increasingly recognized beyond family planning programmes. Consequently, the integration of population factors into development planning has been repeatedly called for.

In the ESCAP region, the necessity for integrating population factors into overall development planning was stressed at the Second Asian Population Conference held at Tokyo in 1972. It was suggested at the Conference that improved understanding of the interrelationships between demographic and socio-economic factors would provide a basis for formulating a more desirable conceptual framework for population policy[1]. These important points were reaffirmed at the 1974 World Population Conference[2], held at Bucharest, and the Regional Post World Population Conference Consultation[3], held at Bangkok in 1975. In

---

[1] *Population Strategy in Asia,* the Second Asian Population Conference, Tokyo, November 1972, *Asian Population Study Series,* No. 28, E/CN. 11/1152, p. 21.

[2] See *Report of the United Nations World Population Conference,* 1974, United Nations publication, No.E. 75.XII.3, pp. 6-8.

[3] See E/CN. 11/1208.

addition, the ESCAP Committee on Population at its first session, held in June 1976, recognized that a better understanding of the interrelationships between population and development would require an interdisciplinary approach for which new methodology should be devised. The Committee therefore recommended that ESCAP should provide assistance to member countries in the application of improved methodology for the formulation of integrated programmes of development planning.

At the International Conference on Population held at Mexico City in 1984, the recommendations for further implementation of the World Population Plan of Action (adopted at the Bucharest World Population Conference) emphasized the need for systematic studies on demographic-economic interrelationships as follows:

> "Recommendation 1: Considering that social and economic development is a central factor in the solution of population and interrelated problems and that population factors are very important in development plans and strategies and have a major impact on the attainment of development objectives, national development policies, plans and programmes, as well as international development strategies, should be formulated on the basis of an integrated approach that takes into account the interrelationships between population, resources, environment and development. In this context, national and international efforts should give priority to action programmes in tegrating population and development."
>
> And,
>
> "Recommendation 72: In setting population research goals, Governments and intergovernmental and non-governmental organizations should endeavour to make them relevant to policies and programmes, with the objective of making innovations in policy formulation, implementation and evaluation. Special emphasis should be given to research on the integration of population processes with socio-economic development, considering not only applied but also theoretical and methodological topics."

In 1976, in recognition of felt needs and in response to those recommendations on the integration of population factors into development strategy, ESCAP started its demographic-economic modelling activities by undertaking a study entitled "Evaluation of the role of population factors in the planning process through the application of development models", the objective of which was to encourage and motivate country planners to improve their development plans by integrating population factors into development planning and policies. And as a follow-up to that project, the Expert Group Meeting on Population and Development Planning was organized at Bangkok in July 1977 to provide planners in the region with an opportunity to discuss effective means of integrating population factors into the over-all development planning process. It was also intended to provide a forum in which researchers could examine the methodological requirements of planners wishing to take population factors into account.

In December 1978, the ESCAP Committee on Population, at its second session, recommended that in countries where adequate and reliable data were available, prototype economic-demographic models should be developed to assist member countries in obtaining a clearer understanding of the interaction between demographic factors and socio-economic development. Accordingly, the Population Division undertook a research project entitled "Comparative Study on Demographic-economic Model Building for Three Selected Countries of the ESCAP Region". An important outcome of the project was prototype demographic-economic models for three countries, Indonesia, Japan and the Republic of Korea. Financial support for the project was provided by the Government of Japan.

The present project on comparative study on demographic-economic interrelationships for selected ESCAP countries may be considered another step on the part of ESCAP towards furthering knowledge in this field with a view to improving understanding of the interrelationships between demographic and socio-economic factors and provides, it is hoped, a more complete and accurate conceptual framework for the formulation of population and development plans and policies.

B. Objectives

The long-range objective of this project is to help widen the knowledge base of policy makers and others concerned with population and development planning in the ESCAP region by appropriate application of demographic-econometric techniques.

The immediate objective of the project is to investigate quantitatively the process of population change and socio-economic development with a view to identifying policy recommendations for three ESCAP member countries. The following are the activities contemplated for each country study:

1. Review of the leading demographic-economic models of the country in the recent past;

2. Analysis of the role of population factors in these studies;

3. Testing, based upon the set of country data, of key demographic and economic hypotheses;

4. Building of a multi-sectoral demographic-econometric system by synthesizing these hypotheses;

5. Examination of the interdependence of demographic and economic variables by simulating alternative time paths;

6. Consideration of policy implications of each time path in response to external stimuli on the basis of a series of sensitivity tests; and,

7. Dissemination of the mechanics and policy implications of the study through appropriate publications.

C. Project Structure

The central part of the project is the use of demographic-econometric techniques for population and development planning. The basic premise is that when economic or social changes have demographic repercussions, or where demographic changes have social and/or economic implications, these wide effects need to be taken into account in policy evaluation. In other words, the design of population and development policies should allow for these interrelationships, and for possible complementarities and conflicts between different policies affecting population and development. Thus the methodology adopted is that of a systems approach which can be viewed as a broad and flexible means of enhancing an investigative capacity for decision making. The system specification will depend entirely on the relevancy of the theories and the availability of data.

Three countries of the ESCAP region, Malaysia, the Philippines and Thailand, participated in this project, which involved developing prototype demographic-economic models for each of them. In order to implement the project, ESCAP recruited an expert to serve as project director. His main function was to co-ordinate, monitor and supervise country studies and an inter-country comparative study. In each participating country a study team composed of a study director, a research associate, a research assistant (computer programmer) and a clerical assistant, was organized to undertake a country study. The study director, with a substantial background in econometrics and demography, was primarily responsible for conducting research work agreed upon by ESCAP.

To assist the study directors, a one-week study directors' meeting was held at Bangkok from 29 October to 2 November 1984 to review and discuss demographic-economic problems and demographic-economic models to be developed for the three participating countries with a view to identifying appropriate demographic-economic models for these countries. Two experts on demographic-economic model building, one from Nihon University Population Research Institute in Tokyo, and the other from the Department of Economics of the University of Bristol in the United Kingdom, were requested to prepare background papers to provide the main technical guidelines on this activity to national experts.

After the First Study Directors' Meeting, the three country studies were undertaken simultaneously by the study teams in their respective countries, with technical support provided by ESCAP. Approximately nine months after the system designs were specified, data were collected and preliminary estimates of equations made, an interim study directors' meeting was held at Bangkok in August 1985 to review the progress of the country studies and discuss problems that had occurred.

The Second Study Directors' Meeting was held at Bangkok in March 1986 to review the draft country study results. Because of the complicated nature of the study, the study directors required almost ten more months to revise and refine their models in accordance with the comments made at the meeting.

The lists of participants at the three study directors' meetings were given in the appendix.

D. Organization of the Report

In addition to the introduction, the report is divided into four parts. The first three parts are the reports of the country studies of Malaysia, the Philippines and Thailand, respectively. A comparative review of the three country studies is presented in Part Four.

The report has not been formally edited by the United Nations.

Appendix

LIST OF PARTICIPANTS

Participants at the three Study Directors' Meetings include:

Mr. Fong Chan Onn, Dean, Faculty of Economics and Administration, University of Malaya, Kuala Lumpur 22-11, Malaysia

Ms. Mathana Phananiramai, Lecturer,Faculty of Economics, Thammasart University, Tha-Prachan, Bangkok

Mr. Vicente Paqueo, Executive Director, Council for Asian Manpower Studies, School of Economics, University of the Philippines, Diliman, Quezon City, Philippines 3004

Mr. Yongyuth Chalamwong, Assistant Professor,Faculty of Economics and Business Administration, Kasetsart University, Bangkhen, Bangkok 10900

Mr. David Demery, Senior Lecturer in Economics, University of Bristol, Bristol, England

Mr. Naohiro Ogawa, Professor and Deputy Director, Population Research Institute, Nihon University, 3-2 Misaki-cho, 1-chome, Tokyo 101, Japan

Mr. Ernesto M. Pernia, Regional Adviser on Population and Employment Policy and Research, ILO Regional Office for Asia and the Pacific, Bangkok

Mr. Francis J.M. Harrigan, Senior Research Fellow, University of Strathclyde, United Kingdom (Interim and Second Study Directors' Meetings)

Mr. Rolando A. Danao, Professor of Economics and Mathematics, School of Economics, University of the Philippines, Diliman, Quezon City, Philippines 3004 (Interim Study Directors' Meeting)

Mr. Kiatichai Vesdapunt, Lecturer, Faculty of Economics and Business Administration, Kasetsart University, Bangkok (Interim Study Directors' Meeting)

Mr. Shigeyuki Abe, Associate Professor of Economics, Faculty of Economics, Kyto Sangyo University, Tokyo, Japan (Interim Study Directors' Meeting)

Mr. Wute Wangwacharakul, Lecturer, Faculty of Economics and Business Administration, Kasetsart University, Bangkok (Interim Study Directors' Meeting)

Mr. Piyasvasti Amranand, Chief, Planning Technique Section, National Economic and Social Development Board, 962 Krung Kasem Road, Bangkok 10100 (First Study Directors' Meeting)

Part One

A CGE ECONOMIC-DEMOGRAPHIC MODEL FOR MALAYSIA

by

Fong Chan Onn

This paper has not been formally edited. The opinions, figures and estimates set forth in the paper are the responsibility of the author, and should not necessarily be considered as reflecting the views or carrying the endorsement of the United Nations.

I. OVERVIEW OF THE MODEL

A. Outline of the Model

In this study we have formulated an interactive demographic-economic model for Malaysia which attempts to simulate the interrelationships between economic and demographic phenomenon for the periods 1970-1980 and 1980-2025. Given the Malaysian government's stated policy of attempting to achieve 70-million population by the year 2100, this model is particularly relevant since it attempts to simulate both the demographic and economic consequences of some aspects of this population policy, albeit until the year 2025.

The model is structured as follows:

1. Demographic Submodel

In the demographic submodel, the nuptiality behaviour is estimated by the use of a logit function with the age at first marriage as a function of economic variables such as per capita gross output and enrollment rates of women in the upper secondary school.

Having estimated the age at first marriage as a function of economic variables, the age specific fertility rates are estimated using again logit functions where the age-specific fertility rates are estimated as a function of per capita gross output, doctor to population ratio, government expenditure on family planning and age at first marriage.

With respect to mortality levels, since mortality levels in Malaysia had been low and stable by international standards, we estimated mortality through the use of a logit function to estimate life expectancy at birth as a function of per capita output, percentage of population over six years whose education level is beyond primary and percentage of population having access to piped water. Having estimated the life expectancy at birth, the survival rate of each group is then derived from the regional life tables of Coale and Demeny [1966].

With the estimated the fertility and mortality variables, the population for each year could be derived in the form of population transition equations. This population – called the natural population – is broken down by urban and rural areas. In order to estimate the urban and rural migration, the level of urbanization is estimated as a function of per capita output. The population distribution, by urban and rural, as a result of the implied urbanization is then computed. The difference between the natural population distribution and the population distribution resulting from economic development gives the implied rural-urban migration.

In order to derive the labour supply – which constitute an important input into the economic submodel – the participation rates of both males and females are estimated; in some cases exogenously, while in other cases as a function of economic variables such as per capita education expenditure and per capita output. With the participation rates and the implied migration pattern, the labour supply by urban-rural classification can be computed.

2. *Economic Submodel*

The economic submodel adopted in this model is a computible general equilibrium model based on a derived 1970 – SAM Table. The economic submodel begins with the dynamic equations which relate capital stock to investment; and wage growth to unemployment, lagged price levels and lagged wage levels.

The next block in the economic submodel is the price block; in which the prices for intermediate goods, value-added and consumption goods are determined. The price level for labour is also determined.

In the third block, the demand for the various factors including intermediate goods, value-added goods and labour are derived on the basis of the Cobb-Douglas production function and maximizing-of-profit behaviour.

In the fourth block, the income and consumption patterns are derived. The incomes, in particular, are estimated as a function of wage levels and labour demand; while in the consumption pattern, a linear expenditure system is used to derive the gross consumption behaviour of rural and urban households for agriculture and non-agriculture products.

In the investment block, the investment by origin and destination are derived using a 1970 B-matrix and with the investment by origin as a function of the profits generated in the non-agricultural sector.

In the last block of the submodel the gross output is derived. The model is closed by the balance-of-trade equation.

B. Testing and Simulation of the Model

From the above descriptions, it can be seen that there is a close interrelationship between the demographic and economic submodels. In the demographic submodel, mortality and fertility as well as participation rates are estimated as functions of economic variables; while in the economic submodel, the wage rates are estimated as a function of labour supply. Since the wages determine the price of labour and labour demand as well as the household income and investment available, the demographic submodel, therefore, has profound effect on the economic submodel.

In the testing and simulation of the model, we began by its calibration against the 1970 – SAM Table. Having calibrated the model, we then perform counter-factual simulations of the model over the period 1970-1980 and simulations of the model on variations in the economic and demographic scenarios over the period 1980-2025.

C. Broad Conclusions

The preliminary conclusions derived from the testing and simulations of the model are as follows:

(i) Based on the trends as given by the period 1970-1980, and the assumptions contained in the reference run, it is estimated that the population of Malaysia would be around 41.2 million by the year 2025, with a per capita Gross Domestic Product (GDP) of $ 6,333, and an urban-rural population distribution of about 50:50.

(ii) With the assumed rate of government transfer to the agricultural sector, the ratio of (per capita) urban to rural household income was found to be 5.7:4.2 in 1985, narrowing to 3.4:3.1 by 2025.

(iii) If the technological progress parameter for the non-agricultural sector was to be increased; this would have significant impact on the non-agricultural output as well as per capita output.

(iv) On the converse, if the agriculture investment were to increase from its 1970 rate of 17 per cent to 50 per cent by the year 2025, this would lead to a decline in per capita GDP to $ 5,796 by the year 2025 compared to $ 6,333 for the reference case.

(v) Similarly, if we increase the indirect tax on the non-agricultural output from its 1980 rate by 5 per cent per annum, this could also lead to a contraction in per capita GDP (to $ 5,750) by 2025 compared to the reference case.

(vi) With respect to the variations in female participation rates, the simulation results indicate that increasing female participation by 2 per cent per annum from its 1980 values would lead to some decline in wage levels, and a marginal contraction in total GDP.

(vii) We also examined the effects of the variations in fertility rates. We ran the cases of low (5 per cent less than the reference case) and high (5 per cent more than the reference case) fertility scenarios and found that lowering fertility could lead to an improvement in welfare as indicated by increasing in per capita output. Similarly, increasing fertility could lead to some contraction in per capita output.

(viii) The broad conclusions of the simulation exercises are as follows: Malaysia would undergo considerable demographic-economic transformation over the coming forty years. Per capita output is projected to increase substantially even under the present projected rate of relatively small decline in fertility rates. However, the welfare of the Malaysian population could be improve further (i.e. the per capita output could be increased further) if the fertility rates were allowed to decline more rapidly. There would also be substantial rural-urban migration leading to a population distribution of about 50:50 for urban and rural by the year 2025.

II. DEMOGRAPHIC-ECONOMIC SITUATION AND SYSTEM-MODELLING EFFORTS IN MALAYSIA

Introduction

The current population policy of Malaysia was enunciated recently. It states that *"Recognizing that a large population constitutes an important human resource to create a larger consumer base with increasing purchasing power to generate and support industrial growth through productive exploitation of national resources. Malaysia could, therefore, plan for a larger population which could ultimately reach 70 million. The experience of some countries of similar size to Malaysia has shown that a larger population is not necessary a liability if the population is provided with skills that can be effectively and productively utilized for national development."* [Malaysia, 1984: p.20-21]. The rationale for the new population policy is premised upon a productive and dedicated population.

Since human economic productivity can only be improved by accelerating economic development, it is essential that a systematic analysis be done to examine the impact which developmental processes have in increasing economic productivity and efficiency of households, as well as in increasing the acceptance of socio-demographic norms and values consistent with productive and healthy households. Further, in the analytical effort it is also necessary to examine the impact changing demographic and fertility patterns have on the developmental processes, particularly the supply of labour and demand for goods and services.

Malaysia is one of the best examples of a country dedicated to the incorporation of population issues and services within the totality of socio-economic development. At the macro-level, the name of the National Family Planning Board has been changed to National Population and Family Development Board, reflecting the increasing emphasis of broader socio-economic issues as the perspective for population services. At the micro-level, the population services have been integrated into the general socio-economic development processes including the Ministry of Health's rural, maternal and child health services since 1973. This is an indication of the seriousness that the government places in the rapid diffusion and acceptance of the healthy and well-spaced family norm among all the residents in the country.

In this chapter we shall survey the current demographic/economic situation in the country, as well as the efforts that have been done in analyzing the interrelationships between demographic patterns and socio-economic development. A preliminary specification of a demographic/economic model would also be specified, which could allow for an in-depth systematic analysis of the demographic-economic relationships in the country.

A. Review of the Demographic Situation

Malaysia's population was estimated at 15.8 million in 1985 with 13.0 million in Peninsular Malaysia, 1.3 million in Sabah and 1.5 million in Sarawak. In 1985, the population on the whole was estimated to be growing at a rate of 2.6 per cent annually.

Table 2.1 shows the population of Peninsular Malaysia by community distributed between the years 1911 and 1985. Malays formed the majority of Peninsular Malaysia's population. In 1970, of the total Peninsular Malaysia's population, 53.2 per cent were Malays, 35.5 per cent Chinese, 10.6 per cent Indians and 0.8 per cent others. This community distribution remained essentially the same at 1985.

The wave of migration during the early 1900s, had a great impact on the age/sex distribution of the population as can be seen from figure 2.1. In 1931, a large majority of the total population in Malaya consisted of men between the ages of 20 to 40. However, by 1942, as shown in figure 2.2, as a result of high births among the settled population and termination of migration, the major proportion of the population consisted of children below the age of 10. This increasing proportion of young population due to rapid natural birth rates was even more pronounced by 1957 as can be seen in figure 2.3. In fact, by 1957, the population of Malaya exhibited the typical population pyramid structure so commonly found in a developing countries with rapid growth rate.

The relative youthfulness of the Malaysian population continue until today. In 1978, about 42 per cent of the population was in the age-group 0 to 14 years while 54 per cent was in the working age-group 15 to 64 years. This indicated that 96 per cent of Peninsular Malaysia's population are under 65 years of age.

However, as a result of the fertility decline experienced since the 1960s, there were some shifts in the age composition. In Peninsular Malaysia the 0 to 14 age-group declined from 42 per cent of the total population in 1978 to 37.3 per cent by 1985. At the same time, the age-group 15 to 64 years increased from 54 per cent in 1978 to 62.7 per cent of the total population by 1985.

In 1985, married women between 15 to 49 years constituted 16.9 per cent of Peninsular Malaysia's population. In terms of urban and rural population distribution, about 41.1 per cent of the population in Peninsular Malaysia was located in the urban areas with 58.9 per cent in the rural areas. It is projected that by 1990 [Malaysia, 1981 a] the urban population will increase further to 42.1 per cent of the total population.

As is obvious from the previous discussions, the demographic situation has changed very sharply in Malaysia over the past five decades. While international migration had been the dominant feature of the pre-war population, there has been a significant declines in fertility rates in the post-war period. During this

Table 2.1 Population by Community Distribution, Peninsular Malaysia, 1911-1985

Year	*Malays*		*Chinese*		*Indians*		*Others*		*Total*	
	No.	*Per cent*	*No.*	*Per cent*	*No.*	*Per cent*	*No.*	*Per cent*	*No.*	*Per cent*
1911	1 364 844	58.6	698 228	29.6	239 169	10.2	36 810	1.6	2 339 051	100.0
1921	1 568 588	54.0	855 863	29.4	439 172	15.1	43 068	1.5	2 906 691	100.0
1931	1 863 864	49.2	1 284 888	33.9	570 987	15.1	68 011	1.8	3 787 750	100.0
1947	2 427 834	49.5	1 884 534	38.4	530 638	10.8	65 080	1.3	4 908 086	100.0
1957	3 125 424	49.8	2 333 756	37.2	735 038	11.7	84 490	1.3	6 278 708	100.0
1970	4 671 900	53.2	3 117 896	35.5	933 250	10.6	66 298	0.8	8 789 344	100.0
1980	6 315 500	53.6	4 136 000	34.9	1 239 000	10.4	90 000	0.8	11 780 500	100.0
1985	7 325 600	56.5	4 248 400	32.8	1 311 900	10.1	82 900	0.6	12 968 800	100.0

Sources: Chander R., *General Report – 1970 Population Census of Malaysia,* Vol. 1, Department of Statistics, Malaysia, 1977.

Khoo, T.H., *General Report – 1980 Population and Housing Census of Malaysia,* Vol. 1, Department of Statistics Kuala Lumpur, Malaysia, 1983.

Malaysia, Mid-Term Review of the Third Malaysia Plan, 1976-1980, Government Press, Kuala Lumpur, 1978.

Malaysia, *Fifth Malaysia Plan, 1986-1990;* Government Press, Kuala Lumpur, 1986.

Figure 2.1 Total Population, Malaya, 1931

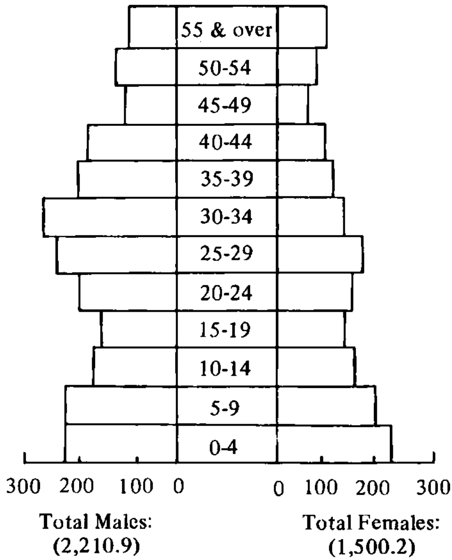


Figure 2.2 Total Population, Malaya, 1947

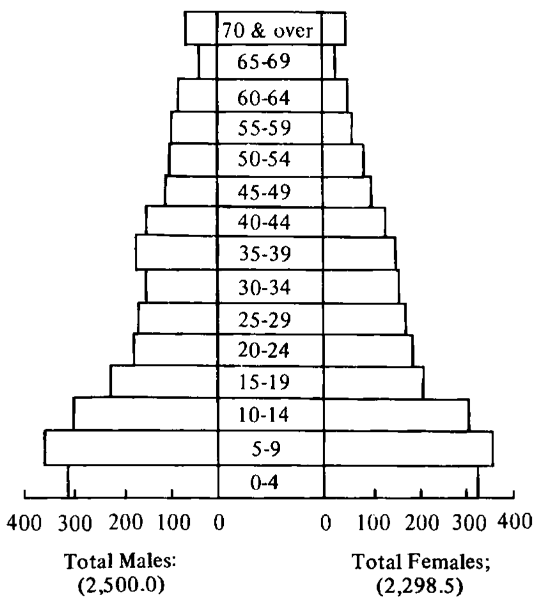
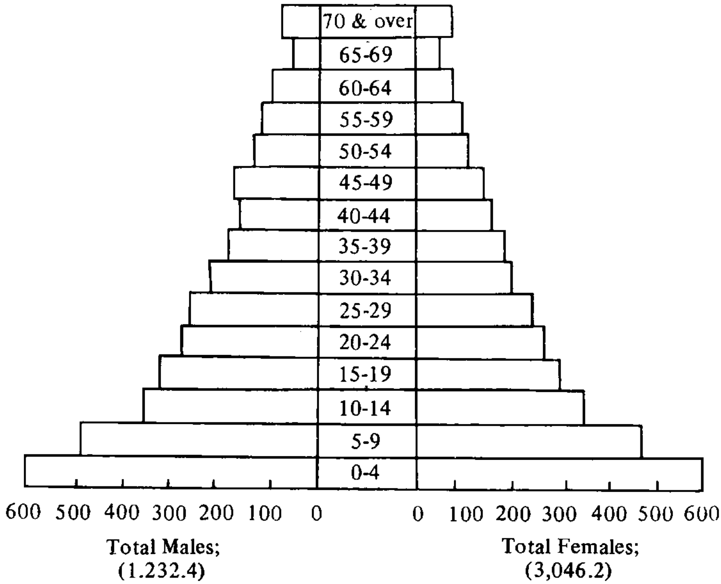


Figure 2.3 Total Population, Malaya, 1957

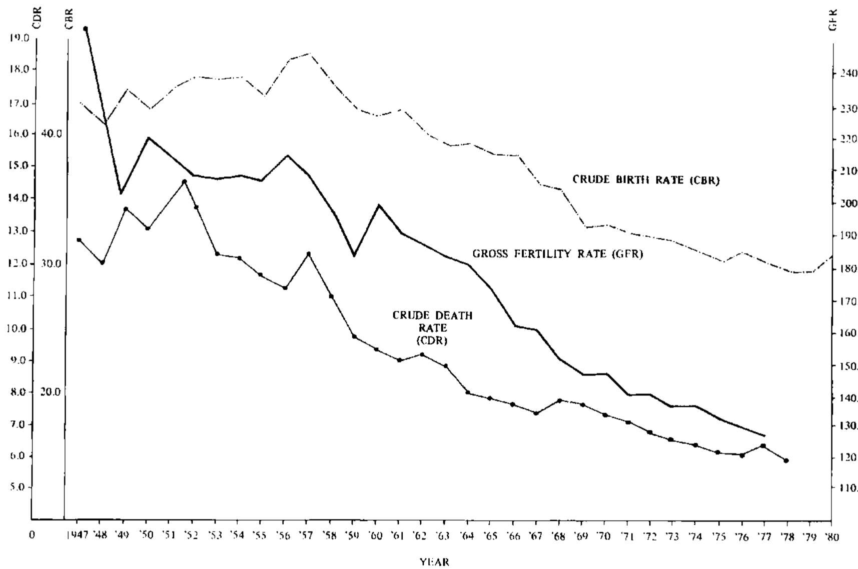


period, Malaysia, particularly Peninsular Malaysia, passed through a major part of the demographic transition. Mortality rates are now very low, fertility rates moderate but declining and natural increase rates are at last sinking to a level of 2.5 per cent per annum. The heritage of earlier high fertility levels is still prevailing in the large proportion of the population in the reproductive age groups, thereby ensuring substantial population growth during the coming two decades [Jones, 1979: p. 21-22].

An overview of the time path of the Malaysian demographic transition can be observed in figure 2.4 which charts three basic demographic indicators from 1947 to 1980 that is the crude birth rate, the general fertility rate and the crude death rate. Erratic fluctuations can be observed especially in the early part of the time series, which may be due to variations in the completeness of registration of vital events; but nonetheless the downward trend of all rates is unmistakable. Assuming that completeness of birth and death registration has improved over the years, the measured trends are probably underestimates of the true declines.

Mortality rates were very high in the late 1950s, with a crude death rate fluctuating around 15 per thousand population, but beginning in the early 1950s, a consistent downward trend in mortality began and this continued up to the present period with the exception of a few years where there was an increase in mortality. By 1960, the crude death rate was slightly above 9 per thousand population and in 1980 the crude death rate declined to a low level of 5.5. This

Figure 2.4 The Demographic Transition in Peninsular Malaysia, 1947-1980



Note: CBR and CDR are expressed in per thousand population basis GFR is expressed in per thousand women in ages 15-49 years basis.

extraordinary low death rate is partially a reflection of the youthfulness in the age-structure of the country.

The pattern of decline in the fertility rates is similar to that of mortality except for a lag of about 7 or 8 years. The fertility rates started to decline rapidly from the late 1950s to the mid-1970s. However, since 1978 a marginal, but significant, increasing trend in the crude birth rates has been observed. The crude birth rate fell from 46 per thousand population in 1957 to 40 per thousand population in 1962, to 35 by 1967 and to 24.9 in 1980. Over the same period, the more refined general fertility rate dropped from 207 to 118 births per thousand women in the reproductive ages of 15 to 49 years.

B. Review of the Socio-Economic Situation

During the period of British rule, economic development in Malaysia was confined to tin-mining and rubber planting. However, economic development in Malaysia since independence was diversified to include a whole spectrum of agricultural activities like oil palm, coconut and cocoa planting, and the acceleration of the industrialization process.

Agriculture remained the dominant sector in Malaysia up to 1985. Table 2.2 shows the Gross Domestic Product (GDP) by sector of origin for Peninsular

Table 2.2 Gross Domestic Product (GDP) by Industry of Origin, Peninsular Malaysia, 1965-1985

Industry	*1960*	*1965*	*1970*	*1975*	*1980*	*1985*
	Per cent of the total GDP	*Per cent of the total GDP*	*Per cent of the total GDP*	*Per cent of the total GDP*	*Per cent of the total GDP*	*Per cent of the total GDP*
Agriculture, forestry and fishing	37.8	31.5	32.0	28.4	22.9	21.0
Mining and quarrying	5.9	9.0	6.6	4.7	4.8	4.9
Manufacturing	8.7	10.4	13.9	16.8	21.2	19.1
Construction	3.0	4.1	4.0	3.9	4.7	5.5
Electricity, gas and water	1.3	2.3	1.9	2.2	2.3	2.8
Transport, storage and communications	3.6	4.3	4.9	6.3	6.7	8.8
Wholesale and retail trade, hotels and restaurants	15.7	15.3	13.8	13.1	13.1	14.1
Finance, insurance, real estate and business services	1.4	1.6	8.8	8.7	8.5	8.2
Government services	11.2	10.6	11.5	13.1	13.4	13.0
Other services	11.4	10.9	2.6	2.8	2.5	2.6
GDP (per cent)	100.0	100.0	100.0	100.0	100.0	100.0
GDP ($ million)	5 220	6 552	11 852	16 911	25 376	35 377

Sources: Malaysia, *First Malaysia Plan, 1966-1970,* Government Press, Kuala Lumpur, 1966.
Malaysia, *Second Malaysia Plan, 1971-1975,* Government Press, Kuala Lumpur, 1971.
Malaysia, *Fourth Malaysia Plan, 1981-1985,* Government Press, Kuala Lumpur, 1981.
Malaysia, *Economic Report, 1984/85,* Ministry of Finance, Kuala Lumpur.

Malaysia. In 1960, the agricultural sector GDP formed about 37.8 per cent of the total GDP, while that of the manufacturing sector formed only 8.7 per cent. However, by 1985, the agricultural sector's share of the GDP has declined to about 21.0 per cent while that of the manufacturing sector has increased to 19.1 per cent of the GDP. This indicates the success of the industrialization process that was implemented since the early 1960s. From an output which was about 21.6 per cent that of the agricultural sector in 1960, the output of the manufacturing sector has grown to a level which is almost equal to that of the agricultural sector in 1985.

Table 2.3 shows the average annual growth rate of GDP by industry of origin for Peninsular Malaysia. The average annual growth rate for the agricultural sector has been much lower than that of the manufacturing sector. For

Table 2.3 Average Annual Growth Rate of Gross Domestic Product by Industry of Origin, 1961-1985

Industry	*1961-65*	*1966-70*	*1971-75*	*1976-80*	*1981-85*
Agriculture, forestry and fishing	4.0	6.8	4.8	3.9	3.4
Mining and quarrying	4.5	1.1	0.4	8.9	6.0
Manufacturing	11.1	9.9	11.6	13.5	4.9
Construction	17.9	4.1	6.6	12.6	8.1
Electricity, gas and water	11.9	8.1	9.8	10.2	9.1
Transport, storage and Communications	5.5	3.0	13.0	9.6	8.4
Wholesale and retail trade, hotels and restaurants	5.3	3.3	6.3	8.2	7.0
Finance, insurance, real estate and business services	10.3	10.2	7.2	8.0	7.2
Government services	4.6	5.2	10.1	9.0	9.8
Other services	7.4	4.7	9.3	6.6	5.1
Gross Domestic Product	6.3	5.5	7.1	8.6	5.8

Sources: Malaysia, *First Malaysia Plan, 1966-1970,* Government Press, Kuala Lumpur, 1966.

Malaysia, *Second Malaysia Plan, 1971-1975,* Government Press, Kuala Lumpur, 1971.

Malaysia, *Fourth Malaysia Plan, 1981-1985,* Government Press, Kuala Lumpur, 1981.

Malaysia, *Fifth Malaysia Plan, 1986-1990,* Government Press, Kuala Lumpur, 1986.

example, during the period of 1981-1985 the manufacturing sector grew at an annual rate of 11.0 per cent, while the annual growth rate for the agricultural sector during the similar period was only 3.0 per cent.

In terms of employment, the agricultural sector employed about 52 per cent of the total working population in 1965. However, in 1985, the percentage employed in the agricultural sector declined to 35.2 per cent. From table 2.4, it can be seen that the manufacturing sector has steadily increased its share of total employment by 1985. In 1965, the manufacturing sector employed about 8.4 per cent of the total employment but by 1985 this percentage has increased to 15.7 per cent, indicating the increasing importance of the manufacturing sector to both production and employment generation.

Since independence, Malaysia has spent a relatively large part of its expenditure on health. As can by seen from table 2.5, the expenditure on health as a proportion of the government expenditure has been around 5 per cent since 1957. Similarly, the expenditure on health as a proportion of Gross National Product (GNP) has been maintained at between 1.5 per cent to 2 per cent since 1957.

This huge expenditure on health is reflected in an improvement of health status for the Malaysian population, indicated by the fact that the infant mortality rate declined from about 7.5 per cent in 1957 to about 1.75 per cent in 1984. The improvements in toddler mortality rate and maternal mortality rate have been even more dramatic. Toddler mortality rate improved from 1.06 per cent in 1957 to 0.15 per cent in 1984. Similarly, maternal mortality rate also declined from 0.28 per cent in 1957 to a insignificant 0.04 per cent in 1984. The crude death rate for total population declined from 1.5 per cent in 1957 to 0.53 per cent in 1984. On the reverse, the life expectancy for the average individual improved from 55.7 years (for males) and 58.1 years (for females) in 1957 to 67.6 years and 72.7 years, respectively by 1984.

The quality of nutrition for the population has also improved. The calories intake per head per day expanded from 2,193 calories in 1957 to 2,657 calories by 1984. There was also an improvement in the protein intake per head per day, from 42.5 grams in 1957 to 60.0 grams in 1984.

Table 2.5 clearly demonstrates the vast improvement in the health and nutritional status of the Malaysian population over the past two decades. The fact that the decline in mortality rate is accompanied by a similar significant decline in fertility rate indicates that Malaysia is in a fairly advanced state of demographic transition, where both mortality and fertility rates are at a declining stage. Hence, a relatively stable population size for Malaysia can be achieved if these trends continue, and then taper to steady levels.

As a result of the purposeful industrialization and agricultural modernization efforts, Malaysia experienced rapid socio-economic development since independence in 1957. The per capita GDP for increased from $M 746 in 1960 to $M 3,475 in 1985 (see table 2.6), representing an increase in per capita GDP of 6.3 per cent per annum.

Table 2.4 Employment by Industry, Peninsular Malaysia, 1965-1985

Industry	*1965*	*1970*	*1975*	*1980*	*1985*
	Share of total (per cent)	*Share of total (per cent)*	*Share of total (per cent)*	*Share of total (per cent)*	*Share of total (per cent)*
Agriculture	52.1	50.5	45.3	40.6	35.2
Mining	2.5	2.6	2.1	1.7	1.2
Manufacturing	8.4	11.4	13.0	15.8	15.7
Construction	3.5	4.0	4.4	5.2	6.6
Electricity, water and sanitary services	0.6	0.8	0.8	1.0	–
Transport, storage and communication	3.9	3.4	3.9	3.8	4.9
Wholesale and retail trade, hotel and restaurant	–	10.9	11.8	12.7	–
Finance, insurance, real estate and business service	11.1	0.9	0.9	1.0	1.8
Government services	–	11.7	13.1	13.9	14.9
Other services	17.9	3.8	4.2	4.3	19.7
Total (per cent)	100.0	100.0	100.0	100.0	100.0
Total ('000)	2 590	3 395.9	4 247.1	5 093.5	5 503.7

Sources: Malaysia, *Second Malaysia Plan, 1971-1975*, Government Press, Kuala Lumpur, 1971.
Malaysia, *Fourth Malaysia Plan, 1981-1985*, Government Press, Kuala Lumpur, 1981.
Malaysia, *Economic Report, 1985/86*, Ministry of Finance, Kuala Lumpur, 1985.

Table 2.5 Socio-Economic Indicators of Health and Nutrition for Malaysia, 1957-1985

Indicators	*1957*	*1970*	*1975*	*1980*	*1984*
Expenditure on Health as percentage of GNP	1.4	1.4	1.9	1.6	1.8
Expenditure on Health as per cent of Total Government Expenditure	1.0	6.5	6.8	5.1	4.7
Crude Death Rate per Thousand	14.9	7.3	6.6	5.5	5.3
Infant Mortality Rate per Thousand[a]	75.0	40.8	35.4	19.7	17.5
Maternity Mortality Rate per Thousand[b]	2.8	1.5	1.0	0.6	0.4
Toddler Mortality Rate per Thousand[c]	10.6	4.2	3.1	1.8	1.5
Life Expectancy – Males	55.7	65.5	64.4	66.7[d]	67.6[d]
Life Expectancy – Females	58.1	68.2	69.6	71.6[d]	72.7[d]
Calories Intake per Head per Day	2 193	2 511	2 525	2 643	2 657
Proteins Intake in gms. per Head per Day	42.5	50.2	54.2	56.2	60.0

Sources: Malaysia, *Statistical Bulletin, December 1980,* Department of Statistics, Kuala Lumpur, 1981.

Malaysia, *Economic Report, 1979/80,* Ministry of Finance, Kuala Lumpur, 1979.

Malaysia, *Social Statistics Bulletin, 1977,* Department of Statistics, Kuala Lumpur 1978.

Malaysia, *Economic Report, 1985/86,* Ministry of Finance, Kuala Lumpur, 1985.

Malaysia, *Fifth Malaysia Plan, 1986-1990,* Government Printers, Kuala Lumpur, 1986.

Notes: [a] Used as an indicator of living conditions in any area.

[b] Indicate standard of obstetric care.

[c] Indicate quality of nutrition.

[d] For Peninsular Malaysia only.

Table 2.6 Malaysia: Selected Socio-Economic Indicators, 1960-1985

Indicators	*1960*	*1970*	*1980*	*1985*
Per capita GDP, Factor Cost ($M)	746	1 350	3 108	3 475
Expenditure on Education as per cent of Total Government Expenditure	13.9	19.1	16.4	17.4
Literacy Rate	51.0	60.8	75.3	n.a.
Number of Televisions owned per 100 population	0.4	2.2	9.0	10.5
Number of Private Cars per 100 population	0.1	2.6	6.3	9.1
Number of Motor Cycles per 100 population	0.3	0.4	0.9	n.a.
Per cent of dwellings with piped-water	n.a.	47.5	65.0	n.a.
Per cent of dwellings with electricity	n.a.	43.7	64.4	n.a.
Copies of Newspaper sold per 100 population	6.1	7.4	16.9	19.9

Sources: Malaysia, *Fourth Malaysia Plan, 1981-1985,* Government Press, Kuala Lumpur, 1981.

Malaysia, *Social Statistics Bulletin, 1983,* Department of Statistics, Kuala Lumpur, 1984.

Malaysia, *Economic Report, 1979/80,* Ministry of Finance, Kuala Lumpur, 1979, *Economic Report 1985/86.*

Khoo Teik Huat, *General Report: 1980 Population & Housing Census of Malaysia,* Department of Statistics, Kuala Lumpur, 1983.

Note: n.a. – not available.

The rapid socio-economic development resulted in significant improvements in the welfare of the population. As can be seen from table 2.6, government expenditure on education increased from 13.9 per cent in 1960 to 17.2 per cent by 1985; resulting in a significant improvement in the literacy rate, from 51 per cent in 1957 to more than 75 per cent by the 1980s.

The other indicators of socio-economic welfare also showed great improvement over the past two decades. For example, the copies of newspapers sold increased from 6.1 per hundred population in 1957 to 19.9 in 1985. Similarly, the percentage of television ownership improved from 0.4 per hundred population in 1960 to 10.5 in 1985, while ownership of private vehicles increased from 0.15 per hundred population in 1960 to 9.1 by 1985. In terms of housing, the percentage of houses with piped water increased from 47.5 per cent in 1970 to 65 per cent in 1980; while the percentage of houses with electricity supply has improved from 43.7 per cent in 1970 to 64.4 per cent in 1980.

C. Review of Population-Development Philosophy and Modelling

The population components, namely its size, growth, composition and distribution, play important roles in the socio-economic development of the country. On the reverse, demographic factors – especially fertility, mortality and migration – can also be affected by socio-economic development. Given the complexity of the forces of demographic and socio-economic development in Malaysia, it is clear that in any developmental planning effort, a demographic economic model has to be developed to systematically examine the inter-linkages between population and development, particularly the determinants and consequences of the desired population growth path, in relation to desired socio-economic growth scenario.

The trend toward greater emphasis on demographic factors in development planning may be briefly reviewed. The First Malaysia Plan (FMP) of 1966-1970 recognized that the country's high rate of population growth could neutralized some of the benefits of economic growth [Malaysia, 1966]. To overcome this problem, the National Family Planning Board was established to undertake a family planning campaign, including promotional work by the government departments and voluntary organizations such as the Family Planning Associations. Apart from this, however, there was no explicit recognition of the relationship between population growth and education, health and the provision of social services.

The Second Malaysia Plan (SMP) of 1971-1975 gave much greater prominence to population problems, and projected an increase in population from about 10.9 million in 1970 to about 12.5 million in 1975, a growth rate of 2.8 per cent per annum. Projection of school-age and working-age population were also made [Malaysia, 1971:p.50].

The problem highlighted in the SMP with regard to population is the increasing size of the labour force leading to the possibility of greater unemployment. Thus, the Plan states that:

"The double task of keeping up with a rapidly increasing labour force and reducing the large backlog of unemployment places a heavy burden on the economy. The present high rates of labour force are expected to continue into the later years of this decade....." [Malaysia, 1971:p.111].

It was also recognized that the high rates of population growth would also result in increasing school establishments. A sizeable part of public expenditure was expected to go into meeting the educational needs of the larger population of school going age. Thus, primary school enrolment was expected to increase by 16.4 per cent over the plan period while enrolment expansion at the secondary level would be even more rapid.

Family Planning and its associated activities continued to be emphasized as an important instrument of policy, but its coverage was envisaged to be even wider. Under the Third Malaysia Plan (TMP) of 1976-1980, the objective of the National Family Planning programme to bring down the birth rate from 31 per

1,000 in 1975 to 28 per 1,000 in 1980. This was to be achieved through a programme covering a million new acceptors. The expansion of other related aspects of family planning – integration with rural health services, population education, etc. – all pointed to the widening of the scope and methods of the programme "from a purely health-oriented and clinic-based to a welfare-based and community-based program" [Malaysia, 1976: p. 418].

At the same time the national education policy had as its objective not only that of coping with increased numbers in schools but also that of upgrading the quality of studies. Implicit in this policy was some notion of manpower planning and allocation for the future, with the educational output geared to future needs. An overall environmental policy to take account of congestion, among other things, has also been outlined in the Plan.

A significant shift in the overall population policy occurred in the early 1980s. As elaborated before, the population policy as enunciated in mid-term review of the Fourth Malaysia Plan states that *"Malaysia could, therefore, plan for a larger population which could ultimately reach 70 million"*. In line with this new population policy, its even more crucial that a demographic/economic model be constructed to examine the inter-linkage between development and population.

D. The Status of Model-Building in Malaysia

This review is based on a number of sources. These include Cheong K.C. (1984) and Sahathavan M., and H.Imaoka (1984). In 1986, there were two large econometric modelling projects undertaken by the government, the Dynamic Input-Output Model for the Industrial Master Plan and the Interactive Model for the EPU. These projects activities were, unfortunately, classified as confidential and will not be reviewed here.

In Malaysia, model-building is of very recent origin, although there have been accounts of the structure and growth of the economy for some time [see, for example, Drake, 1969; Lee, 1974; and Lim, 1973]. The first models dated from around 1968, but were constructed by researchers from international agencies outside the country, and were not much known to local planners and researchers [ECAFE, 1968; Neibuhr, 1962]. Subsequent to these prototypes, several macro-economic models were constructed by local researchers [Cheong, 1972; Cheong, 1976; Lope, 1975; Tan, 1979]. These were based on annual data from the national accounts. Equations were econometrically estimated, with the structure of these models characterized by demand orientation. As econometric models, they were useful in identifying the structure of the economy and in the preparation of forecasts. However, as planning was not the main objective of these models, they were not particularly suitable for use by government planners.

The government, itself, recognizing the usefulness of models in the planning process, had been active in this area. Starting with simple growth models and piecemeal projections of the components of national income in the mid-1960s, the Economic PLanning Unit developed a macro-economic framework from which estimates of key variables were made for development plans. Beginning with the late 1960s, experiments with functional equations explaining demand aggregates were undertaken, the extent of disaggregation and the nature of specifications depending on the quantity and quality of data. These functions became the basis for the macro-economic framework used by the Economic Planning Unit (EPU) for the Third Malaysia Plan (TMP). This framework was one of the two-gap variety, with an input-output model providing a consistency check for the supply and demand sides of the macro-models [EPU, 1979].

Forecasts and projections based on the macro-framework contributed only one portion of the forecasts used in the TMP. Judgemental types of forecasts, based on expert opinions and expectations were also used by the Inter-Agency Planning Group (IAPG) which consisted of various central agencies such as the Treasury, Bank Negara, the Department of Statistics and EPU. Apart from the planning model of the EPU, models were also constructed by Bank Negara and the Treasury.

Tillman (1975) attempted a more formal model of the monetary sector. The model was made up of 15 equations of which 8 were behavioural while the rest were identities. Income and the rate of inflation were treated as exogenous in the model. It was integrated with the real-sector model of Cheong's (1976) as Cheong-Tillman (1976) model. Other sectoral models included that of Leong, Jaafar and Ho's price formation model (1976) and Jaafar's monetary model (1976). Hayes (1976) constructed a real-sector model that aimed linkage with Jaafar's monetary model. However the linkage was not completed. Semudram (1980) constructed the first model that completely integrated the real and financial sectors, and reported results of the final test in 1980.

Abe (1982) experimented with a model which was similar to the of Semudram's. The model consisted of 40 endogenous variables (24 behavioural and 16 identities). On the supply side of the model, production, population and employment were taken into account. On the demand side, consumption, investment, foreign trade, changes in stocks, prices, government and money were included. Stocks were treated as a residual so that demand and supply equilibrium would hold. Sahathavan and Imaoka (1984) developed a model that seeks to liberalized the supply-side constraints in the macro economy as postulated by some of the previous models. They also provided extensive simulation studies of their models.

The EPU-Lysy model differs from other models of the economy in that is a planning model based on the computible general equilibrium (CGE) approach [Abu Baker, Yeoh, Lum, Lysy (1979)]. It has two major features:

(i) Substitution between capital and labour and between domestically produced and imported goods are explicitly modeled using CES functions, and

(ii) the system is price endogenous.

It consisted of just under 50 equations, which are grouped into three blocks—the price block, the production block, and a set of equations to close the system.

The first of these blocks, which contains 14 equations, determines price independent of output under the assumption of constant returns to scale for labour, capital and imported goods. The profit rate, wage rate and foreign exchange rate are assumed known, and the prices of labour, capital and value-added are derived as functions of these variables. The market prices of domestic and imported intermediate goods are determined as markups. Cost of production equations are specified for equipment and capital; the market prices of consumption goods are treated in the same manner as those of intermediate goods. Households are divided according to whether they receive returns from labour or capital, and are assumed to face different prices for consumption goods. The reason for this difference is that the composition of domestically produced and imported goods in the consumption basket differs between the two types of households.

The production block consists of 30 equations which are simultaneously determined. It simulates the demand for labour, capital, domestic output and imports. Total labour income is obtained by multiplying wage rates by labour input and capita input is either distributed abroad or retained in the country. To derive household demand, income is adjusted for taxes and transfers. Household demand equations takes explicit account of substitution between domestically produced and imported goods on the basis of relative prices. Demand for domestic and imported goods for investment, government consumption, exports and change in stocks are exogenous. The EPU-Lysy model was used essentially for development planning by the EPU. Lysy has performed extensive simulations of the model, particularly in respect to the "closure rules" or the manner in which the exogenous variables were determined [Lysy, 1979]. Based on the interest generated by Lysy on the CGE approach towards modelling in Malaysia, several other CGE models for Malaysia have been completed or under completion, including that of Khor (1982).

All the models described above are economic models with minimal linkages to the demographic sector. Only 5 models referred did incorporate some kind of employment or demographic variables. Even the planning exercises of the IAPG and the EPU-Lysy were based on labour force participation rates which were projected exogenously. The need to integrate population factors into economic planning is obvious. On the other hand the combination of high fertility rates and low mortality rates has resulted in a youthful population, with implications for savings and income distribution. On the reverse, a larger population can result in a larger consumer market for goods and services, resulting in more rapid industrial production and development. At the same time, inequalities in incomes between areas have been major determinants of migration, so that policies aimed at influencing population distribution are also important for planning in Malaysia. These considerations provide a cogent argument in favour of constructing an economic-demographic model for planning in this country, while an additional incentive is the existence of a sound data base for most sectors of the country.

III. MODEL DEVELOPMENT AND SPECIFICATION

Introduction

In this chapter, we shall discuss in detail the process of model construction, development and specification processes. The demographic-economic model to be constructed will consist of two submodels: the demographic and the economic submodels.

A. Specification of the Demographic Submodel

In the demographic submodel, it is assumed that the Malaysian population is disaggregated into urban and rural, with sector-specific fertility, mortality and economic participation rates.

1. Nuptiality and Fertility Rate Estimation Block

Malaysia has recently experienced a substantial rise in the age at first marriage owing to increasing income and educational level. In this study, the age at first marriage in the urban (AGE_U) and rural (AGE_R) areas are assumed to be dependent on the per capita gross output (X) and the enrolment rate of women in upper secondary school (ER) in a logit framework with an assymptotic limit; for urban areas this assymptotic limit is assumed to be 27 years and for the rural areas 25 years. The two limits were derived from the time-series data (1960-1980) on age at first marriage.[1]

Using data for 1960-1980, the equations derived are as follows:

$$\ln(25 - AGE_R) = 1.1516 - \underset{(3.01)}{0.001\, X_R} - \underset{(3.21)}{3.098\, ER_R} \qquad N = 21 \quad \text{(i)}$$

D.W. = 1.78, R^2 = 0.996

$$\ln(27 - AGE_U) = 1.641 - \underset{(3.21)}{0.001\, X_U} - \underset{(3.65)}{2.835\, ER_U} \qquad N = 21 \quad \text{(ii)}$$

D.W. = 1.80, R^2 = 0.994

---

[1] Estimated from Noor Laily Abu Bakar and others, *Facts and Figures: Malaysia National Population and Family Development Program,* National Population and Family Development Board, Kuala Lumpur, 1982; and Chander, R., V.T. Palan, Nor Laily Aziz and Tan Boon Ann, *Malaysia Fertility and Family Survey-1974: First Country Report,* (World Fertility Survey Research Project), Department of Statistics and National Family Planning Board, Kuala Lumpur, April 1977.

Equations (i) and (ii) indicate that both per capita gross output and enrolment rate do have significant influence in increasing the age at first marriage. This is particularly true for households in the urban areas. The R^2 for each of the equations was very high suggesting that the equations were significant; the individual t-value of the estimated coefficients were also high showing that these coefficients were individually significant. The Durbin-Watson (D.W.) statistics for the time-series equations showed no serious problem of serial autocorrelation in the relevant equations.

Equations (i) and (ii) were also specified for the three major ethnic groups in the country, with Chinese and Indians having the assymptotic limit of 27 years and Malays 25 years. The equations derived were similar in nature to equations (i) and (ii) (see table 3.1). In particular, the equations for Malays were similar to equation (i), while that for the non-Malays similar to equation (ii). This is not surprising since the rural area is occupied mainly by the Malays and the urban areas mainly by the non-Malays.

Table 3.1 Age at First Marriage by Ethnicity and Urban-Rural Areas

Urban								
Malays	$\ln(25 - AGE_{MU})$	=	1.631	$- 0.0013X_{MU}$ (3.01)	$- 2.231LR_{MU}$ (3.95)	N = 21	R^2 = 0.954	D.W. = 2.11
Chinese	$\ln(27 - AGE_{CU})$	=	1.541	$- 0.0025X_{CU}$ (3.61)	$- 3.21LR_{CU}$ (4.02)	N = 21	R^2 = 0.941	D.W. = 1.95
Indians	$\ln(27 - AGE_{IU})$	=	1.552	$- 0.0026X_{IU}$ (2.96)	$- 2.912LR_{IU}$ (3.23)	N = 21	R^2 = 0.903	D.W. = 1.72
Rural								
Malays	$\ln(25 - AGE_{MR})$	=	1.71	$- 0.0015X_R$ (3.01)	$- 2.301ER_{MR}$ (2.95)	N = 21	R^2 = 0.841	D.W. = 2.52
Chinese	$\ln(27 - AGE_{CR})$	=	1.62	$- 0.0025X_R$ (3.21)	$- 3.021ER_{CR}$ (2.64)	N = 21	R^2 = 0.921	D.W. = 2.01
Indians	$\ln(27 - AGE_{IR})$	=	1.72	$- 0.0031X_R$ (3.11)	$- 2.921ER_{IR}$ (2.86)	N = 21	R^2 = 0.941	D.W. = 1.75

Having estimated the age at first marriage, the fertility equations can be run with the age at first marriage as a dependent variable.

The age-specific fertility rates of women in the urban (μ_{Ui}) and rural (μ_{Ri}) areas for age group i are assumed to be dependent on the per capita gross output (X), the doctor-population ratio (DP), per capita government expenditure on FP (H) as well as the age at first marriage (AGE).[2], in a logit framework with assymptotic lower bounds of $\underline{\mu}_i$ estimated from time-series data, the Fertility and Family Life Survey, 1974 and the Family-Life Survey, 1976/77. The equations were derived in the following forms:

$$\ln (\mu_{Ri} - \underline{\mu}_{Ri}) = a + bX + cDP_R + dH_R + eAGE_R \quad \text{(iii)}$$

$$\ln (\mu_{Ui} - \underline{\mu}_{Ui}) = a + bX + cDP_U + dH_U + eAGE_U \quad \text{(iv)}$$

The actual derived equations linking age-specific fertility rates to the households in the rural and urban areas are presented in table 3.2. The following interesting observations can be made:

a. The age-specific fertility rates for the rural households were significantly higher than in the urban households.

b. Increasing per capita output tended to reduce fertility rates; this is especially so for the urban areas. This could be due to that rural households still hold to the values of wanting large families, and these values are unlikely to be influenced significantly by increasing per capita output alone.

c. Expansion in health expenditure (in the form of increasing Doctor-Population ratio) tended to reduce fertility rates. This effect was found to be more pronounced in the rural areas than in the urban areas. This is not surprising since urban households already experienced fairly low fertility rates, and these rates were unlikely to be influenced by increasing government expenditure on health.

d. The government's expenditure on FP also tended to reduce fertility rates; in this case the effects were more important in the rural areas than in the urban areas. This could be due to that urban households already had their own networks (non-government) for FP services, and hence were not as dependent on the government of FP services as rural households.

e. Age at first marriage is an important variable accounting for decline in age-specific fertility rates. The influence of this variable declined by age categories; this is not surprising since among women of older age groups, the proportion of single women would be relatively small which negates the importance of the variable.

---

[2] The age at first marriage variable was not included in the equations for age groups above 34 years.

f. Since per capita output was already a dependent variable in the equation of age at first marriage, by including both per capita output and age at first marriage as dependent variables to explain age-specific fertility rates, problems of multi-collinearity emerged. This is indicated by the low t-value of the per capita output, particularly among the lower age categories. Nevertheless, the fact that the coefficients for X (per capita output) were still fairly large and significant in the older age group indicates that, even after including age at first marriage, household income still had some impact on fertility rates.

g. All the regression equations had high R^2 and Durbin-Watson (D.W.) statistics of around 2.0. This suggest that the regression equations were significant; and that no major problems of serial correlations were encountered in the time-series data. Further, the t-values for the individual coefficients (except for X) were significant. This is important for it showed that the identified variables are the major socio-economic variables that could influence age-specific fertility rates.

Given the multi-racial nature of the Malaysian society and the pronounced differences in nuptiality patterns and fertility rates of the different ethnic groups, it would be interesting to analyze the relationship between socio-economic variables and age-specific fertility rates by ethnic groups. In this study, the equations of table 3.2 were also separately ran for the three major ethnic groups (see tables 3.3 and 3.4).

From the tables, the following influences can be made:

a. For the households in the urban areas, age-specific fertility rates were the lowest among the Chinese and highest among the Malays. This is true for all the age categories. In some age groups (e.g. 20-24 years), the Chinese-Malay fertility rates differential was as high as 1:1.5.

b. Increasing per capita output tended to reduce age-specific fertility rates. This was true among all the three communities; though the impact of increasing per capita output was more significant among the Chinese households and the Indians households and less important among the Malay households.

c. Increasing health expenditure (i.e. increasing the doctor-population ratio) also had a significant influence in reducing age-specific fertility rates. In this case however, the influence was more important for the non-Chinese families than for the Chinese families. This may because infant mortality rates among the Chinese families were the lowest; thus any increase in doctor-population ratio would result in a proportionately greater improvement in health status for the non-Chinese families resulting in their lower fertility rates.

d. Increasing government health expenditure on FP tended to reduce the age-specific fertility rates; this effect was found to be almost equally significant for all the three communities, perhaps more for the non-Chinese families than

Table 3.2 Socio-Economic Development and Age-Specific Fertility Rates: by Urban and Rural Areas

Age group (years)[a]	Dependent variable	Constant	Regression equations independent variables						
			X	*DP*	*H*	*AGE*	R^2	*N*	*D.W.*
Rural									
1. 15-19	$\ln(\mu_1 - .021)$	−.410	−.0015	−.22	−.37	−.43	.943	21	2.31
			(2.15)	(2.48)	(2.97)	(3.02)			
2. 20-24	$\ln(\mu_2 - .105)$	−.408	−.0013	−.24	−.38	−.44	.935	21	2.01
			(1.38)	(2.66)	(2.96)	(2.87)			
3. 25-29	$\ln(\mu_3 - .138)$	−.409	−.0020	−.25	−.40	−.42	.941	21	1.71
			(1.72)	(2.81)	(2.61)	(2.54)			
4. 30-34	$\ln(\mu_4 - .106)$	−.420	−.0022	−.27	−.41	−.32	.889	21	2.43
			(1.67)	(2.89)	(2.51)	(1.98)			
5. 35-39	$\ln(\mu_5 - .068)$	−.357	−.0017	−.28	−.38	–	.872	21	1.67
			(2.53)	(2.98)	(2.55)	–			
6. 40-44	$\ln(\mu_6 - .027)$	−.323	−.0016	−.29	−.38	–	.881	21	1.54
			(2.28)	(2.34)	(2.52)	–			
7. >44	$\ln(\mu_7 - .002)$	−.245	−.0014	−.21	−.37	–	.853	21	2.09
			(3.11)	(3.24)	(3.12)	–			
Urban									
1. 15-19	$\ln(\mu_1 - .012)$	−.389	−.0015	−.22	−.36	−.44	.941	21	2.31
			(1.02)	(2.36)	(2.04)	(3.63)			
2. 20-24	$\ln(\mu_2 - .062)$	−.377	−.0025	−.17	−.32	−.47	.961	21	2.45
			(1.44)	(2.31)	(1.98)	(3.79)			
3. 25-29	$\ln(\mu_3 - .083)$	−.396	−.0027	−.18	−.31	−.44	.908	21	1.75
			(1.18)	(2.40)	(1.97)	(3.68)			
4. 30-34	$\ln(\mu_4 - .064)$	−.399	−.0034	−.19	−.27	−.34	.901	21	1.56
			(1.32)	(1.99)	(2.56)	(3.32)			
5. 35-39	$\ln(\mu_5 - .041)$	−.321	−.0027	−.14	−.31	–	.862	21	2.27
			(2.26)	(1.92)	(2.33)	–			
6. 40-44	$\ln(\mu_6 - .015)$	−271	−.0023	−.13	−.26	–	.811	21	2.34
			(2.36)	(2.02)	(2.91)	–			
7. >44	$\ln(\mu_7 - .002)$	−.224	−.0021	−.15	−.26	–	.813	21	1.78
			(0.36)	(1.45)	(2.45)				

Notes: [a] Based on time-series data from 1960-1980.
( ) denotes t-value.

Table 3.3 Socio-Economic Development and Age-Specific Fertility Rates: Urban and Ethnicity

Age group (years)	*Dependent variable*	*Constant*	*Independent variables*						
			X	*DP*	*H*	*AGE*	R^2	*N*[a]	*D.W.*
Malays									
1. 15-19	$\ln(\mu_1 - .021)$	−.412	−.0015	−.21	−.35	−.46	.941	21	2.31
			(1.14)	(2.51)	(2.92)	(3.14)			
2. 20-24	$\ln(\mu_2 - .105)$	−.425	−.0016	−.22	−.36	−.47	.931	21	2.49
			(1.42)	(2.61)	(2.81)	(2.95)			
3. 25-29	$\ln(\mu_3 - .138)$	−.432	−.0021	−.23	−.38	−.45	.901	21	2.01
			(1.91)	(2.71)	(2.52)	(2.84)			
4. 30-34	$\ln(\mu_4 - .106)$	−.401	−.0020	−.25	−.39	−.30	.841	21	1.65
			(1.52)	(2.81)	(2.41)	(1.91)			
5. 35-39	$\ln(\mu_5 - .068)$	−.350	−.0015	−.26	−.35	–	.851	21	1.58
			(2.41)	(2.91)	(2.41)	–			
6. 40-44	$\ln(\mu_6 - .027)$	−.300	−.0015	−.27	−.35	–	.865	21	1.95
			(2.21)	(2.85)	(2.46)	–			
7. >44	$\ln(\mu_7 - .002)$	−.250	−.0010	−.20	−.34	–	.845	21	2.01
			(3.01)	(3.01)	(3.01)	–			
Chinese									
1. 15-19	$\ln(\mu_1 - .012)$	−.382	−.0016	−.21	−.35	−.47	.931	21	2.11
			(1.01)	(2.01)	(2.01)	(4.10)			
2. 20-24	$\ln(\mu_2 - .062)$	−.391	−.0020	−.15	−.30	−.49	.942	21	1.56
			(1.21)	(2.21)	(1.91)	(3.92)			
3. 25-29	$\ln(\mu_3 - .083)$	−.412	−.0025	−.16	−.30	−.45	.902	21	1.75
			(1.01)	(2.12)	(1.82)	(3.81)			
4. 30-34	$\ln(\mu_4 - .064)$	−.382	−.0030	−.14	−.25	−.32	.891	21	1.86
			(1.21)	(1.92)	(2.42)	(3.10)			
5. 35-39	$\ln(\mu_5 - .041)$	−.320	−.0025	−.13	−.30	−.01	.842	21	2.56
			(2.34)	(1.93)	(2.21)	–			
6. 40-44	$\ln(\mu_6 - .015)$	−.298	−.0021	−.12	−.24	–	.802	21	2.12
			(2.41)	(2.00)	(2.82)	–			
7. >44	$\ln(\mu_7 - .002)$	−.245	−.0020	−.14	−.24	–	.812	21	2.32
			(3.34)	(2.12)	(2.91)	–			
Indians									
1. 15-19	$\ln(\mu_1 - .012)$	−.392	−.0015	−.21	−.36	−.47	.941	21	2.51
			(1.11)	(3.15)	(3.06)	(2.92)			
2. 20-24	$\ln(\mu_2 - .062)$	−.401	−.0016	−.22	−.36	−.50	.931	21	2.11
			(0.91)	(3.62)	(2.85)	(3.51)			
3. 25-29	$\ln(\mu_3 - .083)$	−.422	−.0018	−.23	−.41	−.51	.852	21	2.23
			(1.01)	(3.42)	(2.51)	(3.62)			
4. 30-34	$\ln(\mu_4 - .064)$	−.412	−.0021	−.25	−.50	−.32	.801	21	1.96
			(1.21)	(3.51)	(2.61)	(1.81)			
5. 35-39	$\ln(\mu_5 - .041)$	−.350	−.0030	−.28	−.51	−.02	.812	21	1.98
			(2.41)	(3.69)	(2.92)	–			
6. 40-44	$\ln(\mu_6 - .015)$	−.301	−.0026	−.31	−.42	–	.800	21	2.28
			(1.82)	(3.08)	(3.51)	–			
7. >44	$\ln(\mu_7 - .002)$	−.256	−.0018	−.25	−.45	–	.814	21	2.34
			(1.92)	(2.91)	(3.21)	–			

Notes: [a] Based on time-series data, 1960-1980.

( ) denotes t-value.

