ASIAN POPULATION STUDIES SERIES No. 37

REPORT ON EVALUATION OF THE ROLE OF POPULATION FACTORS IN THE PLANNING PROCESS THROUGH THE APPLICATION OF DEVELOPMENT MODELS

ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC
Bangkok, Thailand 1978

UNITED NATIONS

THE ESCAP ASIAN POPULATIONS STUDIES SERIES, AND RELATED PUBLICATIONS

A. Asian Population Studies Series*

No.1** *Administrative Aspects of Family Planning Programmes — Report of a Working Group* (E/CN.11/742; United Nations publication, Sales No.66.II.F.10): 1966

No.2** *Family Planning, Internal Migration and Urbanization in ECAFE Countries — A Bibliography of Available Materials* (E/CN.11/807; United Nations publication, Sales No.E.68.II.F.13): 1968

No.3** *Communications in Family Planning — Report of a Working Group* (E/CN.11/830; United Nations publication, Sales No.E.68.II.F.17): 1968

No.4** *Assessment of Acceptance and Effectiveness of Family Planning Methods — Report of an Expert Group* (E/CN.11/882; United Nations publication, Sales No.E.69.II.F.15): 1969

No.5** *Evaluation of Family Planning Programmes — Report of a Regional Seminar* (E/CN.11/936; United Nations publication, Sales No.E.70.II.F.20): 1970

No.6** *Fertility Studies in the ECAFE Region — A Bibliography of Books, Papers, and Reference Materials* (E/CN.11/992; United Nations publication, Sales No.E.72.II.F.3): 1971

No.7** *Interrelation between Population and Manpower Problems — Report and Selected Papers of a Regional Seminar* (E/CN.11/1015): 1972

No.8** *Research, Teaching and Training in Demography — A Directory of Institutions in the ECAFE Region* (E/CN.11/1007): 1972

Supplement No. 1 (E/CN.11/1007/Add.1): 1974
Supplement No. 2 (E/CN.11/1007/Add.2): 1974
Supplement No. 3 (E/CN.11/1007/Add.3): 1976

No.9** *Report of the Working Group on Training of Personnel in Family Planning Programmes* (POP/TPFP/1; mimeographed): 1972

No.10** *Report and Selected Papers of the Regional Seminar on Ecological Implications of Rural and Urban Population Growth* (E/CN.11/1043): 1973

No.11** *Population Aspects of Social Development — Report of a Regional Seminar and Selected Papers* (E/CN.11/1049): 1972

No.12** *Socio-economic Returns of Family Planning Programmes — Report of an Expert Group Meeting* (E/CN.11/1070): 1973

No.13** *The Role of Voluntary Organizations in National Family Planning Programmes — Report of an Expert Group Meeting* (E/CN.11/1087): 1973

No.14** *Comparative Study of Mortality Trends in ECAFE Countries* (E/CN.11/108): 1973

No.15** *A Comparative Study of Family Planning Service Statistics Systems in the ESCAP Region* (E/CN.11/1198): 1975

No.16** *Husband-Wife Communication and the Practice of Family Planning* (E/CN.11/1212): 1975

No.17** *Population Periodicals — A Directory of Serial Population Publications in the ESCAP Region* (E/CN.11/1176): 1974

No.18** *Some Techniques for Measuring the Impact of Contraception* (E/CN.11/1119): 1974

No.19-A** *Asian Resources for a Population Library Information Network — Report of a Working Meeting* (E/CN.11/1114): 1974

No.19-B** *Establishment of a Population Library and Documentation Centre Information Network among the Countries of the ECAFE Region — Report of a Task Force Meeting* (mimeographed): 1974

No.20-A** *Report of the Workshop of ECAFE Population Correspondents from Indonesia* (mimeographed): 1974

No.20-B** *Report of the Workshop of ECAFE Population Correspondents from Indonesia* (mimeographed): 1974

No.20-C** *Report of the Workshop of ECAFE Population Correspondents from the Republic of Korea* (mimeographed): 1974

No.20-D** *Report of the Workshop of ESCAP Population Correspondents from Pakistan* (mimeographed): 1975

No.21 *Comparative Study of Interrelationship between Levels of Literacy and Skill and Fertility Trends* (under preparation)

No.22** *Report of the Expert Group on Developing Indices for Measuring the Impact of Training on Job Performance of Field-workers in Family Planning Programmes* (IX.ISSN. 0066-8451; mimeographed): 1973

No.23** *Comparative Study of Population Growth and Agricultural Change* (E/CN.11/1224), 1975, in five volumes:

A: The Inter-country Report
B: Case Study of Japan
C: Case Study of India
D: Case Study of Sri Lanka
E: A Survey of the Philippines and Thailand Data

No.24** *Role of Surveys and Studies for Family Planning Programme Management and Development — Report of a Regional Seminar* (E/CN.11/1225): 1976

No.25** *Report and Selected Papers of the Expert Group Meeting on Training in Family Planning Programme Administration* (E/CN.11/1226): 1976

No.26** *Report and Papers of the Expert Group Meeting on Social and Psychological Aspects*

---

* No charge, but priority given to Governments and institutions.
ESCAP was previously named the Economic Commission for Asia and the Far East (ECAFE); hence, those titles published before 1975 make reference to ECAFE.

** Available in microfiche form.

ASIAN POPULATION STUDIES SERIES No. 37

REPORT ON EVALUATION OF THE ROLE OF POPULATION FACTORS IN THE PLANNING PROCESS THROUGH THE APPLICATION OF DEVELOPMENT MODELS

ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC
Bangkok, Thailand 1978

UNITED NATIONS

ST/ESCAP 64

CONTENTS

PREFACE

This study was undertaken in response to the emphasis placed on the integration of population factors into development planning in the Declaration of Population Strategy for Development, adopted at the Second Asian Population Conference held at Tokyo in November 1972, and the importance given to the development of socio-economic-demographic models in the World Population Plan of Action adopted by the 1974 World Population Conference held at Bucharest.

The necessity for integrating population planning into the over-all development planning process was emphasized at the Second Asian Population Conference, which declared that population has a direct effect on economic and social development, and recommended that population and socio-economic development be given a co-ordinated and integrated status in national planning. The Conference further suggested that improved understanding of the interrelationship between demographic, economic and social factors would provide a more complete conceptual framework for the formulation of population policy. In this context, the Conference also pointed out the need for the application of sophisticated methods of analysis and urged ESCAP to promote the advancement of knowledge in these fields.

The basic objective of this study is to encourage and motivate country planners to improve their development plans by integrating population factors into development planning and policies. The study should be of assistance to planners in improving procedures for considering the short- and long-term implications of population growth for determining various development priorities and targets, and for considering the implications of various socio-economic programmes and policies with regard to fertility, mortality and migration.

The study was undertaken as part of the work programme of the Division of Population and Social Affairs of the ESCAP secretariat with the financial support from the United Nations Fund for Population Activities.

Summary

Development planning is an attempt to co-ordinate decision making by setting quantitative targets which must be reached in a given period of time. It has become an essential and integral part of the development process of the countries of the ESCAP region. In formulating these plans it is necessary to consider the impact of population growth and movement on the development process. Although rapid population growth is not necessarily the primary cause of the problems facing developing countries, it does intensify these problems and renders their solution more difficult. Furthermore, these problems are intensified and exacerbated by rapid population movement, particularly rural to urban migration.

I. INTRODUCTION

A. Background

The Second Asian Population Conference, held in Tokyo in 1972, recommended that development be viewed as an integrated process and that the interrelationship between economic, social, political and population factors be assessed in all programmes.[1] That view was accepted by the World Population Conference at Bucharest in 1974 where the need to consider population problems within the broader context of socio-economic development was emphasized. The principal aim of this development, of which population goals and policies are integral parts, is to improve levels of living and the quality of life of the people.[2] It was recognized that because population and development are interrelated; population policies must be constituent elements of socio-economic development policies.

In the Asia and Pacific region these policies are embodied in national development plans. Planning is utilized as a technique for achieving an efficient allocation of scarce resources, setting clear cut national objectives and providing a national sense of political, economic and social purpose. The planning exercise serves to provide planners and policymakers with a greater awareness of the facts of their developmental situations and the options open to them.

It was a recommendation of the Second Asian Population Conference that population and economic and social development be given a co-ordinated and integrated status in national planning and plan organizations.[3] This view was reiterated in the World Plan of Action which held that population measures and programmes should be integrated into comprehensive social and economic plans and this integration should be reflected in the goals, instrumentalities and organization for planning.[4] A number of countries in the region have already made significant progress in this direction. For example, the Government of Malaysia has established a Population and Employment Section within the Economic Planning Unit, Prime Minister's Department.

This process has moved forward at the international level as well. In September 1973 planners from this region participated in a workshop entitled "Population and development planning" which was held in Penang under the sponsorship of the Inter-Governmental Co-ordinating Committee, Southeast Asian Regional Co-operation in Family and Population Planning (IGCC).[5] They also participated in a seminar entitled "Integrating population planning into general economic planning" which was held in San Francisco under the sponsorship of the South East Asia Development Advisory Group (SEADAG).[6] This work was carried forward through a SEADAG seminar entitled "The role of economic-demographic models in planning" held in New York in March 1975.[7]

In conformity with suggestions for international co-operation made at the Second Asian Population Conference and resolution 3345 (XXIX) of the General Assembly of the United Nations which called for multidisciplinary research aimed at synthesizing, integrating and advancing existing knowledge on the interrelationship between population resources and the environmental development,[8] ESCAP has undertaken to provide assistance to the members and associate members in the area of integrating demographic, economic and social development planning. In support of this broad objective, it has conducted seminars on the interrelation between population and manpower problems[9] the ecological implications of the growth of

---

1/ ***Population Strategy in Asia*** *(Asian Population Study Series No. 28, E/CN. 11/1152, Bangkok, 1974), p. 66.*

2/ ***Report of the United Nations World Population Conference, Bucharest, 19-30 August 1974*** *(United Nations publication, Sales No. E.75.XIII.3), p.7.*

3/ ***Population Strategy in Asia, op.cit.,*** *p. 21.*

4/ ***Report of the United Nations World Population Conference, op.cit.,*** *p. 23.*

5/ *Inter-Governmental Co-ordinating Committee, Southeast Asian Regional Co-operation in Family and Population Planning,* ***Population and Development Planning*** *(Kuala Lumpur, IGCC, 1974).*

6/ *South East Asia Development Advisory Group, "Report of Population Panel Seminar, San Francisco, 1973," (New York, SEADAG, 1974) (mimeographed).*

7/ *South East Asia Development Advisory Group, "Report of Population Panel Seminar on the role of economic-demographic models in development planning" (New York, SEADAG, 1975) (mimeographed).*

8/ *United Nations General Assembly Resolution 3345 (XXIX), Research on the interrelationship between population resources and environmental development.*

9/ ***Interrelation Between Population and Manpower Problems*** *(Asian Population Study Series, No. 7, E/CN.11/1015, Bangkok. 1971).*

rural and urban population,[10] the population aspects of social development.[11] and the socio-economic returns to family planning.[12] In late 1975 ESCAP conducted an expert group meeting on population projections in the context of development planning.[13]

In mid-1977 ESCAP conducted an expert group meeting on population and development planning. The substantive chapters of this report were used as background papers for that meeting.

In addition to these seminars, ESCAP has undertaken a number of methodological studies designed to facilitate integrated national planning. Among these are two studies designed to assist planners to convert general demographic goals into specific targets for family planning accomplishment.[14]

The Second Asian Population Conference called for increasing sophistication in planning methodology. In moving to carry out this mandate, ESCAP has initiated the present project on "The evaluation of the role of population factors in the planning process through the use of development models", which was approved as part of the population programme for Asia and the Pacific by the Commission at its thirtieth session, held in Colombo in 1974. The project should serve to supplement the work of such agencies as the International Labour Organization (ILO), the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO). The United States Bureau of the Census and the General Electric Corporation's TEMPO research group, which have developed socio-economic-demographic models, and to assist in the selection, coordinated application and evaluation of these models in the ESCAP region. These efforts are consistent with the World Population Plan of Action, which stated that emphases in research should be given to the development of socio-economic and demographic models.[15]

It is anticipated that the outcome of this project will serve as a basis for future work of ESCAP such as expert group meetings, further studies and technical assistance to countries on the use of models for integrating population factors into development planning.