Table 3.4 Socio-Economic Development and Age-Specific Fertility Rates: by Rural and Ethnicity

Age group (years)	*Dependent variable*	*Constant*	*Independent variables*						
			X	*DP*	*H*	*AGE*	R^2	*N*[a]	*D.W.*
Malays									
1. 15-19	ln $(\mu_1 - .021)$	–.414	–.0015	–.22	–.36	–.42	.951	21	2.31
			(1.16)	(2.31)	(2.71)	(3.14)			
2. 20-24	ln $(\mu_2 - .105)$	–.435	–.0016	–.28	–.38	–.45	.900	21	2.45
			(1.54)	(2.62)	(2.61)	(2.95)			
3. 25-29	ln $(\mu_3 - .138)$	–.402	–.0022	–.27	–.34	–.44	.952	21	1.45
			(1.51)	(2.71)	(2.42)	(2.84)			
4. 30-34	ln $(\mu_4 - .106)$	–.410	–.0028	–.26	–.35	–.35	.831	21	1.78
			(1.62)	(2.54)	(2.41)	(1.91)			
5. 35-39	ln $(\mu_5 - .068)$	–.360	–.0016	–.24	–.34	–	.846	21	2.13
			(2.48)	(2.91)	(2.31)	–			
6. 40-44	ln $(\mu_6 - .027)$	–.310	–.0018	–.28	–.31	–	.854	21	2.32
			(2.21)	(2.85)	(2.36)	–			
7. >44	ln $(\mu_7 - .002)$	–.210	–.0008	–.22	–.31	–	.865	21	1.87
			(3.01)	(3.91)	(3.71)	–			
Chinese									
1. 15-19	ln $(\mu_1 - .012)$	–.392	–.0016	–.41	–.41	–.45	.941	21	1.98
			(1.92)	(2.32)	(2.81)	(4.10)			
2. 20-24	ln $(\mu_2 - .062)$	–.381	–.0031	–.16	–.35	–.43	.932	21	1.67
			(1.91)	(2.21)	(1.91)	(2.91)			
3. 25-29	ln $(\mu_3 - .083)$	–.401	–.0042	–.17	–.31	–.45	.931	21	2.36
			(1.04)	(2.81)	(1.82)	(2.91)			
4. 30-34	ln $(\mu_4 - .064)$	–.341	–.0031	–.18	–.28	–.38	.901	21	2.21
			(1.32)	(3.01)	(2.42)	(3.82)			
5. 35-39	ln $(\mu_5 - .041)$	–.301	–.0032	–.15	–.40	–	.841	21	1.98
			(2.94)	(2.01)	(2.21)	–			
6. 40-44	ln $(\mu_6 - .015)$	–.295	–.0041	–.22	–.34	–	.852	21	1.60
			(2.31)	(2.41)	(2.82)	–			
7. >44	ln $(\mu_7 - .002)$	–.234	–.0042	–.21	–.24	–	.861	21	1.87
			(3.01)	(2.42)	(2.91)	–			
Indians									
1. 15-19	ln $(\mu_1 - .012)$	–.410	–.0016	–.32	–.34	–.51	.951	21	1.98
			(1.01)	(3.01)	(3.26)	(2.92)			
2. 20-24	ln $(\mu_2 - .062)$	–.392	–.0018	–.41	–.38	–.47	.965	21	2.31
			(1.21)	(3.62)	(2.54)	(3.51)			
3. 25-29	ln $(\mu_3 - .083)$	–.432	–.0019	–.41	–.45	–.48	.862	21	1.76
			(1.21)	(3.41)	(2.39)	(3.62)			
4. 30-34	ln $(\mu_4 - .064)$	–.451	–.0025	–.28	–.49	–.32	.892	21	1.89
			(1.32)	(2.91)	(2.36)	(1.81)			
5. 35-39	ln $(\mu_5 - .041)$	–.382	–.0034	–.31	–.51	–	.824	21	1.78
			(2.31)	(2.91)	(2.91)	–			
6. 40-44	ln $(\mu_6 - .015)$	–.391	–.0027	–.32	–.59	–	.810	21	2.31
			(1.91)	(3.18)	(3.41)	–			
7. >44	ln $(\mu_7 - .002)$	–.241	–.0021	–.24	–.32	–	.865	21	2.45
			(0.92)	(3.01)	(3.21)				

Notes: [a] Based on time-series data from 1960-1980.
( ) denotes t-value.

for the Chinese families. This could be because a relatively larger proportion of Chinese families seek their FP services from private clinics and medical stores.

e. Age at first marriage was found to be a significant variable explaining age-specific fertility rates for women of less than 30 years of age. This is true for all the three cultures, and is not surprising since one would expect that the large majority of the women above 30 years of age (and in all the three races) to be married.

f. In all the regression equations the R^2 were found to be very high (between 0.80 to 0.95) and significant. This is important, for it indicates that the identified socio-economic variables were the major variables that could have influenced the age-specific fertility rates for families in the informal sector. As explained previously, by including both the per capita output and age at first marriage into the equations for age-specific fertility rates, problems of multicollinearity emerged. This is indicated by the low t-values for the household income variable among the lower age groups. However, the tables showed that the t-values for the other variables were mainly significant. Thus, the inclusion of household income showed that the variable still could make some significant independent influence on age-specific fertility rates (even after the incorporation of age at first marriage), particularly for women in the older age categories.

2. *Mortality and Survival Rate Estimation Block*

Mortality levels in Malaysia have been relatively low and stable by international standard. Within such a context, the common practice in mortality estimation is to estimate life-expectancy at birth (E). The age-specific survival rates can then be derived by using the appropriate model life table which corresponds to the estimated life expectancy at birth.

In this model, life expectancy at birth is estimated for male and female in the urban (EM_U; EF_U) and rural (EM_R; EF_R) areas within a logit framework. The independent variables affecting life expectancy at birth are per capita output (X), per cent of population over 6 years whose educational level is beyond primary level (%E), and per cent of population having access to piped water (W). Further, assymptotic uper bounds of 75 years and 78 years are imposed upon the life expectancy of males and females respectively.

The above three equations are separately estimated for the rural and urban areas. Using time-series data from 1960-1980, the equations relating life expectancy at birth with the independent variables are:

$$\ln (75 - EM_U) = 1.984 - \underset{(2.12)}{0.001X_U} + \underset{(1.05)}{0.002\%E_U} - \underset{(2.21)}{0.002W_U} \qquad N = 21 \quad (v)$$

$$D.W. = 1.76, \qquad R^2 = 0.998$$

$$\ln(78 - EF_U) = 1.984 - \underset{(2.22)}{0.001X_U} + \underset{(1.95)}{0.002\%E_U} - \underset{(2.51)}{0.002W_U} \qquad N = 21 \quad \text{(vi)}$$

D.W. = 2.02, R^2 = 0.998

$$\ln(75 - EM_R) = 1.76 - \underset{(2.52)}{0.001X_R} - \underset{(1.21)}{0.002\%E_R} + \underset{(2.61)}{0.004W_R} \qquad N = 21 \quad \text{(vii)}$$

D.W. = 1.69, R^2 = 0.837

$$\ln(78 - EF_R) = 1.69 - \underset{(2.91)}{0.001X_R} - \underset{(1.91)}{0.002\%E_R} + \underset{(1.01)}{0.004W_R} \qquad N = 21 \quad \text{(viii)}$$

D.W. = 1.79, R^2 = 0.832

The above equations indicate that the per capita output, enrolment rates and access of households to piped water do account for major proportions of the variance in life expectancy at birth. The R^2 of each of the equation was high showing that the equations were significant. Further, the D.W. statistics showed that no serious multi-collinearity were encountered in the time-series data.

Having estimated the life expectancy, the mortality rate for each age group is estimated from the Regional Model Life Tables (Model West) of Coale and Demeny (1966). With the mortality variables estimated, the survival rates (which is 1 – mortality rate) can be computed.

3. *Population Transition Block*

Having estimated the fertility and survival rates, we are now in a position to estimate the transition of population of one year to the next. In each year t the number of births in the rural and urban areas are given by the following equations:

$$PN^O_{Rt} = \sum_{i=10}^{49} \mu^i_{Rt} Z^i_{Rt} \qquad \text{(ix)}$$

$$PN^O_{Ut} = \sum_{i=10}^{49} \mu^i_{Ut} Z^i_{Ut} \qquad \text{(x)}$$

$$ZF^O_{Rt} = [h^O_{Rt} / (1 + h^O_{Rt})]\ PN^O_{Rt}$$

$$ZF^O_{Ut} = [h^O_{Ut} / (1 + h^O_{Ut})]\ PN^O_{Ut}$$

$$ZM^O_{Rt} = [1 / (1 + h^O_{Rt})]\ PN^O_{Rt}$$

$$ZM^{O}_{Ut} = [1/(1 + h^{O}_{Ut})] \; PN^{O}_{Ut}$$

where

PN^{i}_{jt} = Natural population of age i at the mid-point of year t in area j (j = R, rural; U, urban)

ZF^{i}_{jt} = the number of women of age i at the mid point of year t in area j (j = R, rural; U, urban)

ZM^{i}_{jt} = the number of women of age i at the mid-point of year t in area j (j = R, rural; U, urban)

μ^{i}_{jt} = fertility rate of women of age i at the mid-point of year t in area j (estimated from nuptiality and fertility block)

h^{i}_{jt} = female to male ratio of age i at year t in area j (exogenous, estimated from Population Census)

The values of h^{t}_{jt} for 1980, estimated from Khoo (1983), are as follows:

$h^{o}_{R}(0)$ = 0.9596 female to male rural population ratio in age group 0

$h^{o}_{R}(4)$ = 0.968 female to male rural population ratio in age group 1-4

$h^{o}_{R}(9)$ = 0.962 female to male rural population ratio in age group 5-9

$h^{o}_{R}(14)$ = 0.979 female to male rural population ratio in age group 10-14

$h^{o}_{R}(19)$ = 1.045 female to male rural population ratio in age group 15-19

$h^{o}_{R}(24)$ = 1.051 female to male rural population ratio in age group 20-24

$h^{o}_{R}(29)$ = 1.038 female to male rural population ratio in age group 25-29

$h^{o}_{R}(34)$ = 1.021 female to male rural population ratio in age group 30-34

$h^{o}_{R}(39)$ = 1.060 female to male rural population ratio in age group 35-39

$h^{o}_{R}(44)$ = 1.001 female to male rural population ratio in age group 40-44

$h^{o}_{R}(49)$ = 1.021 female to male rural population ratio in age group 45-49

$h^{o}_{R}(54)$ = 0.948 female to male rural population ratio in age group 50-54

$h^{o}_{R}(59)$ = 0.859 female to male rural population ratio in age group 55-59

$h_R^o(64)$ = 0.890 female to male rural population ratio in age group 60-64

$h_R^o(69)$ = 0.749 female to male rural population ratio in age group 65-69

$h_R^o(74)$ = 0.879 female to male rural population ratio in age group 70-74

$h_R^o(75)$ = 0.971 female to male rural population ratio in age group $\geqslant$75

$h_U^o(0)$ = 0.953 female to male urban population ratio in age group 0

$h_U^o(4)$ = 0.948 female to male urban population ratio in age group 1-4

$h_U^o(9)$ = 0.953 female to male urban population ratio in age group 5-9

$h_U^o(14)$ = 0.957 female to male urban population ratio in age group 10-14

$h_U^o(19)$ = 0.999 female to male urban population ratio in age group 15-19

$h_U^o(24)$ = 1.029 female to male urban population ratio in age group 20-24

$h_U^o(29)$ = 0.982 female to male urban population ratio in age group 25-29

$h_U^o(34)$ = 1.002 female to male urban population ratio in age group 30-34

$h_U^o(39)$ = 1.024 female to male urban population ratio in age group 35-39

$h_U^o(44)$ = 0.981 female to male urban population ratio in age group 40-44

$h_U^o(49)$ = 1.013 female to male urban population ratio in age group 45-49

$h_U^o(54)$ = 0.982 female to male urban population ratio in age group 50-54

$h_U^o(59)$ = 0.955 female to male urban population ratio in age group 55-59

$h_U^o(64)$ = 0.957 female to male urban population ratio in age group 60-64

$h_U^o(69)$ = 0.905 female to male urban population ratio in age group 65-69

$h_U^o(75)$ = 1.397 female to male urban population ratio in age group 70-75

The number of female population in each year t at each area j are given by the following equations:

$$ZF^i_{Rt} = \beta F^{i-1}_{R\ t-1}\ ZF^{i-1}_{R\ t-1}$$

$$ZF^i_{UT} = \beta F^{i-1}_{U\ t-1}\ ZF^{i-1}_{U\ t-1}$$

$$ZM^i_{Rt} = \beta M^{i-1}_{R\,t-1}\ ZM^{i-1}_{R\,t-1}$$

$$ZM^i_{Ut} = \beta M^{i-1}_{U\,t-1}\ ZM^{i-1}_{U\,t-1}$$

where

βF^i_{jt} = survival rate of women of age i from year t in area j (estimated from the mortality and survival rate block)

βM^i_{jt} = survival rate of male of age i from year t to year t + 1 in area j (estimated from the mortality and survival rate block)

The total natural urban and rural population of age i at year t is therefore:

$$PN^i_{Ut} = ZF^i_{Ut} + ZM^i_{Ut} \qquad \text{(xi)}$$

$$PN^i_{Rt} = ZF^i_{Rt} + ZM^i_{Rt} \qquad \text{(xii)}$$

The total natural population of age i at year t (PN^t_i) is:

$$PN^i_t = PN^i_{Ut} + PN^i_{Rt} \qquad \text{(xiii)}$$

4. Migration Block

In this study, rural-urban migration will be estimated in two steps. First, the level of urbanization (per cent population living in urban areas) will be estimated as a function of per capita output. Second, the number of rural-urban migrants is the difference between the size of population living in urban areas consistent with the level of urbanization obtained in the first step, and the size of population which grows naturally through births and deaths. Total migrants are further distributed by age-sex according to their propensity to migrate.

The level of urbanization (U%) is related to per capita output as follows:

$$\ln(0.5 - U\%_t) = 1.432 - 0.00013X_t \qquad R^2 = 0.984 \qquad \text{(xiv)}$$
$$(-23.16)$$
$$N = 21, \qquad D.W. = 1.92$$

where 0.5 is the assumed assymptotic upper limit for the level of urbanization in Malaysia

Urban population is computed from

$$PU_t = U\%\,PN_t \qquad \text{(xv)}$$

where $PN_t = PN_{Rt} + PN_{Ut}$

$$PR_t = (1 - U\%)PN_t \qquad \text{(xvi)}$$

Net total rural-urban migration (M_t)

$$M_t = PU_t - PN_{Ut} \qquad \text{(xvii)}$$

The proportion of M_t who are males and females are estimated from the 1980 Census.

i.e. $MM_t = r_m M_t$

$MF_t = r_f M_t$

where

r_m = per cent of migrants who are males

r_f = per cent of migrants who are females

Further,

$$MM(i)_t = q_m(i)_t \, MM_t \qquad \text{(xx)}$$

where $q_m(i)_t$ = per cent of MM_t which are of age i (exogenous)

and $MF(i)_t = q_f(i)_t \, MF_t$

where $q_f(i)_t$ = per cent of $MF(i)_t$ which are of age i (exogenous)

The values of r_m, r_f, $q_m(i)_t$ and $q_f(i)_t$ estimated [Khoo, 1983] for this study are:

r_m	=	0.529	the proportion of migrants who are male
r_f	=	0.471	the proportion of migrants who are females
q_m (4)	=	0.013	the proportion of male migrants in age group 0-4
q_m (9)	=	0.147	the proportion of male migrants in age group 5-9
q_m (14)	=	0.113	the proportion of male migrants in age group 10-14
q_m (19)	=	0.144	the proportion of male migrants in age group 15-19
q_m (24)	=	0.166	the proportion of male migrants in age group 20-24
q_m (29)	=	0.114	the proportion of male migrants in age group 25-29
q_m (34)	=	0.092	the proportion of male migrants in age group 30-34
q_m (39)	=	0.061	the proportion of male migrants in age group 35-39
q_m (44)	=	0.045	the proportion of male migrants in age group 40-44
q_m (49)	=	0.030	the proportion of male migrants in age group 45-49
q_m (54)	=	0.023	the proportion of male migrants in age group 50-54
q_m (59)	=	0.019	the proportion of male migrants in age group 55-59

q_m (64) = 0.015 the proportion of male migrants in age group 60-64
q_m (65) = 0.01 the proportion of male migrants in age group $\geq$ 65
q_f (4) = 0.014 the proportion of female migrants in age group 0-4
q_f (9) = 0.159 the proportion of female migrants in age group 5-9
q_f (14) = 0.126 the proportion of female migrants in age group 10-14
q_f (19) = 0.156 the proportion of female migrants in age group 15-19
q_f (24) = 0.178 the proportion of female migrants in age group 20-24
q_f (29) = 0.111 the proportion of female migrants in age group 25-29
q_f (34) = 0.081 the proportion of female migrants in age group 30-34
q_f (39) = 0.049 the proportion of female migrants in age group 35-39
q_f (44) = 0.045 the proportion of female migrants in age group 40-44
q_f (49) = 0.030 the proportion of female migrants in age group 45-49
q_f (54) = 0.021 the proportion of female migrants in age group 50-54
q_f (59) = 0.016 the proportion of female migrants in age group 55-59
q_f (64) = 0.013 the proportion of female migrants in age group 60-64
q_f (65) = 0.017 the proportion of female migrants in age group $\geq$ 65

5. *Participation Rate Estimation Block*

Since males in age-groups 25-49 years generally have to work, the age-specific participation rates of males for ages 25-49 years are exogenously determined. For male and female participation rates for ages 10-24 years, they are assumed to be functions of per capita education expenditure (E_{jt}) and per capita output (X_{jt}) as follows:

$$m^i_{jt} = a + bE_{jt-1} + cX_{jt-1} \qquad \text{(xxi)}$$

and $$f^i_{jt} = a + bE_{jt-1} + cX_{jt-1} \qquad \text{(xxii)}$$

where m^i_{jt} and f^i_{jt} are the participation rate of male and female of age i in area j at time t.

For male and female participation rate for ages $\geq$50, the dependent variables are assumed to be:

$$m^i_{jt} = a + bRage_{t-1} + cX_{jt-1} \qquad \text{(xxiii)}$$

$$f^i_{jt} = a + bRage_{t-1} + cX_{jt-1} \qquad \text{(xxiv)}$$

where $Rage_t$ is the retirement age at year t.

The age-specific female participation rates for age 25-49 in the rural areas are assumed to be a function of per capita educational expenditure (E) and the proportion of agricultural to total output $(X_{A\,t-1}/X_{t-1})$.

$$m^i_{Rt} = a + bE_{R\,t-1} + c(X_{A\,t-1}/X_{t-1}) \qquad \text{(xxv)}$$

Similarly, the age-specific female participation rate for age 25-49 in the urban areas are assumed to be a function of per capita educational expenditure, $X_{N\,t-1}/X_{t-1}$ and the wage rate of non-agricultural sector $(W_{N\,t-1})$,

$$m^i_{Ut} = a + bE_{jt-1} + cX_{N\,t-1}/X_{t-1} + dW_{N\,t-1} \qquad \text{(xxvi)}$$

Tables 3.5 and 3.6 give the estimates of the participation rates from regression equations.

6. *Labour Supply Block*

The labour supply are estimated as below:

$$1(R)_t = \sum_{i=10}^{65} m^i_{Rt}(ZM^i_{Rt} - MM(i)_t) + \sum_{i=10}^{65} f^i_{Rt}(ZF^i_{Rt} - MF(i)_t) \qquad \text{(xxvii)}$$

$$1(U)_t = \sum_{i=10}^{65} m^i_{Ut}(ZM^i_{Ut} - MM(i)_t) + \sum_{i=10}^{65} f^i_{Ut}(ZF^i_{Ut} - MF(i)_t) \qquad \text{(xxviii)}$$

where

$1(j)_t$ = the total number of people seeking jobs, or the labour supply, in year t at area j.

The labour supply estimated will serve as inputs into the economic sub-model to be discussed in the next subsection.

7. *Summary Structure of Demographic Submodel*

A summary of the structure of the demographic submodel indicating the interrelationships of the various blocks within the submodel, as well as the dependence of the demographic submodel on the outputs from the economic submodel (to be describes in the next section) is presented in figure 3.1.

B. Economic Submodel

The economic submodel is again disaggregated into two areas: – rural and urban – and two sectors – agriculture and non-agriculture. Data is always a

Table 3.5 Participation Rates and Socio-Economic Variables by Urban-Rural

Age group (years)	*Dependent variable*	*Constant*	*Independent variables*				
			E_{it-1}	X_{it-1}	R_{AGEt}	R^2	*D.W.*
Rural[a]							
1. 10-14	m^i_{Rt}	15.5	.12 (2.36)	.0061 (1.31)	–	.96	1.75
2. 15-19	m^i_{Rt}	23.8	.11 (2.24)	.0057 (1.36)	–	.98	1.51
3. 20-24	m^i_{Rt}	30.2	.13 (2.34)	.0041 (1.01)	–	.99	1.62
4. 25-49			exogenously determined				
5. 50-54	m^i_{Rt}	79.95	–	–.0015 (4.01)	.0001 (.51)	.97	2.10
6. 55-59	m^i_{Rt}	79.25	–	–.0016 (3.93)	.0001 (1.00)	.96	2.21
7. ⩾60	m^i_{Rt}	60.50	–	–.0005 (4.51)	.0002 (.82)	.95	2.32
Urban							
1. 10-14	m^i_{Ut}	30.2	–.012 (3.01)	–.0001 (2.45)	–	.98	1.52
2. 15-19	m^i_{Ut}	48.4	–.013 (2.99)	–.0001 (2.48)	–	.98	1.49
3. 20-24	m^i_{Ut}	50.4	–.014 (2.45)	–.0001 (2.21)	–	.99	1.75
4. 25-49			exogenously determined				
5. 50-54	m^i_{Ut}	78.50	–	–.0020 (18.41)	.0009 (.21)	.98	2.21
6. 55-59	m^i_{Ut}	73.20	–	–.0010 (15.31)	.0001 (.52)	.97	2.32
7. ⩾60	m^i_{Ut}	69.40	–	–.0005 (16.32)	.0001 (.59)	.96	1.94

Notes: [a] N = 21, i.e. time-series data 1960-1980. For rural i = A, agricultural sector; for urban i = N, non-agricultural sector.

( ) denotes t-value.

Table 3.6 Female Participation Rates and Socio-Economic Variabes by Urban-Rural

Dependent variable (f^i_{jt})		*Independent variables*							
Age (years)	*Constant*	E_{it-1}	X_{it-1}	X_{it-1}/X_{t-1}	W_{it-1}	$R_{AGE\,t}$	R^2	*D.W.*
Rural[a]								
1. 10-14	15.21	.051 (2.21)	.0041 (1.31)	–	–	–	.95	1.82
2. 15-19	16.07	.065 (2.15)	.0037 (1.42)	–	–	–	.98	1.71
3. 20-24	20.12	.075 (3.21)	.0040 (1.52)	–	–	–	.97	1.92
4. 25-29	52.31	–.045	–	.061 (.02)	–	–	.96	1.92
5. 30-34	50.21	–.035 (5.2)	–	.051 (.01)	–	–	.97	2.21
6. 35-39	49.15	–.040 (3.4)	–	.450 (.05)	–	–	.98	2.01
7. 40-44	48.21	–.039 (4.1)	–	.520 (.06)	–	–	.97	2.31
8. 45-49	49.23	–.040 (5.31)	–	.61 (.07)	–	–	.96	2.42
9. 50-54	47.27	–	–.03 (15.4)	–	–	–.003 (1.51)	.97	2.31
10. 55-59	43.29	–	–.01 (15.3)	–	–	–.001 (1.21)	.96	2.10
11. ⩾60	40.21	–	–.015 (16.2)	–	–	–.002 (1.32)	.95	2.42
Urban								
1. 10-14	25.29	– .003 (1.87)	–.0002 (2.34)	–	–	–	.97	1.56
2. 15-19	31.34	– .002 (1.88)	–.0001 (2.1)	–	–	–	.97	1.49
3. 20-24	32.42	– .015 (1.67)	–.0002 (2.21)	–	–	–	.97	1.64
4. 25-29	30.31	.015 (1.62)	–	–.072 (.66)	.0031 (3.47)	–	.97	1.83

Table 3.6 *(Continued)*

Dependent variable (f^i_{jt})		*Independent variables*						
Age (years)	*Constant*	E_{it-1}	X_{it-1}	X_{it-1}/X_{t-1}	W_{it-1}	$R_{AGE\,t}$	R^2	*D.W.*
5. 30-34	28.24	.013 (1.31)	–	–.083	.0032 (4.21)	–	.96	1.91
6. 35-39	25.97	.012 (1.71)	–	–.064 (.52)	.0014 (3.32)	–	.99	1.51
7. 40-44	24.32	.031 (1.62)	–	–.055 (.53)	.0021 (4.21)	–	.98	2.21
8. 45-49	23.21	.024 (1.52)	–	–.042 (.61)	.0031 (5.23)	–	.97	2.32
9. 50-54	22.85	–	–.0008 (16.32)	–	–	–.004 (1.52)	.96	2.22
10. 55-59	19.82	–	–.0006 (15.21)	–	–	–.003 (1.31)	.96	2.04
11. ⩾60	18.71	–	–.0005 (12.35)	–	–	–.004 (1.21)	.95	2.21

Notes: [a] N = 21, i.e. time-series data 1960-1980. For rural i = A, agricultural sector; for urban i = N, non-agricultural sector.

( ) denotes t-value.

problem in any CGE model; for this study the major sources of data are the 1970 series of macro-economic modelling studies undertaken by the Economic Planning Unit group led by Abu Bakar and Lysy [1979] as well as the data bases presented in Pyatt and others (1984). From these data, a Social Accounting Matrix (SAM) table (two-sector, agriculture and non-agriculture) suitable for the construction of a CGE model required here. The derived SAM Table is presented in Appendix I.

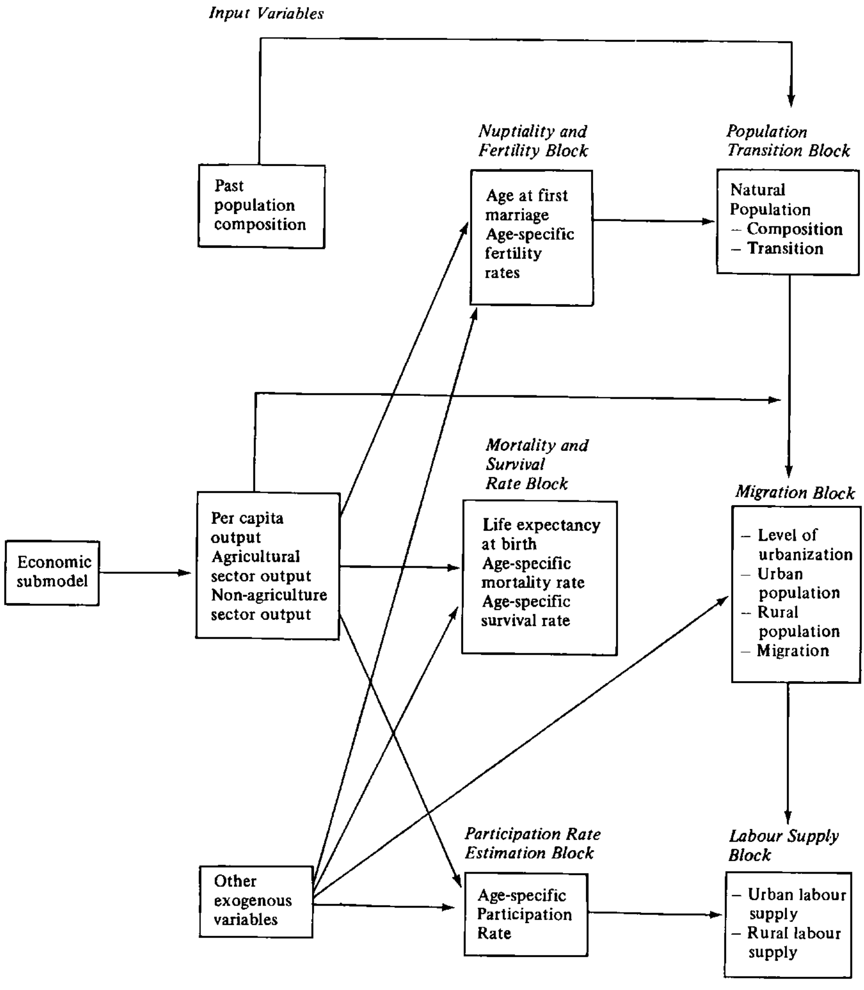
The detailed structures of the submodel are elaborated below.

1. Dynamic Block

The model starts off with the dynamic block which links capital stock (K) to investment (I) (equations (2)), and change in wage rates (Wg) to the inverse of unemployment and the change in the previous period's price levels (Phillips' Curve) as follows:

$$K(i)_t = K(i)_{t-1}(1 - \partial_i) + I(i)_{t-1} \qquad i = A, N \quad (2)$$

Figure 3.1 Structure of Demographic Submodel



$$Wg(i)_t = a + bl(i)_{t-1}/[l(i)_{t-1} - L(i)_{t-1}] + c[PC_{t-1} - PC_{t-2}]/PC_{t-2} \qquad i = A, N \quad (4)$$

$$W(i)_t = W(i)_{t-1}\,[1 + Wg(i)_{t-1}]$$

The base year for this study is 1970, and the 1969 capital stock was derived from Shymala [1974]. The depreciation rate (∂) used is 0.035. The coefficients a, b and c in equation (4) were estimated on the basis of time-series data for 1960-1980 as follow:

$$Wg(A)_t = 0.09835 + 0.001649\ 1(R)_{t-1}/[1(R)_{t-1} - L(R)_{t-1}] + 0.1\ [PC(A)_{t-1} - PC(A)_{t-2}]/PC(A)_{t-2} \quad (4a)$$

$$Wg(N)_t = 0.09835 + 0.001649\ 1(U)_{t-1}/[1(U)_{t-1} - L(U)_{t-1}] + 0.127\ [PC(N)_{t-1} - PC(N)_{t-2}]/PC(N)_{t-2} \quad (4b)$$

where

$K(i)_t$ = Capital stock in sector i at year t
∂_i = Depreciation rate for sector i
$I(i)_t$ = Investment in sector i at year t
$W(i)_t$ = Wage rate in sector i at year t
$Wg(i)_t$ = Change in wage rate in sector i at year t
$1(j)_t$ = Labour supply in area j at year t [from the equations (xxvii) and (xxviii)]
$L(j)_t$ = Labour required or employed work-force in area j at year t
$PC(i)_t$ = Price level of consumer goods in sector i at year t

It should be noted that the labour supply for both the urban and rural areas are computed from the demographic submodel. These variables, therefore, serve as one set of linkage variables between the demographic and the economic submodel. The wage rates provided by equation (6) would be used in the subsequent block for the determination of the various prices, labour demand, household income and investment.

2. *Price Block*

A multi-level production process is assumed for the economy. In this model the prices for the various levels of inputs, i.e. labour, intermediate goods, "value added" goods, consumption goods and gross output, are determined. These are computed as below:

$$PIDA(i) = [1 + \underline{TIDA}(i)]\,PX(A) + \underline{\emptyset IDA}(i)PX(N) \qquad i = A, N \quad (8)$$

$$PIDN(i) = [1 + \underline{TIDN}(i)]\,PX(N) + \underline{\emptyset IDN}(i)PX(N) \qquad i = A, N \quad (10)$$

$$PIMA(i) = [1 + \underline{TIMA}(i)]\,PW(A) + \underline{\emptyset IMA}(i)PX(N) \qquad i = A, N \quad (12)$$

$$PIMN(i) = [1 + \underline{TIMN}(i)]\,PW(N) + \underline{\emptyset IMN}(i)PX(N) \qquad i = A, N \quad (14)$$

$$PIJ(i) = \underline{aIDA}(i)\,PIDA(i) + \underline{aIDN}(i)\,PIDN(i) + \underline{aIMA}(i)\,PIMA(i) + \underline{aIMN}(i)\,PIMN(i) \qquad i = A, N \quad (16)$$

$$PV(i) = [V(i)/K(i)] \wedge [(1 - \mu_i)/\mu_i] * [\underline{AO}(i) * e^{f(i)t} \wedge (-1/\mu_i)] * (PL(i)/\mu_i) \qquad i = A, N \quad (18)$$

$$PCD(i) = [1 + \underline{TCD}(i)]\,PX(i) + \underline{\phi CD}\,(i)PX(N) \qquad i = A, N \quad (20)$$

$$PCM(i) = [1 + \underline{TCM}(i)]\,PW(i) + \underline{\phi CM}(i)PX(N) \qquad i = A, N \quad (22)$$

$$PC(i) = \underline{W1}(i)\,PCD(i) + \underline{W2}(i)\,PCM(i) \qquad i = A, N \quad (24)$$

$$PC = \underline{WE}(A)\,PC(A) + \underline{WE}(N)\,PC(N) \qquad (26)$$

$$PX(i) = \underline{C1}(i)PV(i) + \underline{C2}(i)PIJ(i) \qquad i = A, N \quad (27)$$

$$PL(i) = W(i)\,[1 + LT(i)] \qquad i = A, N \quad (29)$$

$$PEX(i) = PX(i)\,[1 + ET(i)] \qquad i = A, N \quad (31)$$

$$PPV(i) = PV(i)\,[1 + VT(i)] \qquad i = A, N \quad (33)$$

where

PIDA(i) = Price of domestic intermediate agricultural output for sector i at purchaser's price

PIDN(i) = Price of domestic intermediate non-agricultural output for sector i at purchaser's price

PIMA(i) = Price of imported intermediate agricultural output for sector i at purchaser's price

PIMN(i) = Price of imported intermediate non-agricultural output for sector i at purchaser's price

PIJ(i) = Composite price of intermediate goods in sector i at purchaser's price

PV(i) = Price of value added in sector i at basic prices

PCD(i) = Composite price of domestic consumption in sector i at purchaser's price

PX(i) = Price of gross output in sector i at basic price

PC = Composite consumer price index

PC(i) = Consumer price index for sector i

TIDA(i) = Domestic commodity tax rate on input of agriculture in sector i

TIDN(i) = Domestic commodity tax rate on input of non-agriculture in sector i

TIMA(i) = Commodity tax rate on imported input of agriculture in sector i

TIMN(i) = Commodity tax rate on imported input of non-agriculture in sector i

ϕIDA(i) = Margin on intermediate input of agriculture to sector i

ϕIDN(i) = Margin on intermediate input of non-agriculture to sector i

ØIMA(i) = Margin on imported intermediate input of agriculture to sector i

ØIMN(i) = Margin on imported intermediate input of non-agriculture to sector i

aIDA(i) = Proportion of domestic intermediate agricultural imput for composite intermediate goods in sector i

aIDN(i) = Proportion of domestic intermediate non-agricultural input for composite intermediate goods in sector i

aIMA(i) = Proportion of imported intermediate agricultural input for composite intermediate goods in sector i

aIMN(i) = Proportion of imported intermediate non-agricultural input for composite intermediate goods in sector i

AO(i) = Total productivity factor for sector i

f(i) = Rate of technological progress of sector i

PCM(i) = Purchaser's price of imported consumption goods of sector i

TCD(i) = Domestic commodity tax rate on consumption in sector i

TCM(i) = Imported commodity tax rate on consumption in sector i

ØCD(i) = Margin on domestic consumption in sector i

ØCM(i) = Margin on imported consumption in sector i

Wl(i) = Proportion of domestic consumption goods in total consumption of sector i

W2(i) = Proportion of imported consumption goods in total consumption of sector i

WE(i) = Proportion of sector i's consumption goods in total final consumption

C1(i) = Proportion of value added in gross output of sector i

C2(i) = Proportion of composite intermediate goods in gross output of sector i

PL(i) = Labour costs per employee in sector i (wages and EPF)

V(i) = Value added in sector i (basic prices)

PEX(i) = Price of export in sector i at purchaser's price

PPV(i) = Price of value added (including non-commodity indirect taxes) for sector i

LT(i) = Rate of EPF for sector i

ET(i) = Export tax for sector i

VT(i) = Value added for sector i

PW(i) = World price for output of sector i

It should be noted that in the price block, factor inputs composed of two components: intermediate and value added – each of these two components originate from the domestic as well as world markets. The price for value added is derived from Cobb-Douglas production function, on the basis of profit maximization behaviour in the part of producer function with the parameters (μ_i and AO(i)) estimated from cross-sectional data from the 1978 industrial census and the 1980 agricultural census (see also Annex II for derivation of price of value added and demand for labour).

The taxes and trade margins were estimated from the derived 1970 SAM Table (see Annex I); similarly the weights for equations (16), (24), (26) and (27) were estimated from the 1970 I-O Table [Malaysia, 1970] and the 1970 SAM Table [Bakar and Lysy, 1978, and Pyatt and others 1984]. In this block the world prices (PW(i)) are assumed exogenous.

3. *Factors Demand Block*

The demand for the various factors are assumed to be a function of the gross output (X(i)). The demand for labour is again estimated from the Cobb-Douglas production function on the basis of profit maximization.

$$IJ(i) = \underline{C3}(i)^{*}\, X(i) \qquad i = A, N \qquad (35)$$

$$IJDA(i) = \underline{aIDA}(i)\, \underline{C3}(i)\, X(i) \qquad i = A, N \qquad (37)$$

$$IJDN(i) = \underline{aIDN}(i)\, \underline{C3}(i)\, X(i) \qquad i = A, N \qquad (39)$$

$$IJMA(i) = \underline{aIMA}(i)\, \underline{C3}(i)\, X(i) \qquad i = A, N \qquad (41)$$

$$IJMN(i) = \underline{aIMN}(i)\, \underline{C3}(i)\, X(i) \qquad i = A, N \qquad (43)$$

$$V(i) = \underline{C4}(i)^{*}\, X(i) \qquad i = A, N \qquad (45)$$

$$L(i) = \mu_i\, [PV(i)/PL(i)]\, V(i) \qquad i = A, N \qquad (47)$$

where

- IJ(i) = Total composite intermediate input in sector i
- IJDA(i) = Domestic intermediate demand for agricultural goods by sector i (basic prices)
- IJDN(i) = Domestic intermediate demand for non-agricultural goods by sector i (basic prices)
- IJMA(i) = Imported intermediate demand for agricultural goods by sector i (basic prices)
- IJMN(i) = Imported intermediate demand for non-agricultural goods by sector i (basic prices)
- V(i) = Value added in sector i (basic prices)
- X(i) = Gross output in sector i (basic prices)
- $\underline{C3}(i)$ = Proportion of composite intermediate goods in gross output of sector i

$\underline{C4}$(i) = Proportion of composite intermediate goods in gross output of sector i

The weights and parameters for equations (35) to (47) were derived from the 1970 SAM (Appendix I) and I-O Tables.

4. Income Block and Consumption Blocks

The nominal income for rural and urban households are determined as follows:

$$Y(R) = \{ Ç_1 L(A)W(A) + Ç_2 L(N)W(N) + Ç_3 [PV(A)V(A) - L(A)PL(A)] + Ç_4 [PV(N)V(N) - L(N)W(N)] \} * [1 + GR(R)] \quad (48)$$

$$Y(U) = (1 - Ç_1)L(A)W(A) + (1 - Ç_2)L(N)W(N) + Ç_5 [PV(A)V(A) - L(A)PL(A)] + Ç_6 [PV(N)V(N) - L(N)W(N)] * [1 + GR(U) \quad (49)$$

where

Y(j) = Household income in area j at current prices

GR(j) = Rate of government transfer to household in area j

$Ç_1$ = Proportion of agricultural wage income accruing to rural households

$Ç_2$ = Proportion of non-agricultural wage income accruing to rural households

$Ç_3$ = Proportion of profits from agricultural output accruing to rural households

$Ç_4$ = Proportion of profits from non-agricultural output accruing to rural households

$Ç_5$ = Proportion of profits from agricultural output accruing to urban households

$Ç_6$ = Proportion of profits from non-agricultural output accruing to urban households

It should be noted that labour income is fully distributed to rural and urban households, but profits (i.e. [PV(A)V(A) – L(A)PL(A)] and [PV(N)V(N) – L(N)PL(N)] are not all distributed to households. The rate of transfer payment by government to the two areas (i.e. GR(R) and GR(U) are exogenous. $Ç_1 \ldots . Ç_6$ were estimated from the 1970 SAM Table (Appendix I).

The real household incomes are

$$YR(j) = Y(j)/PC \qquad j = R, U \quad (51)$$

The consumption function (real) are derived as follows:

$$CR(j) = \underline{CR}(i)_0 + \underline{MPC}(i)\, YR(i)\, (1 - \underline{TH}(j)) \qquad j = R, U \qquad (53)$$

The nominal consumptions are

$$C(j) = CR(j)\, PC \qquad j = R, U \qquad (55)$$

where

$YR(j)$ = Real household income in area j

$CR(j)$ = Real consumption in area j

$\underline{CR}(j)_0$ = Real basic household consumption of area j

$\underline{MPC}(j)$ = Propensity to consume of households in area j

$\underline{TH}(j)$ = Income tax for households in area j

$C(j)$ = NOminal consumption in area j

The parameters for the consumption function [$\underline{CR}(j)_0$ and $\underline{MPC}(j)$] were estimated from cross-sectional household surveys [see Fong, 1986], while the household tax rate was estimated from the 1970 SAM TAble (Appendix I).

In order to derive the effects of urban-rural household consumption on agricultural and non-agricultural economic sector output, the linear expenditure system [see Khor, 1982, pp 143-144] is used as follows:

$$C_{AR} = \{ [\text{Ç}_{AR} *PC(A)] + \beta_{AR} [C(R) - (\text{Ç}_{AR} *PC(A)) - (\text{Ç}_{NR} *PC(N))] \} /PC(A) \qquad (56)$$

$$C_{NR} = \{ [\text{Ç}_{NR} *PC(N)] + \beta_{NR} [C(R) - (\text{Ç}_{AR} *PC(A)) - (\text{Ç}_{NR} *PC(N))] \} /PC(N) \qquad (57)$$

$$C_{AU} = \{ [\text{Ç}_{AU} *PC(A)] + \beta_{AU} [C(U) - (\text{Ç}_{AU} *PC(A)) - (\text{Ç}_{AU} *PC(A)) - (\text{Ç}_{NU} *PC(N))] \} /PC(A) \qquad (58)$$

$$C_{NU} = \{ [\text{Ç}_{NU} *PC(N)] + \beta_{NU} [C(U) - (\text{Ç}_{AU} *PC(A)) - (\text{Ç}_{NU} *PC(N))] \} /PC(A) \qquad (59)$$

where

C_{Aj} = Real household consumption on agricultural goods in area j

C_{Nj} = Real household consumption on non-agricultural goods in area j

Ç_{Aj} = Basic household consumption of area j for agricultural goods (nominal price)

β_{Aj} = Proportion of "residual" consumption of area j for agricultural goods

β_{Nj} = Proportion of "residual" consumption of area j for non-agricultural goods

By assigning reasonable values for β_{iR} and β_{iU} (the "marginal budget shares ' above the "floor" levels), the values of ÇiR and Çiu were estimated from the 1970 SAM Table.

The consumption (in market prices) by the agriculture and non-agriculture sectors for domestic and imported goods are derived as follows:

$$CD(A) = c_A (C_{AR} + C_{AU}) \quad (60)$$

$$CD(N) = c_N (C_{NR} + C_{NU}) \quad (61)$$

$$CM(A) = C_{AR} + C_{AU} - CD(A) \quad (62)$$

$$CM(N) = C_{NR} + C_{NU} - CD(N) \quad (63)$$

where

CD(i) = Domestic consumption in sector i at market prices

CM)i) = Imported consumption in sector i at market prices

c_i = Proportion of sector i's total consumption for domestic goods

The parameters c_A and c_N were again estimated from the 1970 SAM Table.

The consumption (in basic prices) by the agriculture and non-agriculture sectors for domestic and imported goods are computed as follows:

$$BCD(i) = CD(i)/[1 + \underline{TCD}(i) + \underline{\phi CD}(i)] \qquad i = A, N \quad (65)$$

$$BCM(i) = CM(i)/[1 + TCM(i) + \underline{\phi CM}(i)] \qquad i = A, N \quad (67)$$

where

BCD(i) = Domestic consumption in sector i at basic prices

BCM(i) = Imported consumption in sector i at basic prices

5. *Investment Block*

The investment equations for the model as follows:

$$I(A) = (IS^*\underline{I})^* [PV(A)V(A) - PL(A)L(A)] /([PV(A)V(A) - PL(A)L(A)] + [PV(N)V(N) - PL(N)L(N)]) \quad (68)$$

$$\text{I(N)} = \underline{\text{I}} - \text{I(A)} \quad (69)$$

$$\text{ID(i)} = \underline{\text{iD}}\text{(i)} * \text{I(i)} \qquad i = A, N \quad (71)$$

$$\text{IM(i)} = \underline{\text{iM}}\text{(i)} * \text{I(i)} \qquad i = A, N \quad (73)$$

$$\text{IOD(A)} = \underline{bd}_{11} * \text{ID(A)} + \underline{bd}_{12} * \text{ID(N)} \quad (74)$$

$$\text{IOD(N)} = \underline{bd}_{21} * \text{ID(A)} + \underline{bd}_{22} * \text{ID(N)} \quad (75)$$

$$\text{IOM(A)} = \underline{bm}_{11} * \text{IM(A)} + \underline{bm}_{12} * \text{IM(N)} \quad (76)$$

$$\text{IOM(N)} = \underline{bm}_{21} * \text{IM(A)} + \underline{bm}_{22} * \text{IM(N)} \quad (77)$$

where

$\underline{\text{I}}$	=	Total investment (in 1970 basic prices)
I(i)	=	Investment in sector i (1970 basic prices)
$\underline{\text{ID}}$(i)	=	Domestic investment by destination in sector i (1970 basic prices)
$\underline{\text{IM}}$(i)	=	Imported investment by destination in sector i (1970 basic prices)
IOD(i)	=	Domestic investment demand by origin in sector i (1970 basic prices)
IOM(i)	=	Imported investment demand by origin in sector i (1970 basic prices)
IS	=	Proportion of agriculture sector profit to total profit that is reinvested in agriculture sector
iD(i)	=	Domestic investment rate in sector i
iM(i)	=	Imported investment rate in sector i
$\underline{bd}_{11}$	=	Element of B-matrix for domestic investment
$\underline{bd}_{12}$	=	Element of B-matrix for domestic investment
$\underline{bd}_{21}$	=	Element of B-matrix for domestic investment
$\underline{bd}_{22}$	=	Element of B-matrix for domestic investment
$\underline{bm}_{11}$	=	Element of B-matrix for imported investment
$\underline{bm}_{12}$	=	Element of B-matrix for imported investment
$\underline{bm}_{21}$	=	Element of B-matrix for imported investment
$\underline{bm}_{22}$	=	Element of B-matrix for imported investment

The parameters $\underline{\text{iD}}$(i) and $\underline{\text{iM}}$(i) were estimated from the 1970 SAM Tables, while the b coefficients were derived from the 1971 B-matrix constructed by Lysy and Yeoh [1971].

6. *Closing Equations*

The model is "closed" as follows:

$$EX(i) = \underline{EX}(i) \qquad i = A, N \qquad (79)$$

$$G(i) = \underline{G}(i) \qquad i = A, N \qquad (81)$$

$$\begin{aligned} H = {} & \Sigma \underline{\phi IDA}(i) IJDA(i) + \Sigma \underline{\phi IDN}(i) INJDN(i) + \Sigma \underline{\phi IMA}(i) IJMA(i) \\ & + \Sigma \underline{\phi IMN}(i) IJMN(i) + \Sigma \underline{\phi CD}(i) BCD(i) + \Sigma \underline{\phi CM}(i) BCM(i) \\ & + \Sigma \underline{\phi IOD}(i) IOD(i) + \Sigma \underline{\phi IOM}(i) IOM(i) + \Sigma \underline{\phi E}(i) EX(i) \end{aligned} \qquad (82)$$

$$X(A) = \Sigma IJDA(i) + IOD(A) + EX(A) + BCD(A) + G(A) \qquad (83)$$

$$X(N) = \Sigma IJDN(i) + IOD(N) + EX(N) + BCD(N) + H + G(N) \qquad (84)$$

$$NM = \Sigma PW(i)[IJMA(i) + IJMN(i) + IOM(i) + BCM(i) + GM(i)] \qquad i = A, N \qquad (85)$$

$$NEX = \Sigma PEX(i)\,\Sigma EX(i) \qquad i = A, N \qquad (86)$$

$$BOT = NEX - NM \qquad (87)$$

where

$\underline{EX}(i)$	=	Export of sector i (1970 basic prices)
$\underline{G}(i)$	=	Government expenditure on sector i's goods (1970 basic prices)
H	=	Total margins (trade and transport)
NM	=	Total nominal imports (at current prices)
NEX	=	Total nominal exports (at current prices)
PW(i)	=	World price of sector i (M$)
BOT	=	Balance of payments on current account
GM(i)	=	Government expenditure on imported goods of sector i
$\underline{\phi E}$	=	Export trade margins
$\underline{\phi IOD}(i)$	=	Domestic investment margins from origin in sector i
$\underline{\phi IOM}(i)$	=	Imported investment margins from origin in sector i

7. *Gross Domestic Production Side Equations*

The gross domestic production (GDP) equations for the demand and production sides of the model are as follow:

$$\begin{aligned} GDPD = {} & \Sigma CD(i) + \Sigma IOD(i)\,[1 + TCD(i) + \underline{\phi CD}(i)] + \Sigma IOM(i)\,[1 + \\ & TCM(i) + \underline{\phi CM}(i)] + \Sigma G(i)\,[1 + \underline{\phi G}(i)] + \Sigma GM(i)\,[1 + \\ & \underline{\phi GM}(i)] + \Sigma EX(i)\,[1 + \underline{\phi E}(i)] - \Sigma IJMA(i) - \Sigma IJMN(i) \\ & - \Sigma IOM(i) + \Sigma CM(i) - \Sigma BCM(i) - \Sigma GM(i) \end{aligned} \qquad (88)$$

$$\begin{aligned} GDPP = {} & \Sigma V(i) + \Sigma NCT(i)\,V(i) + \Sigma TE(i)\,EX(i) + \Sigma IDA(i)\,IJDA(i) \\ & + \Sigma IDN(i) IJDN(i) + \Sigma IMA(i)\,IJMA(i) + \Sigma IMN(i)\,IJMN(i) \end{aligned}$$

$$+ \Sigma TCD(i)\ BCD(i) + \Sigma TCM(i)\ BCM(i) + \Sigma ID(i)\ TIOD(i) + \Sigma IM(i)\ TIOM(i) \quad (89)$$

where

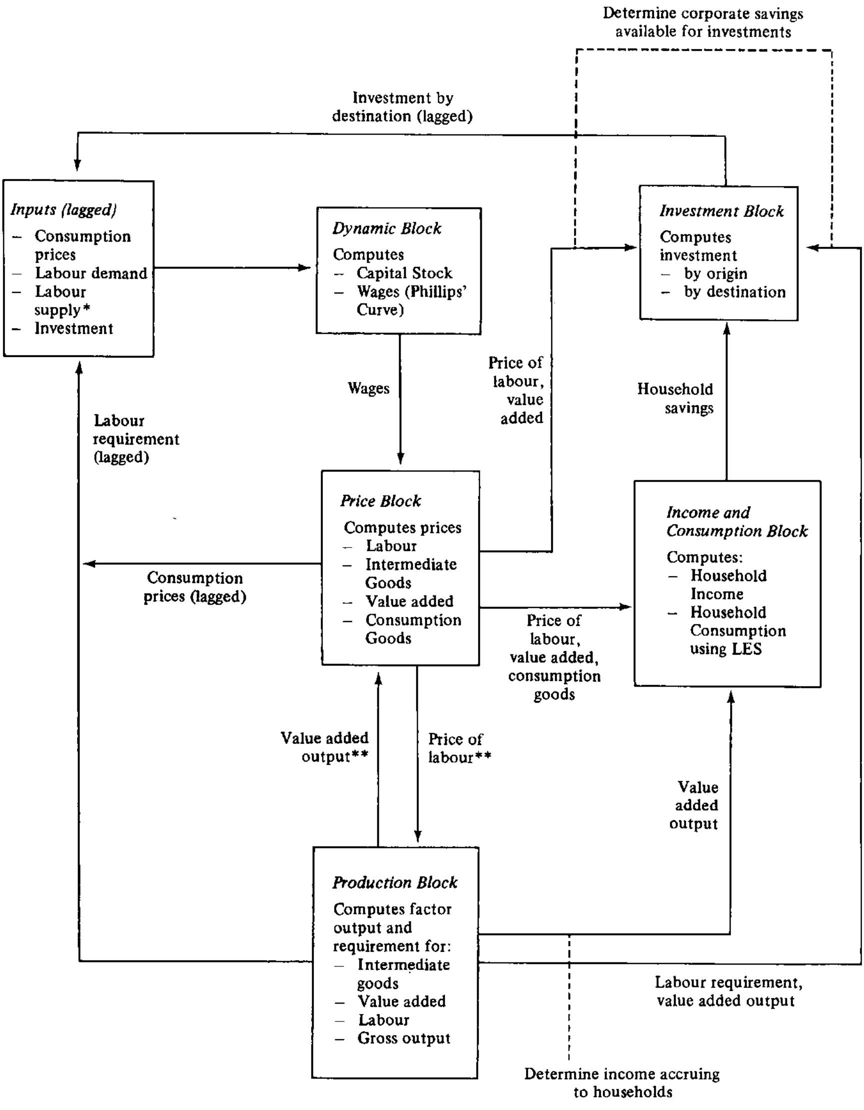
GDPD = GDP in purchaser's prices

GDPP = GDP by expenditure items

8. Summary Structure of Economic Submodel

A summary of the structure of the CGE economic submodel indicating the simultaneous interrelationship among the various blocks – in particular among the price, production, income and consumption, and investment block – in presented in figure 3.2. The demographic input (generated by the demographic submodel) needed by the CGE model include labour supply, and population structures. From the figure, it is also clear that the price block plays a central role in the submodel since it generates the prices that would provide equilibrium among the production, consumption and investment blocks.

Figure 3.2 Structure of Economic Submodel



* From demographic submodel. Population structure is also needed for computing torial per capita income and output.

** Determined through the Cobb-Douglas production function using profit maximization criterion.

IV. SIMULATION RUNS

A. Calibration

The base year for the demographic-economic model formulated in chapter III is 1970. In this respect, the CGE economic submodel was derived from the 1970-SAM Table (contained in Annex I). Numerous runs and adjustments of the parameters and the equations in the submodel were made to ensure that the base model finally adopted gave the exact calibration expected from the SAM Table. The initial values of the exogenous variables and model parameters are given in Annex III. In that Annex the initial values of the (equilibrium) endogenous variables are also given. After exact calibration was attained, the economic submodel was linked to the demographic-submodel via the mortality and fertility equations[3] as well as the wage increment equations[4]. The completed model was large; consisting of over 300 equations – 84 from the CGE economic submodel and about 250 from the demographic submodel. Due to computer software limitations, the simultaneous linkage between the economic submodel and demographic submodel was decoupled, and made to be lagged by one year. This is not an unreasonable assumption. For each year the CGE submodel was solved using the Gauss-Seidel subroutine available in the Time-Series-Processor (TSP) Package. The required outputs from the CGE submodel were then interactively fed into the demographic submodel (written in FORTRAN) using the FORTRAN-V compiler. The required outputs from the demographic submodel were then again fed into the CGE submodel (advanced by one year) for the solution by the TSP. As can be conjectured, this solution procedure was very computer-time intensive. A one year run on the two submodel took about 30 minutes CPU time on the UNIVAC 1100/60 main-frame computer. A complete run on the "interactive" economic-demographic model over 1970-2025 took 3 physical days to be completed.

B. Counter-factual Simulations

Since the base year for the model is 1970, the complete model can be counter-factually tested with respect to some of its outputs (such as distribution of population, economic output, and household income) over the period 1970-1980. Given the numerous output variables of the model, it was decided to focus the counter-factual simulations on the major demographic-economic variables as follows;

---

[3] Mortality and fertility rates are assumed to be functions of per capita economic output and other exogenous variables,

[4] Wage increments are assumed to be function of labour supply, labour demand and price.

Demographic:

(i) Population (by age categories) by rural and urban areas

(ii) Age at first marriage by rural and urban areas

(iii) Fertility rates by rural and urban areas

(iv) Labour supply by rural and urban areas

(v) Migration

Economic:

(i) Household income for agricultural and non-agricultural sectors

(ii) Gross output (such as GDP) and balance of trade

(iii) Per capita gross output

The counter-factual simulation results are presented in Annex IV, in which the computed figures are also compared against some of the actual data.

From Annex IV, it can be seen that the computed population figures and fertility rates were fairly close to the actual data. The economic outputs of the model were also very close to the actual data; this could be attributed to the fact that the SAM Table upon which the CGE model was constructed is fairly realistic, and that the structural coefficients of the table did not change too much over the period 1970-1980.

C. Simulation Results

1. Reference Run

Having done the counter-factual simulations, the model was used to provide simulations of the demographic-economic scenarios for Malaysia over the period 1980-2025. For the reference run, the following assumptions were made:

– Investment-growth – 5 per cent per annum

– Export-growth – 5 per cent per annum

– Rate of government transfer – 40 per cent of revenue to household

– World price growth – 5 per cent per annum

With the above assumptions, the reference run was undertaken. Fortunately no problems of convergence were encountered. The Gauss-Siedel Method provided by the TSP seemed very robust. The major results of the simulation run are given in Annex V.

From the simulation results it can be seen that by 2025, Malaysia could have a total population of 41.24 million with a roughly 50:50 distribution by urban and rural areas. In terms of fertility rates, it is estimated that the urban Chinese and Indians would achieved replacement levels by the year 2010, while the Malays would have a TFR of about 3 children per woman by 2025.

The non-agricultural sector would continue to have higher per capita output levels. Under the assumptions of the reference run by the year 2025, the differential in per capita output between the agricultural and non-agricultural sector would continue to widen. The per capita gross domestic products projected to increase from the present $ 2,240 per person (in 1985) to $ 4,069 per person (in 2010) and $ 6,333 per person (in 2025).

2. *Alternative Assumptions*

The reference run has been made with assumptions that the technical progress of the non-agricultural and agricultural sectors would improve at the rate of 2 per cent and 1.2 per cent per annum respectively, and assumptions concerning the demographic-economic environment which were reflected by past trends. In this section, we present some demographic-economic characteristics as a function of variation in the various assumptions involved.

a. Non-agricultural sector technological progress

In the reference run, the non-agricultural sector is assumed to have a technological progress rate of 2 per cent per aunum. As simulation of the economic effects of the accelerated technological progress, in Annex VI (a) we summarized the case where the non-agricultural and agricultural sectors assumed to have a technological rate of 5 per cent and 1.5 per cent respectively. From the results, it can be seen that it has led to higher wage rates for the non-agricultural sector as well as the agricultural sector. Due to the increase in demand for labour in both the non-agricultural and agricultural sectors as a result of the accelerated technological progress, the gross total output also expanded, leading to some increase in the per capita output.

b. Increasing agriculture investment

In the reference run, the proportion of agricultural investment to total investment was fixed at 17 per cent as given by the SAM Table. In order to examine the effects of increasing the investment in the agricultural sector, in Annex VI (b) we have presented the economic characteristics under the case where agriculture investment to total investment was increased to 42 per cent over 1981-1989 and 50 per cent over 2000-2025. From the results, it can be seen that this could lead to substantial increases in the agricultural wage level and some decreases in the wage level for non-agricultural sector. The gross total output was seen to have decreased with a consequent decline in the per capita output. This is because of the fact that the agricultural sector is less productive and efficient than the non-agricultural sector.

c. **Increasing indirect taxes on non-agricultural output**

In the reference run we have assumed that the indirect taxes for non-agriculture output remain at the rate as given by the SAM Table. In Annex VI (c) we simulated the results where the indirect taxes were increased from the 1980 rate by 5 per cent per annum. The results indicate that increasing the indirect taxes in non-agriculture output would lead to declines in the wage levels of both the non-agricultural and agricultural sectors; as well as declines in total gross output and per capita gross output. This is because by increasing the indirect taxes in non-agricultural sector, we would increased the penalty for non-agriculture performance leading to decline in economic performance of the whole system.

d. **Low and high fertility rates**

In the reference run, we have assumed that the fertility rates were generated by the inter-relationship between socio-economic development and fertility.

In Annexes VI (d) and (e), we simulated the cases in which the fertility rates as given by the reference run changed by minus of plus 5 per cent, leading to the scenarios of low and high fertility respectively. The results indicate that with a 5 per cent reduction in the fertility rates, the total population would have declined somewhat from 41.24 million to 38.88 million in the year 2025. This led to a decline in the total output and per capita output. In the high fertility case, although the consequent increase in population led to an increase in total output, but because of the fact that population had increased from 41.24 million to 43.85 million in the year 2025, there was a decline of per capita output from $ 6,333 to $ 5,452.

e. **Changes in female participation rates**

In the reference run, the female participation rates were simulated to remain at the level given by the 1980 census. In Annex VI (f), we examined the case in which these participation rates were simulated to increase at the rate of 2 per cent per annum from the 1980 levels.

The results indicate that increasing female participation rates would lead to declines in the wage rates for both the agricultural and non-agricultural sectors. There is also a small contraction in total gross output as well as per capita GDP. This result is interesting for it indicates that increasing labour supply by increasing female participation rates would lead to some declines in wage levels. However, the contraction (albeit marginal) in the total output is unexpected and needs further analysis.

References

Abe, Shigeyuki, (1982); "Macroeconomic Model of Malaysia: A Preliminary Study"; November, Kuala Lumpur, *Mimeo.*

Abu Bakar Karim, Yeoh Y.K., Lum C.S. and Lysy, F.J., (1977); "A Macro-Model of Malaysian Prospects", Economic Planning Unit, Kuala Lumpur.

Bakar Karim, Lysy, F.J., (1979); "A Social Accounting Matrix for Malaysia, 1971", Economic Planning Unit and Department of Political Economy, Johns Hopkins University, Research Paper No. 5, August.

Chander, R., (1977); *General Report – 1970 Population Census of Malaysia,* Vol.1, Department of Statistics, Kuala Lumpur.

Cheong, K.C., (1976); "A Macroeconomic Model for West Malaysia, 1949-1968"; *The Developing Economies,* Vol. XIV, No. 1; pp. 47-71.

Cheong, K.C., (1972); "Preliminary Estimates of a Statistical Model for West Malaysia, 1957-68", Kajian Economi Malaysia, Vol. 9, pp. 56-74.

Cheong, K.C., (1984); "Econometric Models for Malaysia" in Institute of Developing Economies (Ed.), *Review of National Economies and Econometric Models,* Institute of Developing Economies, Tokyo, 1984, pp. 117-159.

Cheong, K.C., and Tillman, J.A., (1976); "A Short-Term Econometric Model of the Malaysian Economy, 1967-1974", Paper presented to the Third Malaysian Economic Convention, Penang.

Drake, P.J., (1960); *Financial Development of Malaysia and Singapore,* Australian National University Press, Canberra.

ECAFE, (1968); *Feasible Growth and Trade Gap Projections in the ECAFE Region,* ECAFE, Bangkok.

EPU, (1979); "Development of Macro-Modelling in the EPU", February, *Mimeo,* Economic Planning Unit, Kuala Lumpur.

Fong, C.O., (1986); "Analysis of the Effects of Socio-Economic Development on Nuptiality, Fertility and Mortality in Malaysia"; Faculty of Economics and Administration, University of Malaya, Kuala Lumpur, June.

Hayes, R.W., (1976); "Towards a Macroeconomic Model for Malaysia", Reserve Bank of Australia, *Mimeo.*

Jaafar, Ahmad, (1976); "Towards a Model of the Malaysian Financial Sector", Bank Negara Malaysia, Kuala Lumpur, *Mimeo.*

Jones, G.W., (1979); "Population Growth and Fertility Change in Peninsular Malaysia since 1957", Proceedings of the Seminar on Malaysian Fertility Survey/Population and Development, Malaysia National Family Planning Board, Kuala Lumpur.

Khoo, T.H., (1983); *General Report – 1980 Population and Housing Census of Malaysia,* Department of Statistics, Kuala Lumpur.

Khor, H.E., (1982); "Income Distribution and Unemployment in Malaysia: A Dual Economy (CGE) Model", Ph.D. Dissertation, Princeton University, Princeton, New Jersey.

Lee, S.A., (1974); *Economic Growth and Public Sector in Malaysia and Singapore, 1948-1960;* Ph.D. Dissertation, University of Singapore, Singapore.

Leong, K.W., Jaafar, A., and Ho, T.S., (1976), "Price Formation within a Generalized Macro-framework: Malaysia", *Proceedings of the Seventh Pacific Basin Central Bank Conference on Econometric Modelling,* Seoul, Korea.

Lim, D., (1973); *Economic Growth and Development in West Malaysia, 1947-1970,* Oxford University Press, Kuala Lumpur.

Lope, Raja, (1975); *An Exploratory Macroeconomic Model of the Malaysian Economy,* Ph.D. Dissertation, University of London.

Lysy, F.J., (1979); "A Keynesian Model of Malaysia", Ph.D. Dissertation, Stanford University, Stanford, California.

Lysy, F.J., (1977); "The Mathematical Structure of the Multisectoral Model of Malaysia"; Economic Planning Unit and Development Research Centre, World Bank, Research Paper No.4, December.

Lysy, F.J., and Yeoh, Y.K., (1977); "A B-Matrix for Malaysia, 1971", Department of Statistics, Kuala Lumpur and Development Research Centre, World Bank; Research Paper No.3, November.

Malaysia, (1966); *First Malaysia Plan, 1966-1970,* Government Press, Kuala Lumpur.

Malaysia, (1970); *Input-Output Tables, Peninsular, Malaysia;* Department of Statistics, Kuala Lumpur.

Malaysia, (1971); *Second Malaysia Plan, 1971-1975;* Government Press, Kuala Lumpur.

Malaysia, (1976); *Third Malaysia Plan, 1976-1980,* Government Press, Kuala Lumpur.

Malaysia, (1978 and 1984); *Social Statistics Bulletin 1977 and 1983,* Department of Statistics, Kuala Lumpur.

Malaysia, (1979 and 1985); *Economic Report, 1979/80 and 1985/86,* Ministry of Finance, Kuala Lumpur.

Malaysia, (1980); *Mid-Term Review of the Third Malaysia Plan, 1976-1980,* Government Press, Kuala Lumpur.

Malaysia, (1981a); *Fourth Malaysia Plan, 1981-1985,* Government Press, Kuala Lumpur.

Malaysia, (1981b); *Statistical Bulletin, December 1980,* Department of Statistics, Kuala Lumpur.

Malaysia, (1984); *Mid-Term Review of the Fourth Malaysia Plan, 1981-1985,* Government Press, Kuala Lumpur.

Malaysia, (1986); *Fifth Malaysia Plan, 1986-1990,* Government Press, Kuala Lumpur.

Neibuhr, R., (1968); "Interim Report on an Econometric Model for West Malaysia", IBRD, United States.

Nor Laily Aziz, and others (1978); "The Malaysian Family Planning Programme: Some Facts and Figures", *National Family Planning Board,* May.

Pyatt, G., and Round, J.I., and assisted by Denes, J., (1984); *Improving the Macroeconomic Data Base – A SAM for Malaysia, 1970;* The World Bank, Washington D.C., U.S.A.

Sahathaven, M., and H. Imaoka, (1984); Survey of Econometric Models of Malaysia, *Mimeo,* Institute of Developing Economies, Tokyo.

Sahathaven, M., and H. Imoaka, (1984); Experiments with Macro Economic Modelling of Malaysia, 1967-1982, *Mimeo,* Institute of Developing Economies, 1984.

Semudram, M., (1980); "A Macro-Model of the Malaysian Economy, 1959-1977: Simulation Analysis", Ph.D. Thesis, Macquarie University, Sydney, Australia.

Tan, K.Y., (1979); "A Macroeconomic Model for Malaysia, 1960-1977", A.B. Thesis, Princeton University, April.

Tillman, J.A., (1975); "A Model of the Monetary Sector of Malaysia", World Bank, Washington D.C., *Mimeo.*

Annex I

Two Sector 1970 Social Accounting Matrix (SAM)

Receiving sectors	*Spending sectors*	*Production*			*Trade margins*	*Rest of the world*	*Factors*		*Households*			*Savings/ investment*	*Govern-ment*	*Grand total*
		Domestic												
Production	Domestic	A	N	Total			Labour	Capital	Rural	Urban	Total			
	A	374.90	1 629.27	2 004.17	0.00	524.23			757.90	585.20	1 343:10	260.63	82.72	4 214.85
	N	716.89	1 907.64	2 624.53	1 819.30	4 147.77			1 906.20	1 471.60	3 377.80	1 298.00	1 609.88	14 877.28
	Total	1 091.79	3 536.91	4 628.70	1 819.30	4 672.00			2 664.10	2 056.80	4 720.90	1 558.63	1 692.60	19.092.13
Trade margins	Trade M. Domestic													
	A	28.27	21.72	49.99					94.80	73.30	168.10	7.29		
	N	54.06	244.96	299.02					238.40	184.10	422.50	36.30		
	Total	82.33	266.68	349.01					333.20	257.40	590.60	43.59		
	Trade M. Foreigh													
	A	17.97	11.92	29.89					52.40	40.50	92.90	16.20		
	N	20.29	290.82	311.11					131.80	101.70	233.50	152.50		
	Total	38.26	302.74	341.00					184.20	142.20	326.40	168.70		
	Trade margins total	120.59	569.42	690.01					517.40	399.60	917.00	212.29		1 819.30
Rest of the world	A	120.29	79.80	150.09		13.60			89.73	82.30	172.03	65.20	27.20	
	N	135.89	1 947.22	2 133.11		141.40			603.77	453.10	1 056.87	613.10	256.30	
	Total	256.18	2 027.02	2 283.20		155.00		0.00	693.50	535.40	1 228.90	678.30	283.50	5 256.60
Factors	Factor													
	Labour	1 691.21	4 126.99	5 819.20										5 819.20
	Capital	590.67	2 883.83	3 474.50										3 474.50
Households	H/H													
	Rural						3 724.40	659.10					145.40	4 528.90
	Urban						2 094.90	1 579.60					51.80	3 726.30
Savings/investment	Saving/inv.					57.60		608.00	321.80	436.20	758.00		1 187.42	2 495.82
	Wage taxes	36.95	189.65	103.60										
	Profit taxes	233.12	755.10	988.22										
	Comm. taxes:													
Government	Domestic	60.29	195.30	255.59		487.00			104.50	80.60	185.10	18.70	3.40	
	Foreign	34.68	274.43	309.11		0.20			155.60	120.10	275.70	27.90	2.20	
	Other ind. taxes	98.37	318.63	417.00										
	H/H Inc. taxes								72.00	97.60	169.60			
	Total govt.	463.41	1 733.11	2 196.52		487.20			332.10	298.30	630.40	46.60	5.60	3 366.32
	Grand total	4 214.85	14 877.28	19 092.13	1 819.30	5 256.60	5 819.30	0.00	4 528.90	3 726.30	8 255.20	2 495.82	3 366.32	48 381.26

Sources: Pyatt, Graham, Round, Jeffery I., assisted by Denes, Jane; "Improving the Macroeconomic Data Base – A SAM for Malaysia, 1970"; The World Bank, Washington, D.C.; U.S.A., 1984.

Malaysia, "Input-Output Tables, Peninsular Malaysia", Department of Statistics, Kuala Lumpur, 1970.

Bakar Karim; Lysy, F.J.; "A Social Accounting Matrix for Malaysia, 1971"; Economic Planning Unit, Malaysia; and Department of Political Economy, Johns Hopkins University, Research Paper no. 5, August 1979.

Annex II

Derivation of Demand for Labour and Price of Value Added

Using the Cobb-Douglas production function

$$V_i = A_i^o e^{\lambda_i t} L_i^{\alpha_i} K_i^{1-\alpha_i} \quad (1)$$

and assuming perfectly competitive labour market and product market, we have

$$MR_i \cdot MP_{L_i} = W_i \quad (2)$$

$$= P_{V_i} \left(\frac{V_i}{L_n}\right) \alpha_i = W_i \quad (3)^*$$

$$L_i = \alpha_i \left(\frac{P_{V_i}}{W_i}\right) V_i \quad (4)$$

Substituting L_i in (1), we have:

$$V_i = A_i^o e^{\lambda_i t} \left((\alpha_i \frac{P_{V_i}}{W_i}) V_i \right)^{\alpha_i} K^{1-\alpha_i}$$

$$= A_i^o e^{\lambda_i t} \alpha_i^{\alpha_i} \left(\frac{P_{V_i}}{W_i}\right)^{\alpha_i} V_i^{\alpha_i} K^{1-\alpha_i}$$

$$(P_{V_i})^{\alpha_i} = V_i (A_i^o e^{\lambda_i t})^{-1} \alpha_i^{-\alpha_i} W_i^{\alpha_i} V_i^{-\alpha_i} K_i^{\alpha_i - 1}$$

$$P_{V_i} = \left(\frac{V_i}{K_i}\right)^{\frac{1-\alpha_i}{\alpha_i}} (A_i^o e^{\lambda_i t})^{\frac{-1}{\alpha_i}} \left(\frac{W_i}{\alpha_i}\right) \quad (5)$$

Equation (4) gives the demand for labour, while equation (5) gives the price of value added.

---

* Note that:

$$\frac{\delta V_i}{\delta L_i} = A_i^o e^{\lambda_i t} \alpha_i L_i^{\alpha_i - 1} K_i^{1-\alpha_i}$$

$$= A_i^o e^{\lambda_i t} \alpha_i K_i^{1-\alpha_i} L_i^{\alpha_i - 1}$$

$$= \left(\frac{V_i}{L_i}\right) \alpha_i$$

Annex III

Exogeneous Variables and Parameters and Equilibrium Endogeneous Solution, 1970

Variable	*Initial value in 1970*	*Value remained unchange (1980-2025)*	*Value change per annum (per cent)*
Exogeneous variable			
PWA	1		5
PWN	1		5
I	2 236.93		5
TEXA	524.23		5
TEXN	4 147.77		5
TGA	82.72		5
TGN	1 609.88		5
TGMA	27.2		5
TGMN	256.3		5
Parameter			
TIDAA	0.05522	X	
TIDNA	0.05522	X	
TIDNN	0.05522	X	
TIDAN	0.05522	X	
QIDAA	0.0754	X	
QIDAN	0.01333	X	
QIDNA	0.0754	X	
QIDNM	0.12841	X	
TIMAA	0.13537	X	
TIMAN	0.1539	X	
TIMNA	0.13537	X	
TIMNN	0.13539	X	
QIMAN	0.14935	X	
QIMAA	0.14939	X	
QIMNA	0.14931	X	
QIMNN	0.14535	X	
AIDAA	0.23978	X	
AIDNA	0.45851	X	
AIMAA	0.07693	X	
AIMNA	0.08691	X	
AIDAN	0.24674	X	
AIDNN	0.2889	X	
AIMAN	0.01209	X	
AIMNN	0.2949	X	
TCDA	0.0392	X	
TCDN	0.0392	X	
TCMA	0.22435	X	
TCMN	0.22435	X	
QCDA	0.1252	X	
QCDN	0.1251	X	
QCMA	0.54002	X	
QCMN	0.22094	X	
W1A	0.719266	X	
W1N	0.61863	X	
W21	0.09213	X	
W2N	0.19356	X	
WEA	0.2548	X	
WEN	0.7452	X	
C1A	0.6057	X	
CIN	0.5347	X	
C2A	0.371	X	
C2N	0.44384	X	

Annex III *(Continued)*

Variable	*Initial value in 1970*	*Value remained unchange (1980-2025)*	*Value change per annum (per cent)*
C3A	0.371	X	
C3N	0.44384	X	
C4A	0.6057	X	
C4N	0.5347	X	
L1	1	X	
L2	0.4924	X	
L3	0.46128	X	
L4	0.0767	X	
L5	0	X	
L6	0.43408	X	
CRRO	1 416.391	X	
CRUO	2 067.603	X	
MPCR	0.61	X	
MPCU	0.31	X	
BARR	0.5	X	
BMRR	0.5	X	
BAUU	0.3	X	
BNUU	0.7	X	
CA	0.83746	X	
CN	0.72026	X	
IDA	0.7999	X	
IDN	0.67919	X	
IMA	0.2001	X	
IMN	0.32081	X	
B11	1	X	
B12	0.073	X	
B21	0	X	
B22	0.927	X	
BM11	1	X	
BM12	0.073	X	
BM21	0	X	
BM22	0.927	X	
UA	0.67732	X	
UN	0.54259	X	
ADA	1.3689	X	
AON	2.0891	X	
THR	0.015898	X	
THU	0.02619	X	
LAR	10.915	X	
LNR	2 056.64	X	
LAU	343.82	X	
LNU	1 252.44	X	
QEA	0	X	
QEN	0	X	
QIODA	0.02797	X	
QIODN	0.02797	X	
QIONA	0.24847	X	
QOMN	0.24874	X	
YA	0.02184	X	
YN	0.04595	X	
NCTA	0.03853	X	
NCTN	0.04005	X	
GRR	0.03317	X	
GRU	0.014097	X	
TEA	0.10424	X	
TEN	0.10424	X	
IS	0.42462	X	

Initial Value of the Endogeneous Variables Used in the Economic Submodel

Variable	*Initial value in 1970*	*Variable*	*Initial value in 1970*
KA	2 226.64	TIODA	260.63
KN	10 869.9	TIODN	1 298
WGA	0.1	TIOMA	65.2
WGN	0.1	TIOMN	613.1
WA	0.9873	TIJDAA	374.9
WN	2.6238	TIJDAN	1 629.27
PLA	1.0089	TIJDNA	716.89
PLN	2.7444	TIJDNN	1 907.64
TPVA	1	TIJMAA	120.29
TPVN	1	TIJMAN	79.8
TPXA	1	TIJMNA	135.89
TPXN	1	TIJMNN	1 947.22
TPIDAA	1.13062	TPCMA	1.76437
TPIDAN	1.06855	TPCMN	1.44529
TPIDNA	1.13062	TPCA	1
TPIDNN	1.18363	TPCN	1
TPIMAA	1.28476	TPC	1
TPIMAN	1 246792	TYRR	4 528.9
TPIMNA	1.28468	TYRU	3 726.3
TPIMNN	1.267	TCRR	4 135.1
TPIJA	1	TCRU	3 192.5
TPIJN	1	TCR	4.135.1
TPCDA	1	TCU	3 192.5
TPCDN	1	TCAR	1 044.69
TYR	4 528.9	TCNR	3 090.41
TYU	3 726.3	TCAU	822.69
TIDA	158.414	TCNU	2 369.81
TIDN	1 400.216	CMA	303.52
TIMA	16.919	CMN	1 527.43
TIMN	661.381	TH	1 819.3
TCDDA	1 563.8	TIA	175.333
TCDDN	3 922.71	TIN	2 061.597
TXA	4 214.85	BCDA	1 343.1
TXN	15 877.28	BCDN	3 377.8
TVA	2 552.95	BCMA	172.03
TVN	7 955.57	BCMN	1 056.87
TLA	1 713.9	TIJA	1 563.53
TLN	1 572.9	TIJN	6 603.08
PVIA	1.03853	PEXA	1.10423
PVTN	1.04005	PEXN	1.10423

Annex IV

Counter-Factual Simulation, 1970-1980

	1971		*1973*		*1975*		*1980*	
	Predicted value	*Actual value*	*Predicted value*	*Actual value*	*Predicted value*	*Actual value*	*Predicted value*	*Actual value*
Population								
TPOPN	10.586	10.663	11.166	11.131	11.802	11.632	13.648	13.550
Urban								
TPUN (mill)	2.840	2.930	2.967	3.212	3.105	3.521	3.480	4.492
TPUM (mill)	1.432	1.402	1.497		1.566		1.755	
TPUF (mill)	1.407	1.378	1.471		1.539		1.726	
Malay								
TPUN (000)	781.440	761.812	822.980		868.110		991.950	
BIRT (000)	22.152	22.237	23.961		26.151		29.485	
Male								
age <1	11.140	11.183	12.050		13.151		14.828	
age 1-9	101.812	102.266	101.257		102.689		113.111	
age 10-29	174.881	169.142	184.628		192.400		207.091	
age 30-49	74.437	71.684	81.159		89.206		112.786	
age 50-69	26.857	27.368	30.115		33.540		42.669	
age >70	4.135	1.870	4.685		5.325		7.271	
Total	393.262	383.513	413.894		436.311		497.756	
Female								
age <1	11.012	11.054	11.911		13.000		14.657	
age 1-9	99.268	99.642	99.046		100.853		111.944	
age 10-29	172.392	166.471	182.370		190.252		204.984	
age 30-49	73.949	71.398	80.339		88.155		111.462	
age 50-69	26.538	24.909	29.839		33.268		42.733	
age >70	5.019	4.825	5.578		6.276		8.417	
Total	388.178	378.299	409.083		431.804		494.197	
Chinese								
TPUN (000)	1 680.400	1 647.788	1 749.100		2 123.400		2 026.200	
BIRT (000)	40.421	40.476	43.541		47.345		52.602	
Male								
age <1	20.811	20.839	22.417		24.375		27.082	
age 1-9	198.910	201.364	195.258		195.814		211.089	
age 10-29	360.936	349.898	379.990		394.763		418.335	
age 30-49	155.480	149.252	169.477		185.621		232.917	
age 50-69	82.335	81.721	83.952		86.249		96.303	
age >70	15.267	13.864	18.036		20.632		25.797	
Total	833.739	816.938	869.130		907.454		1 011.523	
Female								
age <1	19.610	19.637	21.124		22.969		25.520	
age 1-9	187.114	189.320	183.959		184.787		199.789	
age 10-29	360.831	351.501	376.160		387.309		403.757	
age 30-49	167.552	161.699	181.160		197.008		242.546	
age 50-69	89.920	88.126	93.690		97.833		110.969	
age >70	21.613	20.567	23.888		26.282		32.103	
Total	846.640	830.850	879.981		916.188		1 014.684	
Indian								
TPUN (000)	378.120	369.978	395.000		413.190		462.100	
BIRT (000)	9.542	9.497	10.148		11.078		12.292	

	1971		1973		1975		1980	
	Predicted value	*Actual value*	*Predicted value*	*Actual value*	*Predicted value*	*Actual value*	*Predicted value*	*Actual value*
Male								
age <1	4.871	4.848	5.180		5.655		6.275	
age 1-9	46.581	47.335	45.533		45.498		48.917	
age 10-29	79.544	76.658	84.475		88.393		95.105	
age 30-49	46.239	46.003	47.222		48.867		55.555	
age 50-69	25.211	24.026	27.377		29.277		32.995	
age >70	3.007	2.668	3.745		4.530		6.614	
Total	205.453	201.538	213.532		222.220		245.461	
Female								
age <1	4.671	4.649	4.968		5.423		6.017	
age 1-9	44.370	44.982	43.544		43.638		47.108	
age 10-29	74.888	71.971	79.850		83.789		90.626	
age 30-49	34.767	33.799	37.171		40.081		49.053	
age 50-69	12.406	11.600	14.041		15.739		20.297	
age >70	1.569	1.439	1.894		2.295		3.539	
Total	172.671	168.440	181.468		190.965		216.640	
Rural								
TPRN (mill)	7.746	7.733	8.198	7.919	8.697	8.110	10.167	8.644
TPRM (mill)	3.913	3.807	4.138		4.388		5.126	
TPRF (mill)	3.833	3.728	4.060		4.310		5.042	
Malay								
TPRN (000)	5 108.000	4 964.845	5 414.100		5 749.200		6 729.300	
BIRT (000)	165.738	165.716	180.449		197.768		87.545	
Male								
age <1	84.347	84.336	91.834		100.648		124.089	
age 1-9	758.836	759.400	759.152		773.838		876.789	
age 10-29	953.772	901.034	1 056.862		1 153.408		1 366.423	
age 30-49	469.141	460.019	490.056		516.412		614.332	
age 50-69	230.061	221.373	246.743		262.804		303.355	
age >70	43.559	41.947	47.795		52.723		66.694	
Total	2 539.716	2 468.109	2 692.442		2 859.833		3 351.682	
Female								
age <1	81.391	81.380	88.615		97.120		119.739	
age 1-9	740.519	741.307	740.394		754.125		852.232	
age 10-29	979.377	929.189	1 076.543		1 166.195		1 361.094	
age 30-49	500.892	492.039	522.703		550.712		651.291	
age 50-69	223.158	211.134	246.077		268.179		322.677	
age >70	42.905	41.687	47.287		53.049		70.610	
Total	2 568.242	2 496.736	2 721.619		2 889.380		3 377.643	
Chinese								
TPRN (000)	1 906.600	1 859.318	2 009.300		2 123.400		2 464.500	
BIRT (000)	57.390	57.387	63.267		70.050		87.545	
Male								
age <1	29.742	29.741	32.788		36.303		45.370	
age 1-9	289.566	291.744	285.222		286.973		320.710	
age 10-29	383.190	364.512	420.325		454.771		527.181	
age 30-49	162.437	155.498	176.795		192.380		239.839	
age 50-69	96.183	97.460	94.512		94.250		101.202	
age >70	23.637	21.851	26.883		29.529		33.472	
Total	984.755	960.806	1 036.525		1 094.206		1 267.774	
Female								
age <1	27.647	27.646	30.479		33.746		42.175	
age 1-9	256.483	257.944	254.881		259.335		295.890	
age 10-29	368.513	351.295	400.955		429.875		490.112	
age 30-49	158.677	153.274	170.889		185.166		230.754	
age 50-69	89.039	87.907	91.625		94.720		105.801	
age >70	21.526	20.446	23.914		26.370		32.011	
Total	921.885	898.512	972.743		1 029.212		1 196.743	

	1971		1973		1975		1980	
	Predicted value	*Actual value*	*Predicted value*	*Actual value*	*Predicted value*	*Actual value*	*Predicted value*	*Actual value*
Indian								
TPRNI (000)	731.200	711.279	775.110		8 246.800		9 735.700	
BIRTH (000)	22.755	22.751	25.756		29.052		36.912	
Male								
age < 1	11.568	11.566	13.094		14.770		18.765	
age 1-9	106.098	106.751	105.590		108.319		127.445	
age 10-29	148.062	140.341	162.332		174.931		201.626	
age 30-49	74.596	73.840	77.018		80.632		95.171	
age 50-69	42.392	41.112	44.737		46.890		52.010	
age > 70	5.404	4.817	6.670		8.012		11.409	
Total	388.120	378.427	409.441		433.554		506.426	
Female								
age < 1	11.187	11.185	12.663		14.283		18.147	
age 1-9	101.475	101.859	101.480		104.535		123.627	
age 10-29	140.670	133.025	155.036		167.796		194.647	
age 30-49	61.672	60.458	64.932		69.369		85.854	
age 50-69	25.364	23.898	28.109		30.799		37.868	
age > 70	2.712	2.427	3.448		4.345		6.998	
Total	343.080	332.852	365.668		391.127		467.141	
Age at first marriage								
Urban								
Malay	21.525	21.525	21.852		21.798		22.701	
Chinese	24.780	24.780	25.164		25.103		25.997	
Indian	22.049	22.050	22.936		22.797		24.834	
Rural								
Malay	19.475	19.475	19.537		19.504		19.694	
Chinese	22.420	22.420	22.506		22.459		22.719	
Indian	19.952	19.950	20.115		20.027		20.517	
Fertility and mortality								
Urban								
Malay								
age 15-19	0.05260	0.05260	0.05236		0.05240		0.05174	
age 20-24	0.16341	0.16430	0.16145		0.16177		0.15648	
age 25-29	0.20071	0.20070	0.19923		0.19948		0.19544	
age 30-34	0.18269	0.18270	0.18238		0.18243		0.18157	
age 35-39	0.12560	0.12560	0.11678		0.11824		0.09276	
age 40-44	0.05270	0.05270	0.04921		0.04979		0.03971	
age 45-49	0.00829	0.01460	0.00805		0.00809		0.00740	
Chinese								
age 15-19	0.01810	0.01810	0.01802		0.01804		0.02683	
age 20-24	0.13730	0.23730	0.13538		0.13568		0.21901	
age 25-29	0.20560	0.20560	0.20382		0.20410		0.31494	
age 30-34	0.16339	0.16340	0.16307		0.16312		0.24363	
age 35-39	0.10240	0.10240	0.09528		0.09645		0.14428	
age 40-44	0.04230	0.04230	0.03957		0.04002		0.06261	
age 45-49	0.00596	0.00780	0.00589		0.00590		0.00983	
Indian								
age 15-19	0.05810	0.05810	0.05738		0.05749		0.07014	
age 20-24	0.20980	0.20980	0.20301		0.20407		0.32677	
age 25-29	0.18389	0.18390	0.18025		0.18082		0.27109	
age 30-34	0.15311	0.15311	0.15240		0.15251		0.20266	
age 35-39	0.09565	0.09000	0.08902		0.09012		0.11459	
age 40-44	0.03110	0.03110	0.02919		0.02951		0.04480	
age 45-49	0.00562	0.00680	0.00557		0.00558		0.00831	

	1971		*1973*		*1975*		*1980*	
	Predicted value	*Actual value*	*Predicted value*	*Actual value*	*Predicted value*	*Actual value*	*Predicted value*	*Actual value*
Rural								
Malay								
age 15-19	0.07460	0.07460	0.07454		0.07457		0.07441	
age 20-24	0.25311	0.25310	0.25287		0.25300		0.25228	
age 25-29	0.26410	0.26410	0.26395		0.26403		0.26357	
age 30-34	0.21580	0.21580	0.21567		0.21574		0.21537	
age 35-39	0.13659	0.13660	0.13563		0.13615		0.13317	
age 40-44	0.05500	0.05500	0.05465		0.05484		0.05375	
age 45-49	0.01410	0.01410	0.01286		0.01350		0.01072	
Chinese								
age 15-19	0.02690	0.02690	0.02688		0.02689		0.02683	
age 20-24	0.22000	0.22000	0.21972		0.21987		0.21901	
age 25-29	0.31582	0.31580	0.31557		0.31570		0.31494	
age 30-34	0.24429	0.24430	0.24410		0.24421		0.24363	
age 35-39	0.14800	0.14800	0.14695		0.14752		0.14428	
age 40-44	0.06410	0.06410	0.06368		0.06391		0.06161	
age 45-49	0.01210	0.01210	0.01127		0.01170		0.00983	
Indian								
age 15-19	0.07060	0.07060	0.07047		0.07054		0.07014	
age 20-24	0.32959	0.32960	0.32877		0.32922		0.32677	
age 25-29	0.27250	0.27250	0.27209		0.27231		0.27109	
age 30-34	0.20370	0.20370	0.20340		0.20356		0.20266	
age 35-39	0.11750	0.11750	0.11668		0.11713		0.11459	
age 40-44	0.04580	0.04580	0.04552		0.04567		0.04480	
age 45-49	0.00870	0.00870	0.00856		0.00863		0.00831	
Household income								
GDPPC	1 325.324		1 382.010		1 431.147		2 019.872	
TYRPC	705.800		793.771		923.537		2 020.752	
TYUPC	1 509.988		1 618.144		1 815.882		3 964.096	
TXAPC	613.808		631.047		650.892		909.153	
TXNPC	5 878.672		6 210.623		6 524.604		9 561.511	
Labour force								
URB (000)	2 486.415		2 605.623		2 765.720		3 127.043	
RUR (000)	3 801.723		4 025.422		4 244.250		4 973.138	
Migration								
Male (000)	600.250		633.790		696.200		803.190	
Female (000)	534.440		564.300		619.870		715.130	
Total (000)	1 134.700		1 198.100		1 316.100		1 518.300	
Gross output								
TBOT (mill)	1 262.408	874.700	1 310.028	1 438.200	48.001	700.500	4 744.268	4 662.200
TNEX (mill)	6 534.971	5 017.000	8 208.560	7 372.000	10 113.912	9 231.000	22 996.931	28 201.000
GDP (mill)	14 029.875	11 589.000	15 431.521	15 904.000	16 890.399	17 365.000	27 567.210	26 188.000

Annex V

Reference Run, 1985-2025

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Population						
TPOPN (mill)	15.808	18.207	20.822	23.657	30.027	41.240
Urban						
Pop (mill)	5.615	6.396	7.241	8.121	9.934	12.304
TPUN (mill)	3.877	4.282	4.688	5.092	5.889	7.045
TPUM (mill)	1.954	2.157	2.361	2.563	2.962	3.539
TPUF (mill)	1.923	2.125	2.327	2.529	2.927	3.506
Malay						
TPUN (000)	1 125.000	1 262.400	1 402.800	1 545.600	1 837.000	2.286
BIRT (000)	31.859	33.792	35.690	37.682	42.096	3.815
Male						
age <1	16.022	16.994	17.949	18.950	21.170	24.893
age 1-9	125.520	136.204	145.627	154.469	172.753	203.502
age 10-29	221.606	238.713	258.291	279.040	320.550	383.002
age 30-49	137.620	160.515	180.558	198.667	234.305	292.071
age 50-69	53.261	66.384	82.160	99.584	134.298	180.996
age >70	9.757	12.737	16.225	20.383	31.075	49.921
Total	563.786	631.547	700.811	771.093	914.152	1 134.386
Female						
age <1	15.837	16.798	17.741	18.732	20.926	24.606
age 1-9	124.505	135.406	144.835	153.650	171.849	202.438
age 10-29	219.537	236.849	256.742	277.807	319.725	382.304
age 30-49	136.259	159.229	179.397	197.677	233.845	292.577
age 50-69	54.053	67.989	84.600	102.939	139.765	189.860
age >70	11.156	14.560	18.699	23.721	36.712	60.036
Total	561.347	630.831	702.014	774.525	922.821	1 151.820
Chinese						
TPUN (000)	2 239.100	2 454.100	2 666.600	2 874.500	3 272.600	3 814.500
BIRT (000)	55.699	57.476	58.926	60.555	64.632	70.980
Male						
age <1	28.676	29.591	30.338	31.177	33.276	36.544
age 1-9	229.628	244.530	255.049	263.276	279.838	307.900
age 10-29	436.454	457.637	482.727	508.957	556.602	618.272
age 30-49	283.057	328.207	365.090	395.028	445.933	517.052
age 50-69	113.756	138.838	170.237	205.034	271.733	347.844
age >70	29.367	32.821	37.591	44.475	64.719	100.671
Total	1 120.938	1 231.625	1 341.032	1 447.946	1 652.101	1 928.283
Female						
age <1	27.022	27.885	28.588	29.379	31.356	34.436
age 1-9	217.608	231.839	241.854	249.672	265.386	291.999
age 10-29	417.488	436.000	459.276	484.118	529.597	588.431
age 30-49	288.821	328.626	359.885	384.839	428.814	494.885

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
age 50-69	129.796	155.357	186.623	220.605	283.875	354.499
age >70	37.377	42.779	49.355	57.918	81.492	122.014
Total	1 118.112	1 222.486	1 325.582	1 426.530	1 620.519	1 886.264
Indian						
TPUN (000)	512.700	565.200	618.240	671.650	779.780	944.400
BIRT (000)	13.238	13.970	14.627	15.306	16.866	19.475
Male						
age <1	6.758	7.131	7.467	7.814	8.610	9.942
age 1-9	53.222	57.512	61.144	64.373	70.879	81.938
age 10-29	100.086	105.565	122.117	119.415	134.448	157.019
age 30-49	64.639	74.087	82.576	89.908	103.065	123.672
age 50-69	35.911	39.177	43.614	49.298	62.288	80.212
age >70	8.683	10.501	12.012	13.382	16.630	23.325
Total	269.299	293.974	318.929	344.188	395.920	394.169
Female						
age <1	6 480	6.839	7.160	7.493	8.256	9.534
age 1-9	51.327	55.490	59.004	62.123	68.403	79.077
age 10-29	95.820	101.480	108.106	115.371	130.129	152.063
age 30-49	59.389	69.505	78.389	86.003	99.530	120.182
age 50-69	25.340	31.103	37.907	45.493	61.083	81.184
age >70	5.044	6.778	8.744	10.981	16.461	26.254
Total	243.400	271.193	299.310	327.464	383.862	468.292
Rural						
POP (mill)	10.193	11.811	13.581	15.536	20.093	28.936
TPRN (mill)	11.931	13.926	16.135	18.565	24.138	34.195
TPRM (mill)	6.015	7.022	8.140	9.370	12.192	17.276
TPRF (mill)	5.917	6.904	7.995	9.195	11.945	16.919
Malay						
TPRN (000)	7 000.300	9 224.200	10 692.000	15 456.000	16 018.000	22 716.000
BIRT (000)	284.523	321.081	357.935	397.441	484.737	619.440
Male						
age <1	144.799	163.404	182.160	202.265	246.692	315.245
age 1-9	1 037.533	1 207.793	1 373.685	1 542.482	1 904.240	2 499.298
age 10-29	1 570.398	1 802.128	2 074.661	2 383.135	3 073.935	4 251.231
age 30-49	759.504	937.262	1 131.372	1 336.653	1 801.356	2 687.051
age 50-69	346.738	400.259	473.095	570.473	832.162	1 350.727
age >70	81.910	97.460	113.555	131.599	182.747	315.372
Total	3 940.882	4 608.305	5 349.528	6 166.607	8 041.133	11 418.924
Famale						
age <1	139.724	157.677	175.775	195.176	238.045	304.195
age 1-9	1 007.720	1 172.862	1 334.877	1 497.813	1 849.115	2 426.996
age 10-29	1 548.403	1 766.283	2 026.925	2 324.668	2 995.493	4 142.152
age 30-49	793.494	962.778	1 144.940	1 337.028	1 777.031	2 633.787
age 50-69	378.619	442.044	521.891	623.421	886.593	1 403.038
age >70	91.471	114.245	138.260	164.209	230.443	386.761
Total	3 959.431	4 615.889	5 342.667	6 142.315	7 976.719	11 296.930

Annex V *(Continued)*

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Chinese						
TPRN (000)	2 878.900	3 349.500	3 869.200	4 438.200	5 736.400	8 076.600
BIRT (000)	102.256	114.589	126.642	139.873	170.559	218.928
Male						
age <1	52.995	59.387	65.633	72.490	88.393	113.460
age 1-9	379.423	441.235	499.596	556.837	682.607	897.862
age 10-29	593.877	671.490	765.582	873.318	1 113.687	1 527.056
age 30-49	300.364	368.683	439.188	510.998	670.975	978.006
age 50-69	118.100	143.754	177.896	220.065	322.055	506.053
age >70	34.992	36.644	40.313	46.777	68.760	121.240
Total	1 479.751	1 721.192	1 988.207	2 280.485	2 946.476	4 143.677
Female						
age <1	49.262	55.203	61.009	67.383	82.166	105.468
age 1-9	353.298	412.138	467.120	520.809	638.529	839.908
age 10-29	548.712	621.254	711.258	814.571	1 043.418	1 433.042
age 30-49	288.201	350.875	414.147	478.714	626.950	919.196
age 50-69	122.958	147.420	180.230	220.977	318.891	496.920
age >70	36.768	41.444	47.274	55.237	79.968	138.340
Total	1 399.199	1 628.334	1 881.039	2 157.692	2 789.922	3 932.875
Indian						
TPRNI (000)	1 152.000	1 351.900	1 573.200	1 817.900	2 383.500	3 402.300
BIRTH (000)	42.923	48.126	53 680	59 879	73.397	93.039
Male						
age <1	21.821	24.466	27.289	30.441	37.313	47.298
age 1-9	154.702	181.101	205.976	231.328	287.335	376.491
age 10-29	229.160	263.776	306.044	353.907	460.281	640.891
age 30-49	116.689	142.074	169.071	197.794	265.894	401.186
age 50-69	57.265	165.088	74.220	95.187	125.103	199.955
age >70	14.446	16.984	19.259	21.672	28.700	47.439
Total	594.083	793.491	801.859	930.328	1 204.627	1 713.260
Female						
age <1	21.102	23 660	26 390	29.438	36.084	45.740
age 1-9	150.387	176.177	200.424	225.111	279.625	366.400
age 10-29	221.924	256.115	297.788	344.875	449.185	625.769
age 30-49	279.423	135.122	162.621	191.543	259.429	393.124
age 50-69	45.752	55.320	67.830	83.826	124.543	203.857
age >70	9.931	12.984	16.242	19.936	29.998	54.151
Total	728.519	659.378	771.295	894.729	1 178.864	1 689.040
Age at first marriage						
Urban						
Malay	23.343	23.765	24.086	24.372	24.779	24.985
Chinese	26.457	26.685	26.819	26.910	26.987	27.000
India	25.849	26.340	26.627	26.817	26.975	27.000
Rural						
Malay	19.882	20.052	20.217	20.402	20.835	21.641
Chinese	22.949	23.148	23.335	23.543	24.016	24.844
Indian	20.920	21.252	21.558	21.900	22.675	24.009

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Fertility and mortality						
Urban						
Malay						
age 15-19	0.05118	0.05075	0.05039	0.05005	0.04648	0.04887
age 20-24	0.15286	0.15054	0.14880	0.14727	0.14514	0.14412
age 25-29	0.19253	0.19059	0.18908	0.18773	0.18572	0.18436
age 30-34	0.18083	0.18026	0.17978	0.17932	0.17853	0.17764
age 35-39	0.07418	0.06127	0.05062	0.04003	0.02168	0.00736
age 40-44	0.03258	0.02767	0.02358	0.01944	0.01205	0.00604
age 45-49	0.00617	0.00552	0.00523	0.00510	0.00501	0.00500
Chinese						
age 15-19	0.01774	0.01766	0.01759	0.01754	0.01744	0.01731
age 20-24	0.12915	0.12811	0.12751	0.12711	0.12680	0.12680
age 25-29	0.19785	0.19671	0.19598	0.19544	0.19479	0.19421
age 30-34	0.16185	0.16151	0.16123	0.16099	0.16056	0.15992
age 35-39	0.06087	0.05044	0.04184	0.03329	0.01847	0.00691
age 40-44	0.02657	0.02273	0.01953	0.01629	0.01051	0.00581
age 45-49	0.00534	0.00515	0.00507	0.00503	0.00500	0.00500
Indian						
age 15-19	0.05496	0.05444	0.05408	0.05379	0.05335	0.05282
age 20-24	0.18230	0.17905	0.17721	0.17600	0.17504	0.17496
age 25-29	0.16872	0.16675	0.16557	0.16474	0.16390	0.16338
age 30-34	0.14999	0.14947	0.14910	0.14879	0.14833	0.14774
age 35-39	0.05727	0.04783	0.04000	0.03212	0.01818	0.00694
age 40-44	0.02009	0.01741	0.01517	0.01290	0.00886	0.00557
age 45-49	0.00522	0.00510	0.00504	0.00502	0.00500	0.00500
Rural						
Malay						
age 15-19	0.07392	0.07334	0.07273	0.07207	0.07059	0.06792
age 20-24	0.23775	0.21954	0.20115	0.18267	0.14621	0.09600
age 25-29	0.26265	0.26158	0.26042	0.25910	0.25594	0.24970
age 30-34	0.21414	0.21263	0.21102	0.20924	0.20514	0.19746
age 35-39	0.13046	0.12809	0.12582	0.12324	0.11704	0.10465
age 40-44	0.04976	0.04525	0.04090	0.03665	0.02867	0.01885
age 45-49	0.00970	0.00922	0.00890	0.00862	0.00823	0.00802
Chinese						
age 15-19	0.02668	0.02651	0.02633	0.02614	0.02571	0.02495
age 20-24	0.20633	0.19053	0.17461	0.15861	0.12710	0.08380
age 25-29	0.31371	0.31234	0.31089	0.30924	0.30534	0.29779
age 30-34	0.24214	0.24037	0.23849	0.23642	0.23168	0.22292
age 35-39	0.14132	0.13874	0.13628	0.13346	0.12671	0.11323
age 40-44	0.05785	0.05246	0.04727	0.04220	0.03268	0.02095
age 45-49	0.00914	0.00882	0.00861	0.00842	0.00815	0.00801
Indian						
age 15-19	0.06951	0.06884	0.06817	0.06743	0.06580	0.06296
age 20-24	0.30680	0.28243	0.25802	0.23355	0.18552	0.12010
age 25-29	0.26960	0.26810	0.26657	0.26483	0.26078	0.25318
age 30-34	0.20112	0.19942	0.19765	0.19571	0.19130	0.18329

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
age 35-39	0.11228	0.11026	0.10833	0.10613	0.10085	0.09030
age 40-44	0.04159	0.03796	0.03446	0.03104	0.02463	0.01673
age 45-49	0.00820	0.00814	0.00810	0.00807	0.00803	0.00800
Household income						
GDPPC	2 240.638	3 219.165	2 180.248	3 152.952	4 069.717	6 333.082
TYRPC	4 211.018	16 586.775	8 087.406	22 660.216	61 107.269	315 522.737
TYUPC	5 797.576	16 534.415	8 797.849	24 393.795	67 666.705	347 296.073
TXAPC	992.765	1 403.082	956.625	1 338.824	1 682.165	2 516.310
TXNPC	11 037.482	16 547.399	11 941.939	17 712.143	25 105.682	44 931.355
Labour force						
URB (000)	3 562.986	4 052.366	4 689.631	5 243.525	6 265.143	7 746.011
RUR (000)	5 814.617	6 744.502	7 978.210	9 125.375	11 508.138	16 595.641
Migration						
Male (000)	962.020	1 161.500	1 393.700	1 645.100	2 181.500	2 822.100
Female (000)	856.540	1 034.200	1 240.900	1 464.800	1 942.400	2 512.700
Total (000)	1 818.560	2 195.700	2 634.600	3 109.900	4 123.900	5 334.800
Gross output						
TBOT (mill)	14 803.241	86 448.225	46 316.253	167 390.835	640 244.435	4 975 753.187
TNEX (mill)	44 830.969	167 900.556	95 977.459	299 575.833	993 979.748	6 565 633.426
GDP (mill)	35 420.009	58 611.341	45 397.132	74 589.397	122 201.400	261 176.290

Annex VI (a)

Varying Technological Progress Parameter of Non-Agriculture, 1985-2025

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Population						
TPOPN (mill)	15.812	18.224	20.856	23.711	30.132	41.458
Urban						
TPUN (mill)	3.879	4.291	4.707	5.121	5.942	7.139
TPUM (mill)	1.955	2.162	2.370	2.578	2.989	3.586
TPUF (mill)	1.924	2.129	2.336	2.543	2.953	3.552
BIRT (000)	101.760	107.034	111.256	115.746	126.216	142.845
Male						
age <1	51.948	54.633	56.780	59.064	64.392	72.852
age 1-9	408.793	441.702	468.139	490.234	533.886	605.848
age 10-29	758.155	802.342	855.392	912.927	1 024.871	1 180.578
age 30-49	485.316	562.804	628.236	683.736	785.158	942.561
age 50-69	202.931	244.400	296.010	353.915	468.360	610.422
age >70	47.807	56.059	65.829	78.249	112.424	173.958
Total	1 954.949	2 161.939	2 370.386	2 578.124	2 989.091	3 586.218
Female						
age <1	43.267	45.450	47.196	49.061	53.413	60.283
age 1-9	349.117	377.088	399.297	417.825	454.514	514.770
age 10-29	688.436	729.137	777.689	829.659	930.205	1 070.315
age 30-49	520.902	589.393	647.690	698.691	795.946	950.417
age 50-69	243.239	292.850	349.613	409.565	523.440	666.902
age >70	73.874	88.474	105.961	127.132	179.292	263.447
Total	1 918.834	2 122.393	2 327.446	2 531.933	2 936.811	3 526.135
Rural						
TPRN (mill)	11.933	13.933	16.150	18.590	24.190	34.319
TPRM (mill)	6.016	7.026	8.147	9.383	12.219	17.339
TPRF (mill)	5.918	6.907	8.002	9.207	11.971	16.980
BIRT (000)	430.460	485.174	539.956	600.323	732.167	937.778
Male						
age <1	220.002	247.960	275.950	306.284	374.175	479.259
age 1-9	1 572.259	1 832.886	2 085.279	2 337.588	2 078.069	3 796.162
age 10-29	2 393.444	2 737.795	3 148.156	3 614.828	4 659.635	6 446.724
age 30-49	1 176.555	1 448.019	1 739.643	2 045.565	2 739.755	4 074.995
age 50-69	522.103	608.168	724.211	885.725	1 279.356	2 057.877
age >70	131.347	151.088	173.126	200.048	280.207	484.085
Total	6 015.710	7 025.917	8 146.366	9 390.039	11 411.196	17 339.101
Female						
age 1-9	210.458	237.213	264.006	562.039	357.994	458.518
age 10-29	1 511.983	1 763.828	2 007.252	2 250.413	2 778.383	3 654.972
age 30-49	2 319.050	2 644.039	3 037.771	3 488.419	4 499.413	6 227.553
age 50-69	1 190.513	1 448.775	1 721.718	2 007.401	2 664.858	3 954.577

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Age at first marriage						
Urban						
Malay	23.189	23.519	23.851	24.164	24.656	24.967
Chinese	26.356	26.553	26.719	26.844	26.970	27.000
Indian	25.624	26.052	26.410	26.676	26.940	26.999
Rural						
Malay	19.823	19.959	20.118	20.299	20.726	21.530
Chinese	22.871	23.026	23.028	23.413	23.885	24.724
Indian	20.775	21.026	21.323	21.661	22.439	23.802
Fertility and mortality						
Urban						
Malay						
age 15-19	0.05129	0.05092	0.50550	0.05020	0.04957	0.04888
age 20-24	0.15373	0.15190	0.15009	0.14840	0.14580	0.14422
age 25-29	0.19321	0.19165	0.19008	0.18861	0.18624	0.18444
age 30-34	0.18097	0.18049	0.18000	0.17951	0.17864	0.17765
age 35-39	0.07909	0.06970	0.05939	0.04867	0.02844	0.00940
age 40-44	0.03454	0.03107	0.02716	0.02300	0.01490	0.00694
age 45-49	0.00626	0.00560	0.00527	0.00512	0.00502	0.00500
Chinese						
age 15-19	0.01776	0.01768	0.01761	0.01755	0.01745	0.01731
age 20-24	0.12963	0.12873	0.12797	0.12742	0.12688	0.12680
age 25-29	0.19830	0.19729	0.19642	0.19573	0.19487	0.19421
age 30-34	0.16194	0.16162	0.16132	0.16104	0.16057	0.15992
age 35-39	0.06483	0.05725	0.04893	0.04027	0.02393	0.00855
age 40-44	0.02810	0.02538	0.02233	0.01907	0.01274	0.00652
age 45-49	0.00537	0.00518	0.00508	0.00503	0.00501	0.00500
Indian						
age 15-19	0.05513	0.05466	0.05424	0.05389	0.05338	0.05282
age 20-24	0.18382	0.18097	0.17863	0.17692	0.17526	0.17496
age 25-29	0.16957	0.16784	0.16638	0.16527	0.16403	0.16338
age 30-34	0.15017	0.14969	0.14927	0.14890	0.14836	0.14774
age 35-39	0.06098	0.05424	0.04674	0.03880	0.02352	0.00862
age 40-44	0.02116	0.01926	0.01713	0.01485	0.01042	0.00606
age 45-59	0.00524	0.00511	0.00505	0.00502	0.00500	0.00500
Rural						
Malay						
age 15-19	0.07397	0.07342	0.07281	0.07216	0.07068	0.06801
age 20-24	0.23796	0.21984	0.20145	0.18295	0.14645	0.09615
age 25-29	0.26279	0.26180	0.26066	0.25935	0.25620	0.24995
age 30-34	0.21426	0.21281	0.21121	0.20944	0.20534	0.19766
age 35-39	0.13140	0.12959	0.12744	0.12496	0.11893	0.10677
age 40-44	0.05008	0.04571	0.04135	0.03707	0.02903	0.01909
age 45-49	0.01014	0.00977	0.00936	0.00897	0.00838	0.00804

Annex VI (a) *(Continued)*

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Chinese						
age 15-19	0.02670	0.02654	0.02636	0.02617	0.02574	0.02498
age 20-24	0.20657	0.19087	0.17494	0.15892	0.12734	0.08395
age 25-29	0.31394	0.31270	0.31126	0.30962	0.30571	0.29812
age 30-34	0.24231	0.24063	0.23876	0.23670	0.23195	0.22317
age 35-39	0.14235	0.14038	0.13804	0.13533	0.12877	0.11553
age 40-44	0.05823	0.05301	0.04781	0.04270	0.03311	0.02124
age 45-49	0.00944	0.00919	0.00891	0.00865	0.00826	0.00803
Indian						
age 15-19	0.06963	0.06902	0.06835	0.06762	0.06598	0.06310
age 20-24	0.30748	0.28339	0.25894	0.23439	0.18618	0.12046
age 25-29	0.26997	0.26866	0.26714	0.26542	0.26135	0.25366
age 30-34	0.20138	0.19982	0.19807	0.19614	0.19171	0.18363
age 35-39	0.11308	0.11154	0.10971	0.10759	0.10246	0.09210
age 40-44	0.04185	0.03833	0.03483	0.03138	0.02492	0.01692
age 45-49	0.00825	0.00820	0.00816	0.00811	0.00804	0.00800
Household income						
GDPPC	2 086.589	2 252.819	2 472.917	2 752.789	3 529.399	5 509.608
TYRPC	2 015.470	2 673.028	3 771.896	5 574.200	13 475.363	61 045.382
TYUPC	7.445	8.040	9.190	10.941	16.862	36.865
TXAPC	914.784	981.317	1 072.231	1 188.582	1 507.856	2 295.787
TXNPC	35.594	39.359	44.322	50.705	68.993	118.191
Labour force						
URB (000)	33.591	4 107.557	4 653.836	5 224.468	6 411.771	8 024.654
RUR (000)	5.791	6 703.500	7 715.000	8 832.043	11 433.781	16 464.480
Migration						
Male (000)	984.570	1 203.200	1 445.200	1 708.300	2 277.400	3 008.100
Female (000)	876.620	1 071.200	1 286.700	1 521.000	2 027.700	2 678.300
Total (000)	1 861.200	2 274.400	2 731.900	3 229.300	4 305.100	5 686.400
Gross output						
TBOT (mill)	−1 979.795	−4 331.966	−7 306.635	−10 798.022	−13 855.569	147 275.866
TNEX (mill)	25 371.608	38 607.457	60 948.629	99 910.118	275 945.646	1 456 075.640
GDP (mill)	32 993.142	41 055.377	51 575.167	65 271.387	106 347.843	228 417.335

Annex VI (b)

Varying Proportion of Agriculture Investment, 1985-2025

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Population						
TPOPN (mill)	15.809	18.219	20.847	23.695	30.097	41.376
Urban						
TPUN (mill)	3.878	4.289	4.702	5.114	5.928	7.112
TPUM (mill)	1.954	2.161	2.368	2.574	2.982	3.573
TPUF (mill)	1.923	2.128	2.334	2.539	2.946	3.539
BIRT (000)	101.689	106.772	110.743	115.058	125.403	141.949
Male						
age <1	51.912	54.499	56.518	58.713	63.977	72.395
age 1-9	408.175	441.010	466.936	488.228	530.689	602.115
age 10-29	758.145	802.078	854.743	911.670	1 021.509	1 173.999
age 30-49	485.316	562.809	628.227	683.670	784.665	940.013
age 50-69	202.930	244.400	296.010	353.915	468.342	610.063
age >70	47.806	56.058	65.828	78.249	112.424	173.944
Total	1 954.284	2 160.854	2 368.261	2 574.444	2 981.606	3 572.529
Female						
age <1	43.237	45.339	46.976	48.764	53.062	59.898
age 1-9	348.600	376.495	398.255	416.088	451.745	571.724
age 10-29	688.343	728.826	776.997	828.363	926.986	1 106.163
age 30-49	520.901	589.356	647.595	698.472	795.123	947.529
age 50-69	243.239	292.850	349.612	409.556	523.359	666.287
age >70	73.874	88.475	105.960	127.132	179.289	360.293
Total	1 918.194	2 121.341	2 325.395	2 528.376	2 929.564	3 711.894
Rural						
TPRN (mill)	11.932	13.930	16.144	18.581	24.170	34.264
TPRM (mill)	6.015	7.024	8.145	9.378	12.209	17.311
TPRF (mill)	5.917	6.906	8.000	9.203	11.961	16.953
BIRT (000)	430.182	484.834	539.382	598.527	730.754	928.825
Male						
age <1	219.860	247.787	275.657	305.878	373.451	474.685
age 1-9	1 571.629	1 831.855	1 846.682	2 335.238	2 881.052	3 787.357
age 10-29	2 393.434	2 737.489	3 147.296	3 613.177	4 655.390	6 435.855
age 30-49	1 176.555	1 448.019	1 739.633	2 045.486	2 739.118	4 071.755
age 50-69	522.103	528.923	725.211	885.725	1 279.334	2 057.417
age >70	131.347	151.088	173.126	200.048	417.732	484.067
Total	6 014.927	6 945.161	7 907.604	9 385.553	12 346.076	17 311.136
Female						
age 1-9	210.322	237.047	263.725	292.650	357.303	454.140
age 10-29	1 511.377	1 762.835	2 005.750	2 248.152	2 773.880	3 646.496
age 30-49	2 319.040	2 643.744	3 037.942	3 486.827	4 495.317	6 217.061
age 50-69	1 190.513	1 448.775	1 721.708	2 007.326	2 664.242	3 951.441
age >70	547.330	644.784	769.951	928.223	1 330.040	2 104.487
Total	5 778.583	6 737.185	7 799.077	8 963.177	11 620.783	16 373.625

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Age at first marriage						
Urban						
Malay	23.200	23.555	23.911	24.230	24.700	24.974
Chinese	26.364	26.574	26.747	26.867	26.977	27.000
Indian	25.641	26.097	26.469	26.725	26.954	27.000
Rural						
Malay	19.844	19.981	20.150	20.336	20.772	21.600
Chinese	22.900	23.056	23.249	23.459	23.941	24.794
Indian	20.828	21.081	21.400	21.747	22.540	23.916
Fertility and mortality						
Urban						
Malay						
age 15-19	0.05128	0.05090	0.05051	0.05015	0.04954	0.04884
age 20-24	0.15366	0.15170	0.14976	0.14804	0.14557	0.14418
age 25-29	0.19316	0.19149	0.18983	0.18833	0.18605	0.18437
age 30-34	0.18096	0.18046	0.17994	0.17945	0.17860	0.17760
age 35-39	0.07873	0.06849	0.05722	0.04600	0.02609	0.00862
age 40-44	0.03440	0.03058	0.02628	0.02190	0.01391	0.00660
age 45-49	0.00625	0.00559	0.00526	0.00511	0.00502	0.00500
Chinese						
age 15-19	0.01776	0.01768	0.01761	0.01755	0.01745	0.01730
age 20-24	0.12960	0.12863	0.12785	0.12731	0.12684	0.12680
are 25-29	0.19827	0.19720	0.19630	0.19563	0.19484	0.19418
age 30-34	0.16193	0.16160	0.16129	0.16102	0.16057	0.15988
age 35-39	0.06454	0.05627	0.04718	0.03811	0.02203	0.00792
age 40-44	0.02799	0.02500	0.02164	0.01821	0.01197	0.00625
age 45-49	0.00537	0.00517	0.00508	0.00503	0.00500	0.00500
Indian						
age 15-19	0.05512	0.05463	0.05420	0.05385	0.05337	0.05278
age 20-24	0.18370	0.18067	0.17824	0.17660	0.17517	0.17497
age 25-29	0.16951	0.16767	0.16616	0.16508	0.16398	0.16335
age 30-34	0.15015	0.14966	0.14922	0.14887	0.14835	0.14770
age 35-39	0.06071	0.05332	0.04507	0.03673	0.02166	0.00798
age 40-44	0.02108	0.01900	0.01664	0.01424	0.00987	0.00587
age 45-49	0.00523	0.00511	0.00505	0.00502	0.00500	0.00500
Rural						
Malay						
age 15-19	0.07395	0.07340	0.07279	0.07213	0.07064	0.06780
age 20-24	0.23788	0.21977	0.20135	0.18285	0.14635	0.09309
age 25-29	0.26274	0.26175	0.26058	0.25926	0.25609	0.14944
age 30-34	0.21421	0.21277	0.21115	0.20937	0.20526	0.19706
age 35-39	0.13106	0.12923	0.12692	0.12434	0.11813	0.10562
age 40-44	0.04997	0.04560	0.04121	0.03692	0.02888	0.01852
age 45-49	0.00997	0.00962	0.00919	0.00883	0.00831	0.00803

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Chinese						
age 15-19	0.02669	0.02653	0.02635	0.02616	0.02573	0.02492
age 20-24	0.20648	0.19079	0.17483	0.15881	0.12724	0.08131
age 25-29	0.31386	0.31261	0.31114	0.30948	0.30555	0.29751
age 30-34	0.24225	0.24057	0.23867	0.23660	0.23184	0.22248
age 35-39	0.14197	0.13998	0.13747	0.13466	0.12790	0.11428
age 40-44	0.05809	0.05288	0.04764	0.04252	0.03293	0.02056
age 45-49	0.00932	0.00909	0.00880	0.00856	0.00821	0.00802
Indian						
age 15-19	0.06959	0.06898	0.06829	0.06755	0.06590	0.06288
age 20-24	0.30723	0.28316	0.25864	0.23408	0.18590	0.11648
age 25-29	0.26983	0.26852	0.26696	0.26521	0.26110	0.25304
age 30-34	0.20129	0.19972	0.19794	0.19598	0.19153	0.18300
age 35-39	0.11279	0.11123	0.10927	0.10707	0.10178	0.09113
age 40-44	0.04175	0.03824	0.03471	0.03126	0.02480	0.01646
age 45-49	0.00823	0.00819	0.00814	0.00809	0.00804	0.00800
Household income						
GDPPC	2 109.295	2 306.081	2 564.688	2 879.804	3 710.669	5 796.048
TYRPC	1 689.097	2 711.397	4 633.465	7 698.002	20 781.718	117 871.244
TYUPC	16.869	23.798	36.306	57.189	152.318	751.792
TXAPC	939.366	1 015.559	1 118.212	1 249.970	1 580.648	2 389.117
TXNPC	35.795	40.123	45.841	52.905	72.555	124.744
Labour force						
URB (000)	3 580.711	4 094.233	4 630.966	5 192.232	6 352.647	7 914.714
RUR (000)	5 798.991	6 712.822	7 730.567	8 852.474	11 468.065	16 518.582
Migration						
Male (000)	976.580	1 193.000	1 428.000	1 684.900	2 235.200	2 929.400
Female (000)	869.510	1 062.200	1 271.500	1 500.100	1 990.200	2 608.200
Total (000)	1 846.090	2 255.200	2 699.500	3 185.000	4 225.400	5 537.700
Gross output						
TBOT (mill)	2 743.605	7 560.739	20 658.395	47 817.631	213 438.767	2 006 180.047
TNEX (mill)	30 360.763	51 736.483	92 271.818	164 193.883	523 794.052	3 409 540.089
GDP (mill)	33 345.849	42 014.496	53 466.046	68 236.946	111 680.004	239 817.288

Annex VI (c)

Varying Indirect Tax Rate on Non-Agriculture, 1985-2025

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Population						
TPOPN (mill)	15.808	18.213	20.836	23.679	30.072	41.343
Urban						
TPUN (mill)	3.877	4.285	4.696	5.104	5.912	7.087
TPUM (mill)	1.954	2.159	2.365	2.570	2.974	3.560
TPUF (mill)	1.923	2.126	2.331	2.535	2.938	3.527
BIRT (000)	101.032	106.125	110.149	114.491	124.752	141.309
Male						
age <1	51.576	54.169	56.215	58.423	63.646	72.069
age 1-9	408.247	439.625	464.699	485.748	527.994	498.759
age 10-29	758.145	801.981	853.929	909.702	1 017.400	1 168.163
age 30-49	485.316	562.809	628.226	683.633	784.019	936.993
age 50-69	202.930	244.400	296.010	353.915	468.330	609.597
age >70	47.806	56.058	65.828	78.249	112.424	173.930
Total	1 954.021	2 159.042	2 364.908	2 569.670	2 973.813	3 459.511
Female						
age <1	42.959	45.063	46.720	48.520	52.783	59.625
age 1-9	348.616	375.296	396.336	413.955	449.419	508.964
age 10-29	688.353	728.566	776.038	826.408	923.182	1 058.926
age 30-49	520.901	589.343	647.489	698.193	794.077	944.254
age 50-69	243.239	292.850	349.612	409.551	523.267	665.512
age >70	73.874	88.475	105.960	127.132	179.288	263.314
Total	1 917.942	2 119.593	2 322.155	2 523.759	2 922.015	3 500.595
Rural						
TPRN (mill)	11.931	13.928	16.140	18.575	24.160	34.256
TPRM (mill)	6.015	7.023	8.142	9.375	12.203	17.307
TPRF (mill)	5.917	6.905	7.998	9.199	11.956	16.949
BIRT (000)	429.846	484.395	538.963	598.082	730.323	935.392
Male						
age <1	219.688	247.563	275.443	305.650	373.231	1 504.040
age 1-9	1 571.664	1 831.012	2 082.257	2 333.497	2 879.253	3 786.209
age 10-29	2 393.434	2 737.434	3 146.801	3 611.924	4 652.623	6 432.096
age 30-49	1 176.555	1 448.019	1 739.632	2 045.465	2 738.712	4 069.743
age 50-69	522.103	608.168	725.211	885.725	1 279.327	3 065.119
age >70	131.347	151.088	173.126	200.048	280.207	484.059
Total	6 014.791	7 023.285	8 142.470	9 382.309	12 203.352	19 341.266
Female						
age 1-9	210.158	236.833	263.520	292.432	357.092	457.352
age 10-29	1 511.411	1 762.025	2 004.344	2 246.475	2 772.148	3 645.390
age 30-49	2 319.040	2 643.691	3 036.467	3 485.620	4 492.648	6 213.429
age 50-69	1 190.513	1 448.775	1 721.708	2 007.305	2 663.850	3 949.493
age >70	547.330	644.784	769.951	928.223	1 330.034	2 104.193
Total	5 778.452	6 736.108	7 795.989	8 960.055	11 615.771	16 369.857

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Age at first marriage						
Urban						
Malay	23.305	23.643	23.980	24.282	24.725	24.975
Chinese	26.433	26.623	26.777	26.883	26.980	27.000
Indian	25.796	26.205	26.535	26.761	26.962	27.000
Rural						
Malay	19.870	20.011	20.175	20.357	20.779	21.552
Chinese	22.935	23.095	23.281	23.486	23.949	24.748
Indian	20.892	21.153	21.458	21.796	22.555	23.845
Fertility and mortality						
Urban						
Malay						
age 15-19	0.05120	0.05083	0.05046	0.05012	0.04952	0.04887
age 20-24	0.15307	0.15121	0.14938	0.14776	0.14543	0.14417
age 25-29	0.19270	0.19111	0.18953	0.18811	0.18595	0.18441
age 30-34	0.18086	0.18037	0.17988	0.17940	0.17858	0.17765
age 35-39	0.07539	0.06547	0.05464	0.04384	0.02474	0.00856
age 40-44	0.03306	0.02936	0.02522	0.02101	0.01334	0.00657
age 45-49	0.00620	0.00556	0.00525	0.00511	0.00502	0.00500
Chinese						
age 15-19	0.01774	0.01767	0.01760	0.01754	0.01744	0.01731
age 20-24	0.12927	0.12840	0.12770	0.12723	0.12683	0.12680
age 25-29	0.19796	0.19698	0.19617	0.19555	0.19482	0.19421
age 30-34	0.16187	0.16156	0.16127	0.16101	0.16056	0.15992
age 35-39	0.06185	0.05384	0.04508	0.03637	0.02095	0.00788
age 40-44	0.02695	0.02405	0.02081	0.01752	0.01152	0.00623
age 45-49	0.00535	0.00516	0.00507	0.00503	0.00500	0.00500
Indian						
age 15-19	0.05500	0.05454	0.05415	0.05383	0.05336	0.05282
age 20-24	0.18266	0.17995	0.17781	0.17636	0.17512	0.17496
age 25-29	0.16892	0.16726	0.16591	0.16495	0.16395	0.16338
age 30-34	0.15003	0.14957	0.14917	0.14884	0.14835	0.14774
age 35-39	0.05819	0.05103	0.04308	0.03507	0.02060	0.00793
age 40-44	0.02036	0.01833	0.01606	0.01376	0.00956	0.00586
age 45-49	0.00522	0.00511	0.00505	0.00502	0.00500	0.00500
Rural						
Malay						
age 15-19	0.07393	0.07337	0.07277	0.07211	0.07063	0.06799
age 20-24	0.23779	0.21967	0.20128	0.18279	0.14633	0.09612
age 25-29	0.26268	0.26168	0.26052	0.25921	0.25607	0.24990
age 30-34	0.21416	0.21271	0.21110	0.20933	0.20524	0.19762
age 35-39	0.13064	0.12875	0.12652	0.12399	0.11801	0.10634
age 40-44	0.04982	0.04545	0.04109	0.03684	0.02886	0.01904
age 45-49	0.00978	0.00944	0.00908	0.00876	0.00830	0.00803

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Chinese						
age 15-19	0.02668	0.02652	0.02634	0.02615	0.02572	0.02497
age 20-24	0.20637	0.19068	0.17475	0.15874	0.12722	0.08392
age 25-29	0.31376	0.31250	0.31105	0.30941	0.30553	0.29805
age 30-34	0.24217	0.24048	0.23861	0.23654	0.23182	0.22312
age 35-39	0.14152	0.13946	0.13703	0.13428	0.12777	0.11506
age 40-44	0.05792	0.05270	0.04750	0.04242	0.03290	0.02118
age 45-49	0.00919	0.00897	0.00872	0.00851	0.00820	0.00802
Indian						
age 15-19	0.06953	0.06892	0.06824	0.06751	0.06589	0.06307
age 20-24	0.30693	0.28285	0.25841	0.23391	0.18585	0.12038
age 25-29	0.26967	0.26835	0.26681	0.26509	0.26107	0.25356
age 30-34	0.20117	0.19959	0.19783	0.19590	0.19150	0.18356
age 35-39	0.11243	0.11082	0.10892	0.10677	0.10168	0.09174
age 40-44	0.04164	0.03812	0.03462	0.03119	0.02478	0.01688
age 45-49	0.00820	0.00816	0.00812	0.00809	0.00803	0.00800
Household income						
GDPPC	2 190.876	2 401.447	2 656.095	2 968.241	3 796.725	5 750.397
TYRPC	3 228.654	5 111.022	7 945.103	12 607.264	33 509.956	163 009.241
TYUPC	5 485.133	8 107.795	12 523.839	19 956.001	53 859.598	260 597.349
TXAPC	972.283	1 052.856	1 151.322	1 271.943	1 590.103	2 333.913
TXNPC	10 792.569	12 331.908	14 238.303	16 632.729	23 323.880	40 525.437
Labour force						
URB (000)	3 568.317	4 076.565	4 612.301	5 172.193	6 338.946	7 954.942
RUR (000)	5 809.945	6 725.766	7 741.496	8 861.847	11 465.968	16 462.792
Migration						
Male (000)	966.390	1 180.000	1 415.800	1 672.900	2 231.800	2 976.600
Female (000)	860.430	1 050.600	1 260.500	1 489.500	1 987.100	2 650.200
Total (000)	1 826.800	2 230.600	2 676.300	3 162.400	4 218.800	5 626.800
Gross output						
TBOT (mill)	10 561.431	22 854.285	47 128.791	96 698.509	402 367.071	3 402 053.409
TNEX (mill)	39 677.785	69 595.714	122 346.722	218 360.659	723 892.350	4 794 978.247
GDP (mill)	34 633.373	43 737.559	55 342.395	70 284.985	114 175.102	237 738.652

Annex VI (d)

Decreasing Age Specific Fertility Rate, 1985-2025

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Population						
TPOPN (mill)	15.706	17.972	20.436	23.086	28.933	38.875
Urban						
TPUN (mill)	3.856	4.239	4.623	5.000	5.726	6.721
TPUM (mill)	1.944	2.136	2.328	2.516	2.879	3.374
TPUF (mill)	1.913	2.104	2.295	2.483	2.847	3.347
BIRT (000)	96.145	100.819	104.306	107.652	114.915	126.623
Male						
age <1	49.082	51.461	53.234	54.935	58.628	64.581
age 1-9	400.649	423.277	443.392	460.655	492.697	543.136
age 10-29	757.755	797.654	841.105	886.306	972.363	1 087.075
age 30-49	485.312	562.782	628.019	682.425	774.901	902.427
age 50-69	202.930	244.399	296.009	353.905	467.976	603.298
age >70	47.806	56.058	65.828	78.249	112.421	173.669
Total	1 943.534	2 135.631	2 327.588	2 516.475	2 878.987	3 374.186
Female						
age <1	40.878	42.803	44.234	45.616	48.617	53.431
age 1-9	341.785	361.176	378.052	392.452	419.236	461.300
age 10-29	687.054	722.711	762.369	803.364	880.640	983.449
age 30-49	521.005	588.987	645.882	694.321	780.574	904.373
age 50-69	243.240	292.863	349.634	409.484	521.949	655.653
age >70	73.874	88.475	105.961	127.135	179.274	262.352
Total	1 907.837	2 097.015	2 286.132	2 472.373	2 830.290	3 320.557
Rural						
TPRN (mill)	11.850	13.733	15.814	18.086	23.207	32.154
TPRM (mill)	5.973	6.924	7.976	9.126	11.718	16.238
TPRF (mill)	5.877	6.809	7.838	8.960	11.489	15.916
BIRT (000)	408.429	459.975	510.058	561.830	672.289	836.380
Male						
age <1	208.742	234.808	260.671	287.126	343.576	427.444
age 1-9	1 541.589	1 760.459	1 984.490	2 210.430	2 683.077	3 426.671
age 10-29	2 392.936	2 721.028	3 093.371	3 509.168	4 433.338	5 968.440
age 30-49	1 176.555	1 448.014	1 739.121	2 041.090	2 699.953	3 902.190
age 50-69	522.103	608.168	725.211	885.709	1 278.080	2 029.863
age >70	131.347	151.088	173.126	200.048	280.202	483.042
Total	5 973.272	6 923.565	7 975.991	9 133.571	11 718.225	16 237.649
Female						
age 1-9	199.687	224.893	249.386	274.705	328.714	408.936
age 10-29	1 482.487	1 694.140	1 910.243	2 127.995	2 583.253	3 299.198
age 30-49	2 318.561	2 627.894	2 984.976	3 386.525	4 280.976	5 765.654
age 50-69	1 190.513	1 448.770	1 721.215	2 003.085	2 626.394	3 787.192
age >70	547.330	644.784	769.951	928.212	1 328.816	2 077.195
Total	5 738.578	6 640.480	7 635.772	8 720.522	11 148.153	15 338.175