In recent years many econometric models have been developed to assist planners in achieving consistency or optimality in their work. At the same time a number of so-called economic-demographic models have been developed the purpose of which has been to illustrate the consequences of rapid population growth and the potential gains to be achieved from limiting fertility.[16] Though these models were originally designed to be illustrative rather than tools of planning, there is growing interest in the question of whether these models might serve as the basis for integrating population planning into over-all development planning. It may be that no single model is suitable for this purpose but each of these models may have unique features which should be utilized in developing a model which is appropriate.

B. Objectives

The basic objectives of this study are: to encourage and motivate country planners to prepare better development plans by integrating population into development planning and policies through the application of new models; to provide planners with appropriate procedures to consider the short-term and long-term implications of the growth of population for fixing priorities and setting targets in various development sectors; to provide

---

10/ ***The Regional Seminar on Ecological Implication of Rural and Urban Population Growth*** *(Asian Population Study Series, No. 10, E/CN.11/1043, Bangkok, 1971).*

11/ ***Population Aspects of Social Development*** *(Asian Population Study Series, No. 11, E/CN.11/1049, Bangkok, 1972).*

12/ ***Socio-Economic Returns of Family Planning Programmes*** *(Asian Population Study Series, No. 12, E/CN.11/1070, Bangkok, 1972).*

13/ ***Report of the Expert Group Meeting on Population Projections*** *(Asian Population Study Series, No. 33, Bangkok 1975).*

14/ ***Some Techniques for Measuring the Impact of Contraception*** *(Asian Population Study Series, No. 18, E/CN. 11/1119, Bangkok, 1974); and* ***Report of the Multinational Study in Methodologies for Setting Family Planning Targets in the ESCAP Region*** *(in preparation).*

15/ ***Report of the United Nations World Population Conference, 1974, op.cit.,*** *p. 20.*

16/ *For a critical examination of this class of models see "Economic-demographic models", in* ***The Population Debate: Dimensions and Perspectives,*** *vol. I (United Nations publication, Sales No. E/F/S.75.XIII.4), pp. 476-483. See also "Growth models for illustrating the effects of alternative increment and employment policies",* ***Economic Bulletin for Asia and the Far East,*** *vol. IX, No. 1, June 1958, pp. 17-31; "Construction of general models of economic and social development" (United Nations Economic and Social Council, Bombay, India, March 1960) (mimeographed), and Edgar Hoover, "Basic approaches to the study of demographic aspects of economic development", in "Economic-demographic models" (New York, United Nations Economic and Social Council, 2 May 1970) (mimeographed).*

guidelines for considering the implications of various socio-economic programmes and policies for fertility, mortality and migration, so that these demographic factors may be treated as endogenous variables which can be modified by making changes in the planning process. Finally, the report of the study may serve as a guideline for training and educational purposes.

C. Procedures

The major models which have been developed by research teams to portray the interaction between demographic, economic and social variables will be analysed and evaluated with regard to their potential usefulness in development planning.

The analysis of these models will focus on the following questions: What are the crucial differences between the major economic-demographic models in terms of structure, purpose and logistic requirements? How can these differences be justified? Are there specific features which are required if the models are to be applicable to the development problems of the ESCAP region? Under what conditions are these models most likely to be applicable? And finally, would the use of an economic-demographic model provide a firmer base for a strong population policy?

D. Models to be reviewed

In the choice of a socio-economic-demographic model, a wide variety of options are available. Models differ in terms of purpose, generality, location, time period, coverage, degree of integration and level of aggregation. Models are designed to aid in planning, policy formulation, preparing projections, explaining past trends or theoretical analysis. They vary in generality from prototype models to models intended to apply only to countries of a specific region or level of socio-economic development, to models which are country-specific. In some models the basic unit is the entire world, in others its major regions. Sometimes the basic unit is the nation or a subnational area. Models may be annual, short-run, intermediate or long-run in their time perspective. Models may be applied to the entire socio-economic-demographic structure, to a number of interrelated sectors or to a single sector. Some models can be fully integrated, providing for interaction between all its components, and others are partially integrated so that the outputs of some sectors of the models serve as inputs for other sectors, or the model can be simply a collection of independent submodels. There are models which deal with individual decision-making units such as households and enterprises; other models use as the basic unit of analysis large aggregates such as industry, government, or the total of all households.

This list of possible options is by no means exhaustive. Models are static or dynamic; that is they illustrate the equilibrium at a point in time or they trace the time path of the variables over time. They are simultaneous in the sense that variables interact upon one another during a specified time period or they are recursive so that current values of the variables influence other variables only in following periods. Models are also constructed in such a way that they can be solved by standard mathematical analysis or they may require computer simulation.

This study will deal with both prototype models and their country-specific applications. It will be concerned with models which are designed for planning and policy formulation. The study will examine models to be used for long-run perspective planning at the national level. Only models intended to cover all sectors of the economy will be considered. Some are fully integrated, while others are composed of partially independent subsectors. The models to be considered will be dynamic, recursive and aggregative. They are also of the type to be solved by computer simulation.

This study will deal with the following prototypes and their country-specific applications: (a) TEMPO-I and TEMPO-II developed by the TEMPO Division of the General Electric Corporation,[16] (b) the Long Range Planning Model (LRPM) series of models developed by the Socio-Economic Analysis Staff, International Programmes Center, Unied States Bureau of the Census, Washington, D.C.,[17] (c) the FAO/LRPM model developed by the Policy Analysis Division of the Economic and Social Department of FAO[18], (d) the model developed by the Population Dynamics Group

---

16/ *Richard Brown and Henry Cole, "The TEMPO model as a basis for development planning" (Washington, D.C., General Electric Corporation, TEMPO, 1975) (mimeographed).*

17/ *Joseph Quinn, "The use of the LRPM and PDM models for structural analyses and development planning" (Washington, D.C., United States Bureau of the Census, 1975) (mimeographed).*

18/ *Wuu-Long Lin and M.G. Ottaviani-Carra, **A Systems Simulation Approach to Integrated Population and Economic Planning** (Food and Agriculture Organization of the United Nations, WS/H2518/E/11.755/1/300, Rome, 1975).*

(PDG), of the University of Illinois at Urbana,[19] and (e) the BACHUE model developed by the Population and Employment Project of the International Labour Organisation.[20]

19/ Paul Handler and Chaisung Roh, "The Population Dynamics Group economic-demographic models and its relationship to planning" (Urbana, Illinois, Population Dynamics Group, University of Illinois, 1975) (mimeographed).

*20/ M.J.D. Hopkins, G.B. Rogers and R. Wery, **A Structural Overview of Bachue — Philippines**, (International Labour Organisation, World Employment Programme working paper No. 20, WEP 2-21/WP.20, Geneva, 1975).*

II. THE ROLE OF POPULATION FACTORS IN THE PLANNING PROCESS

A. Preparing the over-all plan

Economic and social development planning is a deliberate and continuing attempt to project economic and social policy into a workable design or a scheme of arrangements with quantified targets and specific instruments for achieving those targets.[1] This function of government has been gaining in importance in nations of the ESCAP region because it is considered as an instrument for accelerating their rates of economic, social and demographic progress.

Planning is considered necessary for a variety of reasons. Markets in many developing countries have many imperfections. Market prices often fail to reflect true social opportunity costs; individual decisions, therefore, will not optimize economic performance. Furthermore, resources in such economies are often immobile. Private decision-making with regard to investment would not take into account external economies of scale and would, therefore, waste scarce capital and skilled manpower. Furthermore, the creation of a development plan setting forth a detailed statement of national economic and social objectives can serve to consolidate all factions of the nation and mobilize the popular support which is necessary for overcoming the obstacles to development. A development plan also serves as a basis for determining patterns of international development assistance.[2]

Raising levels of income and productivity and reducing the nation's dependence on specific exports and imports are among the major objectives of economic planning. Thus targets are primarily set in terms of national income or *per capita* income, although supplementary targets are often set in terms of the levels of employment and prices, the balance of payments and changes in the distribution of income between households and subnational regions.[3] In the market-oriented developing countries of the ESCAP region these objectives are generally pursued by indirectly influencing the decisions of individual households and enterprises.

There are marked differences in the approaches to planning between market and socialist economies and between developed and developing countries.[4] This report will be primarily concerned with planning in the market-oriented developing nations of the ESCAP region. Within such countries a wide variety of planning activities takes place. It is possible to distinguish between social, economic and demographic planning and between national and regional planning.[5] Planning can be on an aggregate or on a sectoral level. Most planning also involves an integrated system of short, medium and long-term plans.

Most planning techniques are based on models which include as essential elements plan targets, instruments for meeting those targets, data, constraints and structural relationships between the variables. Corresponding to the various types of planning are alternative planning models.[6] This study is primarily concerned with integrated social, economic and demographic planning

---

1/ For a discussion of the many possible meanings of development planning see Albert Waterston, ***Development Planning*** *(Baltimore, Johns Hopkins Press, 1965), ch. 2.*

2/ For a critical appraisal of development planning see Mike Faber and Dudley Seers (eds), ***The Crisis in Planning*** *(London, Chatto and Windus, 1972).*

3/ For a discussion of the significance of ***per capita*** *versus national income as a measure of welfare see George B. Simmons, "Public expenditure analysis and family planning programs", in Leon Tabah (ed.),* ***Population Growth and Economic Development in the Third World*** *(Liege, Belgium, IUSSP, 1976.)*

4/ For a discussion of these differences to the role of population see Warren Robinson, "Planning, population and the macro framework", in Warren Robinson (ed.), ***Population and Development Planning*** *(New York, Population Council, 1975), pp. 10-13. Todaro identifies three types of planning, i.e., planning in capitalist, collectivist and mixed economies, see Michael Todaro,* ***Development Planning, Models and Methods*** *(Nairobi, Oxford University Press, 1971), pp. 2-5.*

5/ Unless otherwise indicated the term regional planning, as used in this report, will refer to the planning of subnational regions. Multinational regions such as the ESCAP region will be referred to as multinational regions.

6/ For a discussion of the various types of planning and related planning models, see Nurul Islam, "The relevance of development models to economic planning in developing countries" ***Economic Bulletin for Asia and the Far East,*** *vol. XXI, No. 1/2, June/September 1970 (United Nations publication, Sales No. E.70.II.F.15).*

models to be used for long-term general plans at the national level. Primary emphasis is placed on this aspect of planning on the assumption that the first step in the planning process is the determination of a target over-all rate of development using a framework cast in terms of national income and output, domestic and foreign investment, private and public consumption and savings.

Planning will not be optimal if it does not take into consideration the impact of demographic trends on economic and social development and *vice versa*. Population size, growth, age-sex composition and spatial distribution are basic determinants of production and employment as well as of the pattern of investment and private and social consumption. Beyond this, optimal planning requires an awareness that the economic and social development itself will have an impact on the distribution, composition, size and growth of the population and its components. Mortality and fertility, migration and urbanization will all be influenced by economic and social development.[7/]

At present planners are faced with a number of obstacles which must be overcome in order to integrate population factors into the planning process. These include a lack of accurate demographic data and an incomplete understanding of the way social, economic and demographic variables should be related in planning and projection models.

In order to achieve socio-economic development in terms of improvement in the quality of life of the people and not merely through economic growth, it is necessary that sectoral plans be prepared which set forth the structural changes that must be made. However, a purely sectoral approach would result in assorted projects which are not part of an integrated whole, therefore the first step in planning is normally the preparation of an over-all plan based on a macro-economic model.

In most developing countries of the ESCAP region, there is a surplus of labour and, therefore, capital is the limiting factor on development.[8/] In cases where there is a redundant labour supply so that the marginal productivity of additional units of labour is zero, the use of a model in the Harrod-Domar tradition (which makes output growth a function of investment and the marginal capital-output ratio) can be justified.[9/] The choice of such models can also be justified on the grounds that a fertility change does not begin to affect the size of the labour force until about 15 years after it occurs.[10/] If such a model is used, demographic factors will affect aggregate output by influencing savings and the pattern of investment.

The rate of growth of population will determine the rate of investment required to achieve target levels of *per capita*[11/] income as well as the maximum amount of income that may be diverted from consumption to investment. The size, composition and rate of growth of the population will determine the proportion of investment devoted to housing, transport and urban facilities thus influencing the average capital-output ratio and hence the level of investment required to meet a given income target.