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Age at first marriage						
Urban						
Malay	23.276	23.637	23.982	24.292	24.741	24.981
Chinese	26.414	26.619	26.778	26.886	26.983	27.000
Indian	25.754	26.197	26.537	26.767	26.966	27.000
Rural						
Malay	19.864	20.013	20.181	20.371	20.814	21.638
Chinese	22.926	23.097	23.289	23.504	23.991	24.841
Indian	20.877	21.157	21.475	21.828	22.630	24.006
Fertility and mortality						
Urban						
Malay						
age 15-19	0.04866	0.04830	0.04794	0.04760	0.04703	0.04643
age 20-24	0.14557	0.14368	0.14190	0.14033	0.13808	0.13693
age 25-29	0.18318	0.18158	0.18005	0.17866	0.17659	0.17516
age 30-34	0.17185	0.17136	0.17088	0.17042	0.16964	0.16876
age 35-39	0.07250	0.06241	0.05184	0.04128	0.02265	0.00747
age 40-44	0.03176	0.02798	0.02393	0.19800	0.01231	0.00595
age 45-49	0.00590	0.00529	0.00499	0.00485	0.00476	0.00475
Chinese						
age 15-19	0.01686	0.01679	0.01672	0.01667	0.01657	0.01644
age 20-24	0.12289	0.12200	0.12132	0.12086	0.12048	0.12046
age 25-29	0.18814	0.18715	0.18635	0.18576	0.18507	0.18450
age 30-34	0.15379	0.15348	0.15320	0.15296	0.15253	0.15192
age 35-39	0.05946	0.05132	0.04278	0.03425	0.01920	0.00695
age 40-44	0.02587	0.02292	0.01975	0.01652	0.01066	0.00569
age 45-49	0.00509	0.00491	0.00482	0.00478	0.00475	0.00475
Indian						
age 15-19	0.05228	0.05182	0.05144	0.05113	0.05069	0.05018
age 20-24	0.17379	0.17101	0.16891	0.16751	0.16634	0.16621
age 25-29	0.16062	0.15893	0.15761	0.15668	0.15574	0.15521
age 30-34	0.14256	0.14201	0.14171	0.14139	0.14092	0.14035
age 35-39	0.05594	0.04864	0.04088	0.03303	0.01889	0.00699
age 40-44	0.01953	0.01746	0.01525	0.01299	0.00889	0.00541
age 45-49	0.00497	0.00485	0.00479	0.00477	0.00475	0.00475
Rural						
Malay						
age 15-19	0.07024	0.06970	0.06912	0.06849	0.06708	0.06453
age 20-24	0.22592	0.20868	0.19119	0.17362	0.13895	0.09120
age 25-29	0.24956	0.24859	0.24748	0.14622	0.24319	0.23722
age 30-34	0.20347	0.20207	0.20053	0.19883	0.19492	0.18759
age 35-39	0.12420	0.12229	0.12008	0.11757	0.11154	0.09946
age 40-44	0.04736	0.04317	0.03901	0.03494	0.02731	0.01791
age 45-49	0.00933	0.00896	0.00859	0.00828	0.00784	0.00762

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Chinese						
age 15-19	0.02535	0.02519	0.02502	0.02484	0.02443	0.02370
age 20-24	0.19608	0.18114	0.16599	0.15077	0.12079	0.07962
age 25-29	0.29809	0.29687	0.29547	0.29389	0.29014	0.28291
age 30-34	0.23008	0.22846	0.22666	0.22468	0.22014	0.21178
age 35-39	0.13455	0.13246	0.13006	0.12733	0.12076	0.10761
age 40-44	0.05506	0.05006	0.04509	0.04023	0.03112	0.01991
age 45-49	0.00876	0.00851	0.00827	0.00805	0.00776	0.00761
Indian						
age 15-19	0.06607	0.06547	0.06482	0.06411	0.06254	0.05981
age 20-24	0.29165	0.26869	0.24543	0.22211	0.17636	0.11410
age 25-29	0.25623	0.25492	0.25343	0.25176	0.24784	0.24053
age 30-34	0.19114	0.18961	0.18791	0.18605	0.18181	0.17413
age 35-39	0.10689	0.10526	0.10339	0.10125	0.09611	0.08582
age 40-44	0.03958	0.03621	0.03286	0.02959	0.02345	0.01589
age 45-49	0.00780	0.00776	0.00771	0.00768	0.00763	0.00760
Household income						
GDPPC	2 187.267	2 402.283	2 672.209	3 006.566	3 913.333	6 152.894
TYRPC	2 857.979	4 220.836	6 456.289	10 157.173	26 591.949	124 364.642
TYUPC	5 430.865	7 979.024	12 306.395	19 641.573	53 550.268	267 307.141
TXAPC	972.172	1 056.163	1 162.625	1 294.569	1 649.644	2 514.119
TXNPC	10 760.645	12 301.460	14 265.535	16 756.756	23 852.807	42 915.734
Labour force						
URB (000)	3 545.418	4 019.180	4 516.734	5 029.153	6 056.816	7 300.718
RUR (000)	5 772.324	6 639.839	7 599.217	8 652.299	11 069.952	15 644.539
Migration						
Male (000)	957.930	1 155.800	1 373.800	1 607.300	2 092.000	2 617.300
Female (000)	852.900	1 029.100	1 223.200	1 431.100	1 862.700	2 330.300
Total (000)	1 810.800	2 184.900	2 597.000	3 038.400	3 954.700	4 947.600
Gross output						
TBOT (mill)	8 558.518	16 776.317	33 800.409	68 296.796	272 275.079	2 044 067.029
TNEX (mill)	37 344.863	62 669.175	107 596.159	187 757.472	589 656.350	3 446 463.066
GDP (mill)	34 353.215	43 173.834	54 609.269	69 409.592	113 224.472	239 193.767

Annex VI (e)

Increasing Age Specific Fertility Rate, 1985-2025

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Population						
TPOPN (mill)	15.884	18.431	21.214	24.251	31.198	43.852
Urban						
TPUN (mill)	3.891	4.326	4.766	5.207	6.100	7.465
TPUM (mill)	1.961	2.180	2.400	2.622	3.069	3.752
TPUF (mill)	1.930	2.146	2.365	2.585	3.031	3.713
BIRT (000)	106.366	111.767	116.291	121.591	135.053	157.063
Male						
age < 1	54.299	57.049	59.350	62.046	68.900	80.102
age 1-9	412.899	455.124	486.508	511.828	564.734	658.605
age 10-29	757.876	804.383	864.475	931.441	1 062.939	1 252.857
age 30-49	485.312	562.783	628.211	684.232	791.746	971.353
age 50-69	202.930	244.400	296.009	354.009	468.493	615.057
age > 70	47.806	56.058	65.828	78.249	112.423	174.101
Total	1 961.122	2 179.798	2 400.381	2 621.806	3 069.236	3 752.076
Female						
age < 1	45.224	47.451	49.310	51.506	57.112	66.232
age 1-9	352.704	388.557	414.918	436.133	480.603	559.363
age 10-29	688.701	732.402	787.507	847.887	966.105	1 137.622
age 30-49	521.020	589.840	649.015	701.617	806.556	984.537
age 50-69	243.240	292.863	349.658	409.717	524.545	674.801
age > 70	73.874	88.475	105.961	127.136	179.342	264.301
Total	1 924.763	2 139.587	2 356.369	2 573.995	3 014.262	3 686.855
Rural						
TPRN (mill)	11.993	14.105	16.449	19.044	25.098	36.387
TPRM (mill)	6.046	7.113	8.300	9.614	12.681	18.391
TPRF (mill)	5.947	6.991	8.149	9.430	12.417	17.996
BIRT (000)	451.509	508.966	567.804	634.236	789.445	1 038.889
Male						
age < 1	230.760	260.120	290.182	324.125	403.442	530.928
age 1-9	1 592.265	1 896.835	2 178.239	2 455.663	3 076.754	4 158.822
age 10-29	2 393.429	2 749.063	3 192.933	3 707.217	4 867.376	6 902.266
age 30-49	1 176.555	1 448.020	1 739.914	2 048.664	2 773.102	4 232.599
age 50-69	522.103	608.168	725.211	885.732	1 280.254	2 081.706
age > 70	131.347	151.088	173.126	200.048	280.210	484.888
Total	6 046.458	7 113.294	8 299.606	9 621.449	12 681.137	18 391.209
Female						
age 1-9	220.749	248.846	277.623	310.112	386.003	507.961
age 10-29	1 531.221	1 825.354	2 096.722	2 364.085	2 962.319	4 004.178
age 30-49	2 319.035	2 654.886	3 080.916	3 577.505	4 699.931	6 667.486
age 50-69	1 190.513	1 448.775	1 721.980	2 010.390	2 697.078	4 107.226
age > 70	547.330	644.784	769.951	928.228	1 330.938	2 128.523
Total	5 808.849	6 822.645	7 947.192	9 190.319	12 076.270	17 415.374

Annex VI (e) *(Continued)*

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Age at first marriage						
Urban						
Malay	23.261	23.598	23.929	24.233	24.691	24.968
Chinese	26.404	26.598	26.755	26.867	26.975	27.000
Indian	25.732	26.150	26.487	26.727	26.952	26.999
Rural						
Malay	19.858	19.994	20.152	20.329	20.739	21.495
Chinese	22.918	23.073	23.251	23.450	23.901	24.686
Indian	20.861	21.112	21.403	21.730	22.468	23.736
Fertility and mortality						
Urban						
Malay						
age 15-19	0.05380	0.05341	0.05302	0.05266	0.05202	0.05132
age 20-24	0.16099	0.15904	0.15714	0.15543	0.15290	0.15142
age 25-29	0.20254	0.20087	0.19924	0.19773	0.19539	0.19366
age 30-34	0.18995	0.18944	0.18892	0.18842	0.18754	0.18654
age 35-39	0.08064	0.07037	0.05936	0.04818	0.02792	0.00974
age 40-44	0.03531	0.03149	0.02729	0.02294	0.01483	0.00723
age 45-49	0.00653	0.00586	0.00552	0.00537	0.00527	0.00525
Chinese						
age 15-19	0.01863	0.01856	0.01849	0.01842	0.01832	0.01817
age 20-24	0.13587	0.13494	0.13420	0.13367	0.13319	0.13314
age 25-29	0.20799	0.20695	0.20608	0.20540	0.20458	0.20392
age 30-34	0.16999	0.16966	0.16935	0.16908	0.16860	0.16792
age 35-39	0.06613	0.05784	0.04895	0.03992	0.02355	0.00888
age 40-44	0.02876	0.02577	0.02249	0.01909	0.01274	0.00680
age 45-49	0.00562	0.00543	0.00533	0.00528	0.00526	0.00525
Indian						
age 15-19	0.05780	0.05731	0.05689	0.05655	0.05604	0.05546
age 20-24	0.19224	0.18933	0.18703	0.18541	0.18395	0.18371
age 25-29	0.17762	0.17584	0.17439	0.17333	0.17219	0.17155
age 30-34	0.15759	0.15710	0.15667	0.15631	0.15577	0.15513
age 35-39	0.06222	0.05482	0.04677	0.03848	0.02316	0.00894
age 40-44	0.02170	0.01961	0.01731	0.01493	0.01049	0.00633
age 45-49	0.00549	0.00536	0.00530	0.00527	0.00525	0.00525
Rural						
Malay						
age 15-19	0.07764	0.07706	0.07643	0.07574	0.07420	0.07144
age 20-24	0.24972	0.23071	0.21141	0.19201	0.15374	0.10101
age 25-29	0.27584	0.27480	0.27360	0.27224	0.26898	0.26253
age 30-34	0.22490	0.22338	0.22170	0.21985	0.21558	0.20761
age 35-39	0.13738	0.13547	0.13324	0.13069	0.12463	0.11279
age 40-44	0.05239	0.04781	0.04326	0.03880	0.03044	0.02012
age 45-49	0.01036	0.01001	0.00964	0.00930	0.00878	0.00845

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Chinese						
age 15-19	0.02802	0.02785	0.02767	0.02747	0.02702	0.02623
age 20-24	0.21675	0.20028	0.18356	0.16677	0.13368	0.08819
age 25-29	0.32950	0.32819	0.32669	0.32499	0.32095	0.31314
age 30-34	0.25432	0.25256	0.25060	0.24845	0.24352	0.23440
age 35-39	0.14883	0.14675	0.14431	0.14154	0.13495	0.12205
age 40-44	0.06090	0.05544	0.05001	0.04469	0.03471	0.02239
age 45-49	0.00972	0.00948	0.00924	0.00900	0.00865	0.00843
Indian						
age 15-19	0.07304	0.07240	0.07070	0.07094	0.06925	0.06631
age 20-24	0.32243	0.29718	0.27156	0.24585	0.19540	0.12660
age 25-29	0.28324	0.28187	0.28029	0.27851	0.27434	0.26651
age 30-34	0.21129	0.20965	0.20783	0.20582	0.20124	0.19292
age 35-39	0.11824	0.11661	0.11471	0.11253	0.10738	0.09729
age 40-44	0.04378	0.04010	0.03644	0.03285	0.02613	0.01783
age 45-49	0.00863	0.00859	0.00854	0.00850	0.00844	0.00841
Household income						
GDPPC	2 162.746	2 342.364	2 574.135	2 861.875	3 628.405	5 452.008
TYRPC	2 823.762	4 107.979	6 205.200	9 635.346	24 516.647	109 199.958
TYUPC	5 382.450	7 813.892	11 932.160	18 846.297	50 173.074	239 562.824
TXAPC	960.574	1 028.246	1 117.699	1 229.328	1 525.032	2 220.745
TXNPC	10 665.191	12 054.254	13 837.124	16 089.504	22 384.181	38 619.131
Labour force						
URB (000)	3 594.279	4 137.312	4 714.032	5 322.779	6 627.019	8 568.578
RUR (000)	5 829.788	6 794.921	7 865.435	9 052.267	11 848.846	17 341.844
Migration						
Male (000)	980.960	1 209.800	1 464.900	1 746.000	2 375.900	3 294.900
Female (000)	873.400	1 077.100	1 304.300	1 554.600	2 115.400	2 933.600
Total (000)	1 854.360	2 286.900	2 769.100	3 300.600	4 491.300	6 228.500
Gross output						
TBOT (mill)	8 557.376	16 755.978	33 775.472	68 175.221	271 257.772	2 029 126.357
TNEX (mill)	37 343.560	62 646.623	107 568.564	187 621.285	588 539.409	3 430 596.323
GDP (mill)	34 353.063	43 172.116	54 607.703	69 403.326	113198.978	239 081.440

Annex VI (f)

Increasing Female Participation Rate, 1985-2025

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Population						
TPOPN (mill)	15.808	18.214	20.838	23.683	30.079	41.354
Urban						
TPUN (mill)	3.876	4.285	4.697	5.106	5.916	7.092
TPUM (mill)	1.954	2.159	2.365	2.570	2.975	3.563
TPUF (mill)	1.923	2.126	2.331	2.535	2.940	3.530
BIRT (000)	101.263	106.303	110.329	114.661	124.923	141.474
Male						
age <1	51.694	54.260	56.307	58.511	63.733	72.153
age 1-9	407.931	439.842	465.264	486.455	528.749	599.856
age 10-29	757.876	801.608	853.720	909.870	1 018.393	1 169.720
age 30-49	485.312	562.783	628.143	683.474	783.886	937.611
age 50-69	202.930	244.400	296.009	353.908	468.274	609.524
age >70	47.806	56.058	65.828	78.249	112.423	173.909
Total	1 953.550	2 158.951	2 365.272	2 570.466	2 975.458	3 562.773
Female						
age <1	43.054	45.131	46.785	206.447	52.839	59.677
age 1-9	348.214	375.405	396.750	186.396	449.946	509.468
age 10-29	688.074	728.132	775.761	694.604	924.002	1 037.423
age 30-49	521.020	589.488	647.590	698.218	794.135	920.876
age 50-69	243.240	292.863	349.649	409.620	523.352	633.953
age >70	73.874	88.475	105.961	127.136	179.313	270.273
Total	1 917.477	2 119.494	2 322.494	2 322.421	2 923.588	3 431.670
Rural						
TPRN (mill)	11.931	13.929	16.141	18.577	24.163	34.262
TPRM (mill)	6.015	7.024	8.143	9.376	12.205	17.099
TPRF (mill)	5.917	6.905	7.998	9.200	11.958	16.952
BIRT (000)	429.975	484.519	539.114	598.255	730.518	935.304
Male						
age <1	219.754	247.626	275.520	305.738	373.330	477.995
age 1-9	1 571.618	1 831.212	2 082.691	2 334.098	2 880.061	3 786.588
age 10-29	2 393.429	2 737.433	3 146.908	3 612.261	4 653.579	6 433.654
age 30-49	1 176.555	1 448.019	1 739.631	2 045.466	2 738.812	4 070.427
age 50-69	522.103	608.168	725.211	885.724	1 279.327	2 057.198
age >70	131.347	151.088	173.126	200.048	280.207	484.061
Total	6 014.806	7 023.547	8 143.088	9 383.336	12 205.316	17 309.922
Female						
age 1-9	210.221	236.893	263.594	292.516	357.187	457.309
age 10-29	1 511.366	1 762.217	2 004.762	2 247.054	2 772.385	3 645.755
age 30-49	2 319.035	2 643.690	3 036.569	3 485.944	4 493.569	6 214.934
age 50-69	1 190.513	1 448.775	1 721.707	2 007.306	2 663.947	3 950.155
age >70	547.330	644.785	769.951	928.223	1 330.034	2 104.271
Total	5 778.466	6 736.360	7 796.583	8 961.043	11 617.123	16 372.423

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Age at first marriage						
Urban						
Malay	23.267	23.616	23.954	24.261	24.715	24.975
Chinese	26.408	26.608	26.766	26.877	26.979	27.000
Indian	25.741	26.172	26.511	26.746	26.959	27.000
Rural						
Malay	19.860	20.003	20.166	20.349	20.774	21.562
Chinese	22.921	23.084	23.269	23.475	23.943	24.759
Indian	20.868	21.133	21.437	21.776	22.544	23.863
Fertility and mortality						
Urban						
Malay						
age 15-19	0.05123	0.05085	0.05048	0.05013	0.04953	0.04887
age 20-24	0.15329	0.15136	0.14952	0.14788	0.14548	0.14417
age 25-29	0.19287	0.19123	0.18964	0.18820	0.18599	0.18441
age 30-34	0.18090	0.18040	0.17990	0.17942	0.17859	0.17765
age 35-39	0.07660	0.06641	0.05560	0.04473	0.02526	0.00855
age 40-44	0.03355	0.02974	0.02562	0.02137	0.01356	0.00656
age 45-49	0.00622	0.00557	0.00526	0.00511	0.00502	0.00500
Chinese						
age 15-19	0.01775	0.01177	0.01760	0.01754	0.01744	0.01731
age 20-24	0.12938	0.12874	0.12776	0.12726	0.12683	0.12680
age 25-29	0.19807	0.19705	0.19621	0.19558	0.19483	0.19421
age 30-34	0.16189	0.16157	0.16128	0.16102	0.16056	0.15992
age 35-39	0.06283	0.05459	0.04587	0.03708	0.02136	0.00787
age 40-44	0.02733	0.02435	0.02112	0.01780	0.01169	0.00622
age 45-49	0.00535	0.00517	0.00507	0.00503	0.00500	0.00500
Indian						
age 15-19	0.05504	0.05457	0.05417	0.05384	0.05337	0.05282
age 20-24	0.18303	0.18017	0.17796	0.17646	0.17514	0.17496
age 25-29	0.16913	0.16739	0.16600	0.16500	0.16396	0.16338
age 30-34	0.15008	0.14960	0.14919	0.14885	0.14835	0.14774
age 35-39	0.05911	0.05174	0.04383	0.03575	0.02101	0.00792
age 40-44	0.02062	0.01854	0.01628	0.01396	0.00968	0.00586
age 45-49	0.00523	0.00511	0.00505	0.00502	0.00500	0.00500
Rural						
Malay						
age 15-19	0.07394	0.07338	0.07277	0.07212	0.07064	0.06798
agr 20-24	0.23782	0.21970	0.20130	0.18282	0.14634	0.09611
age 25-29	0.26270	0.26170	0.26054	0.25923	0.25609	0.24988
age 30-34	0.21418	0.21273	0.21112	0.20934	0.20525	0.19760
age 35-39	0.13080	0.12889	0.12667	0.12414	0.11810	0.10615
age 40-44	0.04988	0.04549	0.04114	0.03687	0.02888	0.01902
age 45-49	0.00985	0.00949	0.00912	0.00878	0.00830	0.00803

Variable	*1985*	*1990*	*1995*	*2000*	*2010*	*2025*
Chinese						
age 15-19	0.02669	0.02652	0.02635	0.02615	0.02572	0.02497
age 20-24	0.20641	0.19071	0.17478	0.15877	0.12724	0.08390
age 25-29	0.31380	0.31253	0.31108	0.30944	0.30555	0.29802
age 30-34	0.24220	0.24051	0.23863	0.23656	0.23183	0.22309
age 35-39	0.14169	0.13961	0.13719	0.13444	0.12787	0.11486
age 40-44	0.05799	0.05275	0.04755	0.04246	0.03292	0.02115
age 45-49	0.00924	0.00900	0.00875	0.00853	0.00820	0.00802
Indian						
age 15-19	0.06955	0.06894	0.06826	0.06753	0.06590	0.06306
age 20-24	0.30705	0.28294	0.25849	0.23398	0.18588	0.12035
age 25-29	0.26973	0.26840	0.26686	0.26514	0.26109	0.25352
age 30-34	0.20121	0.19963	0.19787	0.19593	0.19152	0.18353
age 35-39	0.11257	0.11094	0.10905	0.10690	0.10175	0.09158
age 40-44	0.04168	0.03816	0.03465	0.03122	0.02479	0.01686
age 45-49	0.00821	0.00817	0.00813	0.00809	0.00803	0.00800
Household income						
GDPPC	2 173.118	2 369.997	2 620.083	2 929.463	3 760.997	5 774.662
TYRPC	2 838.022	4 155.399	6 312.089	9 838.413	25 267.526	114 172.838
TYUPC	5 402.409	7 873.759	12 068.281	19 125.537	51 348.810	248 924.197
TXAPC	965.552	1 041.055	1 138.702	1 259.654	1 582.932	2 355.963
TXNPC	10 705.795	12.168.441	14 038.210	16 401.608	23 068.540	40 602.445
Labour force						
URB (000)	3 710.661	4 453.625	5 308.085	6 284.388	8 641.786	13 077.020
RUR (000)	6 034.334	7 349.363	8 919.820	10 792.968	15 761.321	27 432.478
Migration						
Male (000)	970.690	1 184.100	1 420.800	1 678.500	2 236.300	2 958.100
Female (000)	864.260	1 054.300	1 265.000	1 494.500	1 991.100	2 633.700
Total (000)	1 835.000	2 238.400	2 685.800	3 173.000	4 227.400	5 591.800
Gross output						
TBOT (mill)	8 554.403	16 696.815	33 599.089	67 624.305	268 035.733	1 990 826.206

Part Two

A CGE-BASED ECONOMIC-DEMOGRAPHIC MODEL OF THE PHILIPPINES

by

Vicente B. Paqueo

INTRODUCTION

That demographic change is intertwined with the pattern of economic development is widely acknowledged today. The various attempts at integrating population and development planning in countries like the Philippines are indicative of government recognition of the linkage between population and development variables. It is increasingly clear, however, that these efforts at integration are seriously hampered by lack of information regarding the sensitivity of economic-demographic variables to policy changes.

This study applies the computable general equilibrium (CGE) approach to the analysis of economic-demographic change and explores the sensitivity of population and development variables to certain changes in the policy environment. Elements of the policy environment, on which the simulation exercises are focused, includes the pace of world trade and international prices, foreign exchange rate adjustments, domestic taxes, improved efficiency in the manufacturing sector and an autonomous increase in fertility rate.

This paper will be organized as follows. The first section will briefly discuss salient features of the Philippine population and its economy. In section II, the model and its parameters will be presented and the discustion will be in section III. In these two sections and section IV we will introduce various aspects of model development, i.e., data sources, estimation and software/hardware used. Subsequently in section V the simulation exercises will be laid out and the results analyzed. The final section will be our summary and conclusions.

I. BRIEF ECONOMIC-DEMOGRAPHIC PROFILE OF THE PHILIPPINES

The lastest available census figure put the Philippine population at 48 million in 1980 up from 42.2 million in 1975 and 36.8 million in 1970. By 1985, it has been estimated to have increased to at least 55.4 million. And the Philippine government has projected the population to reach 77 million in 2000.

The following are some of the major demographic characteristics. The figures refer to 1980 except for the first item:

Estimated population (mid-year, millions)	55.4 (1985)
Proportion of population under 25 years	62.5 per cent
Proportion of population 65 years and over	3.4 per cent
Sex ratio (per 100 males)	101 females
Median age (years)	17.6
Rate of natural increase	2.7
Population doubling time (years)	25
Crude birth rate (per 1,000)	36.3
Crude dealth rate (per 1,000)	8.8
Total fertility rate (per woman)	4.96
Infant mortality rate (per 1,000)	67.3
Life expectancy at birth (years)	61.8
Population growth rate (1975-1980)	2.68 per annum

There is no consensus regarding demographic information in the Philippines. This set of figures, however, should give readers unfamiliar with the Philippines a feel of the general orders of magnitude of the country's demographic parameters.

Fertility has fallen since 1960. CBR came down from a high of 46.0 in 1960 to 33.6 in 1982. Recent demographic trends are difficult to assess. It is widely argued, however, that fertility decline has significantly and prematurely slowed down. (See Herrin and Paqueo (1985) for a discussion of this issue).

Regarding mortality trends, it is clear that the crude death rate has fallen from over 20 per thousand during the first half of the twentieth century to less than 8.7 per thousand in 1975. In 1960 infant mortality (q_0) was around 113 per thousand. By 1975 it had fallen to 76. Life expectancy at birth, on the other hand, rose from around 40 years or less before the Second World War to about 60 years in 1975.

With regards to the economy, the Philippines is considered a middle income country with a per capita GNP of $ 545 in 1985. Its recent history may be divided into the 1970s, the first half of the 1980s, and the years following the 1985 democratic revolution.

The growth of GNP in the 1970s was around 6.1-6.4 per cent per year, which was slightly above the world average. Open unemployment rate remained steady at about 4-6 per cent until 1983. Underemployment rate during this period was declining between 1971-1976 from 15 per cent to 10.6 per cent. This improvement in employment appears to have been facilitated by a downward adjustment in real wage. The real wage rate in 1980 was only one half its value in 1969.

The rate of economic growth in 1970s could not be sustained in 1980s. As the economy entered 1980s, it began to stall and came under a cloud of uncertainty. In 1983, an external debt became a crisis coincidently with assassination of Senator Benigno Aquino. Import controls were imposed and the peso was devalued relative to the dollar. With the political crisis building up rapidly, GNP declined by 6.8 per cent in 1984 and by another 3.8 per cent in 1985. During this time unemployment and underemployment rate rose. Underemployment rate increased from 21 per cent in 1980 to 36 per cent in 1984. And inflation rate reached 50 per cent in 1984, an unprecedented level in the Philippine post-war history.

The economic growth in 1970s was not sustained for various reasons. First, total factor productivity growth in general was minimal, if not outright negative. Efficiency suffered tremendously as a result of what is known in the Philippines as "crony capitalism". Second, the growth was supported through heavy foreign borrowing, which ceased to be a source of finance due to political and economic uncertainty. Philippine external debt which stood at about $ 8.8 billion in 1975-1979 rose to $ 25.2 billion in 1985. Admittedly, this foreign debt was incurred in 1970s partly as a result of the tremendous increases in the price of oil as well as the deterioration in the terms of trade. Clearly, however, foreign loans were a source of funds to finance waste and unproductive activities. It was also used as the economy entered 1980s to pursue a misguided countercyclical policy, which is reflected in government deficit relative to GNP.

In 1986, the deterioration had stopped as measured by a slightly positive growth of GNP and the prospect of achieving a growth rate of 5 per cent or more is very bright. A new administration took over after the February revolution and democratic processes were instituted that would make government more accountable. In fact liberalization and further structural adjustments have been undertaken. Restrictive fiscal policies and monetary reforms are being pursued. The political economy has stabilized and it is on the road towards economic recovery.

Serious economic problems continue to exist. Examples are the issues of land reform, the debt overhang, the investment incentive code, the population problem and the decline of the educational system. Poverty remains very high and so does underemployment. Population is growing at a rate that is much higher than expected or targeted. And the family planning programme, which continues to be under attack by an increasingly powerful conservative segment of the Philippine society, has not been very successful in reducing fertility.

II. THE MODEL

The present model consists of two major components – the demographic and economic sub-models. It is designed so that it is block recursive to minimize computational costs. The economic component follows essentially a CGE approach to sectoral modelling, while the demographic component is based on the Brass-Logit life table and treats as endogenous the age-specific survival probabilities, the general marital fertility rate and urbanization.

There are four production sectors plus government. The production sectors are:

(1) Food and Agriculture

(2) Forestry, Mining and Quarrying

(3) Manufactured, intermediate and capital goods

(4) Construction, Infrastructure and Services

The benchmark year is 1974. Equilibrium conditions are imposed on the product markets but not on the aggregate labour market and the balance of payments.

The following presents the structural equations. Variables are defined as they appear. But for convenience they are also defined and arranged alphabetically in Annexes. Unless otherwise specified, population variables are thousand persons and real values are expressed in terms of 1974 prices.

MODEL STRUCTURE

I. DEMOGRAPHIC STRUCTURE

INFANT MORTALITY RATE

1.1 $$\ln INFANTM = 2.4025 - 1.0475 \ln (EL_{-1}) + .0169\, PRFOD - 1.1020 \ln (CEXP_{-1}/POP) - .1941 \ln (HCAPH_{-1}/POP_{-1})$$

where

INFANTM = infant mortality (per thousand births)

EL = ratio of full-time equivalent employed workers to total labour force

PRFOD = relative food price (1972 = 100)

CEXP = total private consumption expenditures (in 1974 million pesos)

POP = total population (in thousands)

HCAPH = accumulated health expenditures (in 1974 million pesos)

ln = natural logarithm

1.2 $$FINFANTM = 1/5 \sum_{T}^{4} INFANTM_{t-T}$$

where

FINFANTM = five year moving average of infant mortality

MARITAL GENERAL FERTILITY RATE

1.3 $$\ln MGFR = 8.0252 - 0.07402\ (TPY_{-1}/POP_{-1})/100 - .00642\ PRFOD - .00499\ FINFANTM$$

where

MGFR = marital general fertility rate (per thousand married women)

TPY = total personal income (in 1974 thousand pesos)

LIFETABLE FUNCTIONS AND SURVIVAL RATES

1.4 $$L_1 = 1.0 - 1.01012\ (INFANTM/1000)$$

1.5 $$ALPHA = 1/2 \ln \left\{ (1 - L_1)/L_1 \right\} - BETA * SLOGIT_1$$

where

ALPHA, BETA = parameters in the Brass Logit Life-Table

1.6 $$L_x = \left\{ 1.0 + EXP\ (2\ ALPHA + 2\ BETA * SLOGIT_x \right\}^{-1}$$

where

$SLOGIT_x$ = logit of reference (standard) L_x

Subscript x = age (1, 2, 3, . . . 80)

L_x = survival probability from age 0 to x

1.7 $L_o = .276\,L_o + .724\,L_1$

where

L_x = life table person years lived by a cohort between age x and x + 1

1.8 $L_1 = .410\,L_1 + .59\,L_2$

1.9 $L_x = 1/2\,(L_x + L_{x+1})$

$x = 2, 3, 4, \ldots 79$

1.10 $SURV_B = L_o/L_B$

where

$SURV_x$ = survival probability between age x and x + 1

1.11 $SURV_o = L_1/L_o$

1.12 $SURV_x = (L_{x+1})/(L_x)$

$x = 1, 2, \ldots 78$

1.13 $SURV_{79} = L_{80.5}/L_{79}$

1.14 $SURV_{80P} = .92738$

BIRTHS AND AGE-SPECIFIC POPULATION

1.15 $BIRTH = MGFR/1000 * \left(\sum_{k=4}^{10} POP_k * PCMAR_k\right)$

where

BIRTH = number of births

POP_k = female population in the age cohort k

$PCMAR_k$ = proportion of women in age cohort k who are currently married

1.16 $FBIRTH = .487 * BIRTH$

where

FBIRTH = female births

1.17 $$POP_{o,\,t+1} = BIRTH * SURV_B$$

where

POP_x = single year age specific female population

1.18 $$POP_{x+1,\,t+1} = POP_{x,\,t} * SURV_x$$

x = 1, 2, . . . 78

1.19 $$POP_{80P,\,t+1} = POP_{79,\,t} * SURV_{79,\,t} + POP_{80P,\,t} * SURV_{80P,\,t}$$

where

POP_{80P} = population in the age cohort 80 years and over

1.20 $$FPOP = \sum_{x=0}^{80+} POP_x$$

where

FPOP = total female population (in thousands)

1.21 $$POP_k = \sum_{x=5(k-1)}^{5(k-1)+4} POP_x$$

where

POP_k = five-year age specific female population (in thousands)
k = 1, 2, 3, . . ., 17

1.22 $$POP = (1 + SEXR) * FPOP$$

where

POP = total population (in thousands)
SEXR = male to female sex ratio

1.23 $$POPW = POP - \sum_{k=1}^{2} POP_k * 2$$

where

POPW = working age population (age 10 and over) (in thousands)

1.24 $$POPL = POPW + POP_3 * 2$$

where

POPL = population 15 years old and over (in thousands)

1.25 $DEPNCY_1 = POPL/POP$

where

$DEPNCY_1$ = ratio of POPL to POP

1.26 $DEPNCY_2 = (POPL/POP) * 100$

where

$DEPNCY_2$ = ratio of POPL to POP (per cent)

1.27 $GRPOP = (POP_t/POP_{-1})$

where

GRPOP = population growth rate plus one

1.28 $NGR = (GRPOP - 1) * 1000$

where

NGR = national population growth rate (per 1000)

1.29 $CBR = (FBIRTH/POP) * (1.0/.4878) * 1000$

where

CBR = national crude birth rate (per thousand)

1.30 $CDR = CBR - NGR$

where

CDR = national crude death rate (per thousand)

1.31 $CBRLOC_1 = CBR/(FRACLOC_1 + BPHI * (1 - FRACLOC_1))$

1.32 $CBRLOC_2 = (CBR - CBRLOC_1 * FRACLOC_1)/(1 - FRACLOC_1)$

1.33 $CDRLOC_1 = CDR/(FRACLOC_1 + DPHI * (1 - FRACLOC_1))$

1.34 $CDRLOC_2 = (CDR - CDRLOC_1 * FRACLOC_1)/(1 - FRACLOC_1)$

where

$CBRLOC_r$ = crude birth rate in r where r is coded as 1 (rural) and 2 (urban) (per thousand)

$BPHI$ = ratio of rural to urban crude birth rate
$CDRLOC_r$ = crude death rate in r (per thousand)
$FRACLOC_r$ = proportion of population in r
$DPHI$ = ration of rural to urban crude death rate

1.35 $NGRLOC_r = CBRLOC_r - CDRLOC_r$

where

$NGRLOC_r$ = natural population growth rate in r

1.36 $GRHHOLD = (HHOLD/HHOLD_{-1}) - 1$

where

$GRHHOLD$ = rate of growth of households

URBANIZATION AND MIGRATION

1.37 $PHHLOC_1 = PHHLOC_{1,-1} + ELASH * ((AGEMP/AGEMP_{-1}) - 1)$

where

$PHHLOC_r$ = proportion of household in r
$ELASH$ = elasticity of $PHHLOC_1$ with respect to AGEMP

1.38 $PHHLOC_2 = 1 - PHHLOC_1$

1.39 $HOLDLOC_r = PHHLOC_r * HHOLD$

where

$HOLDLOC_r$ = number of households in location r (in thousands)
r = 1, 2

1.40 $FRACLOC_1 = FRACLOC_{1,-1} + ELASP * ((AGEMP/AGEMP_{-1}) - 1)$

where

$FRACLOC_r$ = proportion of population in r

1.41 $FRACLOC_2 = 1 - FRACLOC_1$

1.42 $POPLOC_r = POP * FRACLOC_r$

where

$POPLOC_r$ = total population in r (in thousands)
r = 1, 2

1.43 $GRPLOC_r = (POPLOC_r/POPLOC_{r,-1}) - 1$

where

$GRPLOC_r$ = growth rate in r
r = 1, 2

1.44 $MIG_r = (GRPLOC_r * 1000) - NGRLOC_r$

where

MIG_r = net migration rate in r (per thousand)
r = 1, 2

1.45 $HSIZE = ((NGR/1000 - GRHOLD) + 1) * HSIZE_{-1}$

where

HSIZE = household size (national average)

1.46 $HSLOC_r = ((GRPLOC_r - GRHLOC_r) + 1) * HSLOC_r$

where

$HSLOC_r$ = average household size in r
r = 1, 2

HEALTH EXPENDITURES

1.47 $TEXH = HLTEX * POP/1000$

where

TEXH = total government health expenditure
HLTEX = per capita government health expenditure

1.48 $HCAPH = HCAPH_{-1} + TEXH$

where

HCAPH = total accumulated health expenditures

II. MACROECONOMIC SUB-MODEL

IMPORT PRICE EQUATIONS

2.1-2.4 $PM_i = PWM_i * (1 + TM_i) * ER$

where

PM_i = peso price of imports of commodity i
PWM_i = world price of imports in "dollars"
TM_i = tariff rate on i
ER = peso/dollar exchange rate

EXPORT PRICE EQUATIONS

2.5-2.8 $PWE_i = PD_i/((1 + TE_i) * ER)$

where

PWE_i = supply price of domestic exports of i (dollars)
PD_i = domestic price of good i (in pesos)
TE_i = export subsidy (or tax) rate

COMPOSITE PRICE EQUATIONS

2.9-2.12 $PC_i = (((DELTA_i ** SIGMA * PM_i ** (1 - SIGMA)) + ((1 - DELTA_i) ** SIGMA_i * PD_i ** (1 - SIGMA))) ** (1/(1 - SIGMA)) /BPAR_i$

where

PC_i = composite price index
$DELTA_i$, $SIGMA_i$, $BPAR_i$ = parameters in Armington's CES trade aggregation function

VALUE-ADDED PRICE EQUATIONS

2.13-2.16 $PN_i = (XSUP_i/KAP_i) ** (-(1 - RHO_i)/RHO_i) * PHI ** (- 1/RHO_i) * (WAGE_i * (1 + TW_i)/RHO_i)$

where

PN_i = value added price of commodity i

$XSUP_i$ = value added of sector i
KAP_i = capital stock in sector i
RHO_i = output elasticity of labour in i
$WAGE_i$ = wage rate in sector i
PHI_i = efficient (scale) parameter in Cobb-Douglas production function
a_{ij} = input-output coefficients
TW_i = "tax" rate on labour shouldered by employers

PRICE INDEX EQUATIONS

2.17-2.20 $PINDEX = \sum_i WEIGHTS_i * PC_i$

where

$PINDEX$ = weighted general price index
$\sum_i WEIGHTS_i = 1$

OUTPUT PRICES (BASIC)

2.21-2.24 $PX_j = \sum_i a_{ij} PC_i + (1 - \sum_i a_{ij}) * PN_i$

OUTPUT PRICES (PURCHASERS)

2.25-2.29 $PD_j = PX_j (1 + TD_i)$

where

TD_i = indirect tax rate

VALUE ADDED

2.30-2.34 $XSUP_i = (1 - \sum_j a_{ij}) * QSUP_j$

where

$XSUP_i$ = total domestic production of i (value added)
$QSUP_i$ = supply of output i

LABOUR DEMAND EQUATIONS

2.35-2.39 $LABI_i$ = $(RHO_i * XSUP_i * PN_i)/(WAGE_i * (1 + TW_i))$

where

$LABI_i$ = labour input in the production of i
$WAGE_i$ = money rate in sector i (pesos)
i = 1, 2, 3, 4

2.40 $LABI_5$ = LABS * (1 + GRGB)

where

LABS = total labour supply
GRGB = rate of growth of government employment

2.41 UNEM = LABS – LABD

where

LABD = total labour demand

2.42 LABD = $\sum_i LABI_i$

2.43 EL = (LABD/LABS)

where

EL = ratio of employment in full time equivalent units to number of persons in the labour force

WAGE EQUATION

2.44-2.48 $WAGE_i$ = $WDIF_i$ * WAGEM

where

$WDIF_i$ = ratio of money wage in sector i to WAGEM
WAGEM = the money wage rate based on the Central Bank wage indicator

2.49 DWAGEA = .52416 – .07117 * GRPIND – .00029 * (LABS – LABD)

where

DWAGEA = WAGEA – $WAGEA_{-1}$

WAGEA = real wage rate based on the CB wage indicator

GRPIND = rate of inflation (per cent)

2.50 $GRWA = (WAGEA/WAGEA_{-1}) - 1$

GRWA = rate of change of WAGEA

2.51 $WAGEM = (1 + GRWA + GRPIND/100) * WAGEM_{-1}$

2.52 $GRPIND = ((PINDEX/PINDEX_{-1}) - 1) * 100$

2.53 $WAGEN = (1/LABD) * \sum_i WAGE_i * LABI_i$

where

WAGEN = weighted average nominal price index

2.54 $WAGER = (((WAGEN/WAGEN_{-1}) - 1) - GRPIND/100) * WAGER_{-1}$

where

WAGER = weighted average real wage rate

LABOUR SUPPLY EQUATIONS

2.55 $LABS = LFR * POPW$

where

LFR = labour force participation rate

POPW = working age population (10 years old and over)

2.56 $LFR = EXP(1.684) * (WAGFA ** (7.87 + 1.724 \ln EDUC)) * ((KAPFP/POP) ** -3.016) * ((KAPG/POP) ** 0.4661) * (EL_{-1} ** 0.492)$

where

EDUC = per cent of adult population 25 years old and over who have not completed a year of high school education

KAPFP = private sector originated fixed capital

KAPG = government originated fixed capital

EXPORT DEMAND FUNCTIONS

2.57-2.60 $EX_i = EPS_i * (PI_i/PWE_i) ** PSI_i$

where

EX_i = export demand (pesos) of commodity i
PI_i = average world price of domestic exports of sector i (dollars)
EPS_i = scale parameter in the export demand function
PSI_i = own price elasticity of export demand of i

IMPORT DEMAND FUNCTIONS

2.61-2.64a $DEE_i = ((DELTA_i/(1 - DELTA_i)) ** SIGMA_i * (PD_i/PM_i) ** SIGMA_i)$

2.64b $IM_i = (DEE_i/(1 + DEE_i)) * TDEM_i$

where

DEE_i = ratio of demand for imported vis-a-vis domestically produced commodity i
IM_i = import demand for product i
$TDEM_i$ = total domestic demand for product i

BALANCE OF PAYMENTS

2.65 $BOP = \sum_{i=1}^{4} PWM_i * IM_i - \sum_i PWE_i * EX_i - FCI + REM + TRF$

where

BOP = balance of payments
FCI = net foreign capital inflow

NET LABOUR INCOME

2.66 $YL = \sum_{i=1}^{5} LABI_i * WAGE_i * (1 - TL_i)$

where

YL = total net labour income
TL_i = payroll tax rate shouldered by an employed worker

NET NONLABOUR FACTOR INCOME

2.67 $YK = (1 - GSK) * \sum_{i=1}^{4} (PN_i * XSUP_i - WAGE_i * (1 + TW_i) * LABI_i) * (1 - TK_i))$

where

YK = total net nonlabour factor income of private enterprises

TK_i = direct tax rate on nonlabour income in sector i

GSK_i = government share of capital factor income

TOTAL HOUSEHOLD INCOME

2.68 $YH = YL + REM + TRF + TRG + SHR * YK$

where

YH = total household income

REM = total net remittances from abroad (pesos)

TRF = total net private transfers from abroad

TRG = total government transfers to the household

SHR = proportion of nonlabour income that goes to the household.

GOVERNMENT INCOME AND CURRENT EXPENDITURE

2.69 $YG = \sum_{i=1}^{5} LABI_i * WAGE_i * (TL_i + TW_i) + \sum_{i=1}^{4} TK_i * (PN_i * XSUP_i - (1 + TL_i + TW_i) * WAGE_i * LABI_i) + YH * TH + \sum_{i=1}^{4} TM_i * IM_i - \sum_{i=1}^{4} TE_i * EX_i + TD_i * \sum_{i=1}^{4} GSUP_i * PD_i + GTF * ER + GSK * YK/(1 - GSK)$

where

YG = government revenue (measure 1)

GTF = net government transfer from abroad

2.70 $GREVT = (YG/YG_{-1} - GRPIND/100) * GREVT_{-1}$

where

GREVT = government revenue (measure 2)

2.71 $CGEX = -2141.9 + .12818 * POP + .3105 * GREVT$

where

$CGEX$ = government consumption expenditures

INVESTMENT EQUATIONS

2.72a $TINV = PIN * GDP_{-1}$

$TINV$ = total investment

PIN = ratio of current fixed investment to last year's GDP

2.72b $FCI = GNP - CEXP - CGEX - TINV$

FCI = net foreign investment requirement

GNP = gross national product

$CEXP$ = total private consumption expenditures

2.73-2.76 $SINV_i = ((PN_i * XSUP_i - WAGE * (1 + TW_i) * LABI_i) * (1 - TK_i))/YK$

$WINV_i = QSUP_i$

where

$SINV_i$ = the share of sector i in total profit

2.77 $WRK = WETA * GDP_{-1}$

where

$WETA$ = ratio of inventory investment to last year's GDP

WRK = total demand for inventory investment

2.78-2.81 $FINV_i = TINV * SINV_{i,-1}$

$WINV_i = WRK * SINV_{i,-1}$

where

$FINV_i$ = fixed investment by sector of destination

$WINV_i$ = inventory investment by sector of destination

2.82-2.85 $KINV_i = FINV_i + WINV_i$

where

$KINV_i$ = total investment by sector of destination

PRODUCT DEMAND FROM INVESTMENT EXPENDITURES

2.86-2.89 $ZETA_i = \sum_j GAMMA_{ij} * FINV_j + MU_i * WRK$

where

$ZETA_i$	=	investment by sector of origin
$GAMMAF_{ij}$	=	purchases of product i as a proportion of fixed investment demand of sector i
MU_i	=	purchases of product i as proportion of inventory investment demand

SECTORAL CONSUMPTION EXPENDITURES

2.90-2.93 $CONS_i = CONSG_i + CONSH_i$

where

$CONS_i$ = total consumption expenditures on good i

2.94-2.97 $CONSG_i = CSHR_i * CGEX$

where

$CSHR_i$ = share of $CONSG_i$ in CGEX

2.98-2.101 $CONSH_i = SUBS_i + (TAU_i/PC_i) * (CEXP * PINDEX - \sum_{j \neq i} PC_j * SUBS_j)$

where

$CONSH_i$	=	private consumption expenditures on product i
$CONSG_i$	=	government consumption expenditures on product i
$SUBS_i$	=	minimum consumption of i
TAU_i	=	marginal budget share of i
PINDEX	=	general price index

TOTAL PRIVATE CONSUMPTION

2.102-2.105 $CEXP = HCON * HHOLD$

$HCON = 355.4 * HSIZE + .656 * FYH$

where

CEXP = total private consumption expenditure

HCON = average household consumption expenditure

HHOLD = total number of households

HSIZE = average household size

FYH = average household income

INTERMEDIATE DEMAND EQUATIONS

2.106-2.109 $INTD_i = \sum_{j=1}^{4} a_{ij} * QSUP_j$

where

$INTD_i$ = demand for composite intermediate input i

a_{ij} = input-output coefficients

TOTAL DOMESTIC DEMAND FOR DOMESTIC PRODUCT

2.110-2.113 $TDEM_i = ZETA_i + CONS_i + INTD_i$

$DDEM_i = (1/(1 + DEE_i)) * TDEM$

where

$DDEM_i$ = total domestic demand for domestically produced good i

TOTAL DEMAND FOR DOMESTICALLY PRODUCED GOOD

2.114-2.117 $XDEM_i = DDEM_i + EX_i$

where

$XDEM_i$ = total demand for domestically produced good i

PRODUCT MARKET EQUILIBRIUM CONDITION

2.118-2.121 $QSUP_i = XDEM_i$

CAPITAL ACCUMULATION

2.122-2.127 $KAP_i = (1 - DEPR) * KAP_{i,-1} + KINV_{i,-1}$

where

KAP_i = capital stock in sector i

2.128-2.131 KAPT $= \sum_{i=1}^{4} KAP_i$

where

KAPT = total capital stock (measure 1)

2.132 KAPFP = $(KAPT/KAPT_{-1}) * KAPFP_{-1}$

where

KAPFP = private sector originated capital stock (measure 2)

2.133 KAPG = $(KAPT/KAPT_{-1}) * KAPG_{-1}$

where

KAPG = government originated capital stock

AGRICULTURAL SHARE IN LABOUR

2.134 EMPG = $(LABI_1 + LABI_2)/LABD$

where

EMPG = proportion of workers in agriculture forestry and mining (measure 1)

2.135 GWAGR = $(EMGP/EMGP_{-1}) - 1$

where

GWAGR = growth rate of "primary" sector's share

2.136 AGEMP = $(1 + GWAGR) * AGEMP_{-1}$

where

AGEMP = proportion of adult (25 years old and over) workers in agriculture

2.137 NAG $(1 + GWAGR) * NAG_{-1}$

where

NAG = proportion of workers 10 years old and over in agriculture (measure 2)

HOUSEHOLD INCOME GROWTH

2.138 $GWRY = ((YH/YH_{-1}) - 1) - GRHOLD - GRPIND/100$

where

GWRY = growth rate of national average household income

GRHOLD = national growth rate of household

LEVEL OF HOUSEHOLD INCOME

2.139 $FYH = (1 + GWRY) * FYH_{-1}$

where

FYH = mean national household income

2.140 $MNLY = \log FYH - 0.50 * VARLY$

where

MNLY = mean of the log of household incomes (national; pesos)

VARLY = variance of the log of incomes

DEFINITION OF "POVERTY LINES"

2.141 $$INCT_g = \sum_{r=1}^{2} THR_{g,r} * HSLOC_r * PHHLOC_r$$

$$ADJTHR_{1,r} = THR_{1,r} * (PRFOD/100)$$

where

$INCT_g$ = national average household income poverty line (measure g = 1, 2, 3)

$THR_{g,r}$ = per capita income poverty line (measure g) in area r (1 = rural; 2 = urban)

$HSLOC_r$ = average household size in r

$PHHLOC_i$ = proportion of household in area r

$ADJTHR_{1,r}$ = "food poverty" threshold ($THR_{1,r}$) adjusted for changes in the price of food relative to the general price index

NUMBER OF POOR HOUSEHOLDS

2.142-2.144 $POORH_g = POVR_g * HHOLD$

where

POORH = number of households below the poverty line g

2.145-2.147 $\log Y_g = (MNLY - \log (INCT_g))/VARLY$

POVERTY RATE

2.148-2.150 $POVR = 1 - 0.50 * (1 + \sum_{j=1}^{4} CEE_j * \log Y_g ** j) ** (-4)$

where

CEE_j = parameter

2.151 $TPY = ((YH/YH_{-1}) + (GRPIND/100 - 1)) * TPY_{-1}$

TPY = total personal income (measure 2)

2.152 $GDP = \sum_{i=1}^{4} XSUP_i$

where

GDP = gross domestic product

2.153 $GNP = GDP + REM + TRF$

where

REM = net remittances from abroad

TRF = net transfer payments from abroad

2.154 $GWPRF = (PC_1/PC_{1,-1}) - 1) - ((PINDEX/PINDEX_{-1}) - 1)$

where

GWPRF = rate of change in the relative food price

2.155 $PRFOD = (1 + GWPRF) * PRFOD_{-1}$

where

PRFOD = ratio of food price relative to general price index

III. DISCUSSIONS

The demographic sub-model is straightforward.[1] It computes for infant mortality and its five-year moving average. It then solves for the marital general fertility rate. Given infant mortality (more exactly, q_1 in the model life table), the survival probability from birth to age x = 1 is computed.

The infant mortality is taken here as an indicator of the general health level of the community.

The model uses the Brass logit model life table system which requires only two parameters ALPHA and BETA to compute for the entire schedule of L_x. The relationship is given in eq. 1.6. for x = 1, since we know L_1 on the bais of INFANTM, we use the logit relation for x = 1 to solve for ALPHA given an exogenously determined BETA.

We assume that there is some proportional relationship between urban and rural CBR as well as CDR, which is reflected by the BPHI and DPHI. In its present form, BPHI and DPHI are exogenously determined, although one can make them depend on the level of urbanization and other variables reflecting differences in economic conditions between urban and rural areas. (That is, when data becomes available in the future). The national CDR is computed as a residual of the natural growth rate of population and the crude birth rate.

The age-specific proportion of currently married women is assumed to be exogenously determined; so are the sex-age specific headship rates which are used to calculate total households.

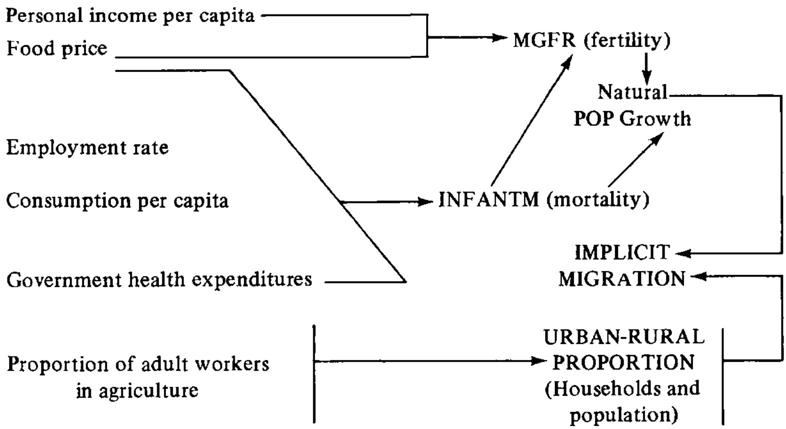
The households and population are distributed between urban and rural by using a proportionality factor. These factors are determined by their estimated relationships with the proportion of adult workers who are employed in agriculture. After computing for the proportionality factor, the model solves for the rate of growth of urban and rural population. With this, together with the natural growth rate of population and CDR for urban and rural areas, separately, the model computes for net migration rates. It then proceeds to solve for urban-rural specific household sizes and other things.

The information on total population, the number of people by broad age groups (e.g. working age and school age), number of households and average household size by urban-rural classification are used in the economic sub-model.

---

[1] This sub-model is based on a modified version of our earlier model. (See Paqueo and Herrin, 1983).

Note that in this model demographic variables are influenced by the following economic factors in this manner:



In simulating the model the demographic component is extended to enable us to compute for total fetility rate (TFR) on the basis of MGFR. The following equations are the basis for computing TFR.

$$MGFR = \frac{1}{MWRA} \left(\sum_{K=4}^{10} ASMFR_K * PCMAR_K * POPF_K \right)$$

$$ASMFR_K = FPAR_K * TFR$$

where

$MWRA$ = total married women in the reproductive age

$ASMFR_K$ = age-specific marital fertility rate

$POPF_K$ = age-specific population of women

$PCMAR_K$ = age-specific proportion of currently married women

$MGFR$ = marital general fertility rate

$FPAR_K$ = the ratio (assume constant) of $ASMFR_R$ to total fertility rate

Through appropriate substitution and manipulation, TFR could be obviously computed given $FPAR_K$ and $PCMAR_K$ MGFR, $POPF_K$ and MWRA are known endogenous variables.

We now turn to the economic sub-model. Basically, it follows very closely the open economy CGE models of Dervis, de Melo and Robinson (1982) and Habito (1984). A distinctive difference, however, is our treatment of wage and employment determination.

We assume that labour is hired up to the point where its expected marginal revenue product is equal to wage rate for the non-governmental sectors. Government demand for labour, on the other hand, is projected to increase at some predetermined growth rate.

The change in the Central Bank real wage rate indicator depends on the rate of inflation and the excess supply of labour. It is faster when the labour market is tight and slower when inflation rate is low. Sector specific wage rates are then determined as a constant proportion of the CB wage indicator.

The labour supply is calculated simply as the product of the working age population and the labour force participation rate, which is treated as an endogenous variable in the model. Labour force participation rate (LFR), as predicted by economic theory, is positively related to real wage within the observed range of the values of the variables under consideration. Private wealth decreases labour participation, while increased government expenditures on social overhead capital raises it. Cross-section studies by Fabella, Paqueo and Paderanga (1984) supports the hypothesis of a positive wage effect on labour participation. Participation rate tends to fall when employment rate is low. This suggests the significance of the so-called discouraged worker effect.

Hence, although the model does not impose that aggregate labour market clears every year, there are feedback mechanisms that could hopefully prevent excess labour demand or supply from running wild. The extent to which they could keep the system from straying too far from equilibrium depends on the estimated parameters and remains to be seen.

The model is demand driven. Demand for a commodity consists of foreign (export) and domestic demand. The latter in turn is disaggregated into demand for investment, intermediate input and final consumption by the private and government sectors. Domestic demand for domestically produced goods is calculated as a fraction of total domestic demand, using cost minimization assumption and standard Armington trade aggregation equation.

Commodity-specific private consumption expenditures are computed by a linear expenditure system (LES). On the other hand, government current expenditure depends on its revenue and total population. Demand for intermediate input is calculated using input-output coefficients. And total investment is computed as a fraction of last year's GNP. Total investment in turn is allocated to sectors of destination according to their last year's share in total profit. Finally, investment by sector of destination is divided into purchases of specific commodities according to some matrix allocators.

Total private consumption expenditures is the product of average household consumption and the number of households. Average household consumption in turn is determined by the average household size and family income.

The model provides for a method of calculating the proportion of households below some average per capita urban-rural specific "poverty threshold", which is adjusted for the relative price of food. It is assumed that income is lognormally distributed. And while the mean of the logarithm of income is endogenous, its variance is assumed to be exogenously determined.

IV. CALIBRATING THE MODEL

A. Demographic Parameters

The demographic model is calibrated using the 1975 Census of Population and parameter estimates from time series data and other sources. The 1974 age-specific population was estimated using adjusted 1975 data.

The infant mortality rate equation is based on the following equations reported in Paqueo and Herrin (1984).

$$\ln \text{INFANTM} = 2.404 - \underset{(-2.02)}{1.0475} \ln \text{EL} + \underset{(4.51)}{.0169} \text{PRFOD}$$

$$- \underset{(-2.78)}{1.103} \ln \left(\frac{\text{CEXP}_{-1}}{\text{POP}_{-1}}\right) - \underset{(-3.41)}{.1941} \ln \left(\frac{\text{HCAPH}}{\text{POP}}\right)$$

$$\bar{R}^2 = .92 \qquad \text{D.W.} = 1.51 \qquad N = 21\ (1957\text{-}1977)$$

The employment rate (EL) is included to take into account distributional effects. The assumption is that vulnerable groups in society suffer less, given the same GNP or aggregate expenditure, when employment rate is high due to distributional effects. The marital general fertility rate equation is a revised version of our earlier estimates and based on updated data on MGFR.

$$\ln \text{MGFR} = 8.0252 - \underset{(-5.21)}{0.00114} \left(\frac{\text{TPY}}{\text{POP}}\right) + \underset{(2.63)}{0.00449} \text{FINFANTM}$$

$$- \underset{(-1.64)}{0.00642} \text{PRFOD}$$

$$\bar{R}^2 = .778 \qquad \text{D.W.} = 1.29 \qquad N = 21\ (1957\text{-}1977)$$

The relationship between the proportion of rural households (PHHLOC_1) and the proportion of adult workers 25 years old and over in agriculture (AGEMP) was estimated using 1975 provincial data as:

$$\ln \text{PHHLOD}_1 = 1.1518 + \underset{(18.30)}{0.775} \ln \text{AGEMP}$$

$$\bar{R}^2 = .825 \qquad N = 72\ (\text{cross-section})$$

This equation implies ELASH = .775

Table 1 presents the 1975 census values for $PCMAR_k$, while table 2 gives headship rates estimates for 1973.

The urban-rural differentials in CDR and CBR for computing BPHI and DPHI is problematic. Based on educated guesses of Philippine demographers we assume BPHI = 0.85 and DPHI = 0.90.

B. Economic Parameters

Table 3 gives the 1974 input-output flows and the sectoral value added. On the basis of table 3 the input-output coefficients were calculated and presented in table 4.

The parameters of the production function assumed in the present model is provided in table 5. These values were not econometrically determined. They are values based on judgements, which we made after looking at relevant literature.

The rest of the parameters presented in the various tables mostly come from Habito's 1984 CGE model of the Philippines, which has been calibrated using the 1974 input-output and related data. Habito's model consists of 18 production sectors. Hence, we got the average values of the parameters, after the 18 sectors have been aggregated into our four sectoral classification of production activities.

Table 1. Per Cent of Women Currently Married by Age: 1948-1975

Age of Women	*Census Years*			
	1948	*1960*	*1970*	*1975*
15-19	14.5	12.4	10.6	12.1
20-24	57.2	54.5	48.6	48.0
25-29	76.8	78.2	76.6	74.2
30-34	80.7	84.8	85.3	85.3
35-39	81.8	86.4	87.4	87.9
40-44	78.0	83.2	85.1	87.1
45-49	74.7	80.2	82.3	84.7

Table 2. Age-sex Specific Headship Rates (Per Cent)

Age	*1968 NDS*		*1973 NDS*	
	Male	*Female*	*Male*	*Female*
15-19	0.2	0.02	0.9	0.1
20-24	11.4	0.38	17.2	0.3
25-29	58.6	1.2	52.3	1.0
30-34	78,7	2.6	77.6	3.3
35-39	89.9	5.1	88.8	5.1
40-44	94.7	7.8	91.7	7.7
45-49	95.0	9.0	95.3	10.4
50-54	95.6	15.6	95.6	14.0
55-59	96.0	20.6	95.2	18.2
60-64	92.5	20.2	91.8	17.3
65+	79.9	27.4	79.4	27.1

Source: Cabigon, J.V. "Patterns, Trends and Differentials in Household Headship in the Philippines," Research Note No. 26 in *Population, Resource, Environment and the Philippine Future: Final Report,* Vol. III-5, University of the Philippines Population Institute, September 1977, (p. 1699).

Table 3. 1974 Input-Output Flows and Value Added

(Million pesos)

Source	*Food and agriculture* *(1)*	*Forestry and mining* *(2)*	*Manufactured, capital and intermediate goods* *(3)*	*Construction, infrastructure and services* *(4)*	*Intermediate demands*	*Private consumption expenditures*	*Gov't expenditures*	*Capital formation*	*Inventory*	*Exports*	*Imports*	*Net final demand*	*Total sales*
(1) Food & agriculture	18 671.03	0	1 681.71	1 233.10	21 585.83	34 200.72	284.25	0	1 065.28	6 918.85	2 809.52	39 659.57	61 245.41
(2) Forestry & mining	51.49	232.59	5 251.58	210.27	5 745.93	545.97	4.66	0	975.26	5 130.89	4 407.57	2 249.22	7 995.15
(3) Manufactured, capital & intermediate goods	3 556.58	949.92	9 891.28	6 189.49	20 587.21	12 105.11	2 158.36	8 173.45	5 031.44	4 368.06	16 242.70	15 593.74	36 180.95
(4) Construction, infrastructure and services	4 423.57	464.10	5 200.80	8 993.23	19 081.66	19 862.62	6 279.86	10 288.63	0	5 871.75	1 939.80	40 363.03	59 444.69
Sub-total	26 702.67	1 646.6	22 025.37	16 626.09	67 000.73	66 714.42	8 727.13	18 462.08	7 072.02	22 289.59	25 399.59	97 865.56	164 866.2
Value added	32 018.49	5 827.72	11 347.10	39 052.39	88 245.70	0	0	0	0	0	0	0	0
Indirect tax	2 524.28	520.79	2 808.57	3 766.23	9 619.86	0	0	0	0	0	0	0	0
Total supply	61 245.41	7 995.15	36 180.95	59 444.69	164 866.22	66 714.42	8 727.13	18 462.08	7 072.02	22 289.55	25 399.59	97 865.56	164 866.2

Table 4. Input-Output Coefficients

Sector:	(1)	(2)	(3)	(4)
(1) Food & agriculture	.30485	0	.04645	.02074
(2) Forestry & mining	.00084	.02909	.14515	.00354
(3) Manufactured, intermediate & capital goods	.05807	.11881	.27338	.10412
(4) Construction, infrastructure and services	.07222	.05804	.14374	.15129

Table 5. Cobb-Douglas Production Function Parameters

Sector:	1	2	3	4
ETA	.40	.40	.50	.55
RHO	.60	.60	.50	.45
PHI	1.855	.438	2.154	1.308

Table 6. Parameters in Armington's Trade Aggregation Function

Product (Sector):	1	2	3	4
SIGMA	2.0	2.0	1.25	.3
DELTA	.185	.554	.369	.000016
BPAR	1.432	1.977	1.915	1.052

Table 7. Linear Expenditures System and Export Demand Parameters

Product (Sector):	*1*	*2*	*3*	*4*
TAU (marginal budget share)	.228	.012	.519	.241
SUBS (substance minimum)	31 987	416	7 050	17 450
PSI (own price export elasticity)	0.9	0.9	1.8	1
EPS (intercept of export function	6 918.8	5 130.9	4 368.1	5 871.8

Table 8. Tax Rates Circa: 1974

Sectors:	*1*	*2*	*3*	*4*	*5*
TD	.04	.065	.078	.063	
TE	.035	.035	.035	.035	
TK	.042	.042	.092	.079	
TM	.35	.35	.35	.35	
TL	.025	.0165	.0165	.033	.033
TW	.025	.0165	.033	.033	
TH	.014				

Table 9. Initial Values of Price Variable: 1974

Sector:	*1*	*2*	*3*	*4*
PM	1	1	1	1
PC	1	1	1	1
PWE	1	1	1	1
PN	1	1	1	1
PD	1	1	1	1
PI	1	1	1	1
PWM	1	1	1	1

Table 10. Fixed Investment Coefficient Matrix

	1	2 (Destination)	3	4
(Source)				
1	0	0	0	0
2	0	0	0	0
3	.54	.34	.47	.38
4	.46	.65	.53	.62

Table 11. Other Parameters in the Economic Model

GRGB .03 GSK .05 SHR .68 CEE1 .196854 CEE2 .115194 CEE3 .000344

CEE 4 .619529 DEPR .035 VARLY 1.5274

Sectors:	1	2	3	4	5
WEIGHTS	.363	.066	.128	.442	
WETA	.0174	.122	.1391	0	
RQX	1.913	1.372	3.188	1.522	
THETA	.35	.10	.15	.40	
CSHR	.0325	.0005	.247	.719	
WDIF	.792	.89	1.95	1.087	1.95

V. SIMULATION RESULTS

The model was simulated using SAS and Gauss-Seidel algorithm. The initial tests show that labour participation rate in many cases became unrealistically high. Hence, we put an arbitrary limit of 75 per cent. We adjusted the fertility equation by setting MGADJ = –40, which means subtracting 40 from the MGFR that would have resulted from the original equation. In implementing the model, some of the variables were lagged one year to minimize computational costs and difficulty.

There are 11 sets of simulation results presented in this section, marked A through K. These are described in table 12. Given our data constraints and the revolutionary change in regime in the Philippine economy, none of these represent in any way a forecast. The usefulness of these results lie solely in the comparison of differences among the simulation outcomes in relation to predetermined changes in parameters and exogenous variables. In the Annexes are presented in comparative format the values of the variables corresponding to specific "experiments".

The discussion here will not go into the details of comparing results. Rather, it will be selective in highlighting key messages, arising out of the simulations.

A key question that we have sought to examine, given the external balance of payments problem constraining Philippine development, is the economic and demographic impact of price changes in the international market. To address this objective, a comparison between A and B would be an appropriate beginning of the discussion of the simulation results.

B is the same as A except that both international prices of exports and imports for all sectors are made to increase at 5 per cent annually. The effect is a higher GDP by 1999 both in absolute and per capita terms. This seems to suggest that, given the relevant parameters of the model, rising prices for both exports and imports would tend to favour the Philippines on the whole. It should be noted, however, that in terms of growth rates there appears to be cyclical reversals. This could be the result of labour market adjustment behaviour in the model. The effect on population is insubstantial.

From B, we then let the demand for Philippine export shift upwards, allowing the intercept (EPSi) of the export function increase at 5 per cent annually for all sectors. Comparing B and C, we find the latter's GDP to be higher. It was about 4.5 per cent higher by the close of the century. Similar results obtain for the real wage rate. With regard to population, it is about 2 per cent lower in C than B by 1995. By 1990-1995, its growth rate in C was 2.84 compared to B's 3.11. Hence, the effect of increasing opportunities to sell in the international market would have significant effects in raising economic growth and a moderate impact in facilitating demographic transition to lower population growth and fertility. Total fertility rate in C is about half a birth less than B by 1995.

Proceeding from C, a series of experiments (D to K) were then conducted, i.e., each of these simulations (D to K) should be compared with C. Continuing with our investigation of the effect of changes in the external sector, international prices of exports for all sectors were made to declining at 5 per cent annually. Its negative economic impact is dramatic. By the time of the next century, C's GDP is 25 per cent higher than D. The differences in growth rates in GDP both in absolute and, even more so in per capita terms, are dramatic. The differences are not only large but occurred with immediate effects. At one point in 1985-1990 GNP growth rate in C was 7.34 compared to D's 2.60. In per capita GDP growth rate, C's is 4.43 in the same period, while D's was a negative rate of –.55. Its demographic impact is also considerable. By 1995 C's population stands at 71.73 million compared to D's 74.11 million. During 1990-1995 the latter was growing at 3.33 per cent per year, while the former was only 2.84. D's crude birth rate in 1995 is 37.22 as opposed to C's 30.59. Total fertility rate during that year is higher in D than C by at least one birth. Finally, CDR in D is higher than C by close to 2 deaths per thousand population.

Note that sector shares and urbanization remain largely unaffected. Labour force participation rate, however, is higher in C in response to higher wages. The wage rate in C in 1995 is 14.32 compared to D's 8.6.

What happens when as in E (vis-a-vis C) the marital general fertility rate is effectively increased by 40 births per 1,000 married women in the reproductive age annually over and above what the MGFR would have been given the values of its socio-economic determinants? Population is higher in E (78.83 million) than in C (71.73 million) by about 10 per cent in 1995. In that year it is growing at 3.23 in E as against 2.84 in C. Total fertility rate is about .9 of birth higher in E. And crude birth rate in E is 34.16 as against C's 30.59. Note, however, that it is lower than D's 37.22. (This is a result which, incidentally, further illustrates the potential importance of external forces on demographic trends through their effects on the local economy and its interactions with fertility decisions and mortality).

The economy under E has more GDP, which is 5.6 per cent larger than C at the close of the century. This is not an unexpected result. What is unexpected is the result that shows very little difference in per capita GDP before 1995 when it is 6.6 per cent greater in C than E. It is worth noting, however, that infant mortality rate and crude death rate are higher as a result of the exogenous increase in fertility. The IMR and CDR in C is only 52.96 and 5.21, respectively, while they are 59.85 and 5.64 correspondingly in E. It is also interesting that urbanization and the various sector shares are relatively unaffected.

Table 12. Simulations

Run No.	
A	Changes in aggregate import and export price index applied to sectors up to 1980; after 1980 international prices of Philippine exports and imports, PWX_i and PWM_i respectively, are assumed to be unchanged.
B	Same as A. *But,* after 1980 PWM_i and PWX_i are made to rise at an annual rate of increase of 5 per cent.
C	Same as B. *But,* export demand is assumed to shift to high levels, i.e., EPS_i for all i's is made to increase at the annual rate of 5 per cent.
D	Same as C. *But,* international prices of exports (P_i for all i's) are declining at the annual rate of 5 per cent
E	Same as C. *But,* MGADJ = 0, i.e., 40 births per 1000 married women in the reproductive age is being exogenously added to the MGFR that would have been obtained given the values of the socio-economic variables.
F	Same as C. *But,* tax rate on income from profit (TK) for sector 1 and 2 are increased by 100 per cent from 4.2 per cent to 8.4 per cent.
G	Same as C. *But,* payroll tax rates (TW and TL) are abolished.
H	Same as C. *But,* indirect tax rate for sector 3 is raised by 28 per cent from .078 to .1.
I	Same as C. *But,* reduce elasticity of proportion of households and population living in rural areas with respect to the ratio of agricultural workers to total employment, i.e., ELASH and ELASP are reduced from .775 to .65, a 16 per cent decrease.
J	Same as C. *But,* the nominal exchange rate relative to its 1974 value, which is actual for 1974-1980, was assumed to be equal to 2.74 after 1980 instead of 1.10. The latter value of 1.10, which is used in other simulations, is the 1980 actual value, while the figure of 2.74 is the actual value of 1985.
K	Same as C. *But,* PHI_3 (the efficiency parameter of the manufacturing sector) is allowed to grow at 2 per cent per year.

What are the effects of changes in the tax regime? How does F, where tax on income from profit is raised by 100 per cent from 4.2 to 8.4 per cent, compare to C? The effect on GDP and other variables are very small. How about payroll taxes? Comparing C and G, the impact of abolishing the current payroll taxes on GDP and private consumption both in absolute and per capita terms appear minimal. Sector shares are hardly affected. Similarly the economic and demographic impact of raising indirect tax from .078 to .10 (a 28 per cent increase) is negligible as can be gleaned from a comparison between C and H.

Comparing now J and C, we note that allowing the nominal foreign exchange rate to rise rapidly produced the following curious results. GDP was slightly higher in J than C as of 1985, after which there is a reversal. Private consumption, per capita, however, is lower in J throughout the period. So is the wage rate. The gain from the exchange rate adjustment appears to be in wiping out the balance of payments deficit and accumulating a large surplus. The social cost is higher mortality. CDR in J is 5.82 as opposed to 5.21 in C. Furthermore, IMR is 64.71 compared to only 52.96 in C. The impact on total population is negligible. The result showing that foreign exchange rate adjustment imposes social costs in terms of consumption and mortality is a plausible result. The extent of its impact, however, in this model depends on the implicit policy of drastic reduction of balance of payment deficit and the rapid accumulation of foreign exchange surplus.

There are significant changes in the sector shares associated with foreign exchange adjustment. By 1995, agriculture in C accounts for only 34.17 per cent, of total employment and 26.76 per cent of total value added. In contrast, in J the corresponding figures are 38.28 per cent and 30.17 per cent, respectively. The biggest loser is sector 4, which is the construction, infrastructure and services sector. This has the effect of substantially increasing the proportion of households in the rural areas.

In the last experiment (K relative to C), we let the efficiency parameter (PHI_3) of the manufacturing sector grow at the annual rate of 2 per cent. As may be expected, GDP in K is larger than in C. The difference is significant but moderate – due perhaps to the relatively small share of the manufacturing sector at the beginning of the simulation period. In 1990 the difference was 4.6 per cent. It rose to 7.5 by the close of the twentieth century. Its impact on private consumption expenditures per capita appears negligible.

The relative share of the manufacturing sector improved very slightly. However, its share in total employment fell significantly. The share in K is 6.24 in 1990 and 5.99 in 1999. In contrast, the corresponding figures in C are 8.34 and 8.61, respectively. Consequently, the urbanization in C seems slightly higher. This is counter intuitive. What may be happenning is that the increase in efficiency in the manufacturing sector allowed the release of labour into the other sectors.

CONCLUSIONS

Several points are worth taking note of in concluding this paper.

1. It would appear that payroll taxes, which in the Philippines are essentially used to finance health insurance and housing programmes, have negligible impact on the economy – at least at their current rates.

2. Access to export markets and a steady rise in the international price of exports do have notable, desirable effects on economic change and facilitate demographic transition, i.e., lower mortality, fertility, and population growth.

3. While there are indeed dramatic gains from adjusting upwards the nominal foreign exchange rate in terms of being able to rapidly wipe out the balance of payments deficit and then accumulate rapidly a surplus, there are significant social costs: lower private per capita consumption and higher mortality. It may, however, be that these social costs may be minimized if rapid accumulation of a huge surplus is avoided. With regards to urbanization, these exchange rate and external balance adjustments seem to result in significant shifts towards agriculture and rural areas away from the services and construction sector as well as from the urban economy.

4. In this model, where mortality and fertility are determined endogenously, an autonomous addition of 40 births per thousand married women in the reproductive age has the effect of reducing the size of GDP. But, what is curious is that per capita GDP is hardly different. However, it has notable negative effects on mortality.

These observations, it must be stressed, are not conclusive. The results being reported here are simply the outcomes of our assumptions about the structure and parameters of the model. And they need to be validated with good empirical analysis of actual events. It is hoped, however, this study would help stimulate research on the issues being addressed in this paper.

References

1. Abramowitz, M. and I. Stegun, (ed.) *Handbook of Mathematical Functions,* Dover Publications, Inc., 1970.

2. Aitchison, J. and J.A.C. Brown, *The Lognormal Distribution With Special Reference to its Uses in Economics,* Cambridge University Press, Cambridge, 1957.

3. Bautista, R., J. Power and Associates, *Industrial Promotion Policies in the Philippines,* Philippine Institute for Development Studies, Philippines, 1979.

4. Boulier, B. and V. Paqueo, "On the Theory and Measurements of the Determinants of Mortality", Population and Human Resources Division, Discussion Paper No. 81-31, Washington, D.C., The World Bank, 1981.

5. Cabigon, J., "Patterns, Trends and Differentials in Household Headship in the Philippines," Population, Resources, Environment and the Philippine Future: Final Report, Vol. III-5, University of the Philippines Population Institute, 1977.

6. Dervis, K., J. De Melo and S. Robinson, *General Equilibrium Models for Development Policy,* A World Bank Publication, Cambridge University Press, Cambridge, 1984.

7. Habito, C., "Equity and Efficiency Trade-offs in Philippine Tax Policy Analysis: A General Equilibrium Approach", Ph. D. dissertation, Harvard University, Cambridge, Massachusetts, 1984.

8. NEDA, *1974 Interindustry (Input-Output) Accounts of the Philippines,* Republic of the Philippines, National Economic and Development Authority, National Census and Statistics Office, Manila, 1979.

9. ______, *Philippine Statistical Yearbook,* Republic of the Philippines, 1986.

10. Paqueo, V., A. Herrin, and Associates, "Population and Development Planning: Modeling Macroeconomic and Demographic Interactions", volume prepared for a NEDA workshop on the applications of the Population and Development Planning model, 10-12 October 1984.

11. Paqueo, V. and A. Herrin, "The Population Development Planning Demographic Sub-model", in Paqueo, and others (1984).

12. The World Bank, "The Philippines, A Framework for Economic Recovery," Report No. 6350-PH, volumes I, II, and III, 1986. 12.

13. Tidalgo, R. and M. Esquerra, *Philippine Employment in the 1970's, Philippine Institute for Development Studies, 1982.*

Annexes

Definitions

$ADJTHR_{1,r}$	=	"food poverty" threshold ($THR_{1,r}$) adjusted for changes in the price of food relative to the general price index
AGEMP	=	proportion of adult (25 years old and over) workers in agriculture
a_{ij}	=	input-output coefficients
ALPHA, BETA	=	parameters in the Brass Logit Life-Table
BOP	=	balance of payments
BIRTH	=	number of births
BPHI	=	ratio of rural to urban crude birth rate
CBR	=	national crude birth rate (per thousand)
$CBRLOC_r$	=	crude birth rate in r where r is coded as 1 (rural) and 2 (urban) (per thousand)
CDR	=	national crude death rate (per thousand)
$CDRLOC_r$	=	crude death rate in r (per thousand)
CEE_j	=	parameter in the equation approximating the normal cumulative density function
CGEX	=	government consumption expenditures
CEXP	=	total private consumption expenditures (in 1974 million pesos)
$CONS_i$	=	total consumption expenditures on good i
$CONSG_i$	=	government consumption expenditures on product i
$CONSH_i$	=	private consumption expenditures on product i
$CSHR_i$	=	share of $CONSG_i$ in CGEX
$DDEM_i$	=	total domestic demand for domestically produced good i
DEE_i	=	ratio of demand for imported vis-a-vis domestically produced commodity i
$DEPNCY_1$	=	ratio of POPL to POP
$DEPNCY_2$	=	ratio of POPL to POP (per cent)

DELTA$_i$, SIGMA$_i$,
BPAR$_i$ = parameter in Armington's CES trade aggregration function

DPHI = ratio of rural to urban crude death rate

DWAGEA = WAGEA – WAGEA$_{-1}$

EDUC = per cent of adult population 25 years old and over who have not completed a year of high school education

EL = ratio of employment in full time equivalent units to number of persons in the labour force

ELASH = elasticity of PHHLOC1 with respect to AGEMP

EMPG = proportion of workers in agriculture forestry and mining (measure 1)

EPS$_i$ = scale parameter in the export demand function

ER = peso/dollar exchange rate

EX$_i$ = export demand (pesos) of commodity i

FBIRTH = female births

FCI = net foreign capital inflow

FINFANTM = five year moving average of infant mortality

FINV$_i$ = fixed investment by sector of destination

FPOP = total female population (in thousands)

FRACLOC$_r$ = proportion of population in r

FYH = mean national household income

GAMMAF$_{ij}$ = purchases of product i as a proportion of fixed investment demand of sector i

GDP = gross demestic product

GNP = gross national product

GREVT = government revenue (measure 2)

GRGB = rate of growth of government employment

GRHHOLD = rate of growth of households

GRHOLD = national growth rate of households

GRPIND = rate of inflation (per cent)

GRPLOC$_r$ = population growth rate in r

GRPOP = population growth rate plus one

GRWA = rate of change of WAGEA

GSK_i	=	government share of capital factor income
GTF	=	net government transfer from abroad
GWAGR	=	growth rate of "primary" sector's share
GWPRF	=	rate of change in the relative food price
GWRY	=	growth rate of national average household income
HCAPH	=	accumulated health expenditures (in 1974 million pesos)
HCON	=	average household consumption expenditure
HHOLD	=	total number of households
HLTEX	=	per capita government health expenditures
$HOLDLOC_r$	=	number of households in location r (in thousands)
HSIZE	=	household size (national average)
$HSLOC_r$	=	average household size in r
$INCT_g$	=	national average household income poverty line (measure g = 1,2,3)
INFANTM	=	infant mortality (per thousand births)
IM_i	=	import demand for product i
$INTD_i$	=	demand for composite intermediate input i
KAP_i	=	capital stock in sector i
KAPFP	=	private sector originated fixed capital
KAPG	=	government originated fixed capital
KAPT	=	total capital stock (measure 1)
$KINV_i$	=	total investment by sector of destination
ln	=	natural logarithm
l_x	=	survival probability from age 0 to x
L_x	=	life table person years lived by a cohort between age x and x+1
LABD	=	total labour demand
$LABI_i$	=	labour input in the production of i
LABS	=	total labour supply
LFR	=	labour force participation rate
LGS	=	proportion of work force employed by government

MGFR = marital general fertility rate (per thousand married women)

MIG_r = net migration rate in r (per thousand)

MNLY = mean of the log of household incomes (national; pesos)

MU_i = purchases of product i as proportion of inventory investment demand

NAG = proportion of workers 10 years old and over in agriculture (measure 2)

NGR = national population growth rate (per 1000)

$NGRLOC_r$ = natural population growth rate in r

PC_i = composite price index

$PCMAR_k$ = proportion of women in age cohort k who are currently married

PD_i = domestic price of good i (in pesos)

$PHHLOC_r$ = proportion of households in area r

PHI_i = efficiency (scale) parameter in Cobb-Douglas production function

PI_i = average world price of domestic exports of sector i (dollars)

PIN = ratio of current fixed investment to last year's GDP

PINDEX = weighted general price index

PM_i = peso price of imports of commodity i

PN_i = value added price of commodity i

POPW = working age population (10 years old and over)

$POORH_g$ = number of households below the proverty line g

POP = total population (in thousands)

POP_k = female population in the age cohort k or five-year age specific female population (in thousands)

POP_x = single year age specific female population

POP_{80p} = population in the age cohort 80 years and over

POPW = working age population (age 10 and over in thousands)

POPL = population 15 years old and over (in thousands)

$POPLOC_r$ = total population in r (in thousands)

PRFOD = relative food price (1972 = 100) or ratio of food price relative to general price index

PSI_i = own price elasticity of export demand of i
PWE_i = supply price of domestic experts of i (dollars)
PWM_i = world price of imports in "dollars"

$QSUP_i$ = supply of output i

REM = total net remittances from abroad (pesos)
RHO_i = output elasticity of labour in i

SEXR = male to female sex ratio
SHR = proportion of nonlabour income that goes to the household
$SINV_i$ = the share of sector i in total profit
$SLOGIT_x$ = logit of reference (standard) L_x
$SUBS_i$ = minimum consumption of i
$SURV_x$ = survival probability between age x and x+1

TAU_i = marginal budget share of i
TD_i = indirect tax rate
$TDEM_i$ = total domestic demand for of product i
TE_i = export subsidy (or tax) rate
TEXH = total government health expenditure
TFR = total fertility rate
$THR_{g,r}$ = per capita income poverty line (measure g) in area r (1 = rural; 2 = urban)
TINV = total investment
TK_i = direct tax rate on nonlabour income in sector i
TL_i = payroll tax rate shouldered by an employed worker
TM_i = tariff rate on i
TPY = total personal income (measure 2)
TRF = net transfer payments from abroad
TRG = total government transfers to the household
TW_i = "tax" rate on labour shouldered by employers

$WAGE_i$ = wage rate in sector i or money rate in sector i (pesos)

WAGEA	=	real wage rate based on the Central Bank wage indicator
WAGEM	=	the money wage rate based on the Central Bank wage indicator
WAGEN	=	weighted average nominal price index
WAGER	=	weighted average real wage rate
$WDIF_i$	=	ratio of money wage in sector i to WAGEM
WETA	=	ratio of inventory investment to last years's GDP
$WINV_i$	=	inventory investment by sector of destination
WRK	=	total demand for inventory investment
VARLY	=	variance of the log of incomes
XDEM	=	total demand for domestically produced good i
$XSUP_i$	=	total domestic production of sector i (value added)
YG	=	government revenue (measure 1)
YH	=	total household income
YK	=	total net nonlabour factor income of private enterprises
YL	=	total net labour income
$ZETA_i$	=	investment by sector of origin
$\sum_i WEIGHTS_i$	=	1

Note: Unless otherwise specified, population variables are in thousand persons; monetary variables are in million pesos and expressed in 1974 prices.

Table 1A. Total Population (in Thousands)

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975	42 645.4	42 645.4	42 646.1	42 645.8	43 077.5	42 646.1	42 645.2	42 648.0	42 646.1	42 646.1	42 646.2
1980	48 369.7	48 369.7	48 371.1	48 370.2	50 038.3	48 363.7	48 350.2	49 578.5	49 566.1	49 567.8	49 554.6
1985	54 930.2	54 999.7	54 816.6	54 893.7	58 038.1	54 790.2	54 734.9	54 842.9	54 816.6	54 972.6	54 791.6
1990	63 476.0	63 467.8	62 804.3	63 528.5	67 869.2	62 760.5	62 654.7	62 852.1	62 804.3	62 908.8	62 731.8
1995	73 337.6	73 231.5	71 734.1	74 110.9	78 832.6	71 665.9	71 512.5	71 808.1	71 734.1	71 731.4	71 586.0

Table 2A. Population Growth Rate (Per Cent)

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975-1980	2.68	2.68	2.68	2.68	3.23	2.68	2.68	3.25	3.24	3.25	3.24
1980-1985	2.71	2.74	2.66	2.70	3.20	2.66	2.64	2.12	2.12	2.18	2.11
1985-1990	3.11	3.08	2.91	3.15	3.39	2.91	2.89	2.92	2.91	2.89	2.90
1990-1995	3.11	3.08	2.84	3.33	3.23	2.84	2.83	2.85	2.84	2.80	2.82

Table 3A. Number of Households (in Thousands)

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975	–	–	8 019	–	–	–	–	–	–	–	–
1980	–	–	10 036	–	–	–	–	–	–	–	–
1985	–	–	12 490	–	–	–	–	–	–	–	–
1990	15 152	15 177	15 222	15 158	15 206	15 217	15 239	15 222	15 222	15 245	15 218
1995	17 929	17 965	18 046	17 911	18 046	18 037	18 072	18 045	18 046	18 071	18 039

Table 4A. Rate of Growth of Households (Per Cent)

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975	4.51	4.51	4.51	4.51	4.51	4.51	4.51	4.51	4.51	4.51	4.51
1980	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59
1985	4.24	4.24	4.24	4.24	4.24	4.24	4.24	4.24	4.24	4.24	4.24
1990	3.82	3.84	3.87	3.81	3.87	3.87	3.88	3.87	3.87	3.85	3.87
1995	3.23	3.22	3.27	3.20	3.31	3.26	3.28	3.27	3.27	3.24	3.27

Table 5A. Crude Birth Rate (Per Thousand)

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975	31.62	31.62	31.64	31.63	37.01	31.64	31.62	31.69	31.64	31.64	31.64
1976	32.56	32.56	32.58	32.57	37.89	32.60	32.47	32.61	32.58	32.58	32.54
1977	31.51	31.51	31.46	31.49	36.76	31.46	31.31	31.50	31.46	31.46	31.43
1978	30.74	30.74	30.55	30.64	35.87	30.52	30.35	39.58	30.55	30.55	30.53
1979	30.50	30.50	30.13	30.31	35.50	30.09	29.88	30.17	30.13	30.13	30.13
1980	30.40	30.40	29.81	30.10	35.23	29.77	29.49	29.85	29.81	29.81	29.82
1981	30.26	30.34	29.54	29.94	34.95	29.50	29.17	29.61	29.54	29.58	29.55
1982	30.74	30.90	29.91	30.38	35.26	29.88	29.51	29.98	29.91	29.99	29.91
1983	31.41	31.56	30.36	31.00	35.62	30.35	29.97	30.43	30.36	30.82	30.35
1984	32.24	32.29	30.90	31.83	36.03	30.89	30.51	30.97	30.90	31.69	30.86
1985	33.29	33.14	31.54	32.95	36.54	31.55	31.16	31.61	31.54	32.86	31.49
1986	34.46	34.03	32.25	34.27	37.11	32.27	31.87	32.32	32.25	32.68	32.18
1987	35.60	34.87	32.91	35.68	37.62	32.93	32.53	32.98	32.91	32.11	32.81
1988	36.49	35.52	33.38	36.93	37.92	33.41	33.02	33.45	33.38	31.94	33.27
1989	36.82	35.72	33.43	37.69	37.81	33.46	33.08	33.50	33.43	32.13	33.30
1990	36.98	35.89	33.45	38.33	37.68	33.47	33.11	33.51	33.45	32.57	33.31
1991	36.89	35.91	33.34	38.75	37.38	33.36	33.02	33.40	33.34	33.00	33.19
1992	36.45	35.67	33.04	38.83	36.74	33.06	32.74	33.10	33.04	32.88	32.89
1993	35.80	35.26	32.53	38.63	35.92	32.54	32.21	32.60	32.53	32.15	32.39
1994	34.47	34.25	31.34	37.64	34.67	31.34	31.00	31.41	31.34	30.78	31.20
1995	33.65	33.85	30.59	37.22	34.16	30.58	30.24	30.67	30.59	30.29	30.45

Table 6A. Crude Death Rate (Per Thousand)

	A	B	C	D	E	F	G	H	I	J	K
1975	6.60	6.60	6.60	6.60	6.92	6.60	6.60	6.60	6.60	6.60	6.60
1976	6.45	6.45	6.38	6.41	6.78	6.38	6.38	6.35	6.38	6.38	6.37
1977	5.17	5.17	4.99	5.08	5.34	4.99	4.89	5.00	4.99	4.99	5.02
1978	5.37	5.37	5.10	5.23	5.55	5.11	4.95	5.11	5.10	5.10	5.15
1979	5.57	5.57	5.25	5.41	5.76	5.27	5.08	5.26	5.25	5.25	5.30
1980	5.60	5.60	5.24	5.42	5.76	5.27	5.07	5.25	5.24	5.24	5.28
1981	5.24	5.24	4.84	5.04	5.30	4.88	4.67	4.85	4.84	4.84	4.87
1982	5.37	5.34	4.87	5.10	5.32	4.70	4.88	4.87	4.89	4.91	4.90
1983	5.75	5.57	5.05	5.46	5.51	4.88	5.06	5.05	5.08	5.10	5.08
1984	6.17	5.84	5.29	5.93	5.76	5.12	5.31	5.29	5.21	5.35	5.33
1985	6.58	6.11	5.54	6.43	5.98	5.36	5.55	5.54	5.33	5.60	5.57
1986	6.65	6.08	5.50	6.59	5.92	5.32	5.51	5.50	4.44	5.56	5.53
1987	6.84	6.23	5.59	6.90	5.98	5.42	5.60	5.59	4.30	5.66	5.62
1988	6.84	6.22	5.56	7.03	5.90	5.38	5.57	5.56	4.88	5.63	5.59
1989	6.74	6.17	5.49	7.08	5.78	5.31	5.50	5.49	5.51	5.56	5.52
1990	6.56	6.06	5.38	7.05	5.63	5.45	5.21	5.39	5.38	5.62	5.42
1991	6.35	5.95	5.29	6.99	5.44	5.36	5.12	5.30	5.29	5.26	5.34
1992	6.18	5.88	5.25	6.92	5.24	5.32	5.08	5.26	5.25	4.90	5.30
1993	6.11	5.88	5.20	6.87	5.20	5.26	5.00	5.22	5.20	4.89	5.26
1994	6.05	5.96	5.15	6.87	5.34	5.21	4.96	5.17	5.15	5.24	5.20
1995	6.05	6.09	5.21	6.94	5.64	5.26	5.04	5.22	5.21	5.82	5.24

Table 7A. Infant Mortality Rate (Per Thousand Live Births)

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975	78.54	78.54	77.58	78.06	79.12	77.58	77.66	77.24	77.58	77.58	77.57
1976	62.60	62.60	60.40	61.49	62.16	60.42	59.16	60.45	60.40	60.40	60.75
1977	65.69	65.69	62.39	64.04	64.77	62.54	60.57	62.50	62.39	62.39	62.98
1978	68.43	68.43	64.56	66.50	67.25	64.84	62.52	64.70	64.56	64.56	65.16
1979	69.34	69.34	65.06	67.21	67.74	65.48	63.01	65.18	65.06	65.06	65.56
1980	66.41	66.41	61.64	64.03	63.95	62.14	59.71	61.77	61.64	61.64	62.01
1981	69.20	68.73	63.25	65.99	65.36	63.85	61.36	63.38	63.25	63.46	63.68
1982	74.38	72.07	66.07	70.96	68.11	66.76	64.15	66.18	66.07	66.38	66.54
1983	79.15	75.00	68.90	76.45	70.81	69.65	66.94	68.98	68.90	67.53	69.34
1984	83.12	77.18	71.04	81.43	72.73	71.84	69.03	71.11	71.04	67.92	71.44
1985	82.58	75.79	69.64	82.05	71.34	70.45	67.68	69.70	69.64	56.31	70.01
1986	83.62	76.38	69.87	84.36	71.37	70.71	67.91	69.94	69.87	53.95	70.27
1987	82.45	75.39	68.66	84.52	69.93	69.50	66.71	68.72	68.66	60.45	69.11
1988	80.18	73.83	67.01	83.81	68.00	67.84	65.09	67.07	67.01	67.57	67.51
1989	76.78	71.48	64.74	82.01	65.52	65.55	62.84	64.80	64.74	67.89	65.30
1990	72.83	68.73	62.21	79.47	62.33	62.99	60.34	62.29	62.21	62.22	62.82
1991	69.11	66.09	59.94	76.62	58.60	60.70	58.07	60.03	59.94	56.13	60.57
1992	66.23	64.01	57.21	73.87	56.33	57.89	54.93	57.42	57.21	53.75	57.90
1993	63.48	62.73	54.33	71.65	56.05	55.00	52.17	54.54	54.33	55.73	54.95
1994	61.44	62.11	52.73	70.29	57.56	53.43	50.84	52.89	52.73	60.44	53.26
1995	61.02	60.58	52.96	70.06	59.85	53.73	51.39	53.04	52.96	64.71	53.40

Table 8A. Marital General Fertility Rate (Per Thousand)

	A	*B*	*C*	*D*	*E*	*F*	*G*	*J*	*K*
1975	220.33	220.33	220.47	220.40	260.49	220.47	220.29	220.47	220.47
1976	224.42	224.42	224.58	224.50	265.09	224.74	223.82	224.58	224.32
1977	214.75	214.75	214.42	214.58	255.52	214.38	213.35	214.42	214.20
1978	206.93	206.93	205.63	206.28	247.49	205.44	204.23	205.63	205.52
1979	202.77	202.77	200.25	201.50	242.98	199.98	198.45	200.25	200.26
1980	199.56	199.56	195.52	197.53	239.19	195.23	193.31	195.52	195.58
1981	196.12	196.64	191.25	193.93	235.32	190.98	188.62	191.48	191.30
1982	196.89	197.94	191.20	194.42	235.55	190.99	188.40	191.71	191.20
1983	198.91	199.96	191.83	196.11	236.30	191.68	189.00	194.83	191.71
1984	202.19	202.64	193.10	199.34	237.60	193.02	190.29	198.32	192.84
1985	207.08	206.27	195.31	204.63	239.80	195.29	192.52	204.01	194.92
1986	213.07	210.53	198.19	211.54	242.73	198.21	195.38	201.52	197.66
1987	219.25	214.76	201.01	219.39	245.60	201.08	198.18	196.74	200.34
1988	224.28	218.19	203.05	226.74	247.58	203.14	200.22	194.68	202.22
1989	227.67	220.60	204.04	232.92	248.37	204.14	201.24	196.21	203.09
1990	228.98	221.74	203.84	237.47	247.86	203.94	201.11	198.48	202.80
1991	228.99	222.25	203.13	241.09	246.39	203.21	200.46	200.99	202.03
1992	227.17	221.53	201.52	243.00	243.10	201.57	198.92	200.49	200.39
1993	224.39	220.15	199.06	243.67	238.86	199.05	196.30	196.62	197.94
1994	220.89	218.66	195.58	243.49	234.85	195.49	192.64	191.94	194.45
1995	217.15	217.65	191.75	243.14	232.20	191.59	188.75	189.64	190.57

Table 9A. Total Fertility Rate

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975	4.301	4.301	4.304	4.302	5.085	4.304	4.300	4.310	4.300	4.304	4.304
1976	4.366	4.366	4.369	4.368	5.158	4.373	4.355	4.373	4.369	4.369	4.364
1977	4.166	4.166	4.160	4.163	4.957	4.159	4.139	4.164	4.160	4.160	4.155
1978	4.004	4.004	3.979	3.991	4.789	3.975	3.952	3.984	3.979	3.979	3.977
1979	3.916	3.916	3.868	3.892	4.693	3.862	3.833	3.873	3.860	3.868	3.868
1980	3.849	3.849	3.772	3.811	4.614	3.766	3.730	3.778	3.772	3.772	3.773
1981	3.783	3.793	3.689	3.741	4.539	3.684	3.639	3.698	3.680	3.694	3.690
1982	3,801	3.821	3.692	3.753	4.547	3.687	3.638	3.701	3.692	3.702	3.692
1983	3.846	3.866	3.710	3.792	4.570	3.707	3.656	3.720	3.710	3.768	3.708
1984	3.919	3.928	3.745	3.865	4.607	3.743	3.691	3.755	3.745	3.846	3.740
1985	4.028	4.013	3.801	3.981	4.666	3.800	3.747	3.811	3.801	3.970	3.793
1986	4.162	4.113	3.874	4.133	4.744	3.874	3.820	3.884	3.874	3.940	3.863
1987	4,305	4.218	3.950	4.309	4.825	3.951	3.895	3.960	3.950	3.867	3.936
1988	4.431	4.312	4.014	4.480	4.894	4.016	3.959	4.025	4.014	3.850	3.998
1989	4.543	4.403	4.075	4.648	4.956	4.077	4.020	4.086	4.075	3.920	4.056
1990	4.604	4.460	4.103	4.775	4.981	4.104	4.048	4.114	4.103	3.996	4.081
1991	4.642	4.507	4.122	4.887	4.989	4.123	4.068	4.133	4.122	4.080	4.099
1992	4.645	4.531	4.125	4.968	4.962	4.125	4.073	4.136	4.125	4.105	4.101
1993	4.631	4.546	4.113	5.028	4.918	4.112	4.057	4.125	4.113	4.064	4.089
1994	4.666	4.621	4.136	5.142	4.932	4.134	4.075	4.150	4.136	4.061	4.112
1995	4.631	4.643	4.094	5.183	4.904	4.090	4.031	4.108	4.094	4.049	4.068

Table 10A. Per Cent of Households in the Rural Areas

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975	56.6	56.6	56.9	56.8	56.9	56.8	57.8	56.8	58.8	56.9	57.1
1980	53.2	53.2	53.5	53.3	53.4	53.7	53.8	53.5	55.8	53.8	54.0
1985	53.3	53.7	54.4	54.2	54.7	54.7	54.6	54.4	56.6	63.4	55.3
1990	53.4	53.8	54.7	55.3	54.5	55.2	55.0	54.7	56.9	62.5	56.4
1995	51.8	53.0	53.7	55.8	54.1	54.2	53.9	53.7	56.0	61.3	55.8

Table 11A. Per Cent of Population Over 64 Years Old

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975	1.50	1.50	1.50	1.50	1.48	1.50	1.50	1.50	1.50	1.50	1.50
1980	1.97	1.97	1.97	1.96	1.90	1.97	1.96	1.96	1.96	1.96	1.97
1985	2.29	2.28	2.28	2.29	2.15	2.27	2.28	2.28	2.28	2.28	2.28
1990	2.47	2.46	2.48	2.48	2.30	2.49	2.49	2.48	2.48	2.47	2.49
1995	2.56	2.56	2.60	2.55	2.37	2.61	2.62	2.60	2.61	2.61	2.61

Table 12A. Per Cent of Population Under 15 Years Old

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975	40.20	40.20	40.20	40.20	40.80	40.19	40.20	40.20	40.20	40.20	40.20
1980	36.21	36.20	36.17	36.19	38.32	36.16	36.12	36.18	36.17	36.17	36.16
1985	33.53	33.58	33.25	33.44	37.01	33.23	33.11	33.29	33.25	33.43	33.23
1990	35.91	35.80	34.94	35.94	39.26	34.91	34.72	34.99	34.94	34.96	34.88
1995	37.27	37.05	35.49	38.00	39.32	35.46	35.24	35.54	35.49	35.40	35.39

Table 13A. Household Size

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975	5.21	5.21	5.21	5.21	5.27	5.21	5.21	5.21	5.21	5.21	5.21
1980	4.70	4.70	4.70	4.70	4.87	5.70	4.69	4.70	4.70	4.70	4.70
1985	4.28	4.28	4.26	4.28	4.53	4.26	4.25	4.26	4.26	4.27	4.26
1990	4.06	4.05	4.00	4.06	4.34	4.00	3.98	4.00	4.00	4.00	3.99
1995	3.96	3.95	3.84	4.01	4.24	3.84	3.83	3.85	3.84	3.84	3.84

Table 14A. Gross Domestic Product (in Million Pesos: 1974)

	A	B	C	D	E	F	G	H	I	J	K
1975	111 869	111 869	113 763	112 808	113 880	113 791	115 045	113 431	113 763	113 763	113 729
1980	131 004	131 051	136 280	133 618	139 475	136 245	137 454	135 984	136 280	135 736	138 145
1985	153 522	158 077	166 638	150 963	175 011	166 563	167 759	166 347	166 638	185 145	171 610
1990	210 624	212 167	228 112	193 060	244 769	227 949	229 757	227 632	228 112	218 555	238 701
1995	273 721	279 828	289 669	241 940	298 730	289 098	289 787	289 476	289 669	237 545	309 686
1999	316 455	327 004	341 777	272 806	361 006	337 558	339 280	337 453	341 777	270 428	367 432

Table 15A. GDP Growth Rate

	A	B	C	D	E	F	G	H	I	J	K
1975-1980	3.42	3.43	3.96	3.69	4.50	3.95	3.90	3.98	3.96	3.86	4.29
1980-1985	3.44	4.12	4.46	2.60	5.10	4.63	4.41	4.47	4.46	7.28	4.84
1985-1990	7.44	6.84	7.34	2.60	7.97	7.37	7.39	7.37	7.34	3.61	7.82
1990-1995	5.99	6.38	6.87	5.58	4.41	5.36	5.22	5.43	6.87	1.74	5.95

Table 16A. Annual Growth Rate of Per Capita GDP (Per Cent)

	A	B	C	D	E	F	G	H	I	J	K
1975-1980	0.61	0.61	–0.35	0.91	1.06	1.13	1.12	1.13	–0.35	1.05	1.43
1980-1985	0.67	1.26	1.56	–0.07	1.65	1.64	1.55	1.56	1.56	4.00	1.96
1985-1990	3.72	3.28	3.96	2.04	3.92	3.88	3.92	3.89	3.96	0.65	4.28
1990-1995	2.66	2.99	2.20	1.52	1.00	2.20	2.13	2.26	2.20	–0.92	2.74

Table 17A. Per Capita GDP (in Thousand Pesos: 1974)

	A	B	C	D	E	F	G	H	I	J	K
1975	2.62	2.62	2.86	2.64	2.64	2.66	2.69	2.66	2.86	2.66	2.66
1980	2.70	2.70	2.81	2.76	2.78	2.81	2.84	2.81	2.82	2.80	2.85
1985	2.79	2.87	3.03	2.75	3.01	3.04	3.06	3.03	3.03	3.36	3.13
1990	3.31	3.34	3.63	3.03	3.60	3.63	3.66	3.62	3.63	3.47	3.80
1995	3.75	3.84	4.03	3.26	3.78	4.03	4.05	4.03	4.04	3.31	4.32

Table 18A. Private Consumption Expenditures Per Capita (in Thousand Pesos: 1974)

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975	1.72	1.72	1.73	1.73	1.71	1.72	1.76	1.73	1.73	1.73	1.73
1980	1.73	1.73	1.79	1.76	1.74	1.78	1.84	1.78	1.79	1.79	1.79
1985	1.65	1.64	1.76	1.62	1.70	1.75	1.81	1.75	1.76	1.68	1.76
1990	1.56	1.55	1.78	1.43	1.71	1.77	1.83	1.77	1.78	1.67	1.79
1995	1.53	1.49	1.87	1.23	1.75	1.86	1.94	1.86	1.87	1.67	1.89

Table 19A. Family Income (Pesos: 1974)

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975	7 599	7 599	7 779	7 687	7 772	7 745	8 192	7 720	7 779	7 779	7 754
1980	6 728	6 667	7 166	6 906	7 234	7 134	7 546	7 112	7 166	7 059	7 165
1985	5 838	5 825	6 660	5 581	6 825	6 628	7 004	6 607	6 660	6 704	6 700
1990	5 445	5 356	6 871	4 430	7 150	6 786	7 265	6 855	6 871	6 489	7 012
1995	5 433	5 194	7 334	3 508	7 405	7 292	7 672	7 274	7 334	6 043	7 475

Table 20A. Per Capita Family Income (Pesos: 1974)

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975	1 359	1 459	1 493	1 475	1 475	1 486	1 573	1 482	1 494	1 494	1 488
1980	1 432	1 418	1 526	1 470	1 486	1 519	1 608	1 514	1 526	1 503	1 526
1985	1 364	1 359	1 563	1 306	1 507	1 556	1 647	1 550	1 563	1 569	1 573
1990	1 341	1 321	1 707	1 090	1 701	1 740	1 843	1 730	1 707	1 640	1 774
1995	1 372	1 316	1 907	875	1 744	1 897	2 004	1 889	1 907	1 573	1 957

Table 21A. Sector Share in Total Value Added (Per Cent)

		A	B	C	D	E	F	G	H	I	J	K
1975												
Sector	1	33.40	33.41	33.36	33.38	33.35	33.32	33.50	33.42	33.36	33.36	33.34
	2	7.09	7.09	7.30	7.19	7.29	7.29	7.44	7.25	7.30	7.30	7.30
	3	13.74	13.74	13.72	13.73	13.73	13.71	13.92	13.53	13.72	13.73	13.74
	4	45.76	45.76	45.62	45.69	45.63	45.68	45.14	45.80	45.62	45.62	45.62
1980												
Sector	1	31.63	31.66	31.63	31.64	31.48	31.56	31.78	31.68	31.63	31.77	31.23
	2	6.99	6.78	7.22	7.10	7.37	7.18	7.24	7.19	7.22	7.18	7.32
	3	14.89	14.86	14.65	14.75	14.76	14.64	14.81	13.86	14.65	14.53	15.20
	4	46.50	46.51	46.51	46.51	46.39	46.61	46.17	47.04	46.51	46.52	46.24
1985												
Sector	1	30.11	29.92	30.15	30.27	29.84	30.07	30.33	30.21	30.15	31.65	29.42
	2	8.03	8.40	8.51	8.08	8.80	8.46	8.51	8.48	8.50	10.71	8.71
	3	15.76	15.93	15.36	15.63	15.58	15.36	15.51	15.15	15.36	15.12	16.35
	4	46.10	45.74	45.98	46.01	45.78	46.10	45.66	46.16	45.98	42.52	45.52
1990												
Sector	1	27.67	27.62	28.27	28.29	27.84	28.18	28.44	28.33	28.27	30.72	27.27
	2	10.41	10.60	10.47	10.48	10.81	10.42	10.47	10.44	10.47	11.85	10.76
	3	17.32	17.41	16.42	16.77	16.72	16.44	16.55	16.21	16.42	15.34	17.73
	4	44.61	44.37	44.84	44.46	44.62	44.96	45.53	45.03	44.84	42.10	44.23
1995												
Sector	1	25.67	25.66	26.76	26.92	26.55	26.66	26.79	26.81	26.76	30.17	25.47
	2	11.58	12.05	11.32	12.10	11.42	11.26	11.40	11.29	11.32	11.93	11.72
	3	18.56	18.72	17.16	17.31	17.27	17.18	17.31	16.94	17.16	15.24	18.82
	4	44.19	43.57	44.76	43.76	44.77	44.91	44.50	44.96	44.78	42.56	43.98

Table 22A. Percentage of Distribution of Investment by Destination

	A	B	C	D	E	F	G	H	I	J	K
1975											
Sector 1	26.1	26.1	26.0	26.0	25.9	25.1	26.3	26.0	26.0	26.0	26.1
2	6.0	6.0	6.3	6.1	6.3	6.1	6.6	6.2	6.3	6.3	6.3
3	14.4	14.4	14.4	14.4	14.4	14.6	14.8	14.0	14.4	14.4	14.0
4	58.7	58.7	58.6	58.7	58.7	59.6	57.5	59.0	58.6	58.6	58.9
1980											
Sector 1	24.8	24.9	24.6	24.8	24.3	24.0	24.9	24.7	24.6	24.9	24.9
2	5.4	5.4	5.6	5.5	5.7	5.4	5.6	5.5	5.6	5.5	5.8
3	16.4	16.3	15.9	16.1	16.1	16.0	16.1	15.6	15.9	15.7	14.2
4	58.7	58.7	59.2	58.9	59.1	59.8	58.6	59.4	59.2	59.2	60.4
1985											
Sector 1	24.3	23.9	24.0	24.8	23.5	23.5	24.3	24.1	24.0	25.5	24.4
2	6.4	6.7	6.7	6.5	6.9	6.5	6.8	6.7	6.7	9.7	7.2
3	17.5	17.9	16.9	17.4	17.2	17.0	17.0	16.6	16.9	17.7	14.0
4	57.1	56.7	57.6	56.7	57.6	58.2	57.2	58.9	57.6	52.4	59.7
1990											
Sector 1	21.3	21.4	22.0	22.7	21.4	21.5	22.2	22.0	22.0	24.6	22.5
2	8.4	8.5	8.2	8.8	8.4	8.0	8.3	8.2	8.2	9.8	9.0
3	19.9	20.0	18.4	19.0	18.8	18.5	18.4	18.1	18.4	17.8	14.0
4	55.7	55.3	57.7	54.8	56.8	57.3	56.3	57.0	56.7	53.0	59.8
1995											
Sector 1	19.8	19.8	21.1	21.9	21.2	20.7	21.5	21.2	21.1	24.9	21.8
2	8.7	9.2	8.3	9.7	8.4	8.1	8.3	8.3	8.3	9.1	9.4
3	20.9	21.2	18.7	19.1	18.7	18.9	18.8	18.5	18.7	17.2	13.4
4	55.9	55.0	57.1	54.6	57.0	57.6	56.7	57.2	57.1	54.0	60.7

Table 23A. Balance of Payments Deficit as a Percentage of GDP

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975	7.10	7.11	5.29	6.21	5.43	5.26	4.60	5.72	5.29	5.29	5.43
1980	19.88	21.42	18.38	20.07	17.70	18.36	18.71	18.74	18.38	19.08	16.98
1985	16.66	18.99	16.73	22.53	15.51	16.67	17.15	17.17	16.73	−10.34	13.76
1990	6.62	9.36	8.22	10.35	6.64	8.15	8.54	8.77	8.22	−11.05	4.33
1995	3.22	3.52	5.64	4.58	7.91	5.61	6.76	6.19	5.64	−10.05	−0.39

Table 24A. General Price Index (1974 = 100)

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975	1.12	1.12	1.45	1.13	1.14	1.15	1.12	1.15	1.15	1.15	1.14
1980	1.43	1.45	1.66	1.55	1.59	1.66	1.65	1.66	1.66	1.68	1.63
1985	1.01	1.26	1.72	1.20	1.61	1.72	1.72	1.72	1.72	3.01	1.67
1990	0.58	0.96	1.70	0.64	1.60	1.70	1.69	1.70	1.70	3.52	1.62
1995	0.46	0.87	2.20	0.41	2.07	2.20	2.21	2.20	2.20	5.05	2.07

Table 25A. Price of Food Relative to the General Price Index (1974 = 100)

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975	90.8	90.8	90.5	90.7	90.5	90.4	91.0	90.4	90.5	90.5	90.7
1980	88.9	88.6	89.3	89.0	88.4	89.7	89.7	89.1	89.3	89.2	89.7
1985	86.8	85.3	88.6	86.0	87.1	89.1	88.9	88.3	88.6	83.7	89.2
1990	78.5	77.8	84.4	74.5	83.0	85.0	84.6	84.1	84.4	82.6	85.5
1995	75.8	73.4	85.4	65.2	85.2	86.1	85.9	85.1	85.4	85.9	86.7

Table 26A. Total Labour Force (in Millions)

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975	16.80	16.80	16.85	16.82	17.18	16.85	17.03	16.82	16.85	16.85	16.85
1980	20.45	20.45	20.57	20.51	21.68	20.59	20.71	20.56	20.57	20.57	20.60
1985	26.29	26.79	26.19	25.65	28.21	26.21	26.36	26.18	26.19	27.56	26.17
1990	34.04	32.88	34.69	31.71	37.52	34.70	34.95	34.65	34.69	35.32	34.64
1995	39.75	39.87	39.86	35.83	42.18	39.82	39.83	39.87	39.86	40.03	39.83

Table 27A. Ratio of Employment in Full-Time Equivalent Units to the Total Labour Force

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975	1.10498	1.10498	1.13497	1.11978	1.11527	1.13556	1.14395	1.13275	1.13497	1.13497	1.13145
1976	0.98153	0.98153	1.01302	0.99696	0.99119	1.01379	1.01985	1.01254	1.01302	1.01302	1.00895
1977	0.96201	0.96201	0.99719	0.97921	0.97438	0.99744	1.00476	0.99592	0.99719	0.99719	0.99357
1978	0.93464	0.93464	0.97399	0.95384	0.95328	0.97380	0.98062	0.97277	0.97399	0.97399	0.97198
1979	0.96203	0.96203	1.01383	0.98725	0.99519	1.01353	1.01972	1.01232	1.01383	1.01383	1.01304
1980	0.94437	0.94526	1.00151	0.97271	0.98673	1.00115	1.00582	1.00020	1.00151	0.99579	1.00014
1981	0.87999	0.90044	0.95471	0.90460	0.94353	0.95438	0.95762	0.95389	0.95471	0.95409	0.95401
1982	0.836549	0.869612	0.92141	0.853563	0.91365	0.92120	0.92331	0.92080	0.92141	0.92863	0.92177
1983	0.802538	0.845739	0.89656	0.811821	0.89290	0.89645	0.89777	0.89608	0.89656	0.92842	0.89778
1984	0.804252	0.854767	0.90851	0.806078	0.90504	0.90849	0.90917	0.90813	0.90851	1.12292	0.91031
1985	0.788366	0.841196	0.89751	0.781523	0.89717	0.89755	0.89759	0.89722	0.89751	1.11424	0.89942
1986	0.786126	0.839205	0.89699	0.770437	0.89980	0.89699	0.89666	0.89686	0.89699	0.97426	0.89871
1987	0.794114	0.844357	0.90368	0.767193	0.91039	0.90371	0.90305	0.90368	0.90368	0.88523	0.90508
1988	0.811935	0.857391	0.91649	0.772622	0.92678	0.91654	0.91571	0.91659	0.91649	0.89323	0.91731
1989	0.837341	0.876333	0.93293	0.786002	0.95399	0.93300	0.93217	0.93307	0.93293	0.96618	0.93309
1990	0.864642	0.896592	0.94734	0.805303	0.99572	0.94741	0.94677	0.94746	0.94734	1.04656	0.94699
1991	0.886850	0.913027	0.97149	0.827704	1.02320	0.97247	0.97862	0.97003	0.97149	1.07593	0.96996
1992	0.912327	0.921369	1.00580	0.848929	1.02163	1.00680	1.01364	1.00410	1.00580	1.04122	1.00442
1993	0.935614	0.922426	1.02495	0.864323	0.99755	1.02528	1.02816	1.02421	1.02495	0.98089	1.02446
1994	0.942258	0.939861	1.01693	0.870758	0.96986	1.01649	1.01459	1.01758	1.01693	0.94180	1.01743
1995	0.935464	0.961199	0.99550	0.871871	0.96159	0.99478	0.99109	0.99682	0.99550	0.95265	0.99677

Table 28A. Central Bank Based Wage Rate Indicator (in Pesos/day: 1974)

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975	14.46	14.46	14.29	14.37	14.26	14.28	14.49	14.26	14.29	14.29	14.34
1976	14.93	14.93	14.75	14.84	14.66	14.74	14.97	14.72	14.75	14.75	14.82
1977	15.53	15.53	15.40	15.47	15.22	15.40	15.66	15.36	15.40	15.40	15.48
1978	15.30	15.30	15.22	15.26	14.94	15.22	15.50	15.18	15.22	15.22	15.30
1979	14.86	14.86	14.82	14.84	14.44	14.83	15.12	14.77	14.82	14.82	14.92
1980	15.17	15.03	15.07	15.05	14.60	15.08	15.40	15.02	15.07	14.97	15.20
1981	15.63	15.27	15.45	15.49	14.89	15.46	15.82	15.39	15.45	15.14	15.61
1982	15.89	15.35	15.71	15.77	15.06	15.71	16.09	15.63	15.71	14.50	15.89
1983	15.88	15.24	15.75	15.77	15.03	15.75	16.14	15.67	15.75	13.36	15.96
1984	15.63	14.95	15.59	15.50	14.82	15.59	15.99	15.51	15.59	11.65	15.84
1985	15.26	14.60	15.37	15.09	14.55	15.37	15.76	15.29	15.37	11.49	15.66
1986	14.76	14.17	15.08	14.53	14.22	15.09	15.47	15.00	15.08	12.10	15.42
1987	14.16	13.66	14.73	13.84	13.84	14.73	15.11	14.64	14.73	12.39	15.11
1988	13.51	13.11	14.35	13.08	13.45	14.35	14.71	14.26	14.35	12.05	14.77
1989	12.87	12.57	13.99	12.27	13.11	13.99	14.34	13.90	13.99	11.38	14.44
1990	12.31	12.08	13.68	11.48	12.90	13.69	14.02	13.60	13.68	10.92	14.18
1991	11.87	11.68	13.46	10.74	12.93	13.47	13.79	13.38	13.46	11.00	13.99
1992	11.56	11.37	13.38	10.08	13.24	13.38	13.73	13.28	13.38	11.52	13.93
1993	11.39	11.11	13.52	9.53	13.68	13.53	13.93	13.41	13.52	12.07	14.10
1994	11.40	10.86	13.90	9.05	14.04	13.92	14.37	13.78	13.90	12.29	14.52
1995	11.50	10.66	14.32	8.60	14.15	14.34	14.81	14.20	14.32	12.09	14.99

Table 29A. Sector Share in Total Employment (Per Cent)

		A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1975												
Sector	1	40.07	40.07	39.89	39.98	39.87	39.81	40.16	39.95	39.89	39.89	39.95
	2	8.56	8.56	8.97	8.77	8.96	8.96	9.26	8.87	8.97	8.97	9.00
	3	6.28	6.28	6.29	6.29	6.30	6.28	6.50	6.10	6.29	6.29	6.08
	4	36.82	36.82	36.83	36.82	36.87	36.94	36.21	37.03	36.83	36.83	36.91
1980												
Sector	1	38.52	38.57	38.47	38.52	38.17	38.59	38.72	38.51	38.47	38.72	38.47
	2	7.80	7.78	8.08	7.93	8.35	8.09	8.06	8.04	8.08	8.01	8.40
	3	7.22	7.19	7.06	7.13	7.21	7.02	7.18	6.92	7.06	6.93	6.27
	4	37.24	37.26	37.76	37.51	37.96	37.66	37.50	37.88	37.76	37.65	38.23
1985												
Sector	1	37.33	37.00	37.41	37.71	36.93	37.60	37.66	37.44	37.41	38.98	37.40
	2	9.12	9.71	9.70	9.16	10.14	9.74	9.63	9.66	9.70	13.81	10.31
	3	7.66	7.87	7.46	7.52	7.71	7.42	7.54	7.33	7.46	7.69	6.10
	4	35.94	35.91	36.66	35.32	37.07	36.49	36.45	36.78	36.66	32.81	37.42
1990												
Sector	1	33.98	34.09	35.14	35.10	34.59	33.34	35.36	35.17	35.14	38.06	35.22
	2	12.50	12.65	12.19	12.58	12.60	12.26	12.13	12.14	12.19	14.09	13.12
	3	9.02	9.04	8.34	8.33	8.63	8.28	8.40	8.22	8.34	7.84	6.24
	4	36.37	36.11	37.06	34.63	37.06	36.85	36.89	37.19	37.06	33.54	38.13
1995												
Sector	1	32.29	32.31	34.17	33.10	34.27	34.38	34.46	34.19	34.17	38.28	34.23
	2	13.23	13.93	12.51	13.97	12.62	12.58	12.36	12.47	12.51	13.05	13.75
	3	9.68	9.84	8.61	8.43	8.59	8.54	8.65	8.49	8.61	7.52	5.99
	4	37.35	36.69	37.72	3.47	37.72	37.50	37.52	37.88	37.72	33.88	39.04

Table 30A. Labour Force Participation Ratio

	A	B	C	D	E	F	G	H	I	J	K
1975	0.5357	0.5357	0.5374	0.5366	0.5479	0.5374	0.5433	0.5367	0.5374	0.5374	0.5374
1976	0.5611	0.5611	0.5640	0.5625	0.5800	0.5642	0.5706	0.5630	0.5640	0.5640	0.5642
1977	0.5429	0.5429	0.5448	0.5438	0.5644	0.5452	0.5495	0.5446	0.5448	0.5448	0.5453
1978	0.5572	0.5572	0.5593	0.5582	0.5833	0.5598	0.5638	0.5590	0.5593	0.5593	0.5599
1979	0.5457	0.5457	0.5477	0.5467	0.5747	0.5481	0.5515	0.5475	0.5477	0.5477	0.5484
1980	0.5521	0.5521	0.5550	0.5535	0.5853	0.5555	0.5585	0.5547	0.5550	0.5550	0.5559
1981	0.5671	0.5633	0.5664	0.5648	0.6001	0.5669	0.5697	0.5662	0.5664	0.5642	0.5670
1982	0.5761	0.5720	0.5753	0.5708	0.6118	0.5758	0.5786	0.5753	0.5753	0.5769	0.5757
1983	0.5924	0.5858	0.5903	0.5840	0.6294	0.5908	0.5935	0.5902	0.5903	0.5806	0.5904
1984	0.6094	0.6001	0.6063	0.5975	0.6479	0.6068	0.6097	0.6061	0.6063	0.6097	0.6062
1985	0.6357	0.6232	0.6319	0.6198	0.6746	0.6324	0.6356	0.6317	0.6319	0.6649	0.6316
1986	0.6541	0.6385	0.6503	0.6338	0.6936	0.6508	0.6541	0.6499	0.6503	0.7244	0.6497
1987	0.6740	0.6553	0.6711	0.6486	0.7145	0.6716	0.6753	0.6706	0.6711	0.7500	0.6704
1988	0.6930	0.6714	0.6927	0.6612	0.7359	0.6933	0.6973	0.6921	0.6927	0.7500	0.6920
1989	0.7103	0.6863	0.7145	0.6707	0.7500	0.7152	0.7195	0.7137	0.7145	0.7500	0.7138
1990	0.7268	0.7010	0.7377	0.6769	0.7500	0.7384	0.7430	0.7367	0.7377	0.7500	0.7369
1991	0.7436	0.7162	0.7500	0.6802	0.7500	0.7500	0.7500	0.7500	0.7500	0.7500	0.7500
1992	0.7500	0.7327	0.7500	0.6811	0.7500	0.7500	0.7500	0.7500	0.7500	0.7500	0.7500
1993	0.7500	0.7500	0.7500	0.6809	0.7500	0.7500	0.7500	0.7500	0.7500	0.7500	0.7500
1994	0.7500	0.7500	0.7500	0.6794	0.7500	0.7500	0.7500	0.7500	0.7500	0.7500	0.7500
1995	0.7500	0.7500	0.7500	0.6776	0.7500	0.7500	0.7500	0.7500	0.7500	0.7500	0.7500

Part Three

A DEMOGRAPHIC-ECONOMIC MODEL FOR THAILAND

by

Mathana Phananiramai*

and

Yongyuth Chalamwong

This paper has not been formally edited. The opinions, figures and estimates set forth in the paper are the responsibility of the authors, and should not necessarily be considered as reflecting the views or carrying the endorsement of the United Nations.

* The authors would like to sincerely thank David Demery, Naohiro Ogawa, Shigeyuki Abe, Francis J.M. Harrigan, Ernesto M. Pernia and Rolando A. Danao for their invaluable comments during the meetings. They would also like to thank Wute Wangwacharakul and Kiatchai Vesdapant for their assistance in the early stages of the model formulation and Duangthip Phatphrachai and Prapol Pattamakitskun for their invaluable assistance in computer work.

I. BACKGROUND OF THE STUDY

A. Preview

It is widely recognized that economic and demographic factors interact. Yet most economic and demographic planning is carried out separately. Many sophisticated economic models treat changes in population and labour supply exogeneously. Most population projections based on crude assumptions about fertility and mortality which are given exogeneously are therefore independent of economic change. The objective of this project is to bridge this gap. That is, to build a model which allows interaction between economic and demographic factors. The model should be able to suggest how demographic change affects, and is in turn affected by, economic variables such as income level, income distribution, wage rates and employment.

The economic-demographic modelling for Thailand has been conducted under the ESCAP project "Comparative Study on Demographic-Economic Interrelationship for Selected ESCAP Countries" funded by the United Nations Fund for Population Activities. Three countries, Malaysia, the Philippines and Thailand, participated in the project. In the process of model evolution, it was agreed that, although comparability of the models was desirable, the design of each model should be tailored to policy questions specific to each country. Therefore there will be considerable differences in this model for Thailand compared to the models for the other two countries; not only differences in model specifications, there will also be differences in computer facilities, both hardware and software, used for estimation and simulation of the model. Therefore, following this section, two short sections on data sources and computer facilities will be described. In the final section of this chapter, a brief description of Thailand and issues of concern will be given. With this introduction we will proceed to a detailed description of the model and estimation procedures in chapters two and three. Chapters four and five will give basic simulation results and experiment with several policy issues using the model.

B. Data Sources

Simulation model specifications will not only be subject to the types of question addressed, but also subject to the availability of data. Given budget and time constraints for this project, we have to fully rely on secondary sources of data for model estimation. In the demographic submodel, behavioural relationship which determines changes over time in fertility, mortality, migration and urbanization school enrollment and the labour force participation rate should ideally be estimated with time series data. However, existing time series data of variables used in some of these relationships are not long enough for estimation purposes. Therefore quite often we have to estimate these relationships using cross-sectional data, namely 72 provincial data. The sources of data that we rely on heavily are the 1980 Population and Housing Census, Labour Force, Socio-Economic, and Population Change Surveys and several other special surveys on fertility. Most of these data surveys are conducted and published by the National Statistical Office.

In the economic submodel, it is even more essential to estimate parameters in the behavioural relationships with time series data. However, this is not feasible because of data constraints. Therefore, most of the parameters used in the model are drawn from the 1975 Social Accounting Matrix (SAM) which was prepared by the National Economic and Social Development Board. Since the SAM for Thailand is highly disaggregated with 22 sectors whereas in this model only 5 sectors are differentiated, considerable computing time had to be spent to readjust the account. Other than the 1975 SAM, we also relied on some other data sources such as the Monthly Bulletin of the Bank of Thailand, Capital Stock of Thailand (1984 edition), National Income Account of Thailand (1984 edition), the Statistical Yearbook for Asia and the Pacific, International Trade Statistics published by the United Nations, and Agricultural Statistics of Thailand (1985 edition) published by the Office of Agricultural Economics.

C. Estimation Procedure and Computer Facilities

Following the suggestions given in the first study directors' meeting, the cost of using the simultaneous equations technique for estimation seems to exceed its benefit for a simulation model of this type. Therefore the single equation technique and particularly the ordinary Least Squares method is used in all the estimations. This is done easily using a micro-computer with the aid of ready-made computer software such as TSP, SPSS or SAS. After all necessary parameters were calculated, they were fed into the system of equations to solve for the value of endogeneous variables. We adopted the "Gauss Seidal" iteration technique. A computer programme using FORTRAN language was designed specially to run this simulation model. The programme requires about 30k bytes that the computer mainframe is used for the purpose of simulation. The computer time required for each simulation run with the Sperry Univac 1100 is about 1.45 to 2.00 minutes. It is important to note that the rate of convergence is quite sensitive to the price equations in the economic submodel.

D. Demographic-Economic Setting

Thailand is a tropical country in South-East Asia. The country covers about 200,000 square miles or 514,000 km^2. Rivers and mountains divide the country into four natural regions : the North, the Northeast, the Central region and the South. Administratively, the country is divided into 72 provinces (Changwat). The province of Bangkok is the capital of the country and it is the center of social and economic activity since the Second World War, the country has undergone tremendous change both in its social and economic structure.

This section is designed to acquaint readers with some salient facts about the population and economy of Thailand, past and present. Finally, as a background for the model specification for Thailand, economic and demographic issues of interest will also be reviewed.

1. Demographic Situation

The population in Thailand from 1911 to 1980 as enumerated in different censuses is shown in table 1.1. The population increased from 8.3 million in 1911 to 44.8 million in 1980 or an increase of 5.4 times in 70 years. The rate of population growth in this period varied from an annual growth rate of 1.4 per cent at the beginning of the period to a peak annual growth rate of 3.2 per cent during 1947-1960. Thereafter, the growth rate started to decline gradually reaching an annual rate of 2.7 per cent in the past decade. The fluctuation in the rate of population growth was mainly due to an unequal rate of decline in birth and death rates. Average crude birth rates, crude death rates and the rate of natural increase during 1920-1985 are shown in table 1.2. The figures showed a rapid decline in crude death rates since the mid-1930s and started to level off in the 1960s. In contrast, crude birth rates declined slowly during 1920-1960 and started to decline more rapidly only after the 1960s. These patterns of

Table 1.1 Enumerated Population, Average Annual Intercensal Growth Rate, Thailand, 1911-1980

Date of census	*Enumerated population (in thousands)*	*Average annual intercensal growth rate*
1 April 1911	8 266	1.36
1 April 1919	9 207	2.19
15 July 1929	11 506	2.19
23 May 1937	14 464	2.96
23 May 1947	17 442	1.89
25 April 1960	26 258	3.22
1 April 1970	34 397	2.76
1 April 1980[1]	44 825	2.68

Source: Table 3, *Country Monograph Series No. 3, Population of Thailand*, ESCAP, 1976.

Note: [1] *1980 Population & Housing Census 1980* The National Statistical Office 1983.