If the productivity of additional units of labour is positive, then a model which incorporates a Cobb-Douglas production function, in which output varies in proportion to some fractional power of each of the factors, would be most appropriate. Implicit in such models is the assumption that the marginal productivity of labour is directly related to the capital-labour ratio and that the marginal producivity of capital is inversely related to this ratio.[12/]

B. Planning investment and consumption

Development plans in most less developed countries of the ESCAP region lay great emphasis on the goal of industrialization and on capital formation as a way of

---

*7/ Asian countries have discussed population problems more frequently in their development plans than have the nations of any other region of the world. See B. Maxwell Stamper, "Population policy in development planning", **Reports on Population/Family Planning** (New York, Population Council, May 1973), p. 5.*

*8/ Nurul Islam, **loc.cit.**, p. 65.*

9/ While the original Harrod-Domar model treats capital as the only relevant scarce factor of production, the "two gap" model elaborates the consequences of a scarcity of foreign exchange as well as a gap between savings and investment.

*10/ Edgar Hoover, **loc.cit.**, p. 3.*

*11/ See A.A. Ayida and G.P.O. Chikelu, "Demographic aspects of development planning", in **The Population Debate: Dimensions Perspectives**, vol. I, **op.cit.***

*12/ A survey of the literature on Harrod-Domar and Cobb-Douglas models is contained in Joseph E. Stiglitz and U. Uzawa (eds.), **Readings in the Modern Theory of Economic Growth** (Cambridge, Mass, MIT Press, 1969). See also C.R. Blitzer, P.B. Clark and L. Taylor (eds.), **Economy-wide Models and Development Planning** (London, Oxford University Press, 1975)*

achieving that goal. Capital formation is considered the key to increased output per worker and consequently to improved living standards. It is also considered to be the key to increasing the level of employment in the modern sector of these economies.

Planning for investment must take account of the subtle and complex relationships between population factors and the rate and composition of capital formation. High rates of population growth can influence the rate of private and public savings in a variety of ways.

The proportion of income which a household can devote to savings will depend in large part on the level of income, and the size and age structure of the family. In general higher rates of population growth are associated with a larger average size of household and a greater proportion of dependent children. For any given level of household income an increase in family size would reduce *per capita* income with the result that a larger proportion of income would be spent on necessities and a smaller portion would be saved.[13/] Higher dependency ratios may depress savings, but they may also depress socially accepted standards of consumption, thus encouraging thrift.[14/] Furthermore, a rapidly growing population will have an age structure more heavily weighted with young adults who may feel it necessary to save for old age.[15/]

Population factors have indirect as well as direct effects on rates of savings. Population factors will influence the distribution of income in a variety of ways which will in turn effect patterns of savings.[16/] Rapid urban growth will tend to reduce the rate of savings because for any given level of income, the rural population saves more than the urban population. By altering the distribution between wage income and property based income, population changes give more weight to the savings propensities of either workers or property owners.

Population changes will also affect the composition of capital formation. Rapid population growth and movement will require the diversion of capital into activities such as the building of schools, hospitals and houses at the expense of immediately productive sectors. Such a pattern of investment would adversely affect the current rate of economic growth and have a depressing effect on the level of future investments. Population factors will also influence the pattern of investment indirectly. By influencing the level and distribution of income they will alter the composition of final demand and, therefore, the structure of capital requirements in various sectors.

Capital formation can also be financed out of a surplus of exports over imports of consumer goods. Population factors can affect the size of this surplus.[17/] Differentials in rates of population growth can adversely affect terms of trade as well as the magnitude of this surplus. Nations with rapidly growing populations will have a comparative advantage in labour-intensive products. By influencing the level and distribution of total income and income *per capita*, population factors will alter the demand for imported consumer goods.

Planners' decisions with regard to alternative investments can also influence the rate of population growth and patterns of migration.[18/] The provision of social overhead capital in either rural or urban areas can affect rates of migration. Investments which result in increased employment of women may reduce fertility while investments which provide employment opportunities for children may result in increased family size.[19/] The choice between building urban hospitals or rural health centres may influence levels and patterns of mortality.

Generally the ultimate objective of development planning is to increase the levels of living of the population which are closely tied to levels of consumption expenditures. In planning consumption expenditures, the ef-

---

13/ See Wenge Eizenga, ***Demographic Factors and Savings*** *(Amsterdam, North Holland Press, 1961).*

14/ Nathaniel Leff, "Dependency rates and savings rates", ***American Economic Review****, vol. 50, No. 5.*

15/ See Donald Eilenstine, "The savings consequences of reducing rates of population growth", and Dale Hein, "Aggregate effects of population on consumption in developing countries", papers presented at the South East Asia Development Advisory Group Seminar on the Role of Population Planning in General Economic Planning, November 1973 (mimeographed).

16/ For a discussion of the distributional impact of a reduction in fertility see ***Socio-Economic Return of Family Planning Programmes*** *(Asian Population Studies Series No. 12, E/CN.11/1070, Bangkok, 1972), chap. 8.*

17/ See Edward K. Hawkins and Roberto Cuca, "Population and external balance", in ***Population and Development Planning, op.cit.,*** *pp. 188-201.*

18/ See Ghazi M. Farooq, "Population distribution and migration", in ***Population and Development Planning, op.cit.,*** *pp 134-149. See also United Nations Department of Economic and Social Affairs, "Population movements and the distribution of social services,"* ***International Social Development Review,*** *No. 1 (New York), 1968, pp. 92-94.*

19/ See James L. McCabe and Mark R. Rosenzweig, "Female employment creation and family size", in ***Population and Development Planning, op.cit.,*** *pp. 323-326.*

fects of changes in age structure, the structure of households and rural-urban location must be considered. These factors will influence the distribution of consumer goods between income and social classes, between geographical areas and between present and future generations. It follows that the pattern of consumer demands which results from an increase in *per capita* income will be quite different from the pattern of demand which will result from an increase in population.

Conversely the choices made by planners as to alternative patterns and levels of consumption goods production will have a significant impact on demographic variables. Consumption of agricultural products, nutrition, will influence mortality, especially that of infants. Nutrition may also be a significant factor in the age at onset of coitus, the length of a woman's fecund period and the interval between births.[20/] Furthermore the purchase of consumer durables may be a significant component in modernization which may affect fertility. A rising standard of living is likely to influence household decisions regarding fertility and relative levels of consumption in rural and urban areas are likely to have a significant impact on rates of internal migration.[21/]

C. Planning industrial and agricultural development

It is widely accepted by planners in the ESCAP region that industrial development must be the central feature of long-term growth. It is also generally recognized that there must be an integration and co-ordination of agricultural and industrial development so that each sector is complementary to the other. This is because the agricultural sector is the principal source of demand for the output of the industrial sector as well as the principal source of supply of raw materials and labour. However, it is considered that over time, only industry is capable of absorbing the future growth of the labour force since availability of arable land is limited.[22/]

In planning industrial development, consideration must be given to the effect of demographic factors on the rate and composition of capital formation and the structure of final demand, the labour force and unemployment. Planners must also recognize that industrialization generally involves urbanization. Thus planning industrialization will require concomitant planning of urbanization. In many countries of the ESCAP region, urban growth is outpacing industrialization thus aggravating problems of unemployment. This inflow to the cities tends to force planners to create additional jobs in industry rather than in agriculture. Because of the serious problems associated with urbanization, planners are now seeking ways to create employment opportunities in rural areas and thereby stem the tide of migrants to the cities.[23/]

D. Planning employment

Because of the great emphasis which is placed on planning industrial and agricultural output, employment planning is often treated as a residual.[24/] Often short- and medium-term plans either do not set employment targets or set targets equal to the expected rate of growth of the labour force without making any explicit provision for achieving full employment. The magnitude of this task is increased by the fact that total population is growing rapidly and this rapid rate of growth results in an age-structure in which new entrants to the labour

---

20/ See William P. Butz and Jean Pierre Habicht, "The effects of nutrition and health on fertility: Hypothesis,, evidence and interventions", and Debora S. Freedman, "Mass media and modern consumer goods: their suitability for policy interventions to decrease fertility", in ***Population and Development Planning, op.cit.,*** *pp. 210-238 and pp. 356-386 respectively.*

21/ See Michael P. Todaro, "A model of urban migration and urban unemployment in less developed countries," ***American Economic Review,*** *vol. 59, No. 1, March 1969, pp. 138-148, and John R. Harris and Michael P. Todaro, "Migration, unemployment and development; a two sector analysis,"* ***American Economic Review,*** *vol. 60, No. 1, March 1970, pp. 126-142.*

22/ Graham Pyatt and Eric Thorbecke, ***Planning Techniques for a Better Future*** *(Geneva, International Labour Office, 1976), p. 75.*

23/ ***Ibid.,*** *p 78. See also United Nations, "Rural community development and planning: Promise and reality,"* ***International Social Development Review*** *(New York), No. 2, 1970, pp. 28-33; and Michael P. Todaro,* ***International Migration in Developing Countries: A Review of Theory, Evidence, Methodology and Research Priorities*** *(Geneva, International Labour Organisation, 1976).*

24/ In the past planners have thought of employment as an automatic side effect of development, however, there is now growing support for making employment the central objective of planning. See National Academy of Sciences, ***In Search of Population Policy*** *(Washington D.C., 1974), p. 15, 16. See also Edgar O. Edwards,* ***Employment in Developing Countries: Report on a Ford Foundation Study*** *(New York, Columbia University Press, 1974).*

force will far exceed retirements for many years to come.

In planning for employment, demographic factors are of central importance. 25/ Targets for employment growth are usually determined by projected labour force growth. Furthermore, patterns of migration are of great significance since the concept of economic development, as opposed to simple growth, implies change in the structure as well as the size of the economy. Thus planning must be concerned with the transfer of labour from the agricultural to the industrial sector and ultimately from industry into high-skill service occupations. 26/ And within these sectors there must be a shift from less to more productive activities.

In quantitative terms the role of population changes in planning employment may be analysed in terms of its relationship to the proportion of the population which is of working age, rates of labour force participation and rates of employment. Rapid rates of population growth brought about by rapid declines in infant mortality will result in an age-structure which is weighted heavily in favour of the very young and thus a heavy burden of dependency.

Given the age-sex structure of the population, the size of a nation's labour force will depend on the activity rates of specific age-sex groups. In general, male activity rates in the working ages will be near the maximum and, therefore, will be independent of population factors. However, the age-specific activity rates of women will vary with marital status and birth rates. Demographic factors will affect age-specific activity rates in a number of indirect ways as well. Population growth and movements may alter educational enrolment rates which in turn will alter activity rates in younger age groups. Through their influence on the pattern of production and demand, demographic factors will alter the demand for occupations in which a high proportion of females are found. By altering employment opportunities, demographic factors may influence females to enter or leave the labour force.

The actual labour input to production will depend upon the proportion of the labour force which is employed. At present, a major problem facing planners in most developing countries of the ESCAP region is the failure of industrial growth to create enough employment opportunities to absorb all who are released by the agricultural sector. This surplus often takes the form of underemployment rather than employment. 27/

The failure to plan for full employment has been largely due to the great difficulties which must be faced in achieving that objective as well as the assumption derived from neo-Keynesian growth models that by maximizing the rate of growth of industrial production, less developed countries could also maximize employment. Low levels of investment (in part because of rapid population growth) result in an inadequate number of new employment opportunities. Attempts to increase the employment generating potential of new investment have often been frustrated by the absence of materials, methods and equipment appropriate to a labour-intensive technology. 28/ This is particularly true in the case of modern industrial products because much of the research on new materials, techniques and equipment design takes place in the developed countries where high labour costs make it important to develop a labour-saving technology. 29/ Among the techniques for dealing with this problem is the subsidized development of labour-intensive technology. However, efforts in this direction are constrained by the need to achieve high

---

25/ *See* ***Demographic Aspects of Manpower*** *(United Nations publication, Sales No. 61.XIII.4) and* ***Interrelation between Population and Manpower Problems, op.cit.*** *An ESCAP study,* ***Comparative Study of Population Aspects of Manpower and Employment,*** *is currently being prepared for publication.*

26/ *Earlier theories of development assumed that planning should be aimed at releasing a sufficient amount of labour from the agricultural sector to support urban industrialization. See W.A. Lewis, "Economic development with unlimited supplies of labour",* ***Manchester School,*** *1954; and J.C.H. Fei and G. Ronis, "A theory of economic development",* ***American Economic Review,*** *1961. Currently planners are concerned with reducing rates of rural-urban migration.*

27/ *Edwards identifies five forms of underutilization of labour, open unemployment, underemployment, the visibly active but under-utilized, the impaired and the unproductive (Edgar O. Edwards,* ***op.cit.,*** *p. 10).*

28/ *Although there has been much talk of "intermediate technologies", few such technologies have actually been developed and used.* ***In Search of a Population Policy, op.cit.,*** *p.16. See also Frances Stewart, "Technology and employment in LDC's", in Edgar O. Edwards,* ***op.cit.,*** *pp. 83-132, and Amartya Sen,* ***Employment Technology and Development*** *(London, Oxford University Press, 1975).*

29/ *Almost 98 per cent of all scientific research is undertaken in developed countries and is directed toward the solution of their own problems and therefore is of little benefit to developing nations. See Michael Todaro,* ***Economic Development in the Third World*** *(New York, Longmans, 1977), p. 79.*

productivity to compete in world markets and the setting of minimum wage levels designed to meet equity objectives. Furthermore, the shortage of manpower with critical skills may prevent or delay the undertaking of productive activities which could provide for the employment of large numbers of less skilled workers.