Table 1.2 Average Crude Birth and Death Rates, 1920-1980

Year	*Average crude*		*Average rate of natural increase (per cent)*
	Birth rate	*Death rate*	
1920-1929[1]	49.4	28.3	2.11
1930-1939[1]	47.6	25.1	2.25
1940-1949[1]	40.6	20.7	1.99
1950-1959[1]	44.9	13.8	3.11
1960-1969[1]	41.4	10.7	3.07
1974-1976[2]	35.6	8.6	2.70
1982[3]	28.0	7.8	2.02
1985[3]	25.5	7.4	1.81

Sources: [1] Table 4, *Country Monograph Series No. 3, Population of Thailand, Ibid.*

[2] *1974-1976 Survey of Population Change.*

[3] Seminar papers on *Population Policy for the Sixth Plan,* organized by the National Economic and Social Development Board at Royal Cliff Beach, Pattaya 1986.

change caused a very high rate of natural increase of more than 3 per cent annually during 1950-1970. At present, the crude birth rate and the crude death rate are estimated to be 25.5 and 7.4 per thousand respectively. These figures imply a natural rate of increase around 1.8 per cent annually.

In order to give a better view of fertility and mortality trends in Thailand, total and age specific fertility rates since 1960 are shown in table 1.3, whereas life expectancy at birth for different periods are shown in table 1.4. The total fertility rate declined from a rate of 6.4 in 1960 to 3.5 in 1984. The decline was slow before 1970 and accelerated thereafter. Changes in the age-specific fertility rate as shown in figure 1.1 demonstrate clearly that rapid fertility decline between 1964 and 1984 was mainly due to fertility reduction among women aged 25-44. The majority of women in this age group are married, therefore fertility reduction occurred within marriage. Obviously, family planning plays an important role in this decline. Figures for life expectancy at birth also confirm the trend in crude death rates presented earlier. Life expectancy at birth was 37 years for males and 39.67 years for females during 1937-1947. It increased rapidly, reaching 55.9 years for males and 62 years for females during 1964-1965. Life expectancy at birth continued to rise but at a slower rate, reaching 59.5 years for males and 65.5 years for females during 1979-1981.

Table 1.3 Estimated Age Specific Fertility Rates, Thailand, 1964-1984

Age	*SPC1 1964-65*	*SOFT 1965-69*	*LS1 1968-69*	*SOFT 1970-74*	*LS2 1971-72*	*SPC2 1974-76*	*CPS1 1978*	*CPS2 1981*	*CPS3 1984*
15-19	0.07	0.07	0.07	0.07	0.07	0.08	0.06	0.06	0.07
20-24	0.26	0.25	0.26	0.22	0.23	0.24	0.21	0.22	0.19
25-29	0.30	0.29	0.29	0.22	0.29	0.25	0.20	0.22	0.18
30-34	0.27	0.26	0.23	0.18	0.18	0.18	0.14	0.14	0.12
35-39	0.22	0.21	0.20	0.17	0.17	0.14	0.11	0.09	0.07
40-44	0.11	0.15	0.15	0.08	0.12	0.07	0.05	0.05	0.05
45-49	0.02	0.02	0.03	0.03	0.03	0.02	0.03	0.01	0.01
TFR	6.30	6.25	6.10	4.85	5.35	4.90	4.00	3.90	3.47

Notes: SPC: *Survey of Population Change,* National Statistical Office.

LS: *Longitudinal Survey,* Institute of Population Studies, Chulalongkorn University.

SOFT: *Survey of Fertility in Thailand (WFS),* National Statistical Office.

CPS: *Contraceptive Prevalence Survey,* Research Institute, NIDA.

Table 1.4 Expectation of Life at Birth by Sex, Thailand, 1937-1981

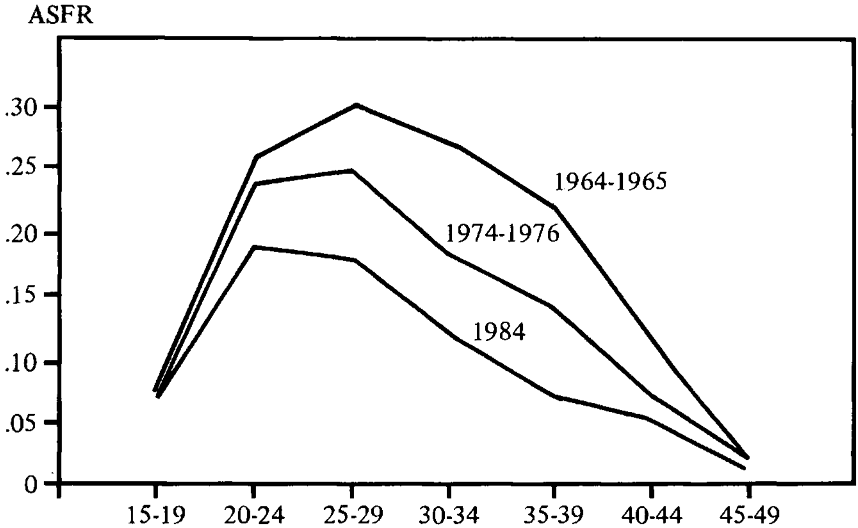
(Unit: Years)

Date of birth	*Male*	*Female*
1937-1947[1]	37.00	39.67
1947-1948[1]	48.69	51.90
1959-1961[1]	53.64	58.74
1964-1965[1]	55.90	62.00
1969-1971[1]	57.70	61.45
1974-1976[1]	58.00	63.82
1979-1981[2]	59.50	65.50

Notes: [1] Table 12, *Survey of Population Change 1974-1976,* National Statistical Office.

[2] "Mortality Assumption for Population Projection", ML. Chalermsuk Boonthai MD. paper presented at the *Seminar of Population Projection for the 6th Plan,* 7 August 1985.

Figure 1.1 Age Specific Fertility Rates in 1964-1965, 1974-1976 and 1984



The distribution of population by region as well as by rural and urban area is given in table 1.5. Rural and urban areas are classified using the criteria of municipality which is established by law for local administrative purposes. Urban areas are referred to here as Nakhon (city) or Muang (town) municipality. The percentage of the population living in urban areas increased from 12.5 in 1960 to 17.5 in 1983. Although the proportion of the urban population has increased over time, the majority of the Thai population still lives in rural areas.

Table 1.5 Distribution of Rural and Urban Population by Region, 1960, 1970, 1980 and 1983

(Unit: Thousand)

Region	*1960*		*1970*		*1980*		*1983*	
	Rural	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*
Bangkok	436	1 701	582	2 495	–	4 697	–	5 018
Central (excluding Bangkok)	5 570	564	6 817	718	8 767	959	9 901	1 104
North	5 356	367	7 049	440	8 416	658	9 314	792
Northeast	8 679	312	11 580	445	15 061	638	16 227	993
South	2 943	329	3 817	455	4 948	680	5 396	770
Whole Kingdom	22 984	3 274	29 844	4 553	37 192	7 633	40 838	8 677

The average rate of population growth in urban areas from 1960 to 1970 was 3.3 per cent annually, compared to a rate of 2.6 per cent in rural areas. The rate of population growth in urban areas from 1970 to 1983 increased to 5.1 per cent annually, while the rate for the rural population declined to 2.4 per cent annually. Urban population growth has 3 major components : natural increase through births and deaths, net migration and area annexation. During 1960-1970, the three components, respectively contributed about 49.9 per cent, 43.6 per cent and 6.5 per cent to urban growth.[1] The percentages of contribution became 40.8 per cent, 29.81 per cent and 29.4 per cent during 1970-1979. From this breakdown by components, about half of the total urban growth for the past two decades could be attributable to natural increase, 5-10 per cent to area annexation and the remaining 40-45 per cent to migration. Hence migration played an important role in urban growth.

Distribution by region indicates that the Northeast is the most populated region in Thailand whereas the South is the least populated region. The percentage of the population living in the Northeast increased from 34.2 in 1960 to 34.8 in 1983. This is because of higher fertility rate in this region. Therefore, success in reducing the population growth rate in Thailand is mainly dependent on success in reducing the fertility rate in the Northeast.

The breakdown of the population aged 6 years and over by educational attainment is given in table 1.6. The percentage of males with no education declined from 31.59 per cent in 1960 to 12.99 per cent in 1980. The percentage for female declined from 44.51 per cent in 1960 to 18.96 per cent in 1980. During these two decades, the majority of the Thai population attained only the primary level of education. The percentage with secondary education increased gradually in the first decade, and more rapidly in the second decade. The per-

Table 1.6 Population Aged 6 Years and Over by Educational Attainment and Sex in 1960, 1970 and 1980

Educational attainment	*1960*		*1970*		*1980*	
	Male	*Female*	*Male*	*Female*	*Male*	*Female*
No Education	31.59	44.51	21.57	31.15	12.99	18.96
Primary	61.81	52.59	71.21	64.77	73.15	71.60
Secondary	6.00	2.60	6.34	3.58	11.41	7.43
College	0.60	0.30	0.88	0.50	2.45	2.01

Source: 1960, 1970 and 1980 Population Censuses, The National Statistical Office.

[1] ESCAP, *Migration, Urbanization and Development in Thailand,* 1982.

centage of the population with a college education also increased over time. However, the percentage of the population with a college education was still quite low, about 2 per cent, in 1980. The educational attainment of females is lower than that of males. The population in urban areas in general had a higher level of education than that in rural areas.

School enrollment ratios are also given in Table 1.7. In 1980, practically all the population aged 6-11 years was enrolled in school. In 1970, it was only about 85 per cent and 78 per cent for males and females respectively. For the population aged 12-17 years, secondary school age, the percentage enrolled in school was 13.6 per cent and 10.0 per cent respectively for males and females in 1970. The percentage of the population in this age group enrolled in school had approximately doubled in 1980.

Table 1.7 School Enrolment Ratio

(Unit: Percentage)

Level	*1970*		*1980*	
	Male	*Female*	*Male*	*Female*
Primary[1]	84.7	77.7	103.1	99.7
Secondary[2]	13.6	10.0	26.0	22.5
College[3]	1.0	0.9	2.9	2.6
Total[4]	34.6	30.0	40.2	36.8

Notes: [1] The percentage of students in primary education and population age 6-11 years.

[2] The percentage of students in secondary education and population age 12-17 years.

[3] The percentage of students in college level and population age 18-29 years.

[4] The percentage of student in all levels and population age 6-29 years.

2. Economic Situation

Almost a century before 1960, economic growth was mainly a response to free trade conditions imposed by Western nations. In response to increasing international demand for rice, teak, tin and rubber, the agriculture and mining sectors had been expanded rapidly. Economic growth during this period was characterized by application of the same technology over the increasing cultivated areas. The government played only a minor role in the growth process.

Since 1961, the government has drawn up five-year national social and economic plans as guidelines for development. Up to the present, Thailand has had four five-year social and economic development plans and is at the moment in the Fifth Plan which ended in 1986. The ultimate goal of all these Plans is to accelerate development, which will lead to increased well-being for the Thai people. However, the emphasis and methods are different. In the First and the Second five-year Plans (1961-1971) the emphasis was to rehabilitate basic infrastructure needed for product expansion. High investment rate characterized this period and a considerable proportion of investment came from foreign savings. The average rate of growth of GDP during this period was approximately 8 per cent annually.

Although the rate of growth of GDP during the First and the Second Plans seemed satisfactory, the benefit of development was not evenly distributed among the Thai population. Therefore, in the Third Plan (1972-1976), more emphasis was given to social and economic equity in addition to growth. During this Plan, public services such as education, medical services and other public utilities were extended to the rural population. The policy of reducing the rate of population growth was stated in this plan for the first time. Family planning was emphasized, especially among poor families. During 1971-1976, although the country still maintained a relatively high rate of growth of GDP at approximately 8 per cent annually and was quite successful in reducing the rate of population growth from approximately 3 per cent to 2.6 per cent annually, the social and economic gap between different groups of the population was not reduced. During the Plan, Thailand had to face several social and economic problems which were created by internal as well as external factors such as the energy crisis, the devaluation of the United States dollar and the increase in world food and factor prices. The inflation rate during 1972-1976 was 12.5 per cent annually, compared to an average of 3 per cent during the Second Plan (1976-1971). By the end of the Third Plan, the investment rate in Thailand, following the world trend, declined considerably. The unemployment rate increased partially owing to the past high rate of population growth and a lower investment rate. In addition, problems of rural poverty, urban disorder and deterioration of natural resources such as land, water resources, forests and fishing grounds became intensified.

Solving problems which occurred at the end of the Third Plan was carried over as the main target in the Fourth Plan (1977-1981). Equal emphasis was given to growth, equity and price stability. The population growth rate were set to be further reduced to an annual rate of 2.1 per cent by the end of the Plan. An attempt was made to keep migration from rural to urban areas at a rate not higher than 2 per cent. In order to reduce the unemployment rate, various projects aimed at job creation in both rural and urban areas were launched. Concern about environmental problems and the conservation of natural resources was explicitly expressed in the Plan. During the Fourth Plan, the average annual growth rate in GDP was 7.3 per cent. This impressive growth rate in a world of stagnation was achieved at some cost. Average inflation was 11.7 per cent. Trade and current account deficits increased from 25,600 million baht and 22,600 million baht in 1977 to 67,300 million baht and 53,000 million baht respectively in 1981. The government cash deficit was 17,500 million baht per year on average during the Fourth Plan period. However, the target of reducing the population growth rate to 2.1 per cent was successfully achieved during this Plan.

3. Recent Economic Development and Related Issues of Interest

From the information reviewed earlier, it is clear that Thailand is currently in the process of demographic transition. During this process, social and economic transition has also been taking place. In the past, the Thai economy depended almost solely on agricultural products. However, since 1960, development plans have tried to encourage growth in both the agricultural and non-agricultural sectors. Since then the relative importance of the aspicultural sector has declined gradually. Table 1.8 gives the relative share of GDP by sector

Table 1.8 GDP at 1972 Prices by Industrial Origin

Industrial orgin	*1975*		*1980*		*1985*	
	GDP	*Per cent*	*GDP*	*Per cent*	*GDP*	*Per cent*
Agriculture	62 081	30.5	71 408	25.8	87 897	23.2
Mining & Quarrying	2 485	1.2	4 531	1.6	6 012	1.6
Manufacturing	36 787	18.1	57 841	20.9	78 921	20.8
Construction	8 514	4.2	14 547	5.2	17 603	4.6
Electricity & Water Supply	3 181	1.6	5 178	1.9	8 875	2.3
Transportation & Communication	13 445	6.6	17 663	6.4	26 242	6.9
Commercial	45 403	22.3	61 079	22.1	88 885	23.5
Ownership of Dwellings	3 555	1.7	4 289	1.5	5 594	1.5
Public Administration	8 359	4.1	11 594	4.2	14 873	3.9
Services	19 704	9.7	28 777	10.4	43 854	11.6
GDP	203 514	100.0	276 907	100.0	378 756	100.0
Per Capita GNP	4 856		5 849		7 038	

Source: National Income of Thailand (Various issues), Office of National Economic and Social Development Board (NESDB), Office of The Prime Minister.

of production in 1975, 1980 and 1985. Value added in the agricultural sector accounted for about 30.5 per cent of GDP in 1975 and declined to only 23.2 per cent in 1985. Moreover, agricultural activities and production also changed from subsistence agriculture with a few crops into highly diversified production with several economic crops, in response to trade and export demand.

Manufacturing expanded rapidly during 1970-1980. This was due to internal promotion as well as a favourable world environment in this period. Its share of GDP increased from 18.2 per cent in 1975 to 20.9 per cent in 1980. Initially, manufacturing promotion was aimed at import substitution; later export oriented industries were also promoted. However, owing to the recent oil shock in 1979 and increasing protectionism in world trade, the expansion in manufacturing has slowed down. During 1975-1985, the share of GDP in construction, electricity, gas and water supply, in transportation and financial services also increased significantly. This direction of development makes the Thai economy highly open, and its performance depends closely on external factors.

Although the importance of agriculture in terms of share of GDP is declining, it is still the most importance sector in terms of labour absorption. Table 1.9 gives the number and percentage of workers aged 11 years and over who are

Table 1.9 Number of Workers 11 Years and Over by Sector of Production

(Unit: Thousand)

Industry	*1975*		*1980*		*1985*	
	Number	*Per cent*	*Number*	*Per cent*	*Number*	*Per cent*
Agriculture	13 270	73.0	15 892	70.7	18 130	69.8
Mining	28	0.2	37	0.2	117	0.5
Manufacturing	1 356	7.5	1 783	7.9	1 986	7.6
Construction	206	1.1	436	1.9	533	2.1
Electricity, Gas and Water Supply	42	0.2	60	0.3	131	0.5
Commerce	1 297	7.1	1 801	8.0	2 085	8.0
Transportation	381	2.1	456	2.0	517	2.0
Services	1 522	8.4	1 887	8.4	2 365	9.1
Banking and Insurance	80	0.4	111	0.5	128	0.5
Total	18 182	100.0	22 463	100.0	25 992	100.0

Source: NESDB.

employed in each sector of production. The percentage of labour absorbed in agriculture was 73 per cent in 1975 and declined to about 70 per cent in 1985. Manufacturing, commerce and services are three sectors of production which also have high labour absorptive capacity and its role in labour absorption is expected to increase in the future.

Judging from the growth rate of GDP and the growth rate of per capita income, which rose from 4,856 baht per year in 1975 to 7,038 baht per year in 1985, the performance of economic development seems quite satisfactory. However, in the process of development, there are always some undesirable consequences. Some issues which are of particular concern to policy makers currently are the following:

1. As mentioned earlier, changes in economic structures during the development process have made Thailand a highly open country and the performance of its economy is highly dependent on the world economy. However, the adjustment of the Thai economy was too slow to cope with rapid changes in the world economy, which has caused economic instability. Recent problems of deterioration of trade and payments deficits, the rising government budget deficit and the rising inflation rate are examples. Therefore, adjustment of economic structure so that the economy may become more self-reliant and more adjustable is emphasized in the Fifth Plan.

2. While the first problem concerns the timeliness of economic adjustment, the second problem concerns the timeliness of social adjustment in the rapidly changing economic environment. Since the majority of the Thai population, especially those in the rural areas, are still poorly educated and live in poor health and poor conditions of hygiene, the opportunity for them to improve their well-being or to induce any change is limited. It is considered crucial that the wide disparity between the population living in rural and in urban areas must be reduced if the country is to move forward together with political stability. Therefore, emphasis in the Fifth Plan is also placed on more adequate provision of various special services like education and health to rural areas. Reducing the population growth rate, with emphasis on the rural areas is still considered as an essential means to achieve this objective.

In addition to these two general issues, two more problems which are directly related to population growth are worth mentioning. First is the problem of rising urban congestion and environmental deterioration in the Bangkok Metropolitan area. In 1983, the population of Bangkok constituted about 58 per cent of the urban population and its size was approximately 50 times larger than municipal Chiang Mai, the next largest city. The predominance of Bangkok in the urbanization process in Thailand has been increasing over time. Immigration is an important factor which contributes to rapid growth in Bangkok. Although urbanization is quite natural during the process of economic development, the unbalanced growth of Bangkok is creating many problems such as traffic congestion, environmental pollution, housing shortages, and an increasing crime rate. But a more important problem is whether the growth of Bangkok benefits the country as a whole. Many studies suggest that Bangkok has outgrown the optimal size for an efficient use of its resources. The unbalanced growth of Bangkok also creates more inequity in the country, since Bangkok and its population enjoy absolutely and relatively more benefits from the development process than the rest of the country. Hence, a policy has been set out in the Fifth National Social and Economic Development Plan to curb immigration to Bangkok. This policy will be carried out in an attempt to reduce the city's dominant social and economic position by promoting alternative locations as centers of social and economic development in each region. The cities which will be promoted are Chiang Mai for the North, Khon Kaen and Nakhon Ratchasima for the Northeast, Chonburi for the East and Shongkhla Hat Yai for the South.

Migration from rural to urban areas not only creates problems in receiving areas, but in sending areas as well. Since most migrants are young adults, in many rural areas with heavy out-migration only children and elders are left behind. This situation clearly hinders rural development, which is established as the first priority in recent development strategy.

The second problem, which has also received much attention, is the problem relating to utilization of labour. Labour problems in Thailand take the form of low productivity and some disguised or open unemployment. With limited cultivatable land, labour absorption in the agricultural sector will be quite restricted in the future. Therefore, the absorptive capacity of the non-agricultural sector has to be relied on the reduction of the unemployment problem. However, employment in this sector in turn depends on the incentive to invest and the availability of investment funds. Since the population growth rate is known to effect both saving and the incentive to invest, in the long run employment has to be dependent on population dynamics and characteristics.

E. The Need For A Demographic-Economic Model

However, understanding about the linkage between population and economic development is still lacking in Thailand. For future social and economic development planning, it seems necessary to have at least partial answers to these problems. What is the likely speed of future demographic change ? Is the speed too fast or too slow for other social and economic development targets ? If the speed is not yet optimal, what might be the course of action to speed up or slow down these changes ? How will demographic changes affect government expenditure on education and health ? How may changes in the structure of population and households affect future demand and supply of labour? Will human resource development be greatly affected by demographic change and how much it will affect productivity ? In order to answer some of these problems this study attempts to build and evaluate a model which relates economic and demographic variables in Thailand. A detail description of the model and results will be presented subsequently.

II. DEMOGRAPHIC SUBMODEL

The demographic economic model developed under this project consists of two submodels, a demographic submodel and an economic submodel.

The demographic submodel is designed to achieve three objectives. First, it translates economic changes which are generated in the economic submodel into changes in demographic behaviour. Second, it generates the size, age-sex distribution and educational attainment of the population, which will be further transformed into the size of workforce through labour force participation rates. Third, it generates the number of households and average household size which will be used to investigate changes in income distribution. In order to achieve these three objectives, the demographic submodel is divided into five submodels or blocks:

(1) Age-sex population projection by area (urban and rural).

(2) Educational projection by sex and by area.

(3) Urbanization and migration.

(4) Household projection and household income distribution.

(5) Projection of labour supply by age and sex.

Detailed description of these blocks is given subsequently.

A. Population Projection Block

The component method of population projection is used in this block. To apply this method, first the level as well as the pattern of fertility which are summarized by total fertility rate (TFR) and age specific fertility rates (ASFR) are estimated. The estimation is based on social and economic variables which are generated in the model in the previous period. Similarly, the level and pattern of mortality, which are summarized by life expectancy at birth and single year survival ratios, are estimated, based on the value of social and economic variables generated in the model. Different levels of fertility and mortality by rural and urban areas are obtained and are used for population projection in the respective areas separately.

1. Fertility Estimation

Age specific fertility rates (ASFR) of any population follow a certain pattern, increasing for young women, reaching the highest level around ages

20-30 and decreasing thereafter. Of course, the pattern can be slightly different from one population to another. This study assumes that ASFR follows a family of Truncated Pearson Type III curves. In order to fit to any particular curve in this family, one has to specify four parameters: (1) TFR to indicate the general level; (2) Mean age of child bearing (MACB) to indicate the average age of child bearing or the centre of the distribution; (3) The relative fertility of women aged 20-24 to women aged 15-19 ($\gamma = {}_5f_{20}/{}_5f_{15}$) – this ratio indicates how rapidly fertility increases for young women; and (4) the relative fertility of women aged 35-39 to women aged 40-44 ($\gamma_1 = {}_5f_{35}/{}_5f_{40}$). This ratio indicates how rapidly fertility declines for older women which will be used to determined the end of child bearing age.

Judging from past information, the critical value to be estimated is the level of fertility of TFR, whereas the pattern of fertility indicated by γ, γ_1 and MACB is less volatile. Therefore a behavioural equation will be estimated for TFR. As for MACB, γ and γ_1, regression equations using time trend has been estimated. The results are as follows:

$$\text{MACB} = \underset{(83.50)}{29.2199} - \underset{(-3.00)}{0.1115}\,T \qquad (2.1)$$

$$R^2 = 0.60 \qquad n = 8$$

$$\gamma = \underset{(25.32)}{3.5451} + \underset{(2.41)}{0.0985}\,T - \underset{(-2.85)}{0.0076}\,T^2 \qquad (2.2)$$

$$R^2 = 0.64 \qquad n = 8$$

$$\gamma_1 = \underset{(7.31)}{2.0058} + \underset{(0.53)}{0.0428}\,T + \underset{(0.24)}{0.0013}\,T^2 \qquad (2.3)$$

$$R^2 = 0.16 \qquad n = 8$$

From the regression results, γ_1 appears to be invariant over time, therefore the end of child bearing age is assumed to be constant at 46 over the simulation period.

Ideally, behavioural equation on TFR should also be estimated using time seried data. However, time series data available in Thailand are not sufficient for estimation. Therefore the equation will be estimated from 1980 data from 72 provinces. Theoretically, TFR should be mainly affected by per capita income (PERCAP), educational attainment (ATMF23: the percentage of the population aged over 6 years whose educational attainment is higher than primary level) and the female labour force participation rate. However, using this set of data, the female labour force participation rate turns out to be statistically insignificant, hence this variable has been dropped from the equation. One possible reason for the insignificant effect of the female labour force participation rate on the fertility rate is that the majority of Thai females are involve in selfemployed activities and, therefore, work and child care are not directly in conflict. The final form of TFR equation to be used in this study is

$$\log(\text{TFR} - 2) = \underset{}{2.0780} - \underset{(-4.81)}{0.191957\ \text{ATMF23}} + \underset{(2.24)}{0.100512\ \text{PERCAP}} - \underset{(-2.60)}{0.001627\ \text{PERCAP}^2} \qquad (2.4)$$

$$R^2 = 0.36, \qquad N = 72$$

All the independent variables are statistically significant at $\alpha = 0.05$. The functional form is specified so that TFR can never go below 2, which is approximately the replacement level. The result implies that educational attainment is the most influential factor affecting TFR. A higher educational attainment of the population corresponds to a lower TFR. PERCAP is included in the model in quadratic form and both terms are statistically significant. It can be interpreted that economic development which is roughly measured by PERCAP will first increase TFR, but this positive effect will diminish and become negative later. This finding seems to confirm the hypothesis that income will depress fertility only when it reaches a certain threshold.

Although population is projected separately by urban and rural areas, TFR, MACB, γ_1 and γ can not be estimated separately due to data limitation. Therefore MACB, γ_1 and γ will be assumed to be invariant with areas. TFR in rural (TFR_R) and urban (TFR_U) area, will be estimated as follows: TFR for the whole Kingdom will be first estimated by equation (2.4) then the ratio of TFR in rural and urban areas (PR) will be obtained. In 1980, TFR for the whole country and PR were 3.8 and 1.64 respectively. It is assumed that PR will approach 1 when TFR is approaching 2, i.e. there will be no difference in fertility among rural and urban residents once the fertility level for the whole country is reaching the replacement level. Using this assumption,

$$PR = e^{-0.55 + 0.27\ TFR}$$

Once TFR and PR are known, TFR_R and TFR_U can be computed such that the weighted average of TFR_R and TFR_U will be equal to TFR for the whole Kingdom. The weights are the proportion of the population in rural and urban areas respectively.

Therefore

$$TFR_U = \frac{TFR}{UR + (1 - UR)\,PR}$$

$$TFR_R = TFR_U \cdot PR$$

where UR is the proportion of population in urban area.

Once TFR, MACB, γ and γ_1 for rural and urban are known, ASFR can be obtained by the Truncated Pearson Type III Curve which could be summarized as follows:

$$ASFR_a = k(a-s)^2 e^{-2(a-s)/u} \qquad s \leqslant a \leqslant u$$

$$= 0 \qquad \text{elsewhere}$$

where s = the beginning age of fertility.

$$s = \frac{S\sqrt{\gamma} + 7.25 - 0.5\,MACB}{\sqrt{r} - 0.5}$$

$$S = 12.821 + 2.0642 \log(\gamma - 0.535)$$

where u = the final age of fertility and is set to be 46 in the case of Thailand

m = the distance between the beginning and peak age of fertility

m = MACB – 0.85 – 5.75

k = the level of fertility which is proportional to TFR

$$k = \frac{4\,TFR}{m\,\{m^2 - 2e^{-2(u-s)/m}\,[(u-s)^2 + m(u-s) + 0.5m^2]\,\}}$$

2. Mortality Estimation

Common practice in mortality estimation is to estimate the level of life expectancy at birth. Then the age specific survival rate can be obtained by using appropriate model life table which corresponds to the estimated life expectancy at birth. This is also the procedure adopted in this study. Life expectancy at birth is estimated separately for males and females as a function of per capita income (PERCAP) and percentage of the population aged over 6 years whose educational attainment is beyond the primary level (ATMF23). PERCAP is entered in the equation in logarithm form since its effect on mortality is expected to be non-linear. The results estimated from 1980 data from 72 provinces are:

$$\log(72 - E_M) = \underset{(7.54)}{4.9643} - \underset{(-4.34)}{0.0452}\,ATMF23 - \underset{(-3.67)}{0.2805}\log(PERCAP)$$

$$R^2 = 0.55, \quad n = 72, \quad F = 42.79 \qquad (2.5)$$

$$\log(77 - E_F) = \underset{(8.44)}{4.5305} - \underset{(-4.09)}{0.0347}\,ATMF23 - \underset{(-3.58)}{0.2234}\log(PERCAP)$$

$$R^2 = 0.53, \quad n = 72, \quad F = 39.24 \qquad (2.6)$$

The functional form is specified so that the upper bounds of life expectancy at birth for male and female are 72 and 77 years respectively. The estimated results conform with our prior expectation. Life expectancy at birth of males and females is influenced by the factors in the same manner. Both income and education are positively related to life expectancy at birth.

A problem similar to that which arises in the case of fertility estimation also occurs here, namely, owing to data limitation, it is not feasible to estimate separate equations of life expectancy at birth for rural and urban areas. Therefore life expectancy at birth for all males and females is extimated by equation (2.5) and (2.6) respectively. The ratio of male life expectancy in urban and rural areas ($\frac{E^oM, U}{E^oM, R}$) was 1.1 in 1980. The ratio for females ($\frac{E^oF, U}{E^oF, R}$) was 1.09 in 1980 . These ratios are assumed to decline gradually towards 1 over time. These additional assumptions combined with the information on the proportion of the urban population can then be used to estimate life expectancy at birth of males and females separately by urban and rural areas in a similar way to that used in the case of TFR. Once the life expectancy at birth is obtained, Brass Standard Life Table and Brass Logit system will be used to estimate the survival ratio in each age group. This method is preferred to using the Coale-Demeny Model Life Table because 1_x can be calculated explicitly by a logit function. Hence the survival ratio in a single year can be obtained directly without several steps of interpolation. This method eliminates a lot of computing work, especially when simulation is done on a yearly basis.

The single year survival ratios and age specific fertility rates obtained above will be used to project population by age and sex in each area (rural and urban) by the component method. All the independent variables appearing in the behavioural equations are one year lagged variables.

B. Educational Projection Block

Since educational attainment is an important factor determining and in turn determined by several types of economic and demographic behaviour, it is important that educational attainment is generated endogeneously in the system. Therefore this submodel is designed to achieve two tasks. First, to project the number of students enrolled in each level of education by sex and by area. Second, to project the number of the population by educational attainment. The number of students enrolled can be used as a guideline for educational planning. The number of the population by educational attainment is an indicator of the level of human capital accumulation. This in turn will reflect the quality of labour and production in the economic submodel.

Education will be divided into three levels, primary, secondary and college level. Both primary and secondary levels will be divided into six grades. College level includes both under-graduate and graduate levels. For educatioal attainment, four levels will be classified: those who have no education, those who have some primary, some secondary and some college education. It should be noted that in this study, once a person has enrolled in any level of education, he will be classified in that level of educational attainment even though he has not yet completed or never completed his study.

1. *Enrolment Projection*

The number of students enrolled in each level of education will simply be calculated as the product of enrolment ratio and the number of the population in the appropriate age-sex group i.e.

$$EN_i^M = ENR_i^M \cdot POP_i^M/100 \quad (2.7)$$

$$EN_i^F = ENR_i^F \cdot POP_i^F/100 \quad (2.8)$$

$$i = 1, 2, 3$$

ENR_i's are estimated using data from 72 provinces as functions of previous educational attainment. The specifications and results are given in table 2.1. The dependent variables in these equations are in the form of log $(100\text{-}ENR_i^S)$. The purpose of specification is to avoid an estimated ENR_i^S that exceeds 100 per cent.

Table 2.1 Regression Equation on Enrolment Ratio
Dependent Variable log $(100\text{-}ENR_i^S)$

Independent variables	*Male*			*Female*		
	Primary	*Secondary*	*College*	*Primary*	*Secondary*	*College*
C	3.2398 (21.99)	4.5106 (280.04)	4.3041 (336.10)	3.3761 (38.10)	4.5289 (369.72)	4.3276 (383.42)
ATMF23	−0.1059 (−7.82)			−0.0838 (−10.20)		
ATMF3		−0.1612 (−20.31)			−0.1339 (−22.19)	
ATMF01			0.0031 (22.10)			0.0029 (23.12)
Sample size	72	72	72	72	72	72
R^2	0.47	0.85	0.87	0.60	0.88	0.88
F	61.18	412.46	488.30	105.94	492.20	534.58

The enrolment ratio should depend on the demand for educational services in each level (assuming no constraint on the supply side). The demand for education will in turn depend on how society views the value of education and the cost of education. The private explicit cost of education in Thailand is very low due to government subsidies, hence it should not be en important factor affecting the decision to invest in education. Other private costs of education and the value of education in the view of society should depend on the general level of education attained by people in that society. Presumably, more highly educated persons tend to attach higher value to education than less well educated persons. Therefore, the enrolment ratio is specified as a function of previous educational attainment. The enrolment ratio at the primary level is postulated as a function of the percentage of population aged 6 and over with education beyond the primary level (ATMF23). It is expected that a higher ATMF23 will correspond to a higher enrolment ratio at the primary level. Similarly, the enrolment ratio at the secondary level should be positively related to the percentage of the population age 6 years and over with education beyond the secondary level (ATMF3). Finally, it is postulated that the enrolment ratio at the college level will be inversely related to the percentage of the population aged 6 years and over with an education of less than secondary level (ATMF01).

These enrolment equations are not separately estimated by area. In order to obtain projected students by area, we simply adjust the constant term to obtain correct estimates for each area in 1980. The value of independent variables will be different by area. The underlying assumption in this practice is that the enrolment ratio responds to changes in the independent variables in the same manner regardless of area.

Up to this point, enrolment projection by broad level of education can be made. However, the information obtained is not sufficient to translate present school enrolment to future educational attainment. To achieve the second task, it is necessary to project enrolment by grade within each level of education. In order to this, repetition and continuation rates in each grade must be known. Estimation procedures for these rates are given in Annex I.

Let $EN^s_{i,j,t}$ be the number of student sex s enrolled in the j grade of level i at time t

$R^s_{i,j,t}$ be the proportion of students sex s in the j grade of level i who repeat in the same grade at time t

$CON^s_{i,j,t}$ be the proportion of student sex s who passed grade j of the i level and continue to enroll in the higher grade or the higher level.

With additional information on repetition and continuation rates, it is possible to generate the number of students enrolled in each grade, except for the very first grade in each successive year. For example

$$EN^s_{i,j,t} = EN^s_{i,j,t-1}(R_{1,j,t-1}) + (1 - R_{1,j-1,t-1}) EN^s_{1,j-1,t-1}, CON_{1,j-1,t-1} \quad (2.9)$$

$$j = 2, 3, 4, 5, 6$$

This equation says that the number of students enrolled in the j grade of the primary level at time t is equal to those who enrolled in the j grade at time t – 1 and fail to pass into grade j + 1 plus those who successfully completed grade j – 1 and continue to grade j at time t. The number of students enrolled in the first grade of primary education ($EN^s_{1,1,t}$) is estimated by

$$EN^s_{1,1,t} = (POP^s_{6,t} + POP^s_{7,t})/Z \qquad (2.10)$$

Where $POP^s_{6,t}$ and $POP^s_{7,t}$ are the number of the population aged 6 and 7 at time t; s refers to the sex of the population. Equations (2.9) and (2.10) together generate the number of students enrolled in each grade in the primary level in each successive year. However, the results generated in this manner will be meaningful only when the repetition rate and the continuation rate can be estimated endogeneously with a certain degree of accuracy. However, this is not possible due to data limitation. Besides, we believe that the enrolment ratio responds to the economic and demographic situation in a more understandable way and can be estimated with higher accuracy. Therefore the proportion of students in each grade which is obtained from equations (2.9) and (2.10) is used to distribute the total number of students enrolled in primary level which is obtained in equation (2.7).

The proportion of students enrolled in the secondary level by grade is calculated in a similar manner. However, the proportion of students enrolled in the first grade of the secondary level is calculated from those who have completed primary education and continue their education.

2. *Educational Attainment Projection*

The number of the population in each level of educational attainment at time t can be calculated from the numbers by educational attainment in previous periods and the number of new enrolments in the following manner:

$$AT^s_{1,t} = AT^s_{1,t-1} \cdot SUR^s_{1,t-1} + NEW^s_{1,t} - NEW^s_{2,t} \qquad (2.11)$$

$$AT^s_{2,t} = AT^s_{2,t-1} \cdot SUR^s_{2,t-1} + NEW^s_{2,t} - NEW^s_{3,t} \qquad (2.12)$$

$$AT^s_{3,t} = AT^s_{3,t-1} \cdot SUR^s_{3,t-1} + NEW^s_{3,t} \qquad (2.13)$$

where

$AT^s_{i,t}$ = the number of the population aged 6 years and over whose educational attainment is level i at time t

$NEW^s_{i,t}$ = the number of newly enrolled students in the i level

$SUR^s_{i,t}$ = the survival ratio of the population with i educational attainment

Equation (2.11) implies that the population aged 6 years and over whose highest educational attainment is the primary level at time t are the survivors of those in the same educational group at time t-1 plus those who are newly enrolled in the primary level, subtracting those who are newly enrolled in the secondary level. The numbers of new enrolments in the primary and secondary level are calculated as the numbers enrolled in the first grade of each level, subtracting those who repeat in the same grade.

$$NEW^s_{1,t} = EN^s_{1,1,t} - R^s_{1,1,t} \cdot EN^s_{1,1,t-1} \qquad (2.14)$$

$$NEW^s_{2,t} = EN^s_{2,1,t} - R^s_{2,1,t} \cdot EN^s_{2,1,t-1} \qquad (2.15)$$

The treatment of new entrants at university will be different because one cannot classify the status of university students according to grade as in the case of students at primary and secondary school. Therefore new entrants will be calculated as the difference between the number of enrolments in year t and those who continue from year t-1:

$$NEW^s_{3,t} = EN^s_{3,t} - EN^s_{3,t-1} (1-d^s_{3,t-1}) \qquad (2.16)$$

where

$d^s_{2,t-1}$ = the proportion of university students who graduate in year t-1.

$d^s_{3,t}$ = assumed to be 0.1 for 1980, to decline by 0.001 point annually until it reaches 0.16, and to be constant thereafter. This assumption is simply based on past trends.

The survival ratio for each educational attainment group is slightly different because of differences in the age composition of the population in each educational group. These survival ratios are calculated in the following manner:

Let

$$SUR^s_{6\text{-}29,t-1} = \frac{POP^s_{7\text{-}30,t}}{POP^s_{6\text{-}29,t-1}}$$

$$SUR^s_{30\text{-}44,t-1} = \frac{POP^s_{31\text{-}45,t}}{POP^s_{30\text{-}44,t-1}}$$

$$SUR^s_{45\text{-}79,t-1} = \frac{POP^s_{46\text{-}80,t}}{POP^s_{45\text{-}79,t-1}}$$

$$SUR_{i,\,t-1} = W^s_{i,\,1} \cdot SUR^s_{6\text{-}29,\,t-1} + W^s_{i,\,2} \cdot SUR^s_{30\text{-}44,\,t-1} + W^s_{i,\,3} \cdot SUR^s_{45\text{-}79,\,t-1}$$

$$i = 1, 2, 3$$

$$\sum_{i=1}^{3} W^s_{i,\,j} = 1$$

These weights are given in Annex II. They are computed from past trends of changes in the age composition of each educational group.

C. Urbanization and Migration Block

This submodel will first estimate the level of urbanization (the proportion of the population living in urban areas, UR) as a function of per capita income (PERCAP) and the proportion of the labour force in agriculture (AGL). Then the number of net rural-urban migrants is estimated as the difference between the size of the population living in urban areas, which will be consistent with the level of urbanization estimated in the first step and the natural growth of population in urban areas.

Urbanization is estimated using 1980 data from 71 provinces (excluding Bangkok). The results are as follows:

$$\log\left(\frac{0.5\text{-}UR}{UR}\right) = \underset{(7.99)}{2.8682} - \underset{(-1.71)}{0.3096}\log(PERCAP) + \underset{(2.68)}{1.1364}\log(AGL) \qquad (2.17)$$

$$R^2 = 0.39, \quad n = 71, \quad F = 21.78$$

A maximum level of urbanization at 0.5 is imposed in the model specification. PERCAP and AGL are entered in logarithm form since the effects are expected to be nonlinear. The result mainly implies that the level of urbanization varies inversely with AGL, and varies directly with the level of PERCAP.

UR is used to divide total population (POP) into urban and rural population and is also used to estimate net rural-urban migration (NM)

Urban population (URP):

$$URP = UR \cdot POP \qquad (2.18)$$

Rural population (RP)

$$RP = (1\text{-}UR)\,POP \qquad (2.19)$$

Net total rural-urban migration (NM)

$$NM = URP - URNP \qquad (2.20)$$

where

URNP = urban population due to natural increase.

In order to obtain a set of population distributed by age and sex for further simulation, migrants must also be distributed by age and sex. This is done by age, sex and educational attainment specific average migration rate. The average percentages of the population who changed their usual place of residence across a provincial boundary in 1975-1980, classified by age, sex and educational attainment, are given in table 2.2. The general pattern is that the migration rate is highest among the population aged 15-29. People with higher educational attainments tend to have a higher migration rate and males are relatively more mobile than females. Data from table 2.2 are used to fit two regression equations which estimate age and educational attainment specific migration rates for males and females. The results are given below:

Male:

$$\begin{aligned} MIGS = & -10.4970 + 1.3794\,AGE - 0.0418\,AGE^2 + 0.0003\,AGE^3 \\ & \quad (2.80) \qquad (3.77) \qquad\qquad (-2.98) \qquad\qquad (2.16) \\ & + 3.5108\,D2 + 7.6141\,D3 \qquad (2.21) \\ & \quad (4.60) \qquad (9.32) \end{aligned}$$

$R^2 = 0.89, \quad n = 27, \quad F = 33.14$

Female:

$$\begin{aligned} MIGS = & -13.4478 + 2.1307\,AGE - 0.0657\,AGE^2 + 0.00057\,AGE^3 \\ & \quad (-2.89) \qquad (4.07) \qquad\qquad (-3.76) \qquad\qquad (3.26) \\ & + 2.9578\,D2 + 5.7730\,D3 \qquad (2.22) \\ & \quad (3.11) \qquad (5.67) \end{aligned}$$

$R^2 = 0.81, \quad n = 27, \quad F = 17.35$

where

D2 = proportion of population with some secondary education.

D3 = proportion of population with some college education.

Using the proportion of the rural population by their educational attainment in equations (2.21) and (2.22), we obtain the migration rates of males and females by age. Applying these rates to the rural population by age and sex, we obtain the estimated number of the rural population who have migrated

Table 2.2 Average Migration Rate by Age-Sex and Educational Attainment

Age & sex	*Educational attainment*			
	No education	*Primary*	*Secondary*	*College*
Male				
5-14	3.7517	3.0648	3.9829	–
15-19	5.3312	5.0397	5.4740	13.0435
20-24	8.2102	8.2228	12.8018	14.3605
25-29	7.9288	8.0194	13.9503	16.9847
30-39	4.6256	4.7495	9.9425	14.3767
40-49	3.3940	3.1009	8.5484	12.6160
50+	1.3867	2.2020	4.3441	6.9364
Female				
5-14	3.803	3 0402	3.3479	–
15-19	7.1795	6.3494	7.0329	12.3348
20-24	6.9498	7.7092	12.2419	17.8523
25-29	5.9637	6.0841	10.3503	16.2637
30-39	4.3529	3.6921	7.6621	9.2405
40-49	2.9843	2.4487	8.4711	5.1587
50+	1.7132	1.7223	3.6036	3.4483

across a provincial boundary within a 5-year period. The age-sex distribution obtained here will be used to distribute the number of net rural-urban migrants which is obtained in equation (2.20). In other words, let MP_i^s be the proportion of migrants across a provincial boundary in a 5-year period who belong to age group i and sex s. Then net rural-urban migrants by age and sex can be obtained by

$$NM_i^s = MP_i^s \cdot NM \qquad (2.23)$$

In order to obtain the rural and urban population after migration has been taken into account, NM_i^s will be subtracted from the rural population and be added to the urban population, respectively according to age and sex. Therefore the urban population in age group i, sex s (URP_i^s)

$$URP_i^s = URNP_i^s + NM_i^s \qquad (2.24)$$

where $URNP_i^s$ is urban population in age group i, sex s before taking migration into consideration

$$RP_i^s = RNP_i^s - NM_i^s \qquad (2.25)$$

where RNP_i^s and RP_i^s are the rural population in age group i, sex s before and after taking migration into consideration. This adjustment will slightly change the age-sex distribution of population in both urban and rural areas.

Finally, how would these migrants affect the educational composition of rural and urban population? The educational attainment of the rural population is lower than that of the urban population, and people with higher education have a higher propensity to migrate. Therefore, the educational attainment of migrants will be assumed to lie between the attainment of the rural and the urban population. Let $ATR_{u,i}^s$ and $ATR_{r,i}^s$ be the proportion of the population aged 6 and over, with the level i of educational attainment in urban and rural areas respectively. Then $ATR_{m,i}^s$, the proportion of migrants sex s with the level i of education will be

$$ATR_{m,i}^s = (ATR_{u,i}^s + ATR_{r,i}^s)/2 \qquad (2.26)$$

$$i = 1, 2, 3$$

$$ATR_{m,o}^s = 1 - \sum_{i=1}^{3} ATR_{m,i}^s$$

Thus, the numbers of migrants classified by education can be obtained. These numbers are used to adjust the number of population classified by educational attainment in both rural and urban areas.

D. Household Projection and Household Income Distribution Block

The projection of demographic variables in the previous three blocks are made separately by rural and urban areas. However. only the national level will be studied in this block and in the labour force block, the reason being because a closed link must be established between these two blocks and the economic submodel. However, it is not possible to generate economic variables separately by rural and urban areas; for example, it is not possible to generate income and labour demand separately by rural and urban areas. Therefore, we have no choice but to study only the national level.

The tasks to be performed in this block are to project the number of households and to distribute these households by income class. The number of households will be estimated by the number of population by the method of headship rate. The age-sex specific headship rates in 1980 are given in table 2.3. Headship rates are defined as the proportion of the population in a certain age-sex category who are heads of household. Let h_i^s be the headship rate for population age i sex s.

Therefore the number of households is

$$H = \sum_s \sum_i h_i^s \ POP_i^s$$

Table 2.3 Age-Sex Specific Headship Rates in 1980

Age	*Male*	*Female*
10-14	.00100	.00061
15-19	.01818	.00673
20-24	.19955	.02362
25-29	.52388	.04137
30-34	.72990	.06206
35-39	.83513	.09466
40-44	.88511	.12647
45-49	.91970	.17073
50-54	.93066	.22570
55-59	.93418	.27667
60-64	.89321	.31290
65-69	.85852	.34843
70-74	.77930	.33348
75+	.57972	.30343

Source: Special tabulation from the sample tape of the 1980 population census.

Average household size (AH) is then obtained by

$$AH = \frac{POP}{H}$$

To estimate the number of households by income class, we assume that household income followed a lognormal distribution. Therefore, if Y is the random variable representing household income, then $X = \ln Y$ will be normally distributed.

The distribution of a lognormal is known as

$$f(Y) = \frac{1}{\sqrt{2\pi}\beta} Y^{-1} e^{-[(\ln Y - \alpha)^2 / 2\beta^2]}$$

where $\beta > 0$

$Y > 0$

Two parameters in the distribution: α and β^2 are known as the mean and variance of the distribution of $\ln Y$.

Let INC and VAR be the mean and variance of Y, then

$$\beta^2 = \ln\left(1 + \frac{VAR}{INC^2}\right)$$

$$\alpha = \ln(INC) - \frac{\beta^2}{2}$$

$\frac{VAR}{INC^2}$ is the coefficient of variation which is a measure of income dispersion relative to the mean. Theoretically, changes in the coefficient of variation should depend on changes in the relative returns of various factors of production and the distribution of households classified by major source of income. But how income distribution by factors of production can be translated into household income distribution is not yet understood; therefore this coefficient of variation will be treated as exogeneously determined in this model.

INC is obtained from the level of disposable income generated by the economic submodel and divided by the number of households i.e.

$$INC = \frac{DY}{H} \text{ where DY is disposable income}$$

Since $\frac{VAR}{INC^2}$ is given exogeneously, VAR is known. Therefore α and β are obtained.

The lognormal assumption implies that

$$Pr\,(a<y<b) = F_x\left(\frac{\ln b - \alpha}{\beta}\right) - F_x\left(\frac{\ln a - \alpha}{\beta}\right)$$

where Pr $(a<y<b)$ is probability of y being between a and b F_x is cumulative standard normal which can be approximated by

$$F_x(\chi) = 1 - \frac{1}{2}(1 + d_1\chi + d_2\chi^2 + d_3\chi^3 + d_4\chi^4 + d_5\chi^5 + d_6\chi^6)^{-16}$$

d_1 = .0498673470 $\quad$ d_4 = .0000380036

d_2 = .0211410061 $\quad$ d_5 = .000048906

d_3 = .0032776263 $\quad$ d_6 = .000053830

(Handbook of Mathematical Functions. Edited by Milton Abramowitz and Irene A. Stegun, 1970.)

E. Labour Force Block

1. Labour Supply

The supply of labour by age and sex will be obtained by the product of age-sex specific labour force participation rates and corresponding number of population. Six behavioural equations to estimate labour force participation rates are obtained using provincial data from the 1980 population census. Three equations are estimated for the labour participation rates of male in three different age-groups 11-24, 25-54 and 55 +. Three more equations are estimated for the rates of females in different age groups. The results are given in table 2.4. The dependent variable is specified as log (100 – LFPR) where LFPR represents the percentage of people participating in the labour market. The specification is

Table 2.4 Regression Equations for Labour Force Participation Rates

Dependent Variable: log (100-LFPR)

Independent variables	Male			Female		
	11-24	*25-54*	*55-74*	*11-24*	*25-54*	*55-74*
Constant	6.1224 (22.22)	5.5968 (17.29)	−20.7982 (−7.37)	7.8645 (25.88)	4.4050 (17.18)	−5.9929 (−2.49)
AGE	−0.1748 (−5.45)	−0.2395 (−14.41)	0.6467 (7.29)	−0.4788 (−13.70	−0.0967 (−7.45)	0.2532 (3.35)
AGE^2	−0.0003 (−0.33)	0.0032 (15.49)	−0.0042 (−6.02)	0.0107 (10.92)	0.0012 (7.69)	−0.0015 (−2.56)
PERCAP	–	−0.0032 (−2.94)	0.0017 (1.90)	–	0.0065 (7.63)	0.0028 (3.71)
UN	0.0596 (4.54)	0.0765 (6.01)	–	0.0924 (6.24)	0.0726 (7.08)	–
TFR	–	–	–	0.0001 (8.10)	0.0001 (6.60)	–
ENR23	0.0180 (7.47)	–	–	0.0141 (4.75)	–	–
R^2	0.97	0.48	0.92	0.89	0.40	0.81
F	1 511.05	100.14	773.01	350.80	56.49	301.36
n	216	432	216	216	432	216

designed so that the labour force participation rate will never go beyond 100 per cent.

The independent variables included in the equation for male age 11-24 are unemployment rate (UN) and school enrolment ratio for the secondary and the college levels (ENR23). Both independent variables are statistically significant and the signs are as expected. Higher unemployment rate and higher school enrolment reduce the labour force participation rate. For female in this age group, TFR is also included as an independent variable. The effects of UN and ENR23 on female labour force participation rates are the same as in the case of male. In addition, the labour participation rate of female also responses to TFR. Higher TFR implies greater household responsibilities for women, hence it is expected to reduce female labour force participation rates.

The independent variables included in the equation for males aged 25-54 are PERCAP and UN. For the female equation, TFR is also included. Unemployment discourages both males and females from participating in the labour market. Higher TFR again reduces the labour force participation rate of females. PERCAP affects the labour participation rate of males and females in different directions. A higher PERCAP increases the labour participation rate of males, but decreases the rate for females. This seems to indicate that if income increases females will withdraw first from the labour market.

The independent variable included in the equations for both males and females aged 55 + is PERCAP. The results imply that an increase in income will reduce the labour participation rate of both males and females in this age group.

In all these equations, age (AGE) and age square (AGE^2) are included as the independent variables to capture the age pattern of the labour force participation rate within each broad age group.

In brief, major results which can be summarized from these equations are as follows: fertility decline will increase the labour force participation rate of females aged below 54. Increased school enrolment will decrease the labour participation rates of both males and females under 25 years old. Unemployment depresses the labour force participation rates of both males and females in most age groups. Finally, a higher income tends to depress the labour participation rates of women in all age groups. But it works in the opposite direction for males in the prime age group.

2. *Employment and Wage Determination*

The supply of labour estimated in 1 gives the number of the adult population who are willing to participate in the labour market. The number of population employed can be estimated by

$$EM = LS(1 - UN)$$

where

EM = the number of employed

LS = the supply of labour and

UN = the unemployment rate.

In this model we assumed a neo-classical wage adjustment mechanism in the labour market. Hence there exists only frictional unemployment. Within the framework of search theory, the higher the educational attainment of the labour force and the greater the variation in employment opportunity, the greater will be the investment of the labour force in the search process. Hence a long-run trend of frictional unemployment rate is estimated as a function of the proportion of agricultural labour (AGL) and the average percentage of males and females who have at least some secondary education (ATMF23). Using 1980 provincial data, the estimated equation is

$$\log\left(\frac{0.1 - UN}{UN}\right) = \underset{(1.29)}{0.7278} + \underset{(1.89)}{0.9810}\,AGL - \underset{(-3.09)}{0.0592}\,ATMF23$$

$$R^2 = 0.61, \quad n = 72, \quad F = 54.14$$

The dependent variable is specified so that the estimated unemployment rate will lie within a range of 0 and 0.1. A higher AGL usually indicates a more homogeneous labour market, hence it corresponds to a lower frictional unemployment rate. The benefits of search will be higher for labour with higher education, hence a higher ATMF23 should correspond to a higher frictional unemployment rate. Empirical results confirm both of these expectations.

Since labour demand (LDP) which is generated in the economic submodel is measured in productivity units, labour employed (labour supply after some allowance for frictional unemployment: EM) which is measured in man-years will be first transformed into productivity units. The productivity index by age-sex and education of labour are given in table 2.5. These numbers are calculated by the relative average wage rates of labour in different age-sex and educational groups compared to the average wage rate of all males in age group 11-24 which is the reference group. For example, if the productivity of the reference group is 1, the productivity of males aged 35-49 with college education will be 3.757. Labour employed in productivity units (EMP) is calculated by

$$EMP = \sum_s \sum_i \sum_j EM_i^s \,.\, ATR_j^s \,.\, W_{ij}^s$$

where

EM_i^s = the number of employed labour in age group i and sex s.

$$\therefore EM_i^s = LS_i^s(1\text{-}UN)$$

ATR_j^s = the proportion of the population of sex s aged 6 years and over with j level of educational attainment.

W_{ij}^s = the productivity index of labour in age group i with educational attainment level j and sex s.

The demand for labour (LDP) is a function of the wage rate, thus, w, which is assumed to adjust until equilibrium is achieved;

$$LDP(w^*) = EMP$$

Table 2.5 Productivity Index of Labour (W^s_{ij})

	Age			
	11-24	*25-34*	*35-49*	*50+*
Male				
No Education or Primary	0.725	1.060	1.229	1.232
Secondary	1.108	1.625	2.340	2.925
University	1.618	2.570	3.757	4.488
Female				
No Education or Primary	0.545	0.667	0.698	0.700
Secondary	1.042	1.456	1.990	2.459
University	1.618	2.278	3.162	3.818

LIST OF VARIABLES

T = Year, T = 0 for 1980

MACB = Mean age of childbearing

γ = The proportion of fertility of women aged 20-24 and women aged 15-19

γ_1 = The proportion of fertility of women aged 35-39 and women aged 40-44

ATMF01 = Average percentage of males and females who either have no education or have only some primary education

ATMF3 = Average percentage of males and females who have some college education

ATMF23 = Average percentage of males and females who have at least some secondary education

PERCAP = Per capita income (in thousand baht)

TFR = Total fertility rate for whole Kingdom

TFR_R = Total fertility rate for rural area

TFR_U = Total fertility rate for urban area

PR = The proportion of rural and urban TFR = $\frac{TFR_R}{TFR_U}$

UR = Proportion of population in urban area

$E^o_{M,U}$ = Life expectancy at birth of urban males

$E^o_{M,R}$ = Life expectancy at birth of rural males

$E^o_{F,U}$ = Life expectancy at birth of urban females

$E^o_{F,R}$ = Life expectancy at birth of rural females

EN^s_j = Number of students sex s enrolled in the level i of education
i = 1 for primary
2 for secondary
3 for college
s = 1 for male
2 for female

ELR^s_i = The percentage of population sex s enrolled in the level i of education

POP^M_i and POP^F_i refer to the number of males and females in age group i
i = 1 for ages 6-11
2 for ages 12-17
3 for ages 18-29

ATR^s_i = The proportion of population sex s aged 6 years and over whose educational attainment is level i

AT^s_i = The number of population aged 6 years and over whose educational attainment is level i

NEW^s_i = The number of new enrolled students sex s in the level i

SUR^s_i = The survival ratio of population sex s with educational attainment at level i

$R^s_{i,j}$ = The proportion of students sex s in the j grade of level i who repeat in the same grade

$CON^s_{i,j}$ = The proportion of students sex s who passed grade j of the level i and enroll in the next grade or in the higher level

AGL = The proportion of labour in the agricultural sector

URP^s_i and RP_i are the number of the population age i sex s in urban and rural areas respectively, after taking net rural-urban migration into consideration

$$URP^s = \sum_i URP_i$$

$$RP^s = \sum_i RP_i$$

NM_i	=	Net rural-urban migrants aged i sex s
		$NM^s = \sum_i NM_i^s$
h_i^s	=	Headship rate for population age i sex s
H	=	Total number of households
AHS	=	Average household size
INC	=	Average household income
VAR	=	The variance of household income
LD	=	Labour demand (productivity unit)
LS	=	Labour supply (man-year)
EM	=	Labour employed (man-year), this is the supply of labour after some allowance for frictional unemployment
EMP	=	Labour employed (productivity unit)
EMP_i^s	=	Labour employed in age group i, sex s
$W_{i,j}^s$	=	Productivity index of labour sex s, age i with educational attainment j

III. ECONOMIC SUBMODEL

Introduction

As stated in the previous chapter, the demographic submodel which takes a long-run time perspective (25-30 years) concentrates on the projection of population (age and sex), education, urbanization, migration, household and household income distribution and labour supply. In this chapter, we focus on partial analysis of the determinants of key economic variables and describe how these relationships are incorporated into the demographic submodel.

The economic submodel is designed to achieve two objectives. First: to determine the demand for labour by sector of production. The model breaks production down into 5 sectors: agriculture, manufacturing, construction, private services and public services. The model also generates gross domestic product by sector. These variables will be used in the demographic submodel. Second, it translates demographic changes, such as labour supply and unemployment which are generated in the demographic submodel into the economic variables.

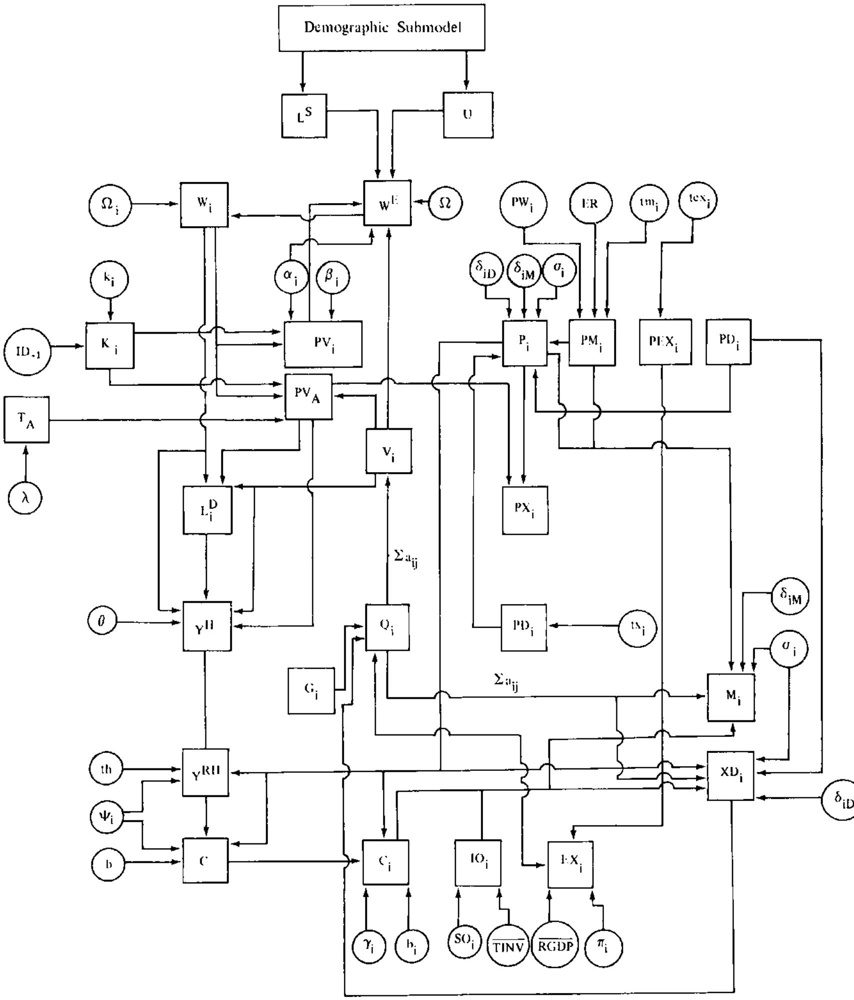
There are some linkages between the demographic and economic submodels which give rise to feedback effects from variables in the two submodels. Changes in fertility rates, for example, affect the size of the labour force and, therefore, the equilibrium wage, sectoral wages, employment and the overall rate of growth of the economy. Conversely, fertility and education are sensitive to changes in per capita income, and the proportion of agricultural employment to total population. These linkages are shown in figure 3.1 which is a schematic diagram of the relationship built in the full model. In figure 3.1 endogeneous variables are represented by rectangles, while exogeneous variables are represented by circles.

The economic submodel proceeds in a series of step to determine: (1) dynamic block; (2) wage block; (3) price block; (4) labour market clearing block, (5) income block and (6) demand block. Each of these steps will be explained briefly in this section of the paper.

A. Dynamic Block

The general equilibrium framework starts off with the dynamic block. It is assumed in the model that each sector is able to finance its fixed capital formation from various sources. The shift in the amount of investment between periods has to be determined by the user. Once the user decides on the investment, the endowment of capital for the next period is derived. This is

Figure 3.1 Schematic Chart of the Economic Submodel



applied in the same manner for all sectors. Let ID_i be the amount for fixed capital formation designated into sector i, then

$$K_{i\,(t+1)} = ID_{it} + (1 - k_i)\,K_{it}$$

or

$$K_{i\,(t)} = ID_{i\,(t-1)} + (1 - k_i)\,K_{i\,(t-1)}, \qquad (3.1)$$

$$i = A, M, C, O, G$$

where K_i is the capital stock of sector i and k_i is a depreciation rate which is assumed to be 0.046 in the agricultural sector and 0.035 in the other sectors. The subscript t is for time.

It was recommended by the group of experts[1] that each country-specific model embody a common production technology. Output is Leontief in value added and is Cobb-Douglas in nature. In this model land-augmented technology is introduced in the production of the agricultural sector.

The basic value added is defined as follows:

$$V_A = \gamma_A \cdot L_A^{\alpha_A} \cdot K_A^{\beta_A} \cdot T^{1-\alpha_A-\beta_A} \tag{3.2}$$

and

$$V_i = \gamma_i \cdot L_i^{\alpha_i} \cdot K_i^{\beta_i}, \qquad i = M, C, O, G \tag{3.3}$$

where

V_A = Value added in agriculture

L_A = Labour used in agriculture

K_A = Fixed capital stock used in agriculture

γ_A = Intercept

α_A = Labour share

β_A = Capital share

A = Agriculture

The rate of disembodied technical progress can be introduced into these functions as follows:

$$V_A = \gamma_A \cdot e^{\lambda_A t} \cdot L^{\alpha_A} \cdot K^{\beta_A} \cdot T^{1-\alpha_A-\beta_A} \tag{3.4}$$

and

$$V_i = \gamma_i \cdot e^{\lambda_{it}} \cdot L_i^{\alpha_i} \cdot K_i^{\beta_i}, \qquad i = M, C, O, G \tag{3.5}$$

Where λ_i is the rate of disembodied technological progress, e is the natural exponent, and the rest of the subscripts are the same as before. When t and λ_i are greater than zero, the quantity of value added in equation (3.4) and (3.5) will exceed those estimated by equation (3.2) and (3.3).

However, as suggested by F. Harrigan and the expert group[2], the simplest way to handle this argument is to augment the dynamic blocks or each of the

[1] David Demery, Francis J.M. Harrigan and Naohiro Ogawa, First Study Directors' Meeting on Comparative Analysis of Demographic-Economic Interrelationships for Selected ESCAP Countries, 29 October – 2 November 1984, ESCAP, Bangkok.

[2] At the Second Study Directors' Meeting on Comparative Study on Demographic-Economic Interrelationships for Selected ESCAP Countries, 5-10 March 1986, Bangkok.

models with an additional variable and equation. The new variable defined as γ_t will be substituted into intercept of the equation where this intercept of production appear in the model to represent the change of the rate of disembodied technological progress overtime. The equation γ_t is defined as:

$$\gamma_t = \gamma_0 e^{\lambda_{it}}$$

The initial period of estimation is 1975, and the capital was derived from the 1975 SAM Table (Chewakrengkai and Lamsam, 1982).

B. Wage Block

The market equilibrium wage rate (W^E) will be first determined according to the mechanism described in chapter II. The wage rate in each sector is then determined by equation (3.6)

$$W_i = \Omega_i W^E, \qquad i = A, M, C, O, G \qquad (3.6)$$

where

W_i = sectoral wage rate

Ω_i = relative average wage rate in each sector

W^E = equilibrium wage rate

Ω_i is estimated from the 1975 SAM Table (Chewakrengkai and Lamsam, 1982).

C. Price Block

This section briefly describes the basic idea behind the formulation of price equations.