The rural and urban aspects of employment problems are clearly related. Rural underemployment results in migration to cities. Thus rural underemployment is often converted into urban unemployment. Rural underemployment may be reduced by increased investment in agriculture and the funding of rural development projects. However, the scarcity of arable land will ultimately limit the possibility of increasing employment in rural areas.

Rural underemployment and urban unemployment will also affect key demographic factors. Children may be less desired and hence fertility may be lower in rural areas when labour is in surplus.[30/] In urban areas, marriages and childbirth may be delayed because young men find it difficult to find a job. Increased employment of women may also contribute to reduced fertility. Increased employment may facilitate improvements in health and nutrition which in turn may reduce infant mortality and the desire for additional children. Therefore, programmes designed to restore full employment must take into account the net effect on fertility. Clearly differential employment opportunities will also be a major factor in determining rates of internal migration.

E. Social planning

The major sectors of social planning are education, health and housing. Planning for these activities should be fully integrated with economic and demographic planning. However, much work remains to be done in designing a methodology for achieving that objective. At present, there is no operational framework of social planning which can be integrated into development planning.

There has been a tendency to regard expenditure on education, health and housing and other social services as consumption outlays, since such investments do not directly and immediately contribute to an increase in output. Although there may be a conflict in the short-run between investments in social services and indirectly productive undertakings, the long-term effects on development of high standards in education, health and housing are most favourable. Investments in social services are essential not only for enhancing the quality of life of the individuals receiving them but also as part of a long-term strategy to develop human resources for efficient production.[31/] The amount of resources that needs to be devoted to investment in this sphere, however, is closely affected by the rate of population growth.

Social planning generally involves a determination of what is required to support some other aspect of the overall development plan or what is required to achieve a specified minimum standard of welfare. The first kind of social planning would adapt social services to meet specific developmental requirements. An example is the setting of educational targets in accordance with the needs for skilled manpower to achieve specified production targets. The second type of planning would involve the setting of specific social targets and then formulating economic plans designed to provide the means necessary to achieve them.

The size of the population and its age-sex composition, the structure of households and patterns of migration will be a major determinant of requirements for education, health services and housing. Thus consideration of the demographic trends is an essential component in the social planning process, both for the setting of specific social services targets and for determining the feasibility of certain social goals. Conversely consideration must be given to the implications of achieving social services targets on future demographic events. Achieving educational health and housing goals may have a significant impact on fertility, mortality and patterns of migration.

F. Planning education

In countries of the ESCAP region, the proportion of gross national product devoted to education has been steadily rising. Public expenditures on education in Asia tripled during the 1960s.[32/] There has been a significant expansion in total enrolment but little growth

---

30/ See David Goldberg, "Residential location and fertility", in ***Population and Development, op.cit.,*** *p. 387-428.*

31/ See Harvey Leibenstein, "The impact of population growth on economic welfare-nontraditional elements", in National Academy of Sciences, ***Rapid Population Growth: Consequences and Policy Implications*** *(Baltimore, Johns Hopkins Press, 1971), pp. 175-198.*

32/ Michael P. Todaro, ***Economic Development In the Third World, op.cit.,*** *p. 238.*

in enrolment rates or increases in expenditure per pupil.[33] In the context of increasing population and increasing educational expenditure, the resources to be allocated to education, the form which education should take, the groups to be educated and the targets to be achieved are some of the difficult issues to be faced in drawing up a programme of social and economic development.

There is increased concern for the form and content of education. Primary and secondary education systems based on patterns adopted by developed countries may be inappropriate for developing countries in the ESCAP region. Since the majority of children will ultimately live in rural areas as adults, primary and secondary education systems may have to be revised to meet the needs of rural development by combining occupational, community improvement and family improvement education with general or basic education. Such a strategy would also place greater emphasis on non-formal education.[34]

Since economic and social development implies the full realization of individual potentialities, education must be considered both a vital form of social consumption and an essential investment in human capital formation. However, planners are giving increased priority to education in recognition that the development of a well-trained labour force is a prerequisite for achieving high levels of production. This "human resources approach" to planning seeks to integrate education, employment, training and health into development planning. It involves projecting manpower requirements by occupation, and then determining the educational techniques to be employed and the resources required. This type of planning must be long term in character because of the length of time involved in the educational process and the need to plan in advance for the training of teachers and the building of schools so that they are ready when required.

Educational planning also requires detailed projection of population by age, sex and rural/urban residence. Information on place of residence is doubly important since the dispersed character of the population poses difficult problems in providing new facilities and trained staff. If school enrolment is nearly universal among certain age groups, then the problem of calculating requirements is basically one of making a demographic projection of the given age group. However, in most countries of the ESCAP region, only a portion of the potential students are enrolled. Hence programmes for expansion of education in these countries will involve increasing enrolment rates, and, therefore, will depend on economic and social as well as demographic considerations.

Education planning models allow planners to convert general educational goals into specific targets which take into account the many links and interrelationships in the educational system. There are two basic models that could be employed, the grade-cohort approach and the enrolment-rate approach.

The "Karachi Plan" adopted by countries within the ESCAP region established educational goals for the year 1980. In conjunction with that plan, a long-term grade-cohort type educational planning model was developed which would illustrate quantitatively the interralationships between the educational variables and other factors in development.[35] The grade-cohort approach model simulates the operation of an educational system. It permits the planner to experiment with changes in a number of key variables singly or in combination to determine the long-run effects of these changes on enrolments, graduations, drop-outs and other key indicators of educational attainment. The model allows the planner to focus on specific changes he might want to make and isolate the effects of these changes on teacher training requirements, building requirements and other educational costs.

Whereas the grade-cohort approach simulates the progression of pupils through the educational system, the enrolment-rate approach examines the system at selected intervals. It is primarily concerned with the proportions of children in different age groups enrolled in

---

33/ Gavin Jones, "Population growth and health and family planning", in ***Population and Development Planning, op.cit.****, p. 69. See also Gavin Jones, "The influence of demographic variables on development via their impact on education", in Ansley J. Coale (ed.),* ***Economic Factors in Population Growth*** *(New York, John Wiley, 1976).*

34/ See P.H. Coombs and Muzoor Ahmed, ***Attacking Rural Poverty: How Nonformal Education Can Help*** *(Baltimore, Johns Hopkins University Press, 1974).*

35/ United Nations Educational Scientific and Cultural Organization, ***An Asian Model*** *(Paris, International Institute for Educational Planning, 1966). This model has not been used by Asian planners because of the heavy demands it makes for data and computation. However this model has been incorporated by Andrew Elek, "A simulation model for long-term policy formation in Papua New Guinea" (Ph.D. thesis, Australian National University, Canberra, March 1976).*

school at different times or different educational levels. Though it does not involve a number of variables which should be important to the educational planners, the enrolment-rate approach can identify for the planners broad long-range problems of educational development, which stem from population growth.[36]

These models can be used by planners to consider the educational impact of several alternative population projections. Even if the differences in total enrolments are small, the relative difference of new entrants into the educational system and thus the difference in annual requirements for new teachers and facilities may be very large.[37] The demand for new teachers and facilities is primarily a function of the growth in student populations rather than its absolute size. A comparison of alternative demographic projections would enable the planner to identify the possible savings, or increased enrolment ratios and year of education per pupil, associated with reduced fertility.

From the viewpoint of individual households, resources saved from the reduced expenditure on bearing and rearing additional children would be available for sending more children to school or continuing their education for a longer period. Per pupil educational costs are almost 12 times higher for secondary education than for primary education.[38] It is in this area that the greatest scope for increased enrolment lies. Thus it is in this area that the greatest savings could be realized through reduced fertility. These savings could be used to improve facilities and increase enrolment ratios.[39]

Planning decisions in the field of education will in turn influence demographic factors such as fertility and migration. Family planning may be included in the curriculum. Provision of additional years of education may result in increasing the age at marriage. The provision of increased education may provide employment opportunities for women which would induce them to postpone marriage or childbearing. Increased education would also tend to enhance women's awareness of attractive alternatives to early marriage. By increasing equality of educational opportunity, disparities in income may be reduced. This in turn may result in reduced fertility. Finally, increased education may raise the economic cost and reduce the economic benefits of children to their parents, thus tending to reduce the economic incentive of families to have additional children. Furthermore, rural-urban differentials in educational opportunities are likely to be significant in influencing patterns of migration.

G. Health planning

Planning which aims at raising the level of health of the population may be viewed as a means of increasing the productivity of the labour force or as a major element in a programme to increase the quality of life. The interrelationships between population growth, movement and health are complex and not well understood.[40] The general state of health of a population can exert a wide range of influences on fertility and mortality as well as migration. These factors will in turn have a great effect on the general state of health. Population growth may complicate the task of health planners in a variety of ways. By reducing *per capita* food consumption, population growth tends to impede improvements in health that can be expected from improvements in nutrition, sanitation and preventative health measures. Population growth contributes to environmental deterioration and crowding which adversely affects health. Furthermore high fertility can be a cause of increased maternal mortality.

The first phase in health planning consists of an assessment of health needs and an assignment of priorities in meeting those needs.[41] These are then converted into targets. Specific health measures are formulated to meet those targets and an allocation of available resources is

---

36/ For a comparison of the grade cohort and enrolment rate approaches to educational planning see Gavin Jones, "Educational planning and population growth" in Warren Robinson (ed.), ***Population and Development Planning, op.cit.****, pp. 88-91.*

37/ Given the rate at which teachers are trained, however, a decline in fertility will result in a more rapid increase in the proportion of trained teachers in the school system.

38/ See G. Psacharopoulos, ***The Return to Education: An International Comparison*** *(London, Elsevier, 1972).*

39/ In Singapore the main contribution of fertility decline to educational development was in rapidly increasing the educational attainment of young people and improving the quality of the educational systems rather than slowing the rise in educational expenditures. See Gavin Jones, "The influence of demographic variables on development via their impact on education", ***loc.cit.***

40/ For a detailed discussion of these linkages see H Hansluwka, "Health, population and socio-economic development", in ***Population Growth and Economic Development in the Third World*** *(Liege, IUSSP, 1976), ch VI.*

41/ See Gavin Jones, "Population growth and health and family planning", in ***Population and Development Planning, op.cit.****, pp. 107-133. For a critique of this approach to planning, see Robert Cassen, "Review of population and development planning," in* ***People****, vol. 3, No. 2, 1976, p. 47.*

made. In projecting health needs and costs, planners may set targets for improvements in the current ratios of health resources to population and then apply this to projected total population. The second stage of the analysis would examine the effect of the changing age-sex structure and its geographical distribution on health requirements. Demographic data and projections particularly with regard to morbidity and mortality, are indispensable in assessing health requirements, plan formulation and the evaluation of plan implementation. The demand for health services will also depend on the size and age-sex composition of the population, rates of fertility and the rural-urban location of the population. Changes in the numbers of infants, children, women of the child-bearing ages, persons of working age and the aged will have significant influences on requirements for health facilities.

Urbanization of the population provides both challenges and opportunities in the field of health planning. Greater attention must be given to public health and sanitation measures. However, the concentration of persons in a given area permits specialization and allows economies of scale in the provision of health services. In planning for rural areas, great attention must be given to means for facilitating the delivery of heatlh services. It has been demonstrated that increased reliance on para-professionals, e.g., "the barefoot doctors" can expand the ability of the health service infrastructure to meet the needs of a growing population.[42/]

Population growth tends to limit the ability of planners to increase the quantity and upgrade the quality of health services, *per capita*. Population growth implies ever increasing requirements for health services. Meeting these requirements diverts resources which might otherwise be devoted to upgrading health care for the currently existing population. Thus by reducing requirements for health resources, programmes of fertility reduction can effect savings which can be used to upgrade existing health services. Using a simple health planning model, requirements can be calculated for a number of alternative population projections. The savings to be achieved through lower rates of fertility can then be compared with the costs of lowering fertility. Thus planners can utilize programmes to reduce fertility not merely as one aspect of a general health service delivery programme, but also as a strategy for economizing on resources in the health sector.

Health planning decisions will have a significant impact on demographic variables. The initial effect of improved health care may be reduced mortality, particularly infant and maternal mortality. Increases in the probability that children will survive should contribute to a long-term decline in fertility thus completing a transition from patterns of low fertility and mortality.[43/] Furthermore, the spatial distribution of health services like the spatial distribution of educational opportunities will influence the relative desirability of urban-rural residence and thus influence the pattern of internal migration.

H. Planning for housing

Planning changes in the structure of production will require planning for the housing of workers and their families. The demand for housing will depend on the size, location and composition of the population. The household is the basic unit demanding housing. The number of marriages and divorces, the age structure of the population and the average size of households are of particular concern to planners. The rural-urban composition of the population will be a major factor in determining the type of household construction and the complementary social infrastructure required, such as transportation, water, power and sewage system.[44/]

By using a number of alternative population projections, a variety of alternative housing plans can be considered and the costs calculated. The savings in building costs can be compared with the costs of achieving alternative levels of fertility. However, the effect of fertility reduction on household formation involves a lag of approximately 20 years. Thus heavy demands for housing in future decades can only be averted by early action to limit fertility.

A major proportion of the demand for new housing is associated with an increasing degree of urbanization of the population. The increase in demand will be more than proportional to the rate of rural-urban migration

---

*42/ See Pi-Chao Chen and Ann E. Miller, "Lessons from the Chinese experience: China's planned birth program and its transferability", **Studies in Family Planning**, vol. 6, No. 10, 1975, pp. 354-366.*

*43/ See T. Paul Schultz, "Interrelationship between mortality and fertility", in **Population and Development, op.cit.**, p. 283.*

*44/ See David Goldberg, "Residential development and fertility", in **Population and Development, op.cit.**, pp. 387-428.*

since migration and urbanization are associated with reduced size of households. This migration is likely to be an outgrowth of population pressure in rural areas.

The housing decisions of planners will have a significant impact on demographic variables. In general, urban residence is more associated with lower levels of fertility than is rural residence.[45] In part this may be due to crowding and lack of economic opportunities for young people. In part it may reflect the fact that children in urban areas receive more education and health care than children in rural areas. These factors lessen the economic incentives to have large families. Thus programmes which slow rates of urbanization may also moderate rates of fertility decline. Migration as well as urbanization may have significant feedback effects on the rate of population change. Since migration rates differ by age, the result will be an alteration in the proportion of the population in the fertile ages in rural and urban areas. By weakening family ties, migration may reduce the value of children as a source of support in old age.

Planners must also take into account the impact of housing programmes on demographic variables.[46] The availability of housing opportunities may be a significant factor in determining patterns of nuptiality and family formation. Similarly access to subsidized government housing may serve as an important component in a scheme of incentives and disincentives designed to influence fertility patterns. Even more marked is the influence of planners' decisions with regard to housing on the pattern of internal migration especially rural to urban movements. The liklihood that government will provide acceptable housing and associated services in urban areas serves to attract migrants and thus increase housing requirements in urban areas. This trend is aggravated by the fact that migration to urban areas often involves the breaking up of extended families into small family groups which adds to the pressure for new housing.

I. Family planning

There is widespread recognition that planners must formulate their demographic objectives within the context of the over-all development plan. A number of countries in the region have included in their development plans specific objectives for moderating rates of population growth through reductions in birth rates.[47]

Decisions on how population should be changed, when it should be changed, and what techniques should be used to accomplish the change should be integrated into the general economic plan. In doing so, it must be recognized that family planning programmes have two separate social functions. First of all they meet the demand for family planning services of the existing population and secondly, by reducing the growth rate of population, they may increase the future level of *per capita* income. Planners must formulate programmes which appropriately serve both functions.

In order to prepare such plans an appropriate set of target-setting procedures will be required. Demographic factors such as the size of the population, the proportion of the population who are women in the child-bearing ages, nuptiality and the age at marriage will be primary determinants of the requirements for family planning services. Planners must also consider the role of other demographic variables such as infant mortality and urban-rural residence in determining requirements for family planning services. Fertility data will be essential to planners for monitoring the implementation of plans in this sector.

Setting goals or targets for population growth rates, birth rates and number of acceptors can serve as important devices for motivation and control. However, such targets are interdependent and, therefore, must be consistent with one another if they are to be integrated into the economic plan. Indentifying the timed effects of family planning activities allows the planner to make a judgement of the consistency of planning goals: for example the number of acceptors needed in any given time period in order to achieve a future birth reduction of a specific size.[48]

The demand for family planning services can be greatly influenced by other aspects of the planning process. High rates of unemployment or lack of suitable housing

---

45/ *A discussion of these influences is found in Benjamin N. Mok, "Population change and housing needs", in* ***Population and Development Planning, op.cit.,*** *pp. 95-100.*

46/ *See* ***Integration of Housing into National Development Plans: A Systems Approach*** *(ST/SOA/Series A. 54).*

47/ *B. Maxwell Stamper,* ***op.cit.,*** *p. 16-22.*

48/ *Theodore Ruprecht, "The introduction of a time dimension model to improve family planning administration", paper presented at South East Asia Development Advisory Group meeting, San Francisco, November 1972.*

may result in postponement of marriage or childbirth. Educational programmes may have the same effect. Agricultural programmes may alter the economic incentive to bear children.49/

In order to undertake cost-benefit analyses to determine the optimum allocation of resources to family planning relative to other investments, planners must have reliable estimates of the relationship between expenditures on family planning programmes and changes in the number and spacing of births. ESCAP has undertaken studies which can provide the planner with a means of relating fertility decline with the acceptance of family planning.50/ It remains for planners in each country to determine the relationship between expenditures on family planning activities and family planning acceptance.

J. Planning subnational regions

Planning for the development of subnational regions differs from over-all national planning in that it is often concerned with reducing disparities in income between regions and emphasizes the spatial organization of production and consumption activities. By serving as a link between national and local developmental activities, regional planning seeks to promote the welfare of the region and the entire nation. Specific objectives would include achieving satisfactory living standards, accelerated development of less advanced subnational regions and the diversification of regional economies.

The spatial distribution of the population and patterns of migration, particularly rural-urban migration, must be central factors in planning rural development. Planners should have available to them,therefore, information on population and labour force trends and projections of future migration.

Technological factors often demand that modern industrial production takes place in large integrated units requiring many workers at a single location. Hence rural to urban migration is a necessary part of the industrialization process. However, rates of rural-urban migration have tended to exceed the levels necessary for industrial growth. As a result, planners have been faced with problems of congestion, lack of public services and inadequate space for housing. Two approaches to dealing with this problem are the decentralization of urban complexes and the provision of infrastructure and public services in rural areas.

Recently planners have given increased attention to solving the problems of excessive growth of major metropolitan areas by planning new cities and growth poles. Thus far these efforts have met with limited success.51/

Migration can be a major element of the planned strategy for regional development. Patterns of migration may serve to balance the level of *per capita* income between regions. Out-migration may also provide a solution for regional unemployment. Such a solution is most appropriate in cases where low living standards in the region are caused by an excessive population-to-resources ratio. However, if the problem is due to the failure to adapt to new technology, then the importation of capital rather than the emigration of persons would seem to be the more appropriate strategy.

Planners may wish to reduce the rate of migration since it is sometimes the cause of increasing *per capita* income disparities between regions. This is primarily due to the fact that migration tends to be age and sex selective and thus results in an alteration in the age structure and household composition of regional populations.

In addition to rural-urban migration, planners must consider migration between rural areas. In Thailand and other parts of Southeast Asia, there has been a substantial movement between rural areas, particularly in search of new land. In other cases, the migration has been from rural areas to smaller urban areas and from smaller urban areas to large urban areas.

Planners must take into account the fact the unemployment may be a consequence as well as a cause of

---

49/ *See Eva Mueller,"The economic value of children in peasant agriculture", in* ***Population and Development, op.cit.,*** *pp. 98-153.*

50/ ***Some Techniques for Measuring the Impact of Contraception*** *(Asian Population Studies Series, No. 18, E/CN.11/1119, Bangkok, 1973); and the* ***Report of the Multinational Study in Methodologies for Setting Family Planning Targets in the ESCAP Region*** *(Asian Population Studies Series No. 31, Bangkok, 1976).*

51/ *See Peter A. Morrison, "A demographic assessment of new cities and growth centers as population redistribution strategies",* ***Public Policy,*** *vol. 21., No. 3 (Summer, 1973), pp. 367-382.*

rural to urban migration.[52] Persons who were underemployed in rural areas may be totally without employment after they move to the city. Hence planning must also take into account the fact that policies designed to solve the problem of unemployment may be self-defeating since they may result in increased rates of migration. Long-run policies which have greater promise of success would be efforts to keep urban wages in line with the opportunity cost of urban labour and raising agricultural prices relative to industrial prices.

K. Conclusion

This discussion illustrates the fact that planners must take into account the fact that population change will influence socio-economic variables and be influenced by them through an intricate network of relationships. At times these influences are mutually reinforcing, while at other times they are offsetting. These effects work over time with a variety of different lag structures. Under such circumstances it will be difficult for planners to form and utilize a mental model which will accurately reflect this host of complex relationships.[53] Therefore it will become necessary for the planners to make use of a more formal mathematical model. Such models are superior to mental models in that the assumptions are set forth openly and in a more precise form so that they may be examined and criticized. Such models also allow the planner to trace the implications of alternative policies through a complex network of interrelationships with the aid of modern computational devices. The following chapter will examine the potential values of economic-demographic models to planners.

---

*52/ See Michael J. Todaro, "A model of labor migration and urban unemployment in less developed countries," **American Economic Review,** vol. 59. No. 1, March 1969, pp. 138-148; and E.M. Godfrey, "Economic variables and rural-urban migration: some thoughts on the Todaro hypothesis", **Journal of Development Studies,** vol. 10. No. 1, October 1973 , pp. 66-78.*

*53/ Donella Meadows and others, **The Limits to Growth** (London, Pan Books Ltd., 1972).*

III. THE ROLE OF ECONOMIC – DEMOGRAPHIC MODELS IN PLANNING

A. The role of development models in planning

In recent years there has been an increasing use of formal mathematical models in the planning process. [1] Planners have found that such models "can be utilized to check the feasibility of a particular plan and ensure optimately in the use of available information and limited resources." [2] Economic models simplify the work of planners by isolating the crucial variables and measuring their influence on the rest of the economy.

Models can be used in three different stages of the planning process. First, a model can assist the planner in producing the macro-economic framework in the first stage of plan formulation. Secondly, a model can be used to illuminate a few critical issues encompassed within the macro-economic framework. Thirdly, a model can be used to explore the implications of various policies on sectoral balance and the balance of payments. [3]

Yet it has been noted that though there is a sophisticated literature on the technical aspects of economic model building aimed at providing a rigorous framework for planning, the work of most development planners is at the project level and is often very far removed from models. [4]

Economic-demographic models can serve a useful purpose in the planning process in four important ways. At the basic level they could be used to persuade planners to recognize the importance of demographic factors in the planning process. At a somewhat more advanced level they could be used to convince planners that population policy should be an important component of a strategy for accelerating development. At an advanced level these models can provide planners with a better understanding of the integrated development process. Finally, at a still higher level these models serve to improve the planning process *per se*.

B. Illustrating the importance of demographic factors

The first generation of large-scale economic-demographic models were designed to highlight the importance of such demographic variables as fertility, infant mortality and migration to the development planner. [5] Their purpose was to serve as devices by which planners could conduct simulation experiments involving alternative values of the demographic variables and, thereby, learn for themselves the significance of such demographic variables in long-run planning.

In particular these models were used to illustrate the effect of rapid population growth on domestic food requirements, food and capital imports, and thus industrial production. These models were used to illustrate the effects of population growth on the demand for education and the resources available to meet that demand. They were also used to illustrate the relationship between rapid population growth and unemployment. By tracing the relationship between population change and the rising demand for food, education and employment opportunities these models sought to emphasize to planners the importance of population factors in the planning process. [6]

C. Illustrating the need for population policy as an integral part of development strategy

A second function of economic-demographic models is to convince planners of the importance of population policy, and particularly fertility reduction, as a strategy for increasing the rate of social and economic development. They draw the planners' attention to the fact that

---

*1/ Nurul Islam, "The relevance of development models to economic planning in developing countries", **Economic Bulletin for Asia and the Far East**, vol. XXI, No. 1/2, June/September 1970, pp. 56-61, 64-65.*

*2/ Michael Todaro, **Development Planning Models and Methods** (Nairobi, Oxford University Press, 1971), p. 9.*

*3/ Nurul Islam, **loc.cit.** See also Joran Ohlin, "Economic theory confronts population growth", in **Economic Factors in Population Growth, op.cit.**, p. 9.*

*4/ **Population and Development Planning, A Report of the IGCC Regional Workshop held in Penang, Malaysia, September 27-29, 1973** (Kuala Lumpur, Intergovernmental Co-ordinating Committee, Southeast Asian Regional Co-operation on Family and Population Planning, 1973), p. 6.*

5/ This group would include TEMPO I, and the Population Dynamics Group model.