1. Import and Export Prices

The landed price of import of commodity i, PM in local currency depends on the average fixed world prices (PW), import tariff (tm) and a fixed exchange rate (ER). The equation is:

$$PM_i = \overline{PW}_i (1 + \overline{tM}_i) \cdot \overline{ER}, \qquad i = A, M \qquad (3.7)$$

The price of export goods and services PEX_i in the agricultural and non-agricultural sector is determined by the purchasers' price of domestically produced goods (PD_i), export tax (tex_i) and fixed exchange rate (ER). The equation is:

$$PEX_i = PD_i / (1 + \overline{tex}_i) \cdot \overline{ER}, \qquad i = A, M \qquad (3.8)$$

Since there are no imports or exports of non-tradable goods, import and export prices for commodities for construction, private and public services are assumed to be 0.

2. Composite Prices (Purchasers' Prices)

This specification follows the SIAM2 (Amranand and Grais, 1983). Let PM be the landed price of imports of commodity i, M_i and let PD_i be the purchasers' price of the associated domestically produced goods, XD_i; import shares are obtained from the solution of:

$$\text{Min } (PM_i \cdot M_i + PD_i \cdot XD_i \text{ subject to } (M_i, XD_i)$$

$$\left\{ \delta_{iM_i}^{-\zeta_i} + (1 - \delta_i) XD_i^{-\zeta_i} \right\}^{-\frac{1}{\zeta_i}} = X_i$$

where X_i = total output demand

Then we can derive share of demand for domestic goods

$$(PM_i \cdot XD_i) / P_i X_i = \delta_i^{\sigma_i} (P_i / PM_i)^{\sigma_i - 1}, \qquad i = A, M$$

and share of demand for import goods as follows:

$$(PD_i \cdot XD_i) / P_i X_i = (1 - \delta_i)^{\sigma_i} (P_i / PD_i)^{\sigma_i - 1}, \qquad i = A, M$$

where $\sigma_i = 1/(1 + \zeta_i)$ is the elasticity of substitution measuring the degree of tradable goods under consideration. Then the marginal cost of the composite goods (composite prices), P_i is derived as:

$$P_i = (\delta_{iD} \cdot D^{\sigma_i} \cdot PD_i^{1-\sigma_i} + \delta_{iM} \cdot M \cdot PM_i^{1-\sigma_i})^{1 / 1-\sigma_i}, \quad i = A, M \quad (3.9)$$

where

δ_{iD} = share of demand for domestically produced goods

$$(\text{e.g. } \delta_{AD} = \left[\frac{Q_A - EX_A}{Q_A - EX_A + M_A} \right]^{1 / \sigma_A})$$

δ_{iM} = shares of demand for import goods

$$(\text{e.g.} - \delta_{AM}^{M_A} = \left[\frac{M_A}{Q_A - EX_A + M_A} \right]^{1 / \sigma_A})$$

3. Value Added Price

In this study, the production function for value added does not appear explicitly in original form in the actual equation of the structure of the model. These functions are used to generate the relationship that provides the labour demand and the value added price equations. The value added price of the agricultural sector and of other sectors behave in the following manner:

$$PV_A = \frac{W_A}{\alpha_A} \cdot V_A^{\frac{1-\alpha_A}{\alpha_A}} \cdot (\gamma_A \bar{T}^{\beta_A} \cdot \bar{K}_A^{1-\alpha_A-\beta_A})^{-1/\alpha_A} \qquad (3.10)$$

and

$$PV_i = (V_i / K_i)^{(1-\alpha_i)/\alpha_i} \cdot \gamma_i^{-1/\alpha_i} \cdot W_i / \alpha_i \quad i = M, C, O, G \qquad (3.11)$$

where

PV_i = price of value added of i sector
W_i = norminal wage of i sector
K_i = fixed capital stock of i sector
V_i = constant price of value added of i sector
T_A = land area (rai)
α_i = share of nominal wages in value added in the base year SAM, (Note $\alpha_G = 1$)
β_A = share of land in value added of agriculture in base year SAM
γ_i = disembodied technological progress

(e.g. $\gamma_i = \dfrac{V_i}{L_i^{\alpha_i} \cdot K_i^{1-\alpha_i}}$ and $\gamma_A = \dfrac{V_A}{L_A^{\alpha_A} \cdot K_A^{\beta_A} \cdot T^{1-\alpha_A-\beta_A}}$)

4. *Price of Output, PX_j*

$$PX_j = \sum_{i=1}^{5} a_{ij} P_i + (1 - \sum_{i=1}^{5} a_{ij}) PV_j \qquad (3.12)$$

i = A, M, C, O, G
j = A, M, C, O, G

where

a_{ij} = the input-output coefficient of the input index i used in sector j
P_i = the composite prices of i sector
PV_j = price of value added of i sector

5. *Output Price (Purchasers' Prices), PD_i*

$$PD_i = PX_j (1 + tx_j), \qquad j = A, M, C, O, G \qquad (3.13)$$

Where tx_j is the mark up rate and PX_j is basic output prices

It should be noted that prices of value added for equations (3.10) and (3.11) are derived on the basis of Cobb-Douglas production functions. The parameters are estimated from time series data from the National Statistical Office (from Censuses), the National Economic and Social Development Board (NESDB), the United Nations Statisticial Yearbook for Asia and the Pacific and the United Nations Commodity Yearbook and Commodity Price Bulletins.

σ_A and σ_M are estimated from CES trade aggregation function

$$M_i = \left(\frac{\delta_i}{1-\delta_i}\right)^{\sigma_i} \cdot \left(\frac{PD_i}{PM_i}\right)^{\sigma_i} \cdot D_i$$

where D_i is total domestic demand, the value of parameters in CES trade aggregation functions of agriculture and manufacturing are 0.6205 and 0.8826 repectively

The remaining coefficients such as tm, te, α_i, a_{ij} were estimated from the 1975 SAM Table (Chewakrengkai and Lamsam, 1982).

D. Labour Market Clearing Block

1. *Equilibrium Wage, W_i^E*

The equilibrium wage is assumed to be a function of value added, V_i, price of value added, PV_i, share of wages in the value added, α_i, the weights of the relative wages to the overall average wage, Ω_i, aggregate labour supply, L^s, and unemployment level, U. The equation is as follows:

$$W^E = \Sigma\left(\frac{\alpha_i V_i PV_i}{\Omega_i}\right) / L^s (1 - U) \qquad (3.14)$$

L^s and U are obtained in the demographic submodel.

2. *Labour Demand, L_i^D*

The labour demand for non-agricultural production, excluding the public services sector, is jointly determined by wage rate, W_i, value added, V_i; price of value added, PV_i and share of wages in the value added. The equations are:

$$L_i^D = (\alpha_i V_i PV_i) / W_i, \qquad i = M, C, O \qquad (3.15)$$

The demand for labour in public services is assumed to be exogeneously determined i.e. $L_G^D = \overline{L}_G^D$

The remaining labour is then assumed to be absorbed in agricultural production.

$$L_A^D = L_i^S(1 - U) - (L_M^D + L_C^D + L_O^D + \overline{L}_G^D) \qquad (3.16)$$

3. *Value Added, V_i*

Value added is simply a fixed proportion of aggregate supply, Q. It is:

$$V_i = (1 - \sum_i a_{ij}) Q_i, \qquad i = A, M, C, O, G \qquad (3.17)$$

E. Income Block

Household income, Y^H, is classified into two components, wage income and capital income. Each household supplies labour services against wage income and also receives capital income and transfers. The nominal household income is:

$$Y^H = (\sum_i L_i^D W_i) + \phi (\sum_i PD_i V_i - \sum_i L_i^D W_i) \qquad (3.18)$$

where

ϕ = share of household income in profit.

The real disposible income, Y^{RH} is:

$$Y^{RH} = \frac{Y^H (1 - th)}{\sum_i \Psi_i P_i} \qquad (3.19)$$

where th is personal income tax and Ψ_i are weights of consumer price index such that $\Sigma\Psi_i$ is equal to one. The parameters, ϕ, th and Ψ_i are also estimated from the 1975 SAM Table.

F. Demand Block

1. *Aggregate Consumption (Naminal)*

From the previous section, the total amount of real income a period is partly distributed to total consumption; the aggregate consumption is thus derived as follows:

$$C = (a + bY^{RH}) (\sum_i \Psi_i P_i) \qquad (3.20)$$

where

C = aggregate consumption

a = an intercept

b = marginal propensity to consume

Y^{RH} = real household income

$\sum_i \Psi_i P_i$ = weighted consumer price index

The parameters for the consumption function, a and b, were estimated from various issues National Income of Thailand, while the other variables such as Y^{RH} and P_i were estimated from the 1975 SAM Table.

2. *Linear Expenditure System (LES)*

The next issue is that of the allocation of total consumption over different sectors. The allocation is obtained through the linear expenditure system (LES). The composite expenditures on goods i (in real terms) are calculated as follows:

$$C_i = \dagger_i + \frac{b_i}{P_i}(C - \sum_j P_j \dagger_j), \qquad i = A, M, C, O, G \qquad (3.21)$$

where

$\dagger_i$ = committed expenditures

b_i = marginal propensity to spend out of the maximum available expenditure.

The remaining parameters are defined in the previous section.

3. *Aggregate Investment, TINV*

This model takes aggregate investment (TINV) as exogeneous. Then

$$TINV = \overline{TINV} \qquad (3.22)$$

4. *Investment by Sector of Destination, ID*

It was suggested that the aggregate $\overline{TINV}$ will be divided into sectors placing demand for investment goods according to a simple profit scheme rule. So investment by destination can be calculated as:

$$ID_i = Sd_i \cdot \overline{TINV} \qquad (3.23)$$

where

Sd_i is calculated from the following ratio

$$Sd_i = \frac{PV_i V_i - W_i L_i}{\Sigma(PV_j V_j - W_j L_j)}$$

5. *Investment by Sector of Origin, IO_j*

The investment by sector of destination is then translated into investment by sector of origin by the capital composition co-efficient, SO_{ij} (Dervis, de Melo and Robinson, 1982). It is a proportion of capital stock in sector j originating in sector i,

$$IO_j = SO_{ij}\,\overline{TINV}, \qquad j = A, M, C, O, G \qquad (3.24)$$

Note that

$$\Sigma SO_{ij} = 1 \text{ for all j and } SO_i = \frac{IO^o}{\sum_i IO_i^o}$$

The coefficients SO_{ij} (in 3.24) and Sd_i (in 3.23) were estimated from the 1975 SAM Table.

6. *Export Demand, EX_i*

For a small open economy, like Thailand, the assumption of product differentiation will lead to less than infinitely elastic demand functions for an exporting country. Based on the assumption of imperfect substitution between the country's exported goods and world products, the world demand for the country's products depends on the fixed "aggregate" world price for products in category PEX_i, the dollar price of a particular country's export, i, and the rest of the world gross domestic product (RGDP). We have

$$EX_i = f_i\left(\frac{\pi}{PEX_i}, \overline{RGDP}\right), \qquad i = A, M \qquad (3.25)$$

The coefficients are estimated by using the time series data from the Statistical Yearbook for Asia and the Pacific, 1982, the Commodity Yearbook and Price Bulletins, and the estimated results for agriculture and manufacturing function can be empirically expressed as:

$$\ln EX_A = \underset{(2.47)}{5.8416} + \underset{(4.81)}{0.9029} \ln (\pi_A / PEX_A) + \underset{(2.04)}{1.0443} \ln \overline{RGDP}$$

$$D.W. = 1.61; \bar{R}^2 = 0.95; F = 139.4$$

and

$$\ln EX_M = \underset{(-3.39)}{-26.334} + \underset{(0.04)}{180} (\pi_M / PEX_M + \underset{(8.52)}{363.68} \overline{RGDP}$$

$$D.W. = 1.30; \bar{R}^2 = 0.94; F = 112.0$$

7. *Import Demand, M_i*

The import demands of the country are subject to cost minimization with regard to the consumption of imported and domestic goods. Similar to exported products, imported and domestic goods are not perfectly substitutable and CES functional form is used to derive trade substitution elasticities, σ_i. The import demand can be written as:

$$M_i = \left(\delta_{iM} \frac{P_i}{PM_i}\right)^{\sigma_i} \cdot \left(\sum_j a_{ij} Q_j + C_i + IO_i\right), \qquad i = A, M \qquad (3.26)$$

where

Q = is an aggregate or composite commodity, the other notions have already been defined in previous sections.

The parameters, δ_{iM} and $\sum_j a_{ij}$ are also generated from the 1975 SAM Table.

8. Domestic Demand, XD_i

The value shares of domestically produced goods in total domestic expenditure can be written as

$$XD_i = (\delta_{iD} \frac{P_i}{PD_i})^{\sigma_i} (\sum_j a_{ij} Q_j + C_i + IO_i), \qquad i = A, M \qquad (3.27)$$

All necessary co-efficients used to compute XD_i are either estimated from the 1975 SAM Table or estimated from previous equations.

9. Material Balances, Q

Total demand for domestic production, XD_i combines with export demand, EX_i, and current government expenditures, G, to produce an aggregate output.

$$Q = XD_i + G + EX_i, \qquad i = A, M, C, O, G \qquad (3.28)$$

10. Balance of Trade

The last equation, representing the rest of the world, is the balance of payment constraint:

$$\sum_{i=A,M} PEX_i \cdot EX_i - \sum_{i=A,M} PM_i \cdot M_i - \overline{F} = 0, \quad i = A, M$$

where

EX_i and M_i = exports and imports respectively.

PEX_i and PM_i = calculated from equations 3.8 and 3.7.

$\overline{F}$ = residual (adjusting factor)

In order to obtain the standard solutions, we start by guessing the value of domestic prices. First solving the labour markets, then, substituting results into the sectoral demand and supply and then the numerical estimates of excess demand and excess supply are obtained. The general equilibrium is reached by revising the initial prices in the iteration process. A complete list of definitions related to the economic submodel variables is presented below.

DEFINITIONS OF VARIABLES

Note that the unit of all the money related variables is millions of 1975 baht unless specified otherwise. Subscript i means five sectors, namely, Agriculture, Manufacturing, Construction, Private Services and Government Services. unless specified otherwise.

Endogeneous variables

C = Total consumption expenditure

C_i = Consumption expenditure

EX_i = Total exports (i = A, M)

ID_i = Investment by destination

IO_i = Investment by origin

K_i = Capital stock

L_i^D = Labour demand (index)

L^S = Total labour supply (index)

M_i = Total imports (i = A, M)

P_i = Composite price (i = A, M; 1975 = 100)

PD_i = Purchaser price

PM_i = Import price (i = A, M)

PEX_i = Export price (i = A, M)

PX_i = Price of output

PV_i = Price of value added

Q_i = Aggregate output

T = Land (1,000 rai)

$TINV$ = Total investment

W_i = Wages

W^E = Equilibrium wages

XD_i = Domestic demand

V_i = Value added

Y^H = Total household income

Y^{RH} = Total real household income

Exogeneous variables

G_i = Government

ER = Exchange rate (1975 = 100)

k_i = Depreciation rate (per cent)

PW_i = Fixed world price (i = A, M)

L_G^D = Employment in government sector

π_i = Index of world price (i = A, M)

tex_i = Export subsidy rate (i = A, M)

th = Personal income tax rate (per cent)

TINV = Total investment

tm_i = Import tariff rate (per cent)

tx_j = Mark-up rate (per cent)

U = Unemployment rate (per cent)

RGDP = Rest of the world gross domestic product (1975 = 100)

IV. THE REFERENCE RUN

Introduction

In order to investigate the effects of various demographic, economic, labour and income distribution policies in Thailand, the model which is described in detail in chapters II and III will be used to simulate future demographic and economic paths. However, before it is possible to understand the likely effects of these policies, it is necessary to understand the path Thailand is likely to take in the future. Therefore a "reference run" will first be provided in this chapter. The reference run gives the most likely outlook of Thailand in the future if there is no deviation of policies from the past. The reference run should not be considered as a prediction of the future since its results are conditional on model assumptions and values of exogeneous variables which are mostly generated from past trends. However, the results provide a basis for comparison with the policy simulation runs which will be given in the following chapter. This chapter will present the mechanics of the simulation, assumptions and initial values of the reference run. Then, the simulation results will be described.

A. Assumptions

In order to simulate the value of all endogeneous variables in the model, initial values of the endogeneous variables have to be given and values of future exogeneous variables have to be assumed. This section will give the source and the initial value of all endogeneous variables. The values of future exogeneous variables and the criteria used to obtain these values will also be given.

1. Assumption and Initial Values in Demographic Submodel

There are several exogeneous variables in the demographic submodel. In the population projection submodel, the level of fertility (TFR) and life expectancy at birth are generated internally at the national level. However, the relative levels between urban and rural areas is given exogeneously. The age pattern of fertility is controlled by γ (the relative fertility of women aged 20-24 to women age 15-17), γ_1 (the relative fertility of women aged 35-39 to women aged 40-44), and MACB (mean age of child bearing). It is assumed that γ and MACB change exogeneously with time and γ_1 is constant over time. The age pattern of mortality is assumed to follow the Brass Standard Life Table, hence the pattern of mortality is also invariable with time.

In the education submodel, the key variables are enrolment ratios which are endogeneous variables. However repetition and continuation rates are given exogeneously, based on time trend.

The level of urbanization is generated internally in the model. This generated level of urbanization implies a certain rural-urban net migration rate for the whole nation. But the relative education, age and sex migration rate is assumed to be constant based on the 1980 pattern.

In the household projection and household income distribution submodel, age-sex specific headship rates are assumed to be constant as of 1980. Income distribution is assumed to follow a lognormal distribution. The mean of the distribution is generated internally, but the variance is given exogeneously. Treating its variance as an exogeneous variable is one major limitation in this submodel. Due to time and data constraints, it has not yet been possible to develop a satisfactory mechanism to understand changes in the variance of household income. However, some useful information on household income can still be drawn from this model even with variances given exogeneously as policy variables. Conditional upon the initial stage and policy adopted, the model will generate the number of households in each income class, which can be useful for various purposes such as to estimate government revenue from income tax, to estimate government expenditure for welfare of the poor, etc.

In the labour supply and employment submodel, labour supply, the frictional unemployment rate and labour demand, which are generated internally in the model, together determine the overall wage rate. The relative wage rate for each age, sex and educational group is determined by past relative average wage rates and is assumed to be constant over time. But the overall level of wage rate will be generated from the economic submodel.

The initial year of simulation of the demographic submodel is 1980. The initial values of demographic variables are taken from the 1980 Population and Housing Census after adjusting for underenumeration. For economic variables, the values in 1980 will be taken from the simulated results in the economic submodel.

2. *Assumptions and Initial Values in Economic Submodel*

In the economic submodel, initial values of lagged endogeneous variables and exogeneous variables are drawn from the 1975 Social Accounting Matrix (SAM) since the 1980 SAM was not yet available for public use. This is to say that the initial year of simulation for the economic submodel is 1975. During 1975 and 1980, economic variables will be generated using actual values on demographic variables as far as possible. Complete simulation of both the demographic and economic submodels started in 1980.

In the economic submodel several initial values and assumptions are imposed. These values can be categorized into 5 columns in table 4.1. The first column presents all the parameters and exogeneous variables, the second column the initial values in 1975, the third column lists all initial values which may or may not stay constant throughout the simulation period, the fourth column all parameters and variables which stay constant throughout the period of simula-

Table 4.1 Predicted Pattern of Changes in the Parameters and the Exogeneous Variables Used in the Reference Run

Variable	*Initial value in 1975*	*Initial value in 1980*	*Value unchanged (1980-2005)*	*Value change per annum (per cent)*
Exogeneous variable				
ER	1.000	1.010		2.3
GA	11 697	12 293.66		6.6
GC	4 205	4 419.49		6.6
GG	12 321	13 603.37		6.6
GM	14 709	14 408.29		6.6
GQ	29 248	30 739.94		6.6
LDG	969 673	1 360 016.54		2.1
PWA	1.0000	1.4900		3.0
PWM	1.0000	1.3470		5.3
RGDP	100.000	120.00	X	
TEAA	0.0439	0.0439	X	
TEKM	0.0552	0.0552	X	
TH	0.0175	0.0175	X	
TXA	0.0210	0.0210	X	
TXC	0.0186	0.0186	X	
TXG	0.0049	0.0049	X	
TXM	0.0463	0.0463	X	
TX!	0.0517	0.0517	X	
TIN	75 747	75 747		2.9
πA	1.0000	2.1200		4.2
πM	1.0000	1.3470		4.2
QG	26 952	32 791.2290		5.8
WG	0.0210	0.0268	X	
Parameter				
AA	0.63355	0.63355	X	
AC	0.41662	0.41662	X	
Ad	0.74136	0.74136	X	
AM	0.31939	0.31939	X	
AQ	0.70606	0.70606	X	
DPA (kA)	0.0460	0.0460	X	
DPC (kC)	0.0350	0.0350	X	
DPG (kG)	0.0180	0.0180	X	
DPM (kM)	0.0350	0.0350	X	
DPØ	0.0350	0.0350	X	
SDA	0.2764	0.2764	X	

Table 4.1 *(Continued)*

Variable	*Initial value in 1975*	*Initial value in 1980*	*Value unchanged (1980-2005)*	*Value change per annum (%)*
SDC	0.0902	0.0902	X	
SDG	0.0058	0.0058	X	
SDM	0.1771	0.1771	X	
SDØ	0.4504	0.4504	X	
SØA	0.0382	0.0382	X	
SØC	0.3759	0.3759	X	
SØM	0.5858	0.5858	X	
SØØ	0.0001	0.0001	X	
λ	1.0000	1.0000		2.0
P_A	0.0502	0.0611		0.6
β_C	0.1115	0.1493		0.6
β_G	0.0210	0.0210		0.0
β_M	0.0556	0.0645		0.6
$\beta_Ø$	0.0925	0.1238		0.6
α A	0.6550	0.6550	X	
α C	0.5989	0.5139	X	
α G	1.0000	1.0000	X	
α M	0.5989	0.5989	X	
α Ø	0.5421	0.5421	X	
Ω A	0.6614	0.6647	X	
Ω C	1.8081	1.7990	X	
Ω M	1.6361	1.6279	X	
Ω Ø	1.8449	1.8266	X	
A	0.38056	0.38056	X	
ψ C	0.00416	0.00416	X	
ψ G	0.0323	0.0323	X	
ψ M	0.39224	0.39224	X	
ψ Ø	0.1907	0.1907	X	
δ DA	0.9421	0.9421	X	
δ DM	0.6851	0.6851	X	
δ MA	0.0048	0.0048	X	
δ MM	0.2400	0.2400	X	

tion, and the last column has variables of which the values change annually based on past trends.

Table 4.2 presents the initial values of endogeneous variables drawn from the 1975 SAM Table as well as the simulated values in 1980. These simulated endogeneous variables along with the exogeneous variables and parameters in 1980 were then fed into the simulation process of the complete model.

B. Results

Given the values of exogeneous variables, all endogeneous economic variables generated for year t will be used in the demographic submodel which will generate endogeneous demographic variables for year t + 1. These demographic variables will be fed into the economic submodel which in turn will generate economic variables in year t + 1. Results of the reference run are given in table 4.3 to table 4.11.

1. Results from the Demographic Submodel

Simulated results from the demographic submodel are given in table 4.3. The values of demographic variables in 1980, which is the initial period of complete simulation, are actual figures. At the time when this research work was taking place (1985-1986) most demographic data later than 1980 were not yet available. Only some variables such as the size of population in urban and rural areas, labour force participation rates and labour supply are available. The actual values of these variables are compared with the simulated results. It turns out that all deviations are within acceptable ranges. Therefore, description of the results from the demographic submodel will start from 1985.

Between 1985 and 2005 the population of Thailand grows from 51.3 million to 68.4 million, an average growth rate of 1.45 per cent annually. The average annual growth rate is 1.57 per cent in the first decade and declines to 1.32 per cent in the second decade. The urban* population in this period grows from 9.19 million to 15.14 million, an average growth rate of 2.53 per cent annually. The percentage of the population in urban areas (UR) increases from 17.92 per cent in 1985 to 22.13 per cent in 2005. UR changes inversely with the proportion of labour in the agricultural sector (AGL). During the period of simulation, AGL declines from 70 per cent to 60 per cent. Although, as the result of migration, the population in urban areas grows faster than the population in rural areas, the majority of the Thai population still lives in rural areas in the year 2005. TFR declines from approximately 3.2 in 1985 to 2.2 in 2005. TFR in rural areas is estimated to decline at faster rate than TFR in urban areas. This is due to the assumption that the relative rural-urban TFR approaches 1 as TFR for the country reaches replacement level at 2. Life expectancy at birth of

---

* Urban population refers to the population living in municipal areas.

Table 4.2 Initial Value of the Endogeneous Variables Used in the Economic Submodel

Variable	Initial value 1975[1]	Initial value 1980[2]	Variable	Initial value 1975[1]	Initial value 1980[2]
C	295 955	410 430	PDO	1.00	0.9296
CA	76 995	110 844	PMA	1.0000	1.5049
CC	6 505	24 631	PMM	1.0000	1.1151
CG	24 756	75 908	PXA	1.0000	1.4761
CM	85 155	99 858	PXC	1.0000	1.2523
CO	31 580	100 414	PXG	1.0000	1.3312
EXA	32 138	61 803	PXM	1.0000	1.5414
EXM	17 157	24 436	PXO	1.0000	0.9862
IDA	20 936	20 936	PEXA	0.9580	1.2154
IDC	6 836	6 836	PEXM	0.9477	1.2482
IDG	443	443	PYA	1.0000	1.5470
IDM	13 415	13 415	PYC	1.0000	1.1111
IDO	34 116	34 116	PYG	1.0000	1.2767
ICA	2 892	2 892	PYM	1.0000	1.9076
IOC	28 473	28 473	PYO	1.0000	0.8368
IOM	44 373	44 373	QA	214 638	341 778
IOO	7	7	OC	41 908	60 910
KA	79 675	158 444	QM	207 937	252 297
KC	32 196	58 813	QO	95 858	161 981
KG	21 450	21 725	TA	112 211	123 890
KM	303 692	316 682	WA	0.0063	0.0119
KO	343 664	446 640	WC	0.0171	0.0322
LDA	10 666 233	15 703 092	WG	0.0095	0.0179
LDC	386 025	286 550	WM	0.0155	0.0268
LDM	2 044 034	2 974 144	WO	0.0175	0.0327
LDO	3 429 349	1 281 994	XA	170 803	267 681
MA	6 521	9 696	XC	31 703	56 491
MM	73 004	107 617	XM	177 070	213 453
PA	1.00	1.4152	XO	66 610	131 241
PC	1.00	1.2044	VA	102 390	195 593
PG	1.00	1.241	VC	12 873	24 192
PM	1.00	1.3592	VG	19 981	24 504
PO	1.00	0.9296	VM	52 935	78 777
PDA	1.00	1.4114	VO	110 636	108 007
PDC	1.00	1.2044	YH	209 536	415 169
PDG	1.00	1.2541	YRH	199 747	315 304
PDM	1.00	1.11654			

Note: [1] SAM 1975; [2] Simulated.

Table 4.3 Simulated Values from Demographic Submodel: Reference Run

	1980	*1985*	*1990*	*1995*	*2000*	*2005*
Population						
POP (million)	46.806	51.290	55.607	59.963	64.285	68.401
M (million)	23.525	25.774	27.9398	30.125	32.291	34.351
F (million)	23.281	25.516	27.668	29.839	31.994	34.0498
POP (U)	8.1396	9.190	10.656	12.109	13.723	15.138
POP (R)	38.6664	42.0998	44.951	47.854	50.562	53.263
YPOP (million)	18.782	18.489	18.004	17.623	17.751	18.025
APOP (million)	26.376	30.957	35.446	39.683	43.272	46.422
EPOP (million)	1.648	1.844	2.158	2.657	3.262	3.954
YDEP (per cent)	71.21	59.73	50.79	44.41	41.02	38.83
EDEP (per cent)	6.25	5.96	6.09	6.69	7.54	8.52
TDEP (per cent)	77.46	65.68	56.88	51.10	48.56	47.35
AHS	5.208	4.903	4.490	4.116	3.811	3.473
H (million)	8.987	10.462	12.384	14.568	16.868	19.143
UR (per cent)	17.39	17.92	19.16	20.19	21.35	22.13
ACL (per cent)	70.04	69.48	66.65	64.11	61.34	60.08
Fertility and Mortality						
TFR	3.85	3.161	2.633	2.373	2.264	2.196
TFR (U)	2.51	2.413	2.282	2.184	2.137	2.105
TFR (R)	4.21	3.320	2.715	2.420	2.298	2.222
EOM (U)	64.90	66.40	68.10	69.00	69.42	69.60
EOF (U)	69.80	70.80	72.10	72.80	73.00	73.10
EOM (R)	59.0	60.8	62.9	64.4	65.4	66.2
EOF (R)	64.0	65.5	67.2	68.5	69.4	70.2
CBR	27.76	24.69	22.74	21.33	20.17	18.70
CDR	8.46	7.58	6.91	6.70	6.77	7.00
Household Income						
GDP (million Baht)	457 031*	553 127	726 811	898 584	1 112 973	1 348 979
AHI (Baht)	47 264*	50 781	56 890	59 906	64 184	68 838
PERCAP (Baht)	9 579*	10 784	13 070	14 986	17 313	19 722
Per cent HP	66.90	63.19	57.69	54.24	49.62	46.52
Education						
ENRM 1 (U) (per cent)	99.00	99.09	99.16	99.19	99.25	99.33
ENRM 2 (U) (per cent)	77.77	70.13	76.85	79.75	82.13	84.54
ENRM 3 (U) (per cent)	9.22	9.26	9.45	9.56	9.77	10.08
ENRF 1 (U) (per cent)	95.45	99.08	99.12	99.15	99.20	99.27
ENRF 2 (U) (per cent)	69.26	63.85	70.75	73.83	76.41	79.09
ENRF 3 (U) (per cent)	8.84	8.35	8.52	8.62	8.82	9.11
ENRM 1 (R) (per cent)	86.92	98.57	99.10	99.39	99.54	99.63
ENRM 2 (R) (per cent)	24.89	22.59	30.38	40.59	48.63	54.81
ENRM 3 (R) (per cent)	1.21	2.22	3.55	4.68	5.44	6.08
ENRF 1 (R) (per cent)	81.76	98.08	98.67	99.03	99.22	99.35
ENRF 2 (R) (per cent)	20.31	18.65	25.50	34.70	42.13	47.98
ENRF 3 (R) (per cent)	1.08	2.03	3.25	4.31	5.01	5.60

Table 4.3 *(Continued)*

	1980	*1985*	*1990*	*1995*	*2000*	*2005*
Student 1 (million)	7.482	7.415	7.117	6.862	6.981	7.141
Student 2 (million)	1.951	2.06	2.585	3.169	3.594	4.025
Student 3 (million)	0.291	0.423	0.606	0.768	0.865	0.930
ATM 0 (U) (per cent)	8.99	9.12	9.13	8.88	8.35	7.63
ATM 1 (U) (per cent)	53.73	52.27	51.79	51.78	51.45	51.09
ATM 2 (U) (per cent)	29.04	28.37	27.40	26.88	26.93	27.12
ATM 3 (U) (per cent)	8.42	10.24	11.68	12.46	13.26	14.17
ATF 0 (U) (per cent)	13.82	13.29	12.47	11.50	10.39	9.18
ATF 1 (U) (per cent)	57.50	57.16	57.38	57.89	58.10	58.26
ATF 2 (U) (per cent)	21.24	20.55	19.70	19.38	19.48	19.61
ATF 3 (U) (per cent)	7.14	8.99	10.45	11.23	12.03	12.96
ATM 0 (R) (per cent)	13.48	13.46	13.20	12.76	12.20	11.48
ATM 1 (R) (per cent)	77.33	72.86	68.52	65.17	63.14	61.57
ATM 2 (R) (per cent)	7.79	12.06	15.93	18.68	20.39	21.89
ATM 3 (R) (per cent)	1.23	1.61	2.35	3.39	4.27	5.06
ATF 0 (R) (per cent)	20.13	18.03	16.64	15.34	14.06	12.71
ATF 1 (R) (per cent)	74.85	72.75	70.47	68.54	67.60	66.98
ATF 2 (R) (per cent)	4.45	7.92	10.89	13.15	14.52	15.72
ATF 3 (R) (per cent)	0.90	1.30	2.00	2.97	3.82	4.59
Labour Force						
LFPRM 1 (per cent)	58	62	61	59	57	54
LFPRM 2 (per cent)	94	95	95	95	95	95
LFPRM 3 (per cent)	61	65	65	64	63	62
LFPRF 1 (per cent)	55	60	60	60	58	56
LFPRF 2 (per cent)	73	74	74	74	74	73
LFPRF 3 (per cent)	37	41	40	39	37	36
MLS 1	4.462	5.103	5.327	5.153	4.819	4.404
MLS 2	6.850	8.132	9.641	11.392	13.0799	14.569
MLS 3	0.972	1.179	1.406	1.6698	1.905	2.220
FLS 1	4.059	4.765	5.071	4.970	4.704	4.443
FLS 2	5.401	6.435	7.546	8.819	10.026	11.030
FLS 3	0.665	0.801	0.957	1.124	1.236	1.392
MLS	12.284	14.414	16.374	18.215	19.804	21.193
FLS	10.125	12.001	13.574	14.913	15.966	16.865
LS	22.409	26.415	29.948	33.128	35.770	38.058
UN	0.0322*	0.0362	0.0427	0.0480	0.0523	0.0557
Productivity (U)	1.2141*	1.2659	1.3276	1.3844	1.4359	1.4830
Productivity (R)	0.9042*	0.9368	0.9860	1.0436	1.0962	1.1512
WE (million Baht/year)	0.01888*	0.02425	0.04611	0.08443	0.18115	0.43410

* Values in year 1981.

both males and females increases gradually over the two decades of simulation. Given these patterns of fertility and mortality, the population aged under 15 years declines slightly from 18.5 millions in 1985 to 17.8 million in in the year 2000 and increases slightly to 18.0 million in the year 2005. The upturn during the last five-year period of the simulation is due to a large cohort of women in the childbearing age which is the result of high fertility in the past. The population aged over 64 years more than doubles from 1.8 million to 4.0 million within two decades. Since the number of old people increases considerably and their family support is expected to decline owing to the smaller average household size, the Government should consider more seriously having welfare programmes for these people. However, in terms of magnitude, children rather than the old remain the major burden for the population of working age.

From the educational submodel, the percentage of the population aged 6-11 years attending school is only slightly below 100 for both males and females in both urban and rural areas in 1985. Hence not much room remains for improving the school enrolment of this age group. For the population of secondary school age (12-17 years), the percentage enrolled in school increases from 70 per cent and 64 per cent in 1985 to 85 per cent and 79 per cent in 2005 in urban areas for males and females respectively. For rural areas, the percentage enrolled in the secondary level starts from a much lower base in 1985, but increases more rapidly. The percentages for males and females are 23 per cent and 19 per cent respectively in 1985, then increase to 55 per cent and 48 per cent in 2005. The percentage of the population aged 18-29 in urban areas enrolled in college increases from about 9 per cent to 10 per cent within two decades. In rural areas, this percentage again starts from a much lower level and increases more rapidly, from about 2 per cent in 1985 to 6 per cent in 2005. These school enrolments together with the size of the school age population imply a rapidly increase in the number of student in the secondary level, of education, from 2 million to 4 million, and in the college level, from .4 to .9 million. But the number of students at the primary level declines in the first decade and increases slightly in the second decade of the simulation period. This implies that pressing demand for government budgetary allocations will shift from primary education to higher education in the future.

Even with these increasing enrolment ratios in formal education, the process of raising the educational attainment of the general public is slow. In 2005, only about 40 per cent of the adult population have education beyond the primary level in urban areas. In rural areas, this percentage is still less than 30 per cent. Therefore, it seems that informal education to raise the general knowledge of the adult population will remain an important complementary programme.

Labour force participation rates for both males and females in the prime age group remain quite constant at 95 per cent for males and 73-74 per cent for females over the simulation period. The labour force participation rate for the population aged 11.24 years is estimated to decline over time. For males the decline occurs sooner and more rapidly than for females. Higher school enrolment is the main reason for this decline. The labour force participation rate for the population aged over 65 years also declines over time, but in this age group the decline seems to be more rapid for females than for males. Higher income seems to be the reason for this decline since higher income causes people, especially women, to retire earlier. These labour force participation rates and the size of the population in each category together determine the size of the labour force available in the economy. The size of the labour force increases from 26.4 million to 38.1 million persons in the simulation period. This implies an average annual growth rate of 1.8 per cent. The size of the labour force gives only one dimension of the workforce reserve since the average educational level of labour related to productivity also increases over time. The average productivity index * of labour increases from 1.33 to 1.48 for urban and from 0.99 to 1.15 for rural areas during 1985-2005. The gap between average productivity of labour in urban and rural areas decreases over time. The frictional unemployment rate is estimated to increase from 3.6 per cent in 1985 to 5.57 per cent in 2005. The supply of labour adjusted for frictional unemployment and the demand for labour together determine the equilibrium wage rate (WE). WE is measured in million baht per year per one reference worker (an average male aged 11-24). The equilibrium wage rate is estimated to increase at an average annual rate of 13.3 per cent in the first decade and 17.8 per cent in the second decade.

Finally, from the household and income distribution submodel, the number of households increases from 10.5 to 19.1 millions. The average household size is reduced from 4.9 to 3.6 persons. Average household income is 50,781 baht per year in 1985 and increases to 68,835 baht per year in 2005, while per capita income increases from 10,784 to 19,722 baht in the same period. Assuming a constant coefficient of variation in household income, then the percentage of households with household incomes of less then 50,000 baht per year is 63 per cent in 1985 and declines to approximately 46 per cent in 2005.

2. Results from the Economic Submodel

Tables 4.4 and 4.5 illustrate a simulation pattern of value added classified by sectors. In terms of the sectoral distribution of value added, there are small changes. A decreasing share of value value added comes from the agricultural sector. Decline in the agricultural sector is due to a slow increase in the price of agricultural produce. These results are consistent with future prospects for the Thai economy.

Construction, private service and public service excluding manufacturing are among sectors whose contribution to the non-agricultural sector increases. Among the non-agricultural sectors, there are significant increases in the proportion of value added of private service (from 24.73 per cent to 31.59 per cent). This is consistent with government policy of trying to increase the role of the private sector in the country.

---

* The meaning of productivity index is given in Chapter III.

Table 4.4 Simulated Value of Real Value Added by Sector, Va, Vm, Vc, Vo, Vt and Rate of Growth of Vg: Reference Run

	Year					
	1981	*1985*	*1990*	*1995*	*2000*	*2005*
Value added (Million baht)	457 031	553 126	726 810	898 584	1 112 973	1 348 979
Va	214 133	250 801	324 824	375 564	450 698	529 220
Vm	79 687	93 023	113 587	131 056	153 726	178 385
Vc	25 095	32 570	44 480	57 996	77 417	100 402
Vo	113 100	140 767	200 169	263 497	341 191	426 181
Vg	25 016	35 965	43 757	70 471	89 941	114 790

Growth rate (per cent)	1981-1985	1985-1989	1990-1995	1995-2000	2000-2005
Vt	4.88	5.61	4.33	4.37	3.92
Va	4.00	5.31	2.94	3.71	3.26
Vm	3.94	4.07	2.90	3.24	3.02
Vc	6.73	6.43	5.45	5.95	5.34
Vo	5.62	7.29	5.65	5.30	4.55
Vg	9.50	4.00	10.00	5.00	5.00

Table 4.5 Proportion of Sectoral Value Added to Total Value Added of Agriculture and Non-agriculture: Reference Run

(Unit: per cent)

Proportion of value added	Year					
	1981	*1985*	*1990*	*1995*	*2000*	*2005*
Agriculture	46.86	45.34	44.69	41.80	40.49	39.23
Non-Agriculture	53.14	54.66	55.31	58.10	59.51	60.77

Turning to the growth of the Thai economy during the next 25 years, it was found that the Thai economy continues to grow at a relatively high rate during the first half of the reference run (the rate is about 4.4 per cent per annum) and then drops to a lower rate in the second half of the run (see table 4.4 and figure 4.1). This may be due to a decline in the contribution of agriculture to total value added.

Table 4.6 contains simulated changes in labour demand by sector. During the simulation period, all this sectoral employment demonstrates a clearly increasing trend. Labour demand in total expands 2.39 per cent per year from the base period, while labour supply expands at 2.51 per cent annually during the same period. The slow-down in the growth rate of employment is due to the gloomy prospects for the growth of GDP explained previously. During this period agriculture remains the major sector absorbing most of the increases in the labour supply. Private services rank second in terms of capacity to absorb labour. Manufacturing is next, while government and construction sectors are among the last groups contributing to the absorption of labour in the economy.

The important variable related to labour is the wage rate, (W_i). This wage rate is measured by million baht per year per male worker with primary education. Wages in the manufacturing, construction and private services rise more rapidly than wages for agriculture. Wages in all sectors increase gradually up to the year 2005 (table 4.7).

Figure 4.1 Simulated Growth Rate of Value Added: Reference Run

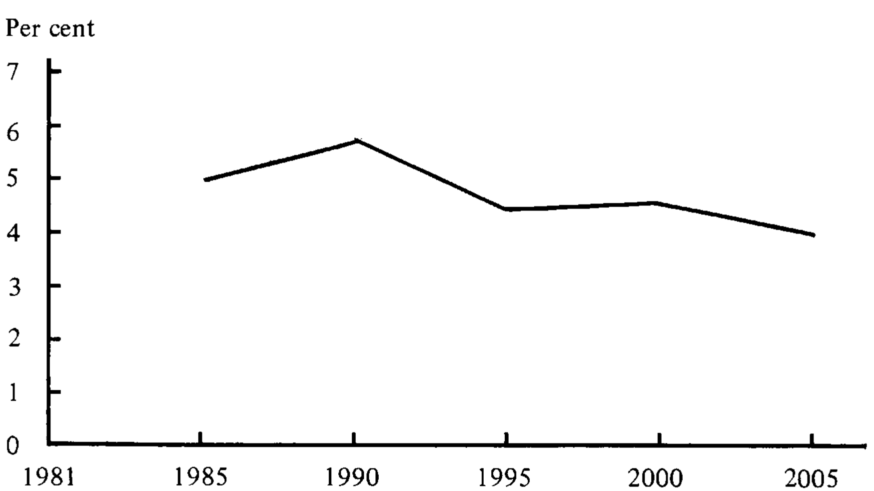


Table 4.6 Simulated Values of the Index of Labour Demand by Sector, Labour Supply and Employment (LDA, LDM, LDC, LDO, LDG and LDT, LS and UN): Reference Run

(Unit: Index)

	Year					
	1981	*1985*	*1990*	*1995*	*2000*	*2005*
LDA	15 319 874	17 707 545	20 004 180	22 277 446	23 958 750	26 162 501
LDM	3 070 084	3 787 554	4 910 430	5 749 196	6 391 623	6 699 709
LDC	400 161	462 366	630 101	869 556	1 220 100	1 585 987
LDO	1 502 676	1 863 793	2 871 563	4 200 124	5 828 816	7 139 199
LDG	1 255 215	1 385 326	1 529 512	1 688 704	1 864 466	2 058 521
LD; Total labour demand	22 601 719	25 456 913	28 669 070	31 538 942	33 899 950	35 939 049
UN; Unemployed persons	751 989	956 183	1 278 773	1 590 199	1 870 786	2 119 883
LS; Total labour supply	23 353 708	26 413 096	29 947 843	33 129 141	35 770 286	38 058 932

Growth rate (per cent)	1981-1985	1985-1990	1990-1995	1995-2000	2000-2005
Total labour supply	2.46	2.54	2.03	1.53	1.24
LDA	3.68	2.46	2.17	1.46	1.77
LDM	5.39	5.33	3.20	2.14	1.94
LDC	3.67	6.38	6.65	7.00	5.38
LDO	5.53	9.02	7.90	6.77	4.13
LDG	2.00	2.00	2.00	2.00	2.00

Table 4.7 **Simulated Values of Nominal Wages by Sector – WA, WM, WC, WO, WG and WT: Reference Run**

(Unit: million baht)

Sectoral wages (W_i)	*Year*					
	1981	*1985*	*1990*	*1995*	*2000*	*2005*
WA	0.01256	0.01614	0.03068	0.05617	0.12053	0.28884
WM	0.03071	0.03944	0.07499	0.13730	0.29460	0.70597
WC	0.03393	0.04359	0.08287	0.15174	0.32557	0.78019
WO	0.03442	0.04421	0.08406	0.15390	0.33021	0.79133
WG	0.02820	0.03417	0.04361	0.05566	0.07104	0.09066

In terms of sectoral distribution of the wage-output price ratio, farmers are likely to face difficult times based on the reference run. The growth of real wages tends to be slower in the agricultural sector than in other sectors, excluding the government one. The real wages in the government sector present a gloomy prospect for government employees. (Table 4.8)

Table 4.8 **Simulated Values of Wage-Output Price Ratio by Sector**

Wage-output price ratio (W_i/PD_i)	*Year*					
	1981	*1985*	*1990*	*1995*	*2000*	*2005*
WA/PDA	0.00880	0.00855	0.00995	0.01034	0.01155	0.01275
WM/PDM	0.01904	0.01887	0.02071	0.02142	0.02461	0.02861
WC/PDC	0.02660	0.02842	0.03169	0.03321	0.03794	0.04331
WO/PDO	0.03318	0.03398	0.03465	0.03303	0.03411	0.03615
WG/PDG	0.02108	0.02078	0.01923	0.01730	0.01503	0.01201

Another economic endogenous variable included in the economic submodel is the output price (PD_i) and composit price (P_1). The simulated pattern of the two prices is presented in table 4.9. The value of PD_i and P_i increases slowly in the first decade and continues to increase more quickly in the last decade of the reference run.

Table 4.9 Simulated Values of Selected Prices By Sector: Reference Run

		Year					
		1981	*1985*	*1990*	*1995*	*2000*	*2005*
A.	*Output prices (PDi)*						
PDA	Agriculture	1.42715	1.88696	3.08386	5.43149	10.43569	22.66163
PDM	Manufacturing	1.61325	2.09030	3.62156	6.40982	11.97049	24.67443
PDC	Construction	1.27570	1.53402	2.61469	4.56854	8.58049	1.01302
PDO	Private Service	1.03727	1.30122	2.42585	4.65926	9.68092	21.89084
PDG	Public Service	1.33771	1.64477	2.26750	3.21717	4.72708	7.54999

Growth rate (per cent)	1981-1985	1985-1990	1990-1995	1995-2000	2000-2005
PDA	7.23	10.32	11.98.	13.95	16.77
PDM	6.69	11.61	12.09	13.30	15.56

B.	*Composite price (Pi)*						
PA	Agriculture	1.43707	1.88855	3.07674	5.36002	10.17719	21.81048
PM	Manufacturing	1.50901	1.89062	3.16850	5.16312	8.79555	16.14529
PC	Construction	1.27570	1.53402	2.61469	4.56854	8.58049	18.01302
PO	Private Service	1.02717	1.30122	2.42585	4.65926	9.68092	21.89084
PG	Public Service	1.33771	1.64477	2.26750	3.21717	4.72708	7.54999

Growth rate (per cent)	1981-1985	1985-1990	1990-1995	1995-2000	2000-2005
PA	7.06	10.25	11.74	13.68	11.64
PM	5.79	10.87	10.25	11.24	12.91
PC	4.71	11.27	11.80	13.43	25.98
PO	5.83	13.26	13.94	15.75	17.75
PG	5.30	6.66	7.24	8.00	9.82

Next, we present selected information relating to the demand component. Table 4.10 describes the simulated value of domestic demand (X_i). The domestic demand of all sectors except for construction oscillates considerably, e.g. in the agricultural sector it increases from 3.84 per cent in 1981-1985 to 5.44 per cent in 1985-1990 and then drops to 3.46 per cent in 1990-1995. It increases again (to 4.25 per cent) in 1995-2000 and finally drops to 3.60 per cent in 2000-2005. The domestic demand for the construction sector decreases slightly throughout the simulation period.

Table 4.10 Simulated Values of Domestic Demand (Xi) By Sector: Reference Run

(Unit: million baht)

Output	*Year*					
	1981	*1985*	*1990*	*1995*	*2000*	*2005*
Domestic demand (Xi)						
XA	279 458	324 994	423 525	502 070	618 191	738 027
XM	220 355	250 526	298 989	332 618	379 115	421 771
XC	58 190	76 810	106 438	135 018	181 152	232 305
XO	131 467	172 715	248 686	309 022	395 883	486 518

Growth rate (per cent)	1981-1985	1985-1990	1990-1995	1995-2000	2000-2005
XA	3.84	5.44	3.46	4.25	3.60
XM	3.26	3.60	2.15	2.65	2.16
XC	7.18	6.50	5.25	5.96	5.09
XO	7.06	7.56	4.44	5.07	4.20

Table 4.11 illustrates some of the other demand components, expressed in nominal terms. The annual rate of growth of consumption fluctuates throughout the simulation periods. The amount of exports and imports rises fairly quickly from 1981 to 1990 and increases slowly up to the end of the simulation period. By definition the difference between imports and exports of goods and services is the balance of trade. As indicated in this table, imports outweigh exports towards the end of the simulation period, except for the last few years, when trade surpluses occur.

Table 4.11 Simulated Values of Selected Aggregate Demand Components (Nominal Terms): Reference Run

(Unit: million baht)

Output	*Year*					
	1981	*1985*	*1990*	*1995*	*2000*	*2005*
Other demand						
C	434 960	548 823	843 913	1 165 151	1 776 868	2 677 410
EX	148 476	206 776	428 235	782 848	1 684 990	3 871 308
IM	153 084	222 225	453 509	858 671	1 752 654	3 797 772

Growth rate (per cent)	1981-1985	1985-1990	1990-1995	1995-2000	2000-2005
C	5.98	8.98	6.67	8.80	8.54
EX	8.63	15.67	12.82	16.56	18.10
IM	9.76	15.33	13.61	15.33	16.72

V. POLICY SIMULATIONS

In this chapter several policy experiments will be presented and the results will be compared with the reference run. Three demographic-related policies and five economic-related policies will be experimented. These policies are:

(1) Slow and rapid decline in fertility

(2) Promoting education

(3) Changing the determination of variation in household income.

(4) Increasing investment in agriculture

(5) Increasing agricultural technology

(6) Increasing tax in manufacturing

(7) Increasing manufacturing output

(8) Slowing down in world trade

Although each policy will affect all endogenous variables in the model, the magnitude of the effect will be large only for some variables depending on the type of policy. In order to shorten the presentation, in each policy experiment, selected variables which are expected to be significantly affected by the policy will be presented. Percentage changes of these variables from the reference run will be calculated and discussed.

A. Slow and Rapid Decline in Fertility

This part of the study will investigate the combined effects of slow and rapid decline in fertility on the simulation results. In the reference run TFR is generated by

$$\text{TFR} = 2 + e^{f(\text{C, ATMF 23, PERCAP})}$$

where C is a constant. This behaviour equation implies that TFR changes in response to education and income. In the experimental run for rapid decline in fertility, we assume that the constant term (C) declines by 4 per cent annually. This assumption can be viewed as representing the success of programmes which accelerate fertility decline. In the experimental run for slow decline in fertility, the constant term is assumed to increase by 2 per cent annually in the first decade and increase by 1 per cent annually in the second decade. This experimental run can be viewed as representing a situation where there is some relaxation in family planning programmes as compared to the past. The values of selected variables from these two experimental simulations and percentage changes as compared to the reference run are shown in tables 5.1 and 5.2 TFR under different assumptions given above is shown in figure 5.1. In the reference

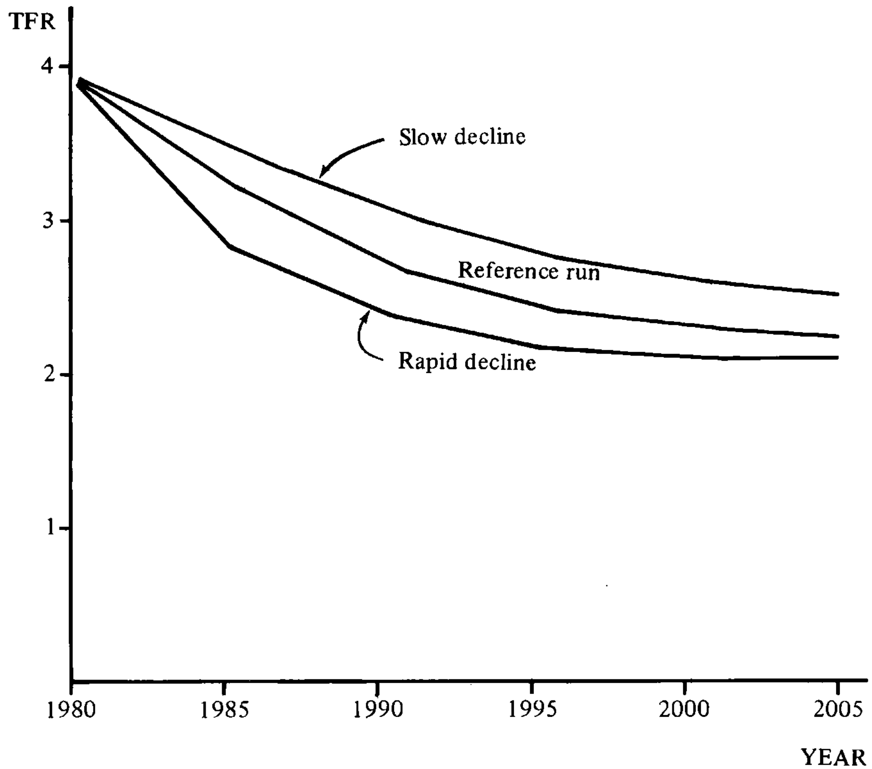
Table 5.1 Rapid Decline in Fertility Simulation: Comparison With the Reference Run

Variable	*1995*		*2005*	
	Value	*Per cent change from reference run*	*Value*	*Per cent change from reference run*
Population				
POP	58.18	−2.97	65.67	−3.99
YPOP	15.83	−10.16	16.42	−8.88
AHS	3.99	−3.16	3.44	−3.64
H	14.57	0.0	19.09	−0.26
TFR	2.14	−9.70	2.06	−6.36
CBR	19.83	−7.30	17.91	−6.47
UR (per cent)	20.30	0.55	23.50	6.19
AGL (per cent)	64.22	0.17	56.14	−6.56
Education				
Student 1	6.07	−11.52	6.49	−9.10
Student 2	3.15	−0.63	3.60	−10.45
Student 3	0.78	0.0	0.88	−5.38
Labour force				
MLS	18.17	−0.23	20.79	−1.91
FLS	14.93	0.12	16.39	−2.83
LS	33.10	0.09	37.18	−2.31
WE	0.07905	−6.37	0.61049	40.63
Economics				
GDP	899 312	0.08	1 439 645	6.72
AHI	59 740	0.28	72 690	5.60
PERCAP	15 457	3.14	21 923	11.16

Table 5.2 Slow Decline in Fertility Simulation: Comparison With the Reference Run

Variable	*1995*		*2005*	
	Value	*Per cent change from reference run*	*Value*	*Per cent change from reference run*
Population				
POP	61.72	2.94	71.50	4.53
YPOP	19.39	10.04	20.18	11.99
AHS	4.24	2.91	3.73	4.48
H	14.57	0.0	19.18	0.21
TFR	2.69	13.50	2.38	8.18
CBR	23.44	9.89	19.61	4.87
UR (per cent)	20.10	–0.50	21.40	–3.17
AGL (per cent)	63.88	–0.36	62.23	3.58
Education				
Student 1	7.54	9.91	8.05	12.75
Student 2	3.16	–0.31	4.44	10.45
Student 3	0.76	–2.56	0.97	4.30
Labour force				
MLS	18.25	0.18	21.53	1.59
FLS	14.84	–0.50	17.23	2.15
LS	33.09	–0.12	38.76	1.84
WE	0.09033	6.99	0.37548	–13.50
Economics				
GDP	900 689	0.23	1 297 767	–3.80
AHI	60 232	0.54	66 708	–3.09
PERCAP	14 593	–2.62	18 151	–7.97

Figure 5.1 TFR Under Three Assumptions



run, TFR declines from 3.85 in 1980 to 2.20 in 2005. Under the assumption of rapid fertility decline, TFR declines to near replacement level in 2005. But under the assumption of slow decline, TFR will be 2.38 in 2005. What will be the implication of these different levels in fertility on the values of other variables in the model? We will first look at population size. Under the rapid fertility decline assumption, the population in 1995 will be 58.18 millions, which is about 3 per cent lower than that estimated in the reference run. By 2005, the population will be 65.67 millions, which is about 4 per cent lower than that estimated in the reference run. It also implies a population growth rate of 1.36 per cent annually during 1985-1995 and rate of 1.22 per cent annually during 1995-2005. The population group whose size is most affected by fertility decline is obviously the population group aged under 15 years. Under rapid fertility decline, the number of the population aged under 15 years will be about 10 per cent lower than under the reference run by 1995, and will be about 9 per cent lower by 2005. Average household size will be about 3.99 and 3.44 in 1995 and 2005, respectively 3.16 per cent and 3.64 per cent smaller than in the reference run. The number of households will not be affected much by the changes in the assumption about fertility in the 25-year period. Rapid fertility decline in the long run will reduce the proportion of labour in the agricultural sector at a faster rate, which will result in a more rapid pace of urbanization.

Changes in the assumption about fertility will greatly affect the number of students at the primary level. Under rapid fertility decline, the number of students at the primary level is estimated to be about 6.07 million in 1995 and 6.49 million in 2005. These numbers are about 11.5 per cent and 9.1 per cent lower than those estimated in the reference run.

The number of students at the secondary level will not be affected by rapid fertility decline until after 15 years. Thus the number of students in the secondary level in 1995 is 3.15 million, which is about the same number as in the reference run. But in 2005, the number is estimated to be 3.60 million, which is about 10.4 per cent lower than in the reference run. The number of students at college level will be affected by rapid fertility decline in a similar way to the number of students at the secondary level, but with a longer time lag. By 2005, the number of college students will be about 0.88 million, which is about 5.4 per cent lower than in the reference run.

If we assume that the Government has to spend about 2,000, 3,800 and 5,600 baht per year per student in the primary, secondary and college levels respectively, rapid decline in fertility will reduce government expenditure on education by 1,656 million baht in 1995 and by 3,176 millions baht in 2005 as compared to the reference run.

In the short run (less than 15 years), rapidly fertility decline will increase the female labour supply because of the higher labour force participation rate for females of childbearing age. But it will reduce the male labour supply among the young and the old. For the young age group, the reduction in the labour supply is the result of higher education which is in turn due to higher per capita income. For the older age group, the reduction is mainly due to higher per capita income. Hence the combined effect on labour supply is very small in the short run. In the long run, however, the reduction in the labour supply as a result of rapidly fertility decline will be more evident. In year 2005, the size of the work force shrinks by 2.3 per cent as compared to the reference run. Equilibrium wage rate (WE) will decline in the first 15 years of the simulation as a result of the increasing supply of labour. But during the last decade of the simulation, WE will be about 40.6 per cent higher than that generated in the reference run. This is due to a smaller cohort of new entrants into the labour market as a result of lower fertility at the beginning of the simulation period.

Finally, rapid fertility decline also raises GDP above the level generated in the reference run. In the first decade of the simulation period, higher GDP is mainly due to an increased supply of labour. In the last decade of the simulation period, higher GDP is mainly due to a higher general price level which is the result of a higher wage rate. Average household income and per capita income increase by 5.6 per cent and 11.2 per cent respectively by 2005 as compared to the reference run.

The implications of a slow decline in fertility can be summarized as follows: the size of the population is estimated to be 61.72 and 71.50 million in 1995 and 2005 respectively. These figures imply a population growth rate of 1.8 per cent annually during 1985-1995 and a rate of 1.48 per cent annually during 1995-2005. The size of the population is 2.94 per cent and 4.53 per cent less than in the reference run in 1995 and 2005. In the long run, the slow decline in fertility will also slow down the process of urbanization. This is partly the result of slow decline in the proportion of agricultural labour (AGL). The population under 15 years of age increases by 10 per cent and 12 per cent in 1995 and 2005 respectively. Failure to reduce the rate of population growth as rapidly as in the reference run will induce a considerable burden of young dependents for the adult population in the future. Slow decline in fertility will also create more pressure on government expenditure on education. The figures in table 5.2 imply that the number of students in the primary level will increase by about 9.9 per cent and 12.7 per cent as compared to the figures in the reference run in 1995 and 2005 respectively. For the secondary and college levels, the number of students will increase by approximately 10.5 per cent and 4.3 per cent respectively in 1995 and 2005. Using the assumption about government expenditure per student per year given previously, slow decline in fertility will cost the Government an additional 1,210 million baht for education in 1995 and 3,640 million baht in 2005, as compared to the reference run. The supply of labour declines by 0.12 per cent in 1995 and increases by 1.84 per cent in 2005. Hence the equilibrium wage rate increases slightly first and declines toward the end of the simulation period. As expected, slow decline in fertility will reduce average household income and per capita income by 3.1 per cent 8.0 per cent respectively by 2005.

As reviewed earlier in chapter I it is a target of the Fifth Five Year Plan to reduce the rate of population growth to 1.5 per cent annually by 1986. However, this target is unlikely to be achieved in time. It is estimated that the population growth rate should be about 1.7 per cent in 1986. Hence the working group on population policy for the Sixth Plan has aimed at reducing the population growth rate to 1.3 per cent by 1991. If we compare the target population growth rate with the simulation results in the reference run, the population growth rate is estimated to be 1.67 per cent in 1986 and 1.57 per cent in 1991. In the experimental run, with rapid decline in fertility, the population growth rate is estimated to be 1.42 per cent in 1986 and 1.36 per cent in 1991. It seems to imply that policy is set to take the path of rather rapid decline in fertility. Various results of the simulation presented above seem to provide reassurance that fertility decline remains a logical development strategy. However, the target set in the Sixth Plan is lower than that generated in the reference run, which means that additional effort is required to achieve that target.

B. Educational Policy Experiment

In the Fifth Five Year Plan, problems of quantity, quality and unequal opportunities ". . . for rural children to seek an education beyond the compulsory level when compared with their urban counterparts." have been raised. Hence the targets have been set (1) to expand primary education to cover all students in the primary school age group, (2) to increase enrollment for secondary and higher education, and (3) to increase opportunities for rural children to seek an education beyond the compulsory level. Using the targets set in the Fifth Plan as guidelines, we perform educational policy experiments under the following assumptions:

1. The enrollment ratio at the primary level for both males and females increases 0.1 per cent per year until it reaches 100 per cent.

2. The enrollment ratio at the secondary level for both males and females in rural areas increases 2 per cent per year throughout the simulation period. The enrollment ratio at the secondary level for children living in urban areas and enrollment at the college level are determined endogenously as in the reference run. These assumptions can be viewed as representing the success of government programmes to solve problems mentioned in the Fifth Plan. The implication of such programmes for social and economic development will be investigated here.

Table 5.3 gives the value and percentage change of selected variables as compared to the reference run. Theoretically, increasing education should also affect fertility, mortality and population growth rates. However, it is expected that the effects should be felt only after a long time. The simulation results seem to confirm this expectation. Increasing education does reduce fertility as expected, but the effect is small in terms of magnitude. The direct effect of increasing the enrollment ratio is to increase the number of students, especially those enrolled at the secondary level. This number is 3,767 million in 1995 and 4,859 million in 2005 which are respectively 18.9 per cent and 20.7 per cent higher than the corresponding number in the reference run. These increasing numbers imply an additional budget of 2,272 million baht and 3,169 million baht in 1995 and 2005 for government expenditure on education.

Another direct effect of increasing enrollment is a reduction of the labour supply in the young age group. The numbers for male and female labour supply in the age range 11-24 is 5.0 and 4.8 million respectively in 1995. These numbers are about 3 per cent lower than in the reference run. In 2005, the supply of labour in this age group is reduced by approximately 6.4 per cent. In terms of total labour supply, such a policy of promoting education will reduce the labour supply by 0.9 per cent in 1995 and 1.4 per cent in 2005. The reduction in labour supply is translated into a higher equilibrium wage rate of about 8 per cent in 1995 and 7 per cent in 2000 as compared to the reference run. However, a twisted result in the direction of change in the equilibrium wage rate is obtained for year 2005. A satisfactory explanation of this result is yet to be found.

Table 5.3 Educational Policy Simulation: Values Compared with the Reference Run of Selected Variables

Variable	*1995*		*2005*	
	Value	*Per cent change from reference run*	*Value*	*Per cent change from reference run*
POP	59.765	−0.33	68.158	−0.36
TFR	2.359	−0.59	2.188	−0.36
CBR	21.28	−0.23	18.65	−0.27
CDR	6.69	−0.15	7.02	0.29
AHS	4.10	−0.39	3.56	−0.36
UR (per cent)	20.30	0.50	21.81	−1.36
AGL (per cent)	63.71	−0.62	60.96	1.46
Student 1	6.745	−1.71	7.147	0.08
Student 2	3.767	18.87	4.859	20.72
Student 3	0.778	1.30	0.928	−0.21
MLS 1	5.003	−2.91	4.107	−6.74
FLS 1	4.826	−2.90	4.177	−5.99
MLS	18.071	−0.79	20.905	−1.36
FLS	14.771	−0.95	16.6340	−1.39
LS	32.842	−0.86	37.535	−1.37
GDP	900 438	0.21	1 312 767	−2.68
AHI	60 051	0.24	67 265	−2.28
PERCAP	15 066	0.53	19 261	−2.34
WE (Million baht/year)	0.09128	8.11	0.41796	−3.72

Increasing education in rural areas slightly slows down the process of urbanization, but the magnitude of the effect is quite small.

C. Income Distribution Experiment

According to the 1981 Household Expenditure Survey, the coefficient of variation of household income $(\frac{VAR}{INC^2})$ is 0.6725. In the reference run this coefficient of variation is assumed to be constant as of year 1981 during the simulation period. This implies that variance of household income is a constant proportion of average household income. This assumption can be viewed as a situation where development policy does not particularly affect income distribution. If this is the case, the percentage of households with incomes of less than 50,000 baht per year declines from 51 per cent in 1985 to 42 per cent in 1985 and 35 per cent in 2005. Average household income (AHI) increases from 50,780 baht per year in 1985 to 59,906 baht in 1995. Average annual growth rate in AHI during 1985-1995 is 1.67 per cent AHI increases to 68,838 baht per year in 2005. The average annual growth rate in AHI during 1995-2005 is 1.40 per cent.