6/ These models may also be useful to planners as a means of understanding the techniques of economic-demographic analysis as well as being a tool for analysing government plans and programmes.

changing demographic conditions will affect the age composition of the population and thus the proportion of the population in the labour force. They also emphasize the fact that the proportion of the national income which is saved is influenced by the number of consumers and their age structure. This in turn affects the volume of capital accumulation. Thus, the changing population growth rate and age composition affect the growth of total output through their effects on the growth of labour and capital. Models of this type could assist planners in making a cost-benefit analysis of various measures designed to alter demographic trends and in determining the appropriate target groups for these activities.

These models can assist the planners by demonstrating that the economic and social goals which they have established will be harder to achieve under certain demographic conditions. Conversely they can also assist the planners by indicating the degree to which these goals can be achieved more rapidly by investing in programmes to alter demographic trends.

D. Providing a better understanding of the development process

The third purpose to be served by economic-demographic models is providing planners with a better understanding of the development process. In particular these models serve to clarify the interactions between economic and demographic variables in the development process. Planning in less developed countries may be hampered by an inadequate understanding of this process and the inability to identify the appropriate development strategy to be followed in the future. These models should help the planner to sharpen his intuition concerning the consequences of economically feasible policy options and enable him to make better decisions.

It has been argued that these models may provide planners with an incomplete and fundamentally incorrect understanding of the development process.[7] Because these models are quantitative in nature and consist of sets of equations, it is contended that they are drawn largely from the neo-classical tradition of economics and fail to reflect, therefore, the qualitative insights that may be drawn from other traditions such as the classical and Marxian.[8] These models must explain development in terms of variables which can be quantified, such as the labour force and the stock of capital, while omitting any reference to the motivations of entrepreneurs or changes in values and attitudes which may be the driving forces in the process of development.

Furthermore, the emphasis which these models place on quantification may emphasize policy questions of "how much?" at the expense of questions of "what kind?" In the field of education, concern may be focused on enrolment rates rather than the type and quality of education and who shall receive it. Furthermore, the emphasis on quantitative factors tends to divert attention from the intervening social changes without which policy changes may be ineffective.

The planner must not rely solely on a quantified economic - demographic model, therefore, but must recognize that there are important development factors which they do not include. But if they are applied with "an understanding of the extent and importance of the relationships they include and omit, quantitative models make planning less, not more dangerous.[9]

E. Improving the planning process

The fourth function served by socio-economic-demographic models is the improvement of the planning process *per se*. In brief these models can contribute to the planning process by: (a) giving planning a long-run orientation; (b) enabling planners to conduct policy experiments; (c) providing planners with projections of population and production; (d) aiding in the analysis of specific problems; (e) improving the data base and (f) assisting in co-ordinating decentralized planning activities.

1. Giving planning a long-run orientation

Among the most significant contributions which these

7/ *W. Brian Arthur and Geoffrey McNicoll, "Large-scale simulation models in population and development: What use to planners?",* ***Population and Development Review,*** *vol. 1, No. 2, December 1975, pp. 254-255.*

8/ *Dudley Seers argues that the neo-classical tradition deals with a special case and is inapplicable to most developing countries. "The limitations of the special case",* ***Bulletin of the Oxford Institute of Economics, and Statistics,*** *vol. 25, No. 2, May 1963, pp. 77-98. It has been argued, however, that traditional theory can be extended to deal with the problems of development see Hla Myint, "Economic theory and development policy",* ***Economica,*** *vol. 34, No. 134, May 1967, pp. 119-127.*

9/ *Gerry B. Rogers, Rene Wery and Michael J.D. Hopkins, "The myth of the cavern revisited: are large scale behavioral models useful?",* ***Population and Development Review,*** *vol. 2, Nos. 3 and 4, September and December 1976, p. 402.*

models could make to the planning process would be to give it a long-run orientation. No government can decide today what it will do 20 years hence. However, short- and medium-term decisions should be based on consideration of their long-run effects. Though the projections derived from a model, such as BACHUE, are intended to deal with a period of 10 to 50 years in the future, they may have immediate policy implications since policies implemented now will have their main impact only after the effects have had time to cumulate. This is particularly true in the case of population policy.

These models were constructed to give policy makers a tool to compare the long-term effects of alternative socio-economic policies. Though long range in nature, these models have been developed to assist planners in evaluating alternative courses of action which can be implemented immediately but the consequences of which would not be made manifest for many years to come.

The various ministries of government are usually concerned with finding solutions for their own short-run problems. It is this preoccupation with short-run factors that makes the introduction of longer-run thinking through application of economic-demographic models even more necessary. Seemingly good short-run solutions may turn out to be bad long-run solutions. For example, short-run solutions to the problems of housing can aggravate problems of rural-urban imbalance and unemployment in the long run. A macro-model can identify these inconsistencies between the short-run and long-run impacts of alternative government policies.10/

Socio-economic-demographic models can also be used to evaluate policies that involve intergenerational trade-offs of welfare. An example of this would be the choice between a social infrastructure project which would benefit this generation as opposed to a reafforestation project which would benefit future generations.

2. Conducting policy experiments

By simulating significant aspects of reality, large-scale economic-demographic models can allow the planner to use the computer to carry out experiments which would otherwise have to be performed in real life. Thus a model of this type makes it possible to assess the consequences of a decision taken at any given moment and to estimate the extent to which short- and long-term objectives can be reached.

The planner can make experiments for a range of such policy choices, comparing the outcomes and identifying those which are most desirable. Because these models are large scale, covering many planning sectors, they can be used to investigate development strategies which involve a package of several policies. "Because they span a variety of elements in the social system, systems models can investigate the simultaneous impact of complementary policies, identifying not only the effects of each individually but also their inter-action effects." 11/ Examples of strategies that might be compared with such models are industrialization, rural development or population planning.

With the help of socio-economic-demographic models, it is possible for planning officials to weigh the impact over time of different government budgets and policies on such variables as *per capita* income, the distribution of income, capital per worker and the supply of educational services. For example, a model could be applied to the problem of raising the standard of living of marginally employed urban slum dwellers. Among the various policies that might be used to incorporate the marginal population into the modern sector are: (a) an absorption of more manpower by the modern sector through increased public and private investment and the increase of educational opportunities; (b) reducing the rate of growth of the marginal population; (c) changing the capital-labour ratio through changing relative factor prices; (d) direct transfers to the marginal population; (e) increasing educational expenditures; (f) family planning programmes directed at the marginal groups. By making a series of simulation runs, it is possible to experiment with various combinations of these policies and analyse their long-term implications for this particularly disadvantaged segment of the population.

3. Providing projections of population and production

Economic-demographic models have the capability of making an important contribution to the planning process by generating projections of population and national product. A number of these models also generate projections of such variables as school enrolment and income distribution. Some models project such employment-related variables as the composition of the work force, the location of the work force and its migration patterns.

10/ *These models can be used to insure intersectoral consistency as well so that economic and demographic targets are compatible.*

11/ *Gerry B. Rogers, Rene Wery and Michael J.D. Hopkins,* ***loc.cit.,*** *p. 400.*

The economic projections made by these models are not forecasts of what will happen to the economy in the future but rather a means by which the relative performance of a variety of demographic projections can be compared and their results checked for sensitivity to the model parameters. The actual outcome of events may be quite different from that projected owing to forces that have not been included in the model. That does not matter for purposes of policy comparison, provided that these forces do not affect one demographic projection differently than they do another.

These models do not forecast the future but rather project the consequences of having achieved the levels prescribed or envisaged for the crucial variables by the plan. Looked at from the opposite perspective, the long-term models can indicate the prescribed levels given the long-term policy goals. They are particularly useful if planners are not so much interested in levels of economic variables as in differences in levels corresponding to alternative policies.

It has been argued that the relationships in these models may have been misspecified on their parameters may have been improperly estimated. They may yield an incorrect evaluation, therefore, of the effects of alternative policies. This is particularly true of economic-demographic models because of their long-run character and their heavy data requirements. Finally, because of the interrelationships within the models, errors can progressively affect each part of the model at each step of the recursive process.[12] Under such circumstances it is argued that the trade-off values will be no more accurate than the absolute values. Thus, the outcomes of these models must be interpreted on a qualitative rather than a quantitative scale. The quantitative outcomes can be of assistance to the planner in generating qualitative conclusions and ranking alternatives.

4. Analysis of specific problems

Economic-demographic models can be constructed in such a way that they can be used to analyse specific problems of concern to planners. For example, if there is great concern for the status of women, these models can be used to determine the effect of fertility levels, job opportunities, education and social practices on the labour force participation of women. If governments wish to minimize urban unemployment through increasing the demand or reducing the supply, this problem is amenable to analysis using a long-range two-sector economic-demographic model.

Planners may use these models to relate current investment in the educational system with long-term costs and benefits of the educational programmes (e.g., increasing educated unemployment and an increase in the stock of human capital). Planners may also wish to use them to gauge the secondary impact of the development of a specific region in a less developed country such as the increase of migration into that area and the resulting increase in unskilled unemployment and the increased burden on local social services.

The types of studies that planners can undertake using socio-economic-demographic models may be classed as specific, intermediate and general. Specific studies allow a detailed analysis of the effects of varying an element of a submodel, for example, the effect of changes in public expenditures on fertility rates. Intermediate studies provide information about the effects produced by changing a group of variables within a submodel such as the impact on fertility of alternative distributions of school enrolments among the three educational levels. General studies analyse the effect of simultaneously changing variables from more than one submodel. This would be the case in the simulation of general development policies for a country.

Examples of other questions that could be addressed through these models are: What is the effect of changes in the age structure of the population on required public expenditures in health education? What would be the effects on mortality and morbidity of a change in the cost of medical care? The models can also be used to study the effects that different control variables may have on a single change indicator such as a change in total government expenditures or a change in the composition of government expenditures on the creation of new employment in modern industry.

It is argued that these models may be inappropriate for analysing specific long-term planning problems because they tend to advance marginalist rather than structuralist solutions. This is done in two ways. First, policy is assumed to be a series of inputs to a given, unquestioned structure. Secondly, it is assumed that all adjustments are of an equilibrating nature. However, long-term planning cannot assume a given socio-economic structure.[13] Long-term planning is likely to be

12/ *W. Brian Arthur and Geoffrey McNicoll,* ***loc.cit.,*** *p. 260.*

13/ *Jan Tinbergen argues that "a really well thought out plan must also clearly envisage the form of the new social order aimed at". Jan Tinbergen,* ***Development Planning*** *(New York, McGraws Hill, 1967), p. 64.*

concerned with changes in land-ownership patterns, the organization of industry and such issues which involve structural change. Furthermore, economic mechanisms in less developed countries may not be equilibrating owing to economies of scale, lack of information and similar factors.

While it is true that economic-demographic models assume the structure to be given, they need not lead to a propensity on the part of planners to make marginal changes when the system requires fundamental modification. A model can demonstrate to the planner whether or not he can achieve his goals within the existing structure. If the model indicates that he cannot, it provides additional support for structural change. Furthermore, if some structural changes can be represented in these models, they can be used to obtain an indication of desirable directions for change. 14/

It has been argued that specific issues are better analysed by means of small models, with accounting systems tailor-made to the issue itself. However, such partial models can be more meaningful if they are developed against a background of a more general analysis based on a complete economic-demographic model. Partial analysis, if not set in a wider context, can provide answers which are incorrect because they do not take into account feedback effects from the rest of the system.

5. Improving planning data

The process of formulating and constructing an economic-demographic model and serve to identify gaps the data-collection system, as well as inconsistencies in data that are currently being collected. Once the model has been constructed, a sensitivity analysis can be conducted to indicate the relative importance of different data series. These models can be used to check census data by simulating demographic events. They can also be used for testing the reasonableness of fertility-mortality relationships.

6. Co-ordinating decentralized planning

In countries where there is significant decentralization of planning functions, economic-demographic planning models can be useful in helping central planners to obtain the co-operation of the thousands of people who play important roles in decentralized planning. By quantifying the implications of various options, these models allow planners to map alternatives, and to debate options and their implications among themselves and with the implementing agencies. Models can thus serve as instruments for co-ordinating the actions of many dispersed implementing agencies. Since planners achieve co-ordination through the imposition of constraints, these models can also assist the planner by reducing the number of iterations needed to bring total allocations within those constraints. The use of economic-demographic models may also serve to centralize the planning process unduly. The result may be that a wide range of policy options involving decentralized decision making will not be considered.

F. Summary

Most development plans are based on a macro-model of some kind. It would be beneficial to planners to use economic-demographic models for this purpose. These models keep before the planner the needs to take into account the role played by population factors in the development process and the possibility of utilizing the plan as a means of influencing rates of population growth and migration. However, there is a dispute as to whether these models accurately portray the essential components of the development process and facilitate appropriate policy interventions.

14/ *Gerry Rogers and others,* ***op.cit.,*** *pp. 404-405.*

IV. THE MAJOR SOCIO-ECONOMIC-DEMOGRAPHIC MODELS

In order to understand the strengths and weaknesses of economic-demographic models better, a representative selection of such models will be described in this chapter. These models were developed under the auspices of the Government of the United States of America or by agencies of the United Nations system. Among the former are the TEMPO and LRPM series of models, the Population Dynamics Group model and the Purdue Development model. Among the latter are BACHUE and the FAO/UNFPA model.

A. The TEMPO models

The TEMPO series of models is composed of TEMPO-I, a simple model designed to illustrate the benefits of reduced fertility, TEMPO-II, an elaboration of TEMPO-I designed to make projections which would be more meaningful to planners, and a number of country-specific adaptations of the basic TEMPO models. The first of these models, TEMPO-I was formulated by Stephen Enke and Richard Zind in 1967.[1] Over the next two years it was further developed by William McFarland and others, and has remained essentially unchanged since 1969.[2] A much debated and criticized model, TEMPO-I has been applied to approximately 30 countries on five continents.[3]

TEMPO-I consists of two submodels, one economic, the other demographic. Demographic variables act on economic variables but not *vice versa*. The demographic part of the model generates a projection of the population by age and sex at five-year intervals. For purposes of integrating this with the economic submodel, yearly projections of the population are then generated by interpolation.

The output of the demographic submodel is used to generate estimates of the labour force, a certain portion of which is assumed to be employed. A Cobb-Douglas production function then determines the size of the gross national product associated with the existing amount of capital and employed labour. This output is then divided into consumption and investment. Consumption varies directly, and therefore investment varies inversely, with population. The sum of the stock of capital available at the beginning of the year and net investment during the year equals the stock of capital at the beginning of the next year. The growth of the capital stock and the labour force then determines employment. The capital stock, employment and the rate of technical progress determine the level of output in the following year. This process is repeated each year for the duration of the projection.

The core of TEMPO-I is a set of relationships describing the generation of the supply of various factors of production and their employment in a Cobb-Douglas production function to produce outputs. The model emphasizes the change in the capital-labour ratio as the labour-to-population ratio changes during the period of demographic transition. The change in the labour-to-population ratio is in response to the change in the age structure of the population.

TEMPO-I includes a term in the production function which takes into account the increase in the efficiency of resource use and hence output per labourer.[4] The ways that the rate of technical progress might be altered by demographic changes are unclear so this factor could have been excluded.[5] However, technical change is often embodied in new capital equipment and so demographic events that favour the accumulation of capital would also result in a more rapid rate of technical progress.

The economic submodel of TEMPO-I is a simple neoclassical growth model. The results of such a model with respect to changes in demographic variables have been derived analytically.[6] When the capital-to-labour ratio multiplied by the rate of population growth equals savings per worker, the capital-to-labour ratio becomes a constant and the economy enters a state of equilibrium

---

1/ *Stephen Enke and R.G. Zind, "Effect of fewer births on average income", **Journal of Biosocial Sciences**, vol. I, No. 1, 1970, pp. 41-55.*

2/ *William McFarland and James Bennet, **Description of the Economic-Demographic Model** (Washington D.C., General Electric Corporation TEMPO, (68 TMP-120), June 1971).*

3/ *Henry Cole and Richard Brown, "The TEMPO models as a basis for development planning," paper presented at SEADAG meeting, New York, March 1975.*

4/ ***Ibid.**, p. A7.*

5/ ***Ibid.**, p. 14*

6/ *Michael Keeley, "Population growth and economic growth: a neoclassical analysis of the TEMPO economic-demographic simulation models" (Washington D.C., General Electric Corporation TEMPO, 1974) (mimeographed).*

where *per capita* income remains constant. Reductions in the rate of growth of the labour force shift this equilibrium state to one at a higher level of *per capita* income. With the addition of technological change and depreciation, the equilibrium involves a constant rate of growth of income per worker and it is this rate which is altered by change in demographic variables.

A major shortcoming of this analytical approach (as opposed to TEMPO computer simulations) is that it fails to deal in detail with the changes in age structure being experienced by less developed countries, particularly those in the ESCAP region. Appropriate models must be capable of dealing with disequilibrium dynamics rather than only with steady state or equilibrium paths. Furthermore, the planner's objectives are likely to include target age-specific populations other than the labour force.

The Human Resources and Budget Allocation Model, TEMPO-II, was designed by Stephen Enke, James Bennet, and Richard Brown in 1971.7/ Their aim was to correct the shortcomings observed in TEMPO-I while retaining as much simplicity as possible consistent with the objective of bringing the model closer to the realities of the development process. Three additions to TEMPO-I were made: (a) a public sector component; (b) feedbacks from government programmes to economic, social and demographic changes; and (c) disaggregation of the model into rural and urban sectors with migration between them.

TEMPO-II is composed of three interacting segments: the demographic, economic and government submodels. In the demographic submodel, population growth (in both the modern and subsistence sectors) is determined by the initial population's, age and sex-specific fertility, mortality and intersectoral migration. Fertility rates depend upon the family planning policies of government but remain independent of the outcomes generated by the economic submodel. Migration between sectors depends on the ratio of *per capita* wage income of the uneducated modern population to the *per capita* income of the subsistence population. Demographic projections are made on an annual basis in order to facilitate complete interaction between the economic and demographic parts of the model.

Like the demographic submodel, the economic submodel of TEMPO-II is divided into a modern and a subsistence sector. The stock of capital and resources is assumed to be fixed in the subsistence sector; therefore its gross product varies less than proportionately with the size of its population. It follows that increasing population results in falling *per capita* output in the subsistence sector. The gross product of the modern sector is determined by a Cobb-Douglas production function as in TEMPO-I except that the labour input is subdivided into educated and uneducated components which in turn are determined by the size and age-sex composition of the educated and uneducated populations. These two variables can then be altered by family planning and education policies. At the option of the user, the uneducated labour force can be adjusted for improved quality because of declining morbidity, which is inversely related to *per capita* income.

The size of the employed labour force varies directly with the size of the uneducated labour force and the capital-labour ratio. It is assumed that a constant fraction of the educated labour force is employed. In TEMPO-II, the change in the capital stock is equal to the sum of private and government investment less depreciation. Private investment is equal to private saving less government borrowing. Savings depends on disposable income and population. Government investment is a function of government policy and gross product.

It should be noted that because of its assumptions the model cannot be used to study employment problems of the educated unemployed nor the relative impact of government borrowing on private savings and private consumption.

The government submodel consists of eight types of expenditures and three sources of revenue. Outlays for education and family planning are policy variables. The other six types of expenditure are specified as constant or a changing fraction of gross product. These expenditures may be financed by tax revenues (which are a function of gross product), by borrowing from foreign sources or from domestic savings, and by the creation of new money. Except for foreign loans and grants to the government, TEMPO-II has no foreign transactions, however, it is anticipated that the foreign sector will ultimately be developed as the model evolves.

Outlays on education and family planning are specified in terms of policy goals rather than policy budgets. The education goals are projected enrolment rates and the family planning goals are acceptance

---

7/ *William C. McFarland, James Bennet and Richard Brown,* ***Description of TEMPO-II Budget Allocation and Human Resources Model*** *(Washington D.C., General Electric Corporation TEMPO, (GE TMP 3), April 1973).*

rates.[8] The education and family planning budgets are determined by the cost of achieving the specified goals, given the sizes of the appropriate subpopulation to which the rates apply.

Sensitivity analysis has been used extensively with both TEMPO models to study the impact of specific parameters on the results of the model. By bringing the planner into this part of the analysis, the importance and scope of demographic change becomes clearer to him.

Since TEMPO-II was intended to serve as the basis for country-specific adaptations, the computer programme was redesigned in order to facilitate future modification of the model by researchers, planners and other users. Variables and parameters can now be easily changed, added, or deleted by changes in input data. The form of the summary printout can also be modified by a change in data input. In order to have the output in the national language, all that is required is a data input modification. Also, by changing the data input, the user can have in the summary the specific variables he is analysing in the order that he wants them. In fact, the potential user can add or substitute entire economic, social and demographic sectors in the basic TEMPO-II model, thus simulating structural change.

By modifying the model, a wide variety of other questions can be explored. Among such potential modifications are the following: (a) the modern sector can be expanded into a number of industries; (b) agriculture can be detailed; (c) an export sector can be added; (d) the modern labour force can be divided into several categories. With each addition to the basic model, the number of policy levers available to the planner increases.

TEMPO-I and TEMPO-II represent two extremes in a continuum from very simple to very complex models. TEMPO-I is simple, and can be understood by everyone. It is useful in attracting planners' attention. TEMPO-II is more complex, yet more useful. It addresses problems actually faced by planners.

B. Adaptations of the TEMPO-II model

The ways in which TEMPO-II can be modified to meet the specific requirements of planners can be illustrated by three adaptations of the model in Peru, Colombia and Venezuela. The experience gained in a Latin American context should be transferable, in large measure, to the planning situation of countries in the ESCAP region.

1. Peru

In co-operation with the United States Agency for International Development, the National Institute for Planning in Lima, adapted the TEMPO model to serve as an analytical tool which was relevant to the main concerns of Peruvian planners which were urban employment, income growth, income distribution and rural development.[9]

The first phase of the Peruvian effort was an analysis of economic and demographic trends. To facilitate this analysis, the model was subdivided into three sectors: (a) a rural traditional sector consisting of those persons and activities devoted to producing agricultural output for domestic consumption; (b) an urban services sector which includes both traditional and modern service activities; and (c) a modern sector encompassing urban and rural activities using capital-intensive modern methods of production.

The model applied to Peru varies from TEMPO-II in that it is disaggregated into three sectors and it does not use a Keynesian consumption function, rather, it attributes a decisive role to public policy in setting the levels of public and non-public investment. Finally, it diverges from TEMPO-II in that it provides for a detailed analysis of the urban-rural employment problem.

The modified model retained a number of characteristics of TEMPO-II. It is recursive, and economic magnitudes are expressed in constant prices. It assumes only a supply constraint. Demographic movements are exogenous to the model. The demographic sector acts upon the economic sector but there is no feedback. Since it was felt that structural changes would invalidate past relationships, equation parameters were fixed by assumption rather than being obtained from regression analyses.

Three fertility hypotheses were considered: (a) that fertility would remain constant at present levels; (b) that there would be a linear decline over the next 30 years;

8/ The emphasis on quantitative goals has been criticized by W. Brian Arthur and Geoffrey McNicoll, loc.cit., p. 256.

9/ This model is described in Juan Wicht-Rossel, "Long run projections of the economy and population of Peru", paper presented at a SEADAG Seminar on the Role of Economic Demographic Models in Development Planning, New York, 1975.

and (c) that a sharp decline in the near future would be followed by a levelling at low fertility. The rural population was assumed to be increasing at a constant rate. Rural-urban migration as a percentage of rural population was assumed to increase. It was assumed that the declines in fertility would be the result of urbanization, educational improvement and social development and not of birth control programmes.

In each of the three sectors, production was determined by a Cobb-Douglas production function relating output to the capital stock, employed labour and rate of technical change in that sector. The sectoral labour force components were a function of the population in each sector and the given labour force participation rates. The rates of employment in the traditional agricultural sector and the urban service sector were a function of the rate of growth of *per capita* income. It was assummed that a constant percentage of the labour force in the modern sector was employed.