Now suppose that the Government pursues a policy which aims at reducing income inequality in the country. The result of such a policy is to reduce the coefficient of variation of household income by 15 per cent each year. That is

$$\frac{VAR}{INC^2} = 0.6725\, e^{-.015t}$$

t = 0 for 1980. This policy will not cause any change in the average household income as compared to the reference run. However, the percentage of households with average household incomes of less than 50,000 baht per year will decrease more rapidly. In 1995, this percentage is 38.66, which implies that the number of households in this income bracket is reduced by about 0.5 million households compared to the reference run. In 2005, the percentage of households with incomes of less than 50,000 baht is 28.35, which implies a reduction of 1.2 million households from the reference run. Of course, under this policy the percentage of households in the highest income bracket (AHI greater than 200,000 baht per year) is also reduced from 4.48 per cent in the reference run to 3.1 per cent in the policy run at the end of the simulation year.

Table 5.4 Household Income Classified by Income Classes for the Reference Run and Decreasing Variation of Determination Runs

Income class	*1985*	*1990*	*1995*	*2000*	*2005*
Reference run					
Less than 50,000 baht per year	51.03	44.73	41.89	38.17	34.51
50,000-99,999	36.60	39.37	40.38	41.49	42.29
100,000-199,999	10.69	13.45	14.80	16.72	18.73
More than 200,000	1.69	2.49	2.93	3.62	4.48
Total Number of Households	10.462	12.389	14.568	16.868	19.143
Average Household Income	50 781	56 896	59 906	64 184	68 838
Decreasing co-efficient variation					
Less than 50,000	50.22	42.73	38.66	33.51	28.35
50,000-99,999	37.68	41.80	49.20	46.71	48.82
100,000-199,999	10.58	10.70	14.70	17.16	19.78
More than 200,000	1.51	2.05	2.23	2.62	3.1
Total Number of Households	10.462	12.384	14.568	16.868	19.143

D. Increasing Investment in Agriculture

It is assumed in this experiment that there is an additional 10 per cent increase in the share of agricultural investment expenditure in each simulation period. This policy attempts to increase the capital stock of the agricultural sector, which feeds directly into the price of value added. This policy simulation represents a recommendation which actually attempted to increase the surplus of agriculture and stimulate the export of agricultural commodities. The results of this policy experiment are illustrated in table 5.5.

1. Economic Variables

The economy grows slowly in this policy experiment, with value added 0.76 per cent lower in 1995, and 9.09 per cent higher in 2005 as compared to the reference run. In this policy simulation at least two sectors, agriculture and manufacturing, expand in 1995. The value added of the two sectors increase by 1.14 per cent and 0.71 per cent respectively as compared to the reference run. In the same period the value added of the construction and private service sectors are lower in 1995 than in the reference run. However in 2005 the entire economy expands in this policy simulation run. GDP is up by 6.17 per cent in manufacturing and 11.52 per cent in the construction sector.

When we direct the national policy toward agriculture, labour demand in agriculture and manufacturing are increased slightly in 1995 as compared to the reference run. The increase in labour demand is the results of increasing agricultural output and manufacturing output. But in the long run, the labour demand in most sectors except agriculture increase compared to the reference run. The wages and prices of value added generally drop below the reference run in 1995. The opposite direction is observed in 2005 when wages and value added prices increase above the reference run. The effect of directing additional investment into agriculture is that overall exports and imports decrease in 1995 but increase in the later period.

2. Demographic Variables

This policy experiment generates little pronounced effect upon the demographic factors. In 1995, the simulated values of population decrease slightly by 0.04 per cent, while in the long run this effect vanishes as compared to the reference run. The crude birth rate and TFR decrease slightly due to increases in per capita income. This policy experiment causes the percentage of households with incomes of less than 5,000 baht (per cent HP) to increase slightly.

E. Increase in Agricultural Technology

In this policy, it is assumed that the rate of technological progress increases by an additional 1 per cent each year. This policy can be viewed as representing the effort of government to increase agricultural output. The results of this policy simulation are presented in table 5.6.

Table 5.5 Increasing Share of Agricultural Investment Expenditure by Additional 10 Per Cent in Each Simulation Period

Variable	1985 (15 years)		2005 (25 years)	
	Value	Per cent change from reference run	Value	Per cent change from reference run
Demographic				
POP	59.940	−0.04	68.404	0.004
CBR	21.31	−0.94	18.78	0.43
CDR	6.71	0.15	6.97	−0.43
TFR	2.370	−0.12	2.207	0.50
LS	33.134	0.02	37.949	−0.28
UR	20.10	−0.44	23.58	6.55
Per cent HP	54.85	1.12	42.69	8.23
Economic				
V	890 757	−0.76	1 470 885	9.04
VA	379 860	1.14	587 957	11.10
VM	131.984	0.71	189 396	6.17
VC	55.185	−4.85	111 964	11.52
VO	253 257	−3.89	466 778	9.53
VG	70 471	0	114 790	0
LDA	22 476 094	0.89	23 759 221	−9.19
LDM	5 843 139	1.63	7 425 326	10.83
LDC	804 585	−7.47	1 889 402	19.13
LDO	3 983 799	−5.15	8 355 854	17.04
WE	0.06897	−18.31	0.33510	−22.80
WA	0.4589	−18.30	0.33540	−22.74
WM	0.11217	−18.30	0.81990	18.39
WC	0.12396	−18.31	0.90610	28.35
WO	0.12573	−18.30	0.91900	17.80
WG	0.05566	0	0.09070	0
PVA	5.07670	−20.25	33.97940	17.93
PVM	8.62880	−17.29	55.9792	22.08
PVC	3.7512	−20.58	32.5921	28.07
PVO	3.9082	−19.22	32.7557	27.06
PVG	2.6530	0	4.32126	0
EX	708 509	−9.50	4 483 458	15.81
IM	763 825	−11.04	4 272 164	12.49

Table 5.6 Accelerating Rate of Technological Progress in the Agricultural Sector by Additional 1 Per cent Each Year. Comparison with Reference Run After 15 and 25 Years

Variable	*1985 (15 years)*		*2005 (25 years)*	
	Value	*Per cent change from reference run*	*Value*	*Per cent change from reference run*
Demographic				
POP	59.935	–0.04	68.444	0.064
CBR	21.34	0.04	18.84	0.75
CDR	6.70	0	6.95	–0.71
TFR	2.372	0	2.215	0.86
LS	32.523	–1.84	37.867	–0.49
UR	20.16	–0.14	24.80	12.06
Per cent HP	54.24	0	39.72	–14.61
Economic				
V (Y)	903 967	0.71	1 566 258	16.10
VA	384 478	2.37	616 122	16.42
VM	133 595	1.94	193 337	8.38
VC	56 192	–3.11	126 956	26.45
VO	259 231	–1.62	515 053	20.85
VG	70 471	0	114 790	0
LDA	22 437 625	0.72	25 358 827	–3.07
LDM	5 707 160	–0.73	6 841 126	2.11
LDC	844 389	–2.89	1 717 882	8.32
LDO	4 112 346	–2.09	7 613 296	6.64
WE	0.06974	–17.40	0.84197	93.96
WA	0.46400	–17.39	0.56022	93.96
WN	0.11342	–17.39	1.36929	93.96
WC	0.12534	–17.40	1.51324	93.96
WO	0.12713	–17.39	1.53484	93.96
WG	0.05566	0	0.90660	0
PVA	5.93945	–6.70	58.97606	104.68
PVM	9.60095	–7.98	93.39530	103.67
PVC	4.34002	–8.11	59.37839	133.33
PVO	4.46575	–7.69	57.25971	122.12
PVG	2.65300	0	4.32126	0
EX	722 498	–7.71	6 345 107	63.90
IM	767.429	–10.63	6 133 336	61.50

1. Economic Variables

The direct effect of increasing agricultural technology causes GDP to increase by an additional 0.71 per cent over the reference run in 1995. GDP is higher in 2005 with a 16.10 per cent increase over the reference run. As the value added of the agricultural sector expands, the value added of manufacturing also expands but at a slower rate. An adverse effect of increasing agricultural technology is found in the construction and private service sectors. The value added of these two sectors drops below that in the reference run in 1995 but recover during the last decade of simulation.

The slow expansion of value added in non-agricultural sectors has caused a decline of employment in these sectors and an expansion in agricultural employment in 1995. But the opposite results are found in 2005. Because of the expansion of agricultural value added due to technology increases, the prices of value added, wages and foreign sectors are driven down below those in the reference run in 1995. Again, the opposite result is observed in 2005.

2. Demographic Variables

The higher value added levels which feed in to the demographic submodel have small effects on demographic variables. After 15 years, the total population is slightly (.04 per cent) below that in the reference run. After 25 years the total population increases by only 0.06 per cent. The effect of higher value added in the long run as the result of higher agricultural technology is to decrease the percentage of households with incomes of less than 50,000 baht by about 14 per cent in 2005 as compared to the reference run.

F. Increasing Tax in Manufacturing

In this policy experiment, it is assumed that taxes in the manufacturing sector increase exogenously by 10 per cent. This policy can be viewed as representing a policy of either increasing government income or discouraging the expansion of manufacturing. The results are presented in table 5.7.

1. Economic Variables

The entire economy is not as severely affected by this policy as one would expect. The growth of value added diminishes during the first 15 years and slightly recovers in 2005 as compared to the reference run. Most of the simulated values of economic variables, labour demand, wages, price of value added and imports and exports are generally lower than in the reference run in 1995. However, in 2005 similar effects are found among the major economic variables such as wages, price of value added and imports and exports demand. Therefore, the policy of discouraging the expansion of the manufacturing sector has some adverse affects for the entire economy.

2. Demographic Variables

The decline in the level of income as a result of this policy also has few implications on demographic variables. The population for the entire period is

Table 5.7 Increasing Taxes in the Manufacturing Sector by Additional 10 Per Cent During the Simulation Period

Variable	1985 (15 years)		2005 (25 years)	
	Value	Per cent change from reference run	Value	Per cent change from reference run
Demographic				
POP	59.946	−0.03	68.379	−0.03
CBR	21.31	−0.09	18.720	0.11
CDR	6.71	0.15	7.00	0
TFR	2.370	−0.12	2.198	0.09
LS	33.134	0.02	38.039	0.04
UR	20.10	−0.44	22.30	0.77
Per cent HP	54.76	0.95	45.98	−1.16
Economic				
V	890 245	−0.82	1 368 723	1.46
VA	373 914	−0.44	540 148	2.064
VM	130 790	−0.20	181 447	1.72
VC	56 567	−2.46	101 081	0.68
VO	258 503	−1.89	431 258	1.19
VG	70 471	0	114 789	0
LDA	22 499 283	1.00	22 915 966.750	−0.94
LDM	5 721 054.563	−0.49	6 864 656.875	2.46
LDC	830 718.594	−4.67	1 579 963.844	−0.38
LDO	4 056 307	−3.42	7 206 062.938	0.94
WE	0.07773	−7.94	0.39974	−7.91
WA	0.05172	−7.92	0.26598	−7.91
WN	0.1264	−7.93	0.65009	−7.92
WC	0.13969	−7.94	0.71844	−7.91
WO	0.14169	−7.93	0.72869	−7.92
WG	0.05566	0	0.09066	0
PVA	5.84519	−8.18	26.76458	−7.11
PVM	9.58635	−8.12	42.64544	−7.0
PVC	4.25204	−9.97	23.39004	−9.09
PVO	4.38249	−9.43	23.84108	−7.52
PVG	2.65300	0	4.32126	0
EX	749 504.242	−4.26	37 325 589.0	−3.51
IM	818 566.515	−4.67	3 614 239.9375	−4.83

slightly lower than in the reference run. The crude death rate and total fertility rate are affected in the same direction, with the value slightly higher in 2005 than in the reference run. This policy has almost no effects on labour supply and income distribution.

G. Increasing Manufacturing Output

In this policy, it is assumed that the rate of technological progress in manufacturing increases by an additional 1 per cent each year. This policy can be viewed as representing the aim of the Government to increase manufacturing output. The results of this policy simulation are presented in table 5.8.

1. Economic Variables

As a result of this policy, GDP is 0.02 lower in 1995 than in the reference run. The slow-down in the growth of GDP in the construction and private services sectors contribute to a decline in GDP. In 2005, the economic growth of value added increases because of a consistent increase in the sectoral valued added.

A slow-down in the growth of value added leads to lower employment and lower wages in the economy. This is remarkably pronounced in the construction sector which registers decreases of 2.89 per cent in employment and 6.78 per cent in wages as compared to the reference run in 1995. In 2005, employment in agriculture drops by 3.07 per cent due to the increase in employment in non-agricultural sectors caused by the expansion of the GDP of non-agricultural sectors in general. Both imports and exports drop below those in the reference run in 1995. In 2005, however, the norminal values of imports and exports are higher than in the reference run.

2. Demographic Variables

The demographic effects of this policy simulation are relatively weak. The Population decreases slightly, while the crude birth rate, crude death rate and TFR register no change. The percentage of households with incomes of less than 50,000 baht (per cent HP) increase slightly in 1995 and later decrease (by 3 per cent) as compared to the reference run. Since per cent HP decreases in the long run, the use of policy to improve technology in the manufacturing sector as a means of alleviating poverty should be considered.

H. Slowing Down in World Trade

In this policy, it is assumed that the annual rate of growth of the rest of the world GDP decreases exogenously by 1 per cent. This policy can be viewed as representing a deterioration in the world market. The results of this policy simulation are presented in table 5.9.

Table 5.8 Accelerating Rate of Technological Progress in the Manufacturing Sector by Additional 1 Per Cent in Each Simulation Period

Variable	1985 (15 years)		2005 (25 years)	
	Value	Per cent change from reference run	Value	Per cent change from reference run
Demographic				
POP	59.950	−0.02	68.402	0
CBR	21.33	0	18.73	0.16
CDR	6.70	0	6.99	−0.14
TFR	2.37	0	2.201	0.23
LS	33.129	0	33.018	−0.09
UR	20.11	−0.3	22.62	2.21
Per cent HP	54.39	0.37	44.93	−3.41
Economic				
V	897 378	−0.02	1 396 346	3.51
VA	376 735	0.31	548 278	3.60
VM	131 968	0.70	182 754	2.45
VC	57 205	−1.36	105 748	5.32
VO	260 999	−0.95	444 779	4.36
VG	70 471	0	114 790	0
LDA	22 437 625	0.72	25 358 826	−3.07
LDM	5 707 160	−0.73	6 841 126	2.11
LDC	844 389	−2.89	1 717 882	8.32
LDO	4 112 346	−2.09	7 613 296	6.64
WE	0.07870	−6.77	0.48500	11.72
WA	0.05237	−6.77	0.32270	11.72
WN	0.12799	−6.78	0.78870	11.72
WC	0.14145	−6.78	0.87170	11.73
WO	0.14347	−6.78	0.88410	11.72
WG	0.05566	0	0.09070	0
PVA	5.93945	−6.70	32.72289	13.57
PVM	9.60095	−7.97	51.15688	11.56
PVC	4.34002	−8.11	29.56961	16.20
PVO	4.46575	−7.69	29.67203	15.10
PVG	2.65300	0	4.32126	0
EX	755 008	−3.56	4 201 006	8.52
IM	820 526	−4.44	4 091 374	7.73

Table 5.9 Slowing Down in World Trade: Decreasing in the Rest of the World by an Additional 1 Per Cent in Each Simulation Run

Variable	*1985 (15 years)*		*2005 (25 years)*	
	Value	*Per cent change from reference run*	*Value*	*Per cent change from reference run*
Demographic				
POP	59.935	−0.05	68.379	−0.03
CBR	21.31	−0.09	18.74	0.21
CDR	6.71	0.15	6.99	−0.14
TFR	2.369	−0.16	2.202	0.27
LS	33.122	−0.02	38.099	0.11
UR	20.01	−0.89	22.780	2.93
Per cent HP	54.94	1.29	44.600	−4.12
Economic				
V	888 288	−1.03	1 410 689	4.57
VA	374 185	−0.037	556 699	5.194
VM	131 198	0.11	184 835	3.62
VC	55 935	−3.55	105 967	5.54
VO	256 499	−2.66	448 398	5.21
VG	70 471	0	114 790	0
LDA	22 570 492	1.32	25 111 908	−4.02
LDM	5 740 717	−0.15	7 061 239	5.40
LDC	811 396	−6.69	1 698 480	7.09
LDO	3 987 984	−5.05	7 640 725	7.02
WE	0.07336	−13.11	0.44177	1.77
WA	0.4881	−13.10	0.29394	1.77
WN	0.11931	−13.10	0.71884	1.77
WC	0.13185	−13.11	0.79396	1.77
WO	0.13374	−13.10	0.80530	1.77
WG	0.05566	0	0.09066	0
PVA	5.5153	−13.36	29.9893	4.08
PVM	9.0609	−13.15	47.6736	3.97
PVC	3.9672	−16.00	26.7840	5.25
PVO	4.1041	−15.17	27.07226	5.02
PVG	2.6530	0	4.32130	0
EX	720 655	−7.94	3 990 848	3.09
IM	789 150	−8.10	3 868 720	1.87

1. Economic Variables

As a result of this policy, the aggregate value added is 1.03 per cent lower in 1995 than in the reference run. The direct effect of this policy is to cause a decline in the value added of all sectors except the manufacturing sector. This effect either diminishes or disappears in the long run. GDP is 4.57 per cent higher than in the reference run by 2005.

The slow-down in the growth of GDP has a long-term effect on employment in agriculture. In 2005 the growth of employment in agriculture is 4.02 per cent lower than in the reference run. The opposite effect of this policy on non-agricultural employment is found in this period as a consequence of increasing GDP as compared to the reference run. The slow-down in world trade causes wage rates and prices of value added to drop below those in the reference run in 1995 and to recover slightly in the later period. Similar effects are found for imports and exports; their values drop about 8 per cent in 1995 as the result of lower world prices but increase slightly in the later period.

2. Demographic Variables

The impact of this economic policy on demographic variables is small, especially in the areas of crude birth rate, crude death rate, TFR, population and labour supply. The main effect of this policy on income distribution is a small increase in the number of families in the low income bracket in 1995. An opposite effect is experienced at the end of the simulation period.

Concluding Remarks

To our knowledge, this is the first demographic-economic simulation model ever built for Thailand. It may also be one of only a few demographic-economic models built elsewhere which use the CGE model in the economic part. Hence we are still at the stage of trying to imporve our model. Many questions have not yet been answered: how the age-sex structure of the population affects consumption and investment patterns; how migration, urbanization and relative wage rates are related; how we can explain changes in household income distribution by investment both in human and physical capital. These are areas which require further investigation.

In terms of our model specification, we found that the CGE model is extremely sensitive to wage rate and price changes. Hence it does not seem appropriate to simulate for a long period of time unless some subjective assumptions about parametric changes have to be made. In the case of Thailand, the only source of the value of parameters available is the 1975 SAM Table. This is not sufficient to make any "good" estimates on the structural change of the economy. On this aspect, we think that unless more information is available for such estimates, it does not seem appropriate to use the CGE framework in a demographic-economic simulation model of a long-term nature.

References

Abramowitz. M. and Irene Stegun. *Mathematical Function, With Formulas, Graphs, and Mathematical Tables,* Dover Publication, New York 1970.

Amranand P. and W. Grais. *The Siam 2 Model,* National Economic and Social Development Board and World Bank, 1983.

Anker Richard and James C. Knowles. *Population Growth, Employment and Economic-Demographic Interactions in Kenya:* BACHUEKENYA. St. Martin's Press, New York 1983.

Bank of Thailand, Monthly Report (various issues).

Chewakrengkai, A. and B. Lamsam (1982). *A Social Accounting Matrix For Thailand 1975,* Joint Publication by NESDB and IBRD.

Dervis, K.J. de Melo, and S. Robinson (1982). *General Equilibrium Models for Development Policy,* Cambridge University Press, Cambridge.

Luther, Norman Y. "Fitting Age-Specific Fertility With a Truncated Pearson Type III Curve" *Asian and Pacific Census Forum,* East West Population Institute, May 1982.

National Economic and Social Development, Office of the Prime Minister, Bangkok, Thailand. *National Economic and Development Plan* (various issues).

__________ *Capital Stock of Thailand 1970-80,* 1984.

__________ *Social Accounting Matrix (SAM) 1977,* 1983.

__________ *National Income of Thailand* (various issues).

National Statistical Office, Office of the Prime Minister, Bangkok, Thailand.

__________ *Population and Housing Census,* 1960, 1970 and 1980.

__________ *Labor Force Survey* (various issues).

__________ *Household Expenditure Survey* (1981).

Office of Agricultural Economics. *Agricultural Statistics of Thailand, Crop Year 1983/84.*

Office of the National Education Commission, Office of the Prime Minister, Bangkok, Thailand, *Education Sector Survey,* 1983.

United Nations: *Country Monograph Series No. 3: Population of Thailand,* Economic and Social Commission for Asia and the Pacific, 1976.

__________ *Migration, Urbanization and Development in Thailand,* Economic and Social Commission for Asia and the Pacific, 1982.

__________ *Modelling Economic and Demographic Development,* Asian Population Studies Series, No. 54.

__________ Report of the First Study Directors' Meeting on Comparative Study on Demographic-Economic Interrelationship for Selected ESCAP Countries, Bangkok, November 1984.

__________ Report of the Interim Study Directors' Meeting on Comparative Study on Demographic-Economic Interrelationship for Selected ESCAP Countries, August 1985.

__________ Report of the Second Study Directors' Meeting on Comparative Study on Demographic-Economic Interrelationship for Selected ESCAP Countries, March 1986.

__________ *Statistical Yearbook of Asia and the Pacific* (various issues).

__________ *Internal Trade Statistics* (various issues).

Annex I

ESTIMATION OF REPETITION AND CONTINUATION RATES

Information on repetition and continuation rates in Thailand is scarce and inaccurate. This incomplete information is further complicated by two changes in the educational system. Therefore, the rates over time are not always comparable. Some repetition rates for the primary and secondary level are given in table 1.1. Some important patterns can be observed from these figures. Firstly, the repetition rates decrease over time. Secondly, the repetition rates tend to be lower for higher grades than for lower grades. And thirdly, the repetition rates for major terminal grades (Grades 4 and 6 in the primary level and grade 5 or 6 in the secondary level) are in general lower than for other grades in the same level. Using this information, future repetition rates are forecast by the following equations:

For grades 1-4 in the primary level

$$R_{1jt} = 3 + e^{3.038137-0.0395965t-0.7116D2-0.7005D3-1.6469D4}$$

t = 0 for 1973, D2 = 1 for f = 2,

D3 = 1 for j = 3, D4 = 1 for j = 4

For grades 5-6 in the primary level

$$R_{1jt} = 3 + e^{2.4095-0.9823D6}$$

D6 = 1 if j = 6

For grades 1-6 in the secondary level

$$R_{2jt} = 3 + e^{1.9643-0.1783t+0.0682D2-0.3805D3-0.5600D4-0.3564D5}$$

D2 = 1 if j = 2, D3 = 1 if j = 3,

D4 = 1 if j = 4, D5 = 1 if j = 5, or 6

Continuation rates are further estimated from the number of students in each grade and the repetition rates implied by the above equation. For example, the continuation rate from grade 1 to 2 in 1975 in the primary level is calculated by

$$\frac{\text{Students in grade 2 year 1976} - (\text{Students grade 2 year 1975})(\text{Repetition rate})}{(1\text{-Repetition rate})(\text{Student in grade 1 year 1975})}$$

Table A.1.1 Repetition Rate by Grade

Year	Primary						Secondary					
	1	*2*	*3*	*4*	*5*	*6*	*1*	*2*	*3*	*4*	*5*	*6*
1973	23.34	13.89	12.96	6.00	11.00	6.58	9.82	8.99	5.85	–	–	–
1974	23.15	13.95	13.55	6.32	13.38	7.69	10.37	8.84	6.65	–	–	–
1975	22.40	13.27	13.23	6.36	14.36	8.07	10.46	8.50	5.30	6.67	–	–
1976	21.94	13.26	13.43	6.87	16.17	9.01	10.56	9.37	5.93	7.41	4.99	–
1977	21.10	11.77	12.18	6.70	15.92	7.01	8.35	7.47	4.54	4.64	2.33	–
1978	21.39	10.32	11.29	7.21	15.04	6.60	4.09	7.59	7.72	4.57	5.02	–
1979	17.96	9.38	9.52	6.66	13.94	5.91	4.34	4.42	6.03	3.76	5.55	–
1980	19.18	11.07	8.21	6.07	12.89	5.78	–	–	–	–	–	–

Source: Calculated from a survey of teachers and students.
National Statistical Office and Ministry of Education.
Volume 1973-1979.

Note: Comparable figures are not available.

Continuation rates for 1970-1980 are shown in table 1.2. The continuation rate for grades 1-2, 2-3, 3-4, 5-6 was around 0.95. Hence, this rate will be used over the simulation period, the continuation rate for grade 4-5 increases rapidly over time. This is due to the efforts of the government to expand compulsory education from 4 to 6 years. Hence the continuation rate for P4 – P5 will be forecast by

$$CON_{4,4,t} = 0.95 - e^{-0.2813-0.2204t}$$

The continuation rate is bounded by an upper limit of 0.95.

The continuation rate to secondary level for those who have completed primary level follows two different patterns. While the continuation rate from P4 – P5 was low, the continuation rate from P7 – MS1 was high and continuation rate for MS3 – MS4 was low. This was because under the educational system in 1970-1978, major terminal points of education were P4, P7, and MS3. But under the educational system since 1978, major terminal points of education are P6 and MS6. Continuation rates under the new system are not yet available. Therefore in this study, the continuation rate for P6 – MS1 will be assumed to be 0.5 and continuation rates for MS1 – MS2, MS2 – MS3, MS3 – MS4, MS4 – MS5 will be assumed to be 0.95.

Table A. 1.2 Estimated Continuation Rates

Year	*P1/P2*	*P2/P3*	*P3/P4*	*P4/P5*	*P5/P6*	*P7/S1 (P6/S1)*	*S1/S2*	*S2/S3*	*MS3/MS4 (S3/S4)*	*MS4/MS5 (S4/S5)*	*S5/S6*
1970	0.95	0.97	0.95	0.40	0.95	0.83	0.97	1.00	0.33	0.67	
1971	0.93	0.96	0.95	0.45	0.98	0.86	0.97	0.99	0.30	0.71	
1972	0.95	0.97	0.96	0.49	0.98	0.87	0.98	1.00	0.31	0.71	
1973	0.93	0.96	0.95	0.50	0.95	0.85	0.96	0.97	0.32	0.66	
1974	0.94	0.97	0.95	0.52	0.93	0.83	0.95	0.97	0.34	0.68	
1975	0.94	1.00	0.95	0.55	0.92	0.80	0.94	0.96	0.38	0.98	
1976	0.94	1.00	0.95	0.60	0.91	0.78	0.94	0.95	–	–	
1977	0.95	0.98	0.97	0.84	0.90	–	1.00	1.00	–	–	
1978	0.97	0.99	0.98	0.86	0.91	0.59	0.98	0.95	–	0.92	
1979	0.96	0.90	1.00	0.87	0.90	0.48	0.97	0.95	–	0.95	
1980	0.95	0.94	1.00	0.86	0.94	..	0.97	–	–	–	

Annex II

Table A.2.1 Weights Used in the Survival Ratio

Year	Male						Female					
	W_{11}	W_{12}	W_{21}	W_{23}	W_{32}	W_{33}	W_{11}	W_{12}	W_{21}	W_{23}	W_{32}	W_{33}
1980	.6229	.2137	.7506	.0597	.3504	.1481	.6849	.2067	.8379	.0332	.2721	.0542
1985	.5991	.2142	.7645	.0584	.3484	.1499	.6629	.2073	.8479	.0325	.2703	.0549
1990	.5749	.2148	.7779	.0571	.3464	.1516	.6403	.2078	.8575	.0318	.2686	.0556
1995	.5503	.2154	.7908	.0558	.3444	.1533	.6169	.2084	.8665	.0311	.2668	.0563
2000	.5255	.2160	.8031	.0546	.3424	.1551	.5931	.2090	.8751	.0304	.2633	.0578
2005	.5006	.2165	.8149	.0534	.3403	.1569	.5688	.2095	.8832	.0397	.2633	.0578
2010	.4756	.2171	.8261	.0522	.3383	.1587	.5441	.2101	.8908	.0290	.2616	.0585

The weights in this table are calculated by:

$$\log\left(\frac{1}{W_{11}} - 1\right) = \underset{(-89.52)}{-0.776284} + \underset{(3.35)}{0.01998t} + \underset{(0.27)}{0.274523D}$$

$$n = 6, \qquad R^2 = 0.86$$

$$\log\left(\frac{1}{W_{12}} - 1\right) = \underset{(17.37)}{1.344847} - \underset{(-0.13)}{0.0006845t} - \underset{(-0.51)}{0.041827D}$$

$$n = 6, \qquad R^2 = 0.08$$

$$W_{13} = 1 - W_{11} - W_{12}$$

$$\log\left(\frac{1}{W_{21}} - 1\right) = \underset{(-17.98)}{-1.642342} - \underset{(-2.54)}{0.01521t} + \underset{(5.54)}{0.54077D}$$

$$n = 6, \qquad R^2 = 0.92$$

$$\log\left(\frac{1}{W_{23}} - 1\right) = \underset{(11.39)}{3.369729} + \underset{(0.24)}{0.004695t} - \underset{(-1.94)}{0.612168D}$$

$$n = 6, \qquad R^2 = 0.56$$

$$W_{22} = 1 - W_{21} - W_{23}$$

$$\log\left(\frac{1}{W_{32}} - 1\right) = \underset{(3.80)}{0.984049} + \underset{(0.11)}{0.001786t} - \underset{(-1.33)}{0.366896D}$$

$$\log\left(\frac{1}{W_{33}} - 1\right) = \underset{(9.88)}{2.859715} - \underset{(-0.14)}{0.00271t} - \underset{(-3.59)}{1.110428D}$$

$$n = 6, \qquad R^2 = 0.81$$

$$W_{31} = 1 - W_{32} - W_{33}$$

D = 1 for males
= 0 for females

t = 0 for 1980. Data are taken from the 1960, 1970 and 1980 population census separately for males and females.

Part Four

A COMPARATIVE REVIEW OF THE MODELS

by

David Demery

Naohiro Ogawa

Francis J.M. Harrigan

* This paper is a joint product of three authors. David Demery reviewed economic submodels, Naohiro Ogawa reviewed demographic submodels and Francis J.M. Harrigan reviewed the simulation results.

INTRODUCTION

Our purpose in this paper is to provide a comparative review of three economic-demographic models presented in earlier parts. In the development of these models each study director was encouraged to focus on specific medium-term problems of urbanization, rural-urban migration and population change. Naturally they were free to investigate issues of particular interest or relevance to the specific country application. In this review we begin by outlining the modelling strategies adopted, highlighting differences and similarities of approach. In the second section we deal with a comparative review of demographic submodels of the three models. In the third section we compare some key simulation results and in a concluding section we summarize and suggest lines for further research.

I. ECONOMIC SUBMODELS

A. Key Features

We begin by examining some key features of the three models. First it was agreed at the First Study Directors' Meeting that each study address the issue of urban growth and migration. In each case the study directors distinguished urban and rural populations and did not examine the somewhat narrower issues surrounding the growth of large cities in each of the three countries (namely, Bangkok in Thailand, the Klang Valley in Malaysia and Metropolitan Manila in the Philippines).

In the modelling of urban growth there are interesting differences and similarities of approach. In the Malaysian case urbanization is a function of output per head, with a ceiling of 50 per cent imposed *a priori*. By contrast, in the Philippine model the proportions of households located in urban areas are functions of proportions of adult workers in agriculture. These two approaches are combined somewhat in the Thai model, where the proportion of the population urbanized is a function both of per capita income and the proportion of the labour force engaged in agriculture. In Thailand an urbanization ceiling of 50 per cent is also imposed.

In no case was the decision to migrate from rural to urban location made a function of the relative rate of pay between (say) agriculture and industry. Generally, modellers provided equations explaining the proportion the population urbanized and computed migration as the difference between the actual urban population and its "natural" population.

Secondly in all three cases it is encouraging to note that models were based on base-year social accounting matrices (or SAMs). The discipline of ensuring conformity to a detailed set of base year national accounts provides a check on model consistency and it ensures the imposition of important national accounting identities. Specifically it ensures that every item of expenditure is matched on another account by an item of receipt. Moreover calibration of the model so that it replicates the base-year data is a valuable exercise, one that may reveal inconsistencies in the model structure.

Paqueo's model for the Philippines is based on Habito's (1984) computable general equilibrium model, which was itself calibrated using the 1974 input-output accounts. Fong's Malaysian model is based on a reconstructed SAM for 1970, using a number of alternative SAMs for that year. The Thai model is based on the World Bank SAM for Thailand. Difficulties encountered in replicating the base-year accounts have helped to identify structural errors in the models and this underscores the importance of what may be termed "SAM-based modelling".

Thirdly, all three economic models are broadly of the "computable general equilibrium" (CGE) class, in which commodity prices adjust to ensure material balance equilibrium. However, Phananiramai and Chalamwong conclude that without a better idea of the processes of structural change, "it does not seem appropriate to use CGE framework in demographic-economic simulation". Of course uncertainty over the course and pattern of structural change bedevil all long-run modelling exercises, whether of the CGE class or otherwise. More specifically detailed information on the likely future patterns of sector specific technological progress will increase confidence in the models' simulations. But it is hard to imagine that these are reasons for downgrading the role of prices (and wages when appropriate) in achieving harmony between the various supplies and demands of a nation's resources.

Of course CGEs may *invalidly* assume a primary role to price adjustment in achieving a general equilibrium. If commodity prices are sticky, it is now well known that "spill-over effects" will be important, as rationed agents in one market alter their behaviour on other markets. The conditions for a general non-Walrasian equilibrium in such economies are currently receiving attention in the literature, but the development of *applied* models with these features is in its infancy. The lack of understanding of long-run structural change is no reason to forsake the CGE modelling approach. Rather the CGE approach must be combined with a fuller explanation of the determinants of medium-term growth and extended if necessary by consideration of equilibria achieved through non-price rationing schemes. However, it is not clear to us that the latter is an appropriate research direction for the application of CGEs to many developing countries, especially in the ESCAP region.

The three models accept price flexibility for commodity market equilibrium but the three adopt alternative assumptions concerning the behaviour of the labour market. In the Malaysian case for example, a standard Phillips curve is assumed, in which wage rates are currently fixed but respond between periods to levels of excess supply of labour and changes in the price level.

In the Thailand model, labour market equilibrium is achieved in aggregate. The non-agricultural sectors have "first claim" on manpower resources, with the residual taken up by the agricultural sector. It is not clear how the wage rate adjusts to clear the labour market *and* the level of agricultural employment acts as the residual to ensure labour market clearing.

Finally, in the Philippine case the labour market adjusts with a lag to excess supply of labour and may be viewed as similar in spirit to the Malaysian model.

In their simulation experiments the study directors followed somewhat divergent paths. The main simulations that we consider in this review are the following (details can be obtained from the country papers):

Malaysia:

(1) A rise in non-agricultural technological progress.

(2) A rise in the share of agricultural investment.

(3) A rise in the rate of indirect tax on non-agricultural goods.

(4) A lowering of total fertility.

(5) A raising of total fertility.

(6) An increase in female participation.

Philippines:

(1) Increase in import and export prices after 1980.

(2) (1) + higher levels of export demand.

(3) (2) + 40 additional births per 1000 married women of reproductive age.

(4) (2) + the abolition of payroll taxes.

(5) (2) + a peso devaluation.

Thailand:

(1) Slow decline in fertility.

(2) Fast decline in fertility.

(3) Promotion of education.

(4) Increasing share of agricultural investment.

(5) Increasing taxes on manufacturing output.

(6) Increasing technological progress in manufacturing.

(7) Slowing growth of world trade.

In all three cases the lessons to be learned from the simulations are obtained from a comparison of each of these simulation runs with a "reference" run. Whilst the Malaysian simulations are focussed on internal issues those of the Philippines concentrate somewhat on external issues. In the Thai case one simulation addresses the effects of a slowing of world trade.

The three models present rather different approaches to sectoral disaggregation. The production sectoral subdivisions are as follows:

Malaysia:

Agricultural

Non-agricultural

Philippines:

Food and Agriculture
Forestry, mining and quarrying
Manufacturing
Non-manufacturing industries
Services
Government

Thailand:

Agricultural
Manufacturing
Construction
Private services
Public services

B. Country-specific Reviews

1. Malaysia

The base year for the Malaysian model is 1970 and the simulations cover the period up to 2025. The economic-demographic linkages are not extensive: the age at first marriage is influenced by per capita gross output (though we wonder whether this is per capita GDP) and age-specific fertility rates are also influenced by per capita output (directly and indirectly through the age at first marriage). As Malaysia is a multi-ethnic country, the Malaysian model distinguishes the three main ethnic groups (Malay, Chinese and Indian), though the racial distinction is not carried over to the economic model. Life expectancy at birth is similarly affected by per capita output. The demographic model determines levels of labour supply for the economic sub-module.

The Malaysian economic model is a dualistic model based on a SAM for 1970. The interaction between the economic and demographic sub-modules posed considerable computing problems for the Malaysian director because the non-linear solution algorithm used to solve the economic model (provided by TSP) was combined with a separately developed Fortran programme for the demographic module. As a result the director admitted that "a complete run on the "interactive" economic-demographic model over 1970-2025 took 3 physical days to be completed".

The model adopts a "Keynesian" closure, with the wage rate fixed within the solution period and unemployment being determined for a given level of aggregate demand. Aggregate consumption is also "Keynesian" in nature, and its allocation across sectors in determined by a linear expenditure system. Total investment expenditure is exogenous and sectoral investment is determined by relative profits. Exports are also exogenous. Households are distinguished by whether they are urban or rural.

The Malaysian model runs through a historical period (viz. 1970 to date) and the director provides details of model performance through this interval and compares this with actual figures. In 1971 for example the model over-predicts GDP by 21 per cent, which is somewhat unusual given the fact that the model must replicate exactly the 1970 Social Accounts. By 1980 however the overprediction is reduced to 5 per cent.

2. *Philippines*

The base-year for the Philippine model is 1974 and the simulations cover the period to 1995. The director does not provide comparisons of the model performance with actual data over the known historical period. Factor and foreign exchange markets are non-clearing. Economic-demographic linkages in the Philippine model are more varied and somewhat unusual. Personal income per capita and food prices influence fertility. In addition the employment rate and consumption per capita influence infant mortality. Again the labour force is determined from the population projections and passed over to the economic sub-module.

The closure of the economic model is again Keynesian with real wages adjusting with a lag. Aggregate investment is modelled *via* an accelerator relationship and allocated to sectors *via* a profit share relationship. The consumption function is of a standard Keynesian type and its allocation across sectors is determined by a linear expenditure system. Export demand is assumed to be sensitive to the relative world price.

3. *Thailand*

The base-year for the Thailand model is 1980 and the simulations cover the period to 2005. Linkages between the economic and demographic sub-modules are straightforward: per capita income exerts a quadratic influence on the total fertility rate (with TFR rising initially and falling eventually with higher levels of income). Per capita income also exerts a negative effect on mortality. As noted above per capita income and the share of the labour force in agriculture also influence urban growth. The population projections help determine the level of the labour force through the application of variable age-specific participation rates.

Interestingly the unemployment rate is estimated as a function of proportion of the labour force in agriculture and the proportion of the labour force which has attained secondary education (negatively to the first and positively to the second). These effects are meant to capture influences on the frictional level of unemployment through the effects on search behaviour.

Gross output is a Leontief function of value added and intermediate input whilst value added is a Cobb-Douglas function of capital and labour. Total investment and therefore aggregate capital accumulation are exogenous but investment by destination is calculated *via* a profit share relationship. All three models adopt similar approaches to the modelling of investment by destination. Exports are determined by relative world and domestic prices and world GCP growth. Balance of payments equilibrium is maintained throughout but it is not clear how this is achieved with fixed exchange rates and goods market equilibrium.

II. DEMOGRAPHIC SUBMODELS

All the three country-specific models which have been developed in connection with ESCAP's model-building project consist of the following two principal components: demographic and economic submodels. Although the economic submodels of these three models are relatively comparable in both scope and structure, the demographic submodels are considerably more heterogeneous in these aspects. For example, the demographic submodel incorporated in the Malaysian model includes behavioural equations on fertility, mortality, urban-rural migration, and labour force participation. In the case of the Philippine demographic submodel, the functional relationships on infant mortality, marital fertility, household formation, urban-rural migration, and health expenditures have been estimated to allow for the interactive processes between population and economic variables. The Thai demographic submodel sheds light upon fertility, mortality, urbanization-cum-migration, labour force participation, educational enrollment and attainment, household formation, and income distribution. One of the primary reasons for such diversity in the three demographic submodels is related to the fact that each of these participating countries has different population trends and policy goals in recent years. The other important reason lies in the different availability of population data required for estimating model parameters.

Given these differences in the coverage of these demographic submodels, it appears to be rather fruitless to attempt to highlight both similarities and dissimilarities among the three demographic submodels. In the first half of this section, therefore, our discussion is confined to reviewing a few key behavioural equations commonly contained in these submodels. In the latter half, some of the simulated results are highlighted with a view to describing the sensitivity of interaction between population and economic variables.

A. Modelling Fertility Variables

In each of the three demographic submodels, the total population is broken down by location, i.e., urban and rural. It should be noted, however, that each model uses a substantially different mothod to do the disaggregation. Let us first discuss how each model has handled the fertility component.

In the Malaysian demographic submodel, age-specific fertility rates (ASFRs) have been estimated for each ethnic group as well as each geographical area, using time-series data over the period 1960-1980. The explanatory variables incorporated in each ASFR equation are per capita output, the doctor-population ratio, the per capita government expenditure on the family planning programme, the female literacy rate, and the female age at first marriage. The estimated coefficients for these explanatory variables have been consistent with theoretical predictions. To keep the estimated result within a reasonable range, the Malaysian modeller has imposed a lower bound for each ASFR equation. Although this is one fo the techniques widely employed in modelling work, no rationale for such floor values has been given in the Malaysian report. Moreover, it seems to be worthwhile to test the sensitivity of the floor values, by using alternative values. The sensitivity test of this nature is particularly important for a country like Malaysia where the population growth pattern for each ethnic group is one of the government's main concerns. In addition, the specification of each ASFR equation for Malays has failed to capture their recent fertility upsurge, although this is a formidable task to undertake.

One of the unique features in the fertility component of the Malaysian demographic submodel is the fact that apart from the fertility equation, the female age at first marriage has been explicitly estimated. In this equation, however, there are two statistical problems. First, the determinants of the age at first marriage include per capita output and the female literacy rate, both of which have already been incorporated as the predicators in the ASFR equations. This implies that these predictors and the age at first marriage are highly correlated. Because of this statistical problem, the explanatory power of per capita output has proved to be relatively limited in the ASFR equations for younger age groups. Second, to avoid the possibility of a continuous rise in the age at first marriage, the equation for Malays has an upper limit of 25, while for Chinese and Indians, a ceiling value of 27 has been imposed. In view of the recent trends of the age at first marriage for Malays, however, it seems desirable to attempt to introduce alternative ceiling values. It is highly conceivable that in the course of economic development, the age at first marriage might become increasingly comparable among the three ethnic groups.

Although there still remain some serious statistical problems, it should be mentioned that the fertility component of the Malaysian demographic submodel has improved considerably in several aspects since the Second Study Directors' Meeting held in March 1986. In contrast, the fertility component of the Philippine submodel has remained virtually unchanged since the meeting. As compared with both Malaysian and Thai demographic submodels, the Philippine population submodel has a substantially simpler structure primarily because of the limited availability of data. The Philippine submodel has only one fertility-related behavioural equation, i.e., the marital general fertility rate (MGFR) equation. The determinants of MGFR are per capita personal income, the relative food price, and infant mortality. The coefficients of these explanatory variables have been estimated, using the time-series data over the period 1957-1977. On the basis of the estimated result on MGFR and the proportion of currently married women which is exogenously determined, GFR at the national level is computed. The computed GFR is further used to estimate urban and rural fertility levels, by utilizing a certain proportional relationship on urban-rural fertility differentials. It is worth remarking that although a link between MGFR and the total fertility rate (TFR) had been absent from an earlier version of the Philippine demographic submodel, the Philippine modeller has managed to incorporate it in its final version, by assuming a set of (i) the constant ratios of age-specific marital fertility to TFR and (ii) the age-specific proportion of currently married women.

It is important to note that because no age structural factor has been contained in the MGFR equation, a serious specification error has been committed in this equation. Unlike the cases of the two other country models, the Philippines' key fertility equation has incorporated the following two interesting factors: the effect of infant mortality upon fertility, and the concept of the new home economic approach.

Among the three demographic submodels developed in this modelling project, the Thai submodel has the most complex fertility component. The TFR equation determines the overall fertility level. The explanatory variables in this equation are per capita GDP and educational attainment. Although both Malaysian and Philippine fertility equations have been estimated from time-series data, the Thai fertility equation has been estimated on the basis of cross-sectional data, i.e., 1980 data from 72 provinces. The specification of the Thai fertility equation is highly comparable to that of the Malaysian fertility equation. It should be noted, however, that the estimated TFR is further used to compute TFR for urban and rural areas by applying a set of weights, as has been the case for the Philippines. These weights change curvelinearly over time in such a way that the ratio of rural TFR to urban TFR decreases from 1.64 in 1980 to 1.0 which is a replacement level. Both urban and rural TFRs are translated into ASFRs through an application of Truncated Pearson Type III curves.

The foregoing discussion clearly shows that the fertility component of each country-specific model has a markedly different structure, and operates differently to a substantial degree. Nonetheless, each model has managed to undertake some numerical experiments by assuming alternative fertility cases. Undoubtedly, such simulation exercises are extremely useful in their national contexts. Furthermore, it is important to observe that all of these exercises have pointed to the significantly negative effect of high fertility upon national economic development. In contrast to both the Malaysian and Philippine cases, the Thai case has indicated that alternative fertility paths are unlikely to affect the future economic performance to a pronounced extent; this result stems from the fact that because the fertility level in contemporary Thailand has already been substantially low, the alternative fertility paths assumed for the Thai simulation exercises have a considerably narrower range than those for the other two countries.

B. Modelling Mortality Changes

As compared with fertility, the mortality component of each submodel has been developed in a more simplified fashion. Similar to fertility, however, the way in which each project team has modelled mortality changes varies considerably from country to country. For instance, in the case of the Philippine population submodel, the infant mortality equation, coupled with the Brass logit system, plays a key role in estimating age-specific survival probabilities. In both the Thai and Malaysian demographic submodels, life expectancy at birth rather than infant mortality provides a base for computing age-specific survival probabilities. Although the Thai modellers, like the Philippine case, have linked the estimated life expectancy level to the Brass logit system, the Malaysian modeller has related the estimated life expectancy level to the Coale-Demeny model life tables.

It should be noted that as with its fertility component, the Malaysian mortality component has improved considerably since the Second Study Directors' Meeting. In an earlier version, the Malaysian submodel had assumed that the age-sex-ethnicity-location-specific mortality rates would decline by 0.01 per cent per year, thus reaching a level widely prevalent in contemporary developed countries. In the final version, however, the sex-location-specific life expectancy equations have been estimated, using times-series data. The explanatory variables included in these equations are output per capita, the proportion of the population aged 6 and over having beyond-primary education, and the proportion of the population having access to piped water. Furthermore, the upper bounds of 75 years and 78 years have been imposed upon the life expectancy of males and females, respectively.

Similar to the Malaysian case, the Thai life expectancy equations have included both economic and education factors as explanatory variables, i.e., per capita GDP and the percentage of the population aged 6 and over whose educational attainment is beyond primary education. The ceiling values imposed are 72 years for males and 77 years for females.

Caution should be exercised with regard to the choice of upper bounds in these life expectancy equations. In contemporary Malaysia, life expectancy at birth is 65.0 years for males, and 68.8 years for females. In the Malaysian model, therefore, the mortality differential between males and females is expected to remain virtually at the same level as the current one. A similar observation is applicable to the Thai case. In Thailand, male life expectancy at birth was 60.7 years over the period 1980-1985 while female life expectancy was 64.8 years over the corresponding period. In the Thai model, therefore, the mortality differential by sex is expected to increase by only 0.9 years throughout the simulation period. It should be emphasized, however, that in a developed country like Japan, the mortality differential between males and females has been expanding over time. Moreover, a change in the sex differential in mortality has an important implication for designing desirable policies for the future family support system for the elderly in each country. For these reasons, it seems necessary for both Malaysian and Thai modellers to re-estimate their mortality equations by introducing alternative upper boundaries, and to test the sensitivity of these alternative ceiling values.

In the Philippine demographic submodel, the infant mortality equation has been estimated on the basis of time-series data, incorporating as explanatory variables the per capita private consumption expenditure, the relative price of food, the per capita accumulated health expenditure, and the ratio of full-time equivalent employed workers to the total labour force. In view of the interactive process between infant mortality and fertility, however, it seems worthwhile to include a fertility variable in the equation as an additional explanatory variable.

As discussed earlier, both Thai and Philippine submodels have used the Brass logit system to compute age-specific survival probabilities. Evidently, this system can be used as a powerful tool for developing countries, particularly in Africa. For a country like Thailand which aims at attaining the status of a newly industrializing country before the end of this century, it is highly questionable to utilize the Brass logit system throughout the simulation period.

It is unfortunate that none of these three models has conducted any simulation exercises by assuming different mortality paths. Given the fact that fertility changes are currently a main policy concern in these three countries, these shortcomings may be regarded as unavoidable. It should be stressed, however, that as the process of development proceeds in these countries, the importance of mortality change in their national economic planning will be enhanced.

C. Modelling Internal Migration

In all three demographic submodels, both rural and urban populations are estimated by computing the following two sources of urban growth: (i) natural increases; and (ii) rural-urban migration and classification changes combined.

In the Malaysian submodel, the volume and age distribution of rural-urban migrants have been estimated by taking the following two steps. First, the level of urbanization is computed as a function of per capita output. In this urbanization equation, the upper boundary of Malaysia's future urbanization has been set at a 50 per cent level. Second, the number of rural-urban migrants is calculated as the difference between the size of the urban population consistent with the level of urbanization obtained in the first step, and the growth of the urban population through births and deaths. Total migrants are further distributed by age and sex, using the constant matrix comprised of the age-sex selectivity pattern of rural-urban migrants.

The Thai submodel has an urbanization-cum-migration mechanism highly comparable to the Malaysian one. One major difference between these two submodels, however, is that the parameters of the Thai matrix on the age-sex selectivity pattern vary over time in accordance with a change in educational attainment for each age-sex group. Because the pattern of internal migration is directly influenced by changes in socio-economic factors, the use of the constant matrix in the Malaysian submodel is problematic. As a partial solution to this problem, the Malaysian modeller should have conducted a series of simulation runs by assuming alternative parameters for the migration matrix.

Although both Malaysian and Thai submodels have assumed 50 per cent as upper bounds, this assumption needs to be carefully assessed in the case of the former. Taking into account the fact that Malaysia's current level of urbanization is approximately 35 per cent one can safely suggest that the Malaysian modeller consider the possibility of applying higher ceiling values for urbanization. For example, the United Nations population projections prepared in 1984 show that urbanization for Malaysia is expected to reach a 67 per cent level by the year 2025.

In the Philippine demographic submodel, the rural and urban populations are computed only in terms of their size, primarily because of the limitation of data. Although the rural-urban migration process is less disaggregated in the Philippine submodel than in the two other submodels, the former has one interesting feature which is completely absent from the latter; in the Philippine migration component, the urbanization equation has the proportion of agricultural employment in total employment as a main explanatory variable, thus capturing in a more explicit manner the impact of labour sectoral changes upon the volume of rural-urban migration. Modelling this interrelationship between labour allocation and urbanization is extremely useful in analysing the effect of production structural adjustments upon the process of urbanization. In fact, the Philippine modeller has successfully demonstrated, by conducting a few simulation experiments, the impact of external shocks upon the process of urban growth. It should be added, however, that no clear distinction between occupational shifts and residential mobility has been made in this urbanization equation for the Philippines.

It is only the Philippine model that has evaluated the effect of an alternative urban growth path upon a host of economic and demographic variables, as shown in Simulation I.

D. Effect of Economic Change Upon Demographic Variables

Apart from simulation runs with alternative assumptions on demographic variables, the modellers participating in this project have undertaken a number of interesting policy experiments by changing parameters for economic variables. These economic policy experiments include: (i) an increase in investment in agriculture; (ii) faster improvement of agricultural technology; (iii) a rise in taxes in manufacturing; (iv) faster growth of manufacturing output, and a slowing down in world trade.

In all three models, these changes in economic variables affect demographic variables through a change in per capita income or per capita output. In addition to this linkage commonly incorporated in these three models, each country-specific model has been equipped with different interactive channels. For this reason, these economic policy experiments have yielded different demographic consequences for each country, thus making it a formidable task to compare inter-country simulation results for demographic variables.

Despite these difficulties involved in inter-country comparisons, these three models are particularly useful in analysing some of the newly-emerging research issues on economic development and population change. The research issue of economic openness and demographic responses is one of the salient examples. Moreover, this research issue is highly relevant to the three countries participating in this modelling project. For instance, the export-to-income ratio in 1985 is 49.1 per cent for Malaysia, 14.7 per cent for the Philippines and 17.3 per cent for Thailand. These percentages are considerably higher than the percentage for Japan (12.9 per cent). A brief comparison of these statistics indicates that external factors, through internation trade, affect the economic performance of these ASEAN countries, which in turn, influences various demographic variables. It is hoped, therefore, that these models developed in this project will be further utilized as analytical tools for some of the newly-emerging research topics.

III. SIMULATION RESULTS

The variety of the simulation experiments conducted by the three directors makes comparisons of the results quite tricky, so the lessons to be drawn from this section are inevitably general in nature. The results numbers in each case correspond to those identified in section B above (these are repeated in Annex A for convenience). Since the details of simulation output differ somewhat between the studies, we restrict ourselves in this review to the broad economic-demographic indicators (like total population size and GDP per capita).

A. Malaysia

In the Malaysian case (table 1) the reference simulation envisages a growth of the total population to just over 41 million by 2025 (interestingly, putting the population "on target" for the "new population policy" objective of 70 million, since Malay fertility is still above 3 at the close of these simulations). Fong states in the text that this population splits 50-50 urban and rural by the close of the period, but this was not apparent in the tables presented. From what we understand of the results given, the proportion urban actually falls to 30 per cent by 2025. In the alternative simulations it was not possible to compute the proportion of the *population* urbanized. Instead we report the

Table 1. Simulation Results: Malaysia

	Population (millions)		*Proportion of labour force urbanized (per cent)*		*Per capita GDP*		*TFR: Urban Malay (25-29 years)*	
	2000	*2025*	*2000*	*2025*	*2000*	*2025*	*2000*	*2025*
Ref:	23.7	41.2	36	31	3 153	6 333	195.4	194.2
Sim. (1)	23.7	41.5	37	33	2 753	5 510	188.6	184.4
Sim. (2)	23.7	41.4	37	32	2 880	5 796	188.3	184.4
Sim. (3)	23.7	41.3	37	33	2 968	5 750	188.1	184.4
Sim. (4)	23.1	38.9	37	32	3 007	6 153	178.7	175.2
Sim. (5)	24.3	43.9	37	32	2 861	5 452	197.7	193.7
Sim. (6)	23.7	41.4	37	32	2 929	5 775	188.2	184.4

proportion of the *labour force* urbanized as this is explicitly given in the tables. In the reference run the proportion of the labour force urbanized is simulated to be 36 per cent in 2000 and 31 per cent in 2025. The author does not provide an intuition for this unusual feature. GDP per capita grows to M$ 3, 153 at the end of the century and to M$ 6,333 at the close of the simulation period.

Of course, of more interest than the reference run results *per se* are the alternative simulations. The effects of raising the rate of technological progress in non-agriculture (from 2 per cent p.a. to 5 per cent p.a.) are given as Simulation 1. Of the indicators presented in table 1 very little changes. Population for example is simulated to be 41.46 million compared with 41.24 million in the reference run, though our representative indicator of fertility, the Malay urban fertility rate for 25-29 year olds, is 5 per cent lower under faster technological progress. However GDP per capita is simulated to be actually *lower* than in the reference run (M$ 5,509.60 compared with M$ 6,333.10 in the reference run, i.e. 13 per cent lower). Again no intuition is offered for this unusual result, though the author argues in the text that the simulation led to "some increase in the per capita output".

The results of raising the share of agricultural investment (from 17 per cent in the reference run to 50 per cent, by stages) are given under Simulation 2. Again the simulation hardly influences population size at the close of the period and most of the indicators given in table 1 are unaffected by this change except for GDP per capita, which shows a marked decrease. These features are true for all the "economic" simulations reported (i.e. Simulations 1-3). Naturally lowering (Simulation 4) and raising (Simulation 5) fertility rates will affect population size (in the former population is 5.7 per cent lower and in the latter 6.3 per cent higher by the year 2025). Both lower and higher fertility depress GDP per capita. We wonder whether the author has inadvertently introduced additional changes to the models run under the alternative simulations for the low and high fertility cases to straddle that for the reference simulation. This would explain some of the counter-intuitive results reported above.

B. The Philippines

The simulations reported in the Philippine case (the key features being presented in table 2) have to be interpreted somewhat carefully as they are nested. Thus, to evaluate the effect of increased world prices, for example, a comparison of Simulation 1 with the reference run is appropriate: but the appropriate comparison for the evaluation of higher export demand (on its own) is Simulation 2 with Simulation 1. The reference run envisages a growth of the Philippine population from 42.6 million in 1975 to 73 million by 1995. The proportion of households urbanized rises from 43.4 to 48.2 over 1975-1995. The total fertility rate falls from 4.301 to 3.783 in 1981 but is then simulated to rise to 4.631 in 1995 and the infant mortality rate falls to 61.02 deaths per thousand by the end of the simulation. GDP per capita is simulated to rise from 2.62 (thousand pesos in 1974 prices) in 1975 to 3.75 in 1995.

Table 2. Simulation Results: The Philippines (1995)

	Population (millions)	*Proportion of households urbanized (per cent)*	*Per capita GDP*	*TFR*	*Infant mortality rate*
Ref.:	73.33	48.2	3.75	4.631	61.02
Sim. (1)	73.23	47.0	3.84	4.643	60.56
Sim. (2)	71.73	46.3	4.03	4.094	52.96
Sim. (3)	78.83	45.9	3.78	4.904	59.85
Sim. (4)	71.73	38.7	3.31	4.049	64.71
Sim. (5)	71.59	44.2	4.32	4.068	53.40

Turning to the alternative simulations, we report in table 2 the results for the terminal year of the simulations (1995). We consider first the set of economic policies: Simulations 1 – 2 and 4 – 5. The increase in world import and export prices after 1980 (Simulation 1 has marginal effects, raising per capita GDP by 2.4 per cent over the reference simulation, lowering mortality and raising fertility. The demographic effects of this change are minor. Raising export growth has a marked (5 per cent) effect on GDP per capita and a surprisingly significant impact on infant mortality and total fertility (the former falls to 52.96 from 60.56 in Simulation 1 and the latter falls to 4.094 from 4.643). Higher world prices and faster export growth both have a depressing effect on urbanization - their combined effect causing a 4 per cent reduction in the proportion of households urbanized.

By contrast the abolition of the payroll tax raises the infant mortality rate (to 64.71 from 52.96 in Simulation 2 with fertility remaining largely unaffected. GDP per capita shows a marked (18 per cent) deterioration. There is also a significant reduction in the urbanization rate - a 16 per cent fall to 38.7 per cent in 1995. The devaluation Simulation 5 raises GDP per capita by 7 per cent but leaves the demographic variables largely unaffected (including the proportion of households urbanized).

The higher fertility Simulation 3 has its predictable effect on TFR and interestingly raises infant mortality (from 52.96 in Simulation 2 to 59.85 in Simulation 3). The expected reduction in per capita GDP is in evidence (falling by over 6 per cent in Simulation 3 from Simulation 2). The urbanization rate is largely unaffected by the fertility simulation. Note that this simulation raises population by 10 per cent and lowers per capita GDP by 6 per cent. In general the Philippine simulations indicate that economic growth is strongly affected by the one demographic change considered here (higher fertility), but in general demographic variables are less sensitive to changes in the economic environment with infant mortality rates being more sensitive than most.

C. Thailand

Finally we turn to the simulations reported for the Thai model, given as table 3 (with the simulation numbers again reflecting their presentation in section B). In the reference simulation the Thai population rises to 68.4 million in 2005, with 22 per cent living in urban locations. TFR falls slowly throughout the simulation to 2.196 at the close. GDP per capita is simulated to double over the period, reaching 19,722 baht in 2005.

The first two simulations consider the effects of slowing and increasing the decline in fertility and these assumptions are reflected in the simulated values for TFR. In the slower decline (i.e. higher fertility) case, population is nearly 5 per cent higher than in the reference simulation whereas the lower fertility simulation projects population to be 4 per cent lower. As in the Philippine case, lower fertility leads to higher GDP per capita (11 per cent higher than the reference run in 2005). Since the capital stock is unchanged from its reference level, a lower labour force combines with more capital per worker to raise per capita GDP. However, we were puzzled by the rise in *aggregate* GDP in the low fertility case (this is not presented in table 3). Total GDP is higher in the low fertility case (1,439 billion baht in 2005) than it is in the

Table 3. Simulation Results: Thailand

	Population (millions)		*Urbanization rate (per cent)*		*Per capita GDP*		*TFR*	
	1995	*2005*	*1995*	*2005*	*1995*	*2005*	*1995*	*2005*
Ref.:	59.96	68.4	20.19	22.13	14 986	19 722	2.373	2.196
Sim. (1)	61.70	71.50	20.10	19.61	14 593	18 151	2.69	2.38
Sim. (2)	58.18	65.67	20.53	20.67	15 457	18 151	2.14	2.06
Sim. (3)	59.77	68.16	20.30	21.80	15 066	18 151	2.359	2.188
Sim. (4)	59.94	68.40	20.10	23.58	nr	nr	2.370	2.207
Sim. (5)	59.95	68.38	20.10	22.30	nr	nr	2.370	2.198
Sim. (6)	59.95	68.40	20.10	22.62	nr	nr	2.370	2.201
Sim. (7)	59.94	68.38	20.01	22.78	nr	nr	2.369	2.202

nr: not reported.

reference simulation (1,349 billion baht in 2005). Similarly it is difficult to understand the mechanism that *lowers* aggregate GDP in the higher fertility case as a higher input of labour with capital input unchanged would be expected to raise GDP. We wonder whether *composition* effects are responsible for this paradox but the authors did not provide sufficient sectoral detail for this to be investigated. The proportion urbanized was unaffected by the fertility simulations.

In Simulation 3 primary and secondary enrollment rates are raised. This policy has a very marginal effect on both economic and demographic variables wtih GDP per capita actually 2 per cent lower. The authors do not investigate the mechanism at work here.

In Simulation 4 a larger proportion of investment is allocated to agriculture. Again the effects are marginal, though the proportion urbanized at first falls below its reference value and then rises significantly above it, reaching 23.58 per cent in 2005 (6.55 per cent above reference). This probably reflects a rise in GDP per capita which is not reported for this simulation. Simulations 5 and 6 raise taxes and technological progress (respectively) in manufacturing. Again the demographic effects of these changes are minor though in the faster technological change simulation urban growth is marginally higher.

In the final simulation the growth of world trade decreases by 1 per cent. Again the effects are very marginal, with urban growth recording slightly higher values. The sensitivity of urbanization in these last four simulations probably reflects changes in per capita GDP which were not presented in the relevant tables.

IV. CONCLUDING COMMENTS

The three economic-demographic models are focused on medium term issues. In all three models per capita GDP is simulated to rise significantly in the reference simulations. In the Malaysian and Thai cases fertility rates are simulated to decline (demographic transition), though in the former case Malay fertility remains relatively high. However, the Philippine model simulates a rise in TFR after 1980.

The broad lessons from the simulation experiments appear to be:

(a) changes in the economic environment, whether internal or external, have marginal effects on demographic variables;

(b) changes in fertility have more pronounced effects on the economy and per capita GDP. In some cases these changes are counter intuitive;

(c) urbanization is relatively insensitive to fertility change in the Malaysian model but in the Philippine and Thai cases it falls with faster population growth. Sensitivity of urban growth to changes in the economic environment is greater in the Thai and Philippine cases, presumably because in both models urban growth is affected by structural changes (e.g. the share of the non-agricultural sectors) rather than simply by GDP per capita.

The models developed in the project are complex and interpretation of the results requires an intimate understanding of each model: thus the best interpreters of the simulation results are the directors themselves. The advantages and disadvantages of general equilibrium modelling of the type employed in the project are now widely recognized – incorporation of direct and indirect effects of proposed changes, imitation of the operation of markets etc. on the credit side, and a tendency to focus on static issues of allocation rather than the dynamic issues that lie at the heart of many development issues. In the application of these models to economic-demographic interaction over the medium term the weaknesses of the CGE approach are perhaps more apparent than its strengths.

However, the ESCAP project was focused specifically on the key issue of urban growth and migration and in this area the application of structural models of the CGE sort is very appropriate. Moreover, their application is essential if answers to welfare questions are required or if the process of urban growth is thought to depend on changes in the terms of trade or relative wage structures. In all three models great attention has been given to the preparation of the data bases and to overall model design and the directors are to be congratulated on developing interesting models with imperfect and at times incomplete information.

If these models are to provide the basis for further modelling efforts by the country directors, what lessons can be learned? In our view the main lesson is that the models should focus more sharply on specific issues. In the present case urban growth and migration were the primary policy questions but in each case a great deal of work remains to be done in isolating the key factors behind urbanization. The returns to this work are undoubtedly great as most, if not all, countries in the ESCAP region face problems (whether economic, political, social or demographic) arising from urban growth and rural-urban migration. In further work in the region we would like future modelling research to focus more sharply on these issues in order to provide additional insights for policy design.

Annex

Simulation Runs

Malaysia

(1) A rise in non-agricultural technological progress.

(2) A rise in the share of agricultural investment.

(3) A rise in the rate of indirect tax on non-agricultural goods.

(4) A lowering of total fertility.

(5) A raising of total fertility.

(6) An increase in female participation.

Philippines

(1) Increase in import and export prices after 1980.

(2) (1) + higher levels of export demand.

(3) (2) + 40 additional births per 1000 married women of reproductive age.

(4) (2) + the abolition of payroll taxes.

(5) (2) + a peso devaluation.

Thailand

(1) Slow decline in fertility.

(2) Fast decline in fertility.

(3) Promotion of education.

(4) Increasing share of agricultural investment.

(5) Increasing taxes on manufacturing output.

(6) Increasing technological progress in manufacturing.

(7) Slowing growth of world trade.