Since the model was to be used to evaluate the impact of alternative savings ratios, the ratio of savings to gross national product was assumed to be controlled by public policy measures. The allocation of investment among the three sectors was also determined exogenously and was treated as the result of alternative development policies. The capital-output ratio in all three sectors and the capital-labour ratio in the traditional agricultural and urban service sector were determined by the model. The capital-labour ratio in the modern sector however was exogenous. As in TEMPO-II, there was no endogenous foreign sector in the model. Net exports were assumed to be 5 per cent of gross national product.

Using three fertility and two investment hypotheses, six simulation runs covering all possible combinations were made for the period 1970 to 2000. For total and sectoral output levels, the investment coefficient was crucial whereas fertility differentials had a minor effect. Fertility differentials were quite important however as determinants of *per capita* output.10/

The projections indicated that while traditional agriculture will lose ground relative to the other two sectors in terms of the value of output, emphasis should be placed on dealing with the problem of the urban service sectors where *per capita* output will fall with the great inflow of migrants. The solution to that sector's problem depends on fertility levels in the traditional agricultural sector (hence migration) and on investment in the modern sector (hence labour absorptive capacity). High over-all fertility rates imply continued high rural to urban migration which would result in diminishing labour productivity and average income in the urban service sector, unless, the modern sector is able to absorb the excess population.

With regard to the employment problem, the projections indicated that, given the assumed added investment capability allowed by the low fertility assumption, total employment would be greater under conditions of low fertility than under conditions of sustained high fertility. The projections also illustrated the increasing differences in labour productivity by sector, and therefore the increasing inequality of income unless some strong measures are taken to redistribute income.11/

2. Colombia

In 1973, the Corporacion del Centro Regional de Poblacion initiated the development of a new economic-demographic model which could be useful for planning in the Colombian context.12/ The purpose of this model was to assist in the study of the implications of possible changes in selected demographic, social and economic variables for economic development and social welfare. First, the Corporacion experimented with TEMPO-II, examining the data requirements and evaluating the components which would be of interest to potential government users. It was later decided to build a modified model (SERES) selecting those parts of TEMPO-II which were useful in the Colombian context.

SERES is a deterministic, dynamic, recursive, non-linear model characterized by (a) a high degree of interaction between its economic, social, demographic and governmental variables; (b) great importance given to the government sector as a major determining factor in development; and (c) a high degree of disaggregation within the economic sector.

10/ This arises from the time period considered. Clearly over 30 years the effects of fertility reductions on employment and output will be of less quantitative importance than dependency ratio effects.

11/ For a discussion of such measures, see ***Premises and Implications of a Unified Approach to Development Analysis and Planning*** *(E/CN.11/1270). For an analysis of policy experiments using large scale models to study income distribution policy, see I. Adelman and others;* ***The Political Economy of Egalitarian Growth*** *(Geneva, ILO, 1976).*

12/ See "Structure and uses of model SERES", ***CCRP Monographs,*** *vol. 3 (Bogata, December 1974).*

The Colombian model is divided into four major parts: economic, government, social and demographic, each of which contains one or more of the seven submodels. The economic submodel projects gross output, the distribution of income among different categories of income earners, levels of employment and unemployment, the size and composition of the foreign sector, and the level of aggregate savings and investment. The government submodel is subdivided into two parts. One deals with the proposed budget and allows simulation of various government policies. The other calculates the actual revenues and expenditures during each period. The social submodel of SERES is composed of three parts. They deal with education, health and family planning and generate levels of school enrolment, mortality and morbidity, and acceptors of family planning services. The demographic submodel is composed of demographic and migration parts which permits the generation of the population distribution by age, sex and place of residence.

The model operates in the following sequence: initially, current government policies are combined with economic factors and public expenditure programmes to generate current levels of taxation; the economic submodel then use this information as well as the values generated by other submodels to calculate the final demand in each of 10 productive sectors. The total output for each sector is then calculated by means of an input-output table. These outputs are constrained by the availability of capital and labour at the appropriate skill level. For this purpose labour is broken down into four occupational categories. The levels of production determine the levels of income in each occupational category and income earned from capital. They also determine consumption and savings, imports, exports, foreign borrowing and investment by sector. The level of production is an input to the second part of the government submodel along with levels of taxation. This determines government borrowing and the level of government spending (including spending for health education and family planning) in the following period.

The education part of the social submodel calculates a preliminary enrolment figure and the corresponding public spending required. This is done on the basis of enrolment rates, school age population and changes in the demand for education which in turn depends on costs per student and the income distribution. If the required public spending differs from the amount of educational expenditure calculated in the government submodel, then the preliminary enrolment is adjusted to obtain final enrolments. The educational section also generates the educational structure of the population classified into three educational levels: primary, secondary and higher. This is further disaggregated by age, sex and region. The projections generated by the educational section are also used in the economic submodel to generate the labour force by educational level, and in the demographic submodel to generate the number of women in the fertile ages by educational level.

The health part of the social submodel determines the potential demand for health services by age and illness group and by the number of inputs required to satisfy this demand. The total expenditure allowed by the government submodel is then distributed to the various health subprogrammes according to a set of priorities. The satisfied demand for medical services is obtained by comparing the effective demand with the supply of services. The level of mortality and labour days lost on account of illness are estimated separately for those who do and those who do not receive appropriate medical care. The number of deaths becomes an input to the demographic submodel and the number of labour days lost becomes an input to the economic submodel.

The family planning part of the social submodel calculates the supply and demand for family planning services in order to generate the number of acceptors. This is then transformed into births averted which is used in the demographic submodel.

The demographic part of the demographic submodel provides the structure of the population by age and sex for each year (before migration) according to patterns of fertility and mortality that are endogenous to the model. Mortality is determined by changes which originate in the health part of the model and changes in fertility which are determined by changes in the education and family planning parts of the social submodel.

The migration part of the demographic submodel distributes the population by place of residence (urban or rural). It also classifies the migrants by age and sex in order to take into account the selectivity of the migratory process. Given this classification, population data can be used in the education, health and family planning submodels.

3. Venezuela

In order to shed light on questions raised by the Venezuelan planning agency CODEPLAN, the Instituto de Estudios Superiores de Administracion (IESA) adapted the TEMPO-II model to deal with the key plan-

ning problems of that country.13/ Among those problems were the reliance on a single export (petroleum) and the extent of foreign domination of the petroleum sector.

Although the model used by IESA has its origins in the TEMPO-II "human resources" model, it has taken into account the special characteristics of the Venezuelan economy by treating petroleum as a separate productive sector, the incorporation of a foreign sector, and the disaggregating of the population into four subgroups.

The model is made up of two sets of relationships: demographic and economic. The demographic submodel divides the population into the following groups: subsistence, marginal, modern uneducated and modern educated. Each subpopulation has distinct characteristics. The subsistence and marginal populations comprise the rural and the urban poor, respectively. The remaining modern population, while predominantly urban is not segregated geographically. Instead, the modern population is divided into uneducated (less than five years of schooling) and educated (at least five years of schooling). It is assumed that the subsistence and marginal populations are uneducated. Each of the subpopulations is divided into 14 five-year age groups. All demographic projections in the model are made for five-year intervals. Since economic variables are projected annually, the values of population variables used in the economic equations are obtained by interpolation.

Migration is taken into account in the model because it is assumed that the total subsistence population cannot increase beyond its present size, and the excess subsistence population is assumed to migrate to join the marginal population. The marginal population, in turn, may become modern by becoming educated or by obtaining employment in the modern economy. Thus the elimination of rural and urban poverty depends upon the expansion of education and employment opportunities.

In the economic submodel, total production in the subsistence sector is assumed to depend solely upon the size of the population of working age. Similarly, production in the marginal sector depends solely upon the size of the marginal labour force. The marginal labour force is that portion of the total uneducated labour force which is not employed in either the subsistence or modern sector. Consumption in the subsistence and marginal sectors is assumed to be equal to total sectoral production plus welfare payments received.

The modern economy is subdivided into a petroleum and a non-petroleum sector, each of which uses capital and labour from the educated and non-educated modern population in the production of output. Petroleum is assumed to be the priority sector in obtaining resources, therefore, its output is determined by total demand. The remaining capital is used in the modern non-petroleum sector. The amount of capital in this sector determines the demand for labour. Unused educated workers are considered to be unemployed. Unused uneducated labour enters the marginal sector.

Private investment is equal to private savings. Public investment may be specified either as a predetermined percentage of total national product or as the residual component of the government budget. Foreign investment is equal to new investment plus reinvestment in projects the profits from which cannot be repatriated. New investment is limited to an exogenously specified percentage of foreign-owned capital.

Government revenues, both taxes and royalties, are raised entirely in the modern sector. The government sector performs a number of functions which affect the levels of output or consumption. It makes expenditures for education, health, welfare transfers, public investment, family planning and other purposes. Given public education policy, the model determines total expenditure for education. Private expenditure on education is a given percentage of modern consumption. The government education budget is equal to that part of the total which is not covered by private expenditure. Educational expenditure both private and governmental, increases the stock of educated labour and thus adds to the total product. Health expenditure is assumed to vary directly with the total population. Thus, a more rapid rate of population growth requires greater government expenditure for health, leaving fewer resources available for government investment. Welfare transfers to the subsistence and marginal populations vary directly with the size of those groups. The growth of the subsistence and marginal populations consequently reduces government investment. Government expenditure for family planning is directed at all but the modern educated population. In each sector, a specified percentage of women in the fertile age groups is assumed to enter family planning programmes at a fixed cost per acceptor. It is assumed that the relative decline in fertility in each of the three

---

13/ This model is described in Anibal Fernandez, "The IESA/TEMPO model", paper presented at a SEADAG Seminar on the role of economic-demographic models in development planning, New York, 1975.

subpopulations is proportional to the percentage of women of fertile age that accepts family planning.

These three models provide an illustration of the ways in which the TEMPO series of models can be altered and adapted to meet the requirements of planners in countries with widely differing problems and objectives. In the case of Peruvian planners the main concerns were employment, income growth, income distribution and rural development. The Colombian model sought to highlight the interaction of economic, social, demographic and governmental variables with great stress given to the role of the government sector as a determining factor in development. The Venezuelan model was designed to highlight for planners the problems associated with the foreign domination of the petroleum sector and the reliance on a single export (petroleum). It should also be noted that all three models dealt with problems of migration as well as population size.

C. Long-range planning models (LRPM)

The LRPM series of socio-economic-demographic models were developed by the Socio-Economic Analysis Staff of the International Statistical Programmes Center of the United States Bureau of the Census as part of a general programme to develop computer methodologies or models which can be used for evaluating the relationships among social, economic and demographic variables over time. Thus, far, three basic models have been developed.[14/] They are referred to as Long-Range Planning Models (LRPM), 1, 2 and 3. In addition, a fourth model has been constructed under contract, the Purdue Development Model.

The purpose of the Census Bureau's model-building project is to encourage more and better research and planning about demographic, social and economic development processes. Formulation of an integrated socio-economic analysis system resulted in the initial development of LRPM-1 in early 1971, by H. Albert Green. It was developed for the United States Agency for International Development to assist country officials to prepare their quantified national-level perspective plans. This quantification was intended to portray the implications of different demographic and social services policy assumptions for economic development particularly in regard to social services such as health and education.

LRPM-2 is a major revision of LRPM-1.[15/] LRPM-3, developed by Joseph Quinn, provides the user with a number of additional options. LRPM-4 is an adaptation of the Purdue Development Model.

LRPM-2 consists of eight separate submodels: DEMOG, FMPLAN, MIGRAT, DEMWA, HEALTH, EDUC, HOUSE and ECSIM. The demographic submodel, DEMOG, provides a projection of population by age and sex at five-year intervals for up to 50 years. At the users' option, the model can provide projections disaggregated by urban-rural residence. The model can also make use of Sprague multipliers to obtain single year data. LRPM-2 provides the user with more options than TEMPO in the way rates can be entered and the frequency with which they can be changed. In LRPM, the user may also move from one schedule to another by stepwise shifts or arithmetic or geometric progression. The demographic output of LRPM-2 can be classified according to sex, age and region. LRPM-3 adds the classification of educational attainment.

The family planning submodel, FMPLAN, projects the number of births averted through the operation of a national family planning programme. In addition, the number of service units required by type and the operating and investment costs for each service unit type are projected. The migration submodel, MIGRAT, distributes the projected population between rural and urban place of residence and estimates net rural migration by age and sex. Age-and sex-specific rural and urban labour force projections are made through the DEMWA submodel. In addition, the submodel calculates consumer population equivalents, health consumer population equivalents and school-age groupings. It also provides annual estimates of all variables projected for five-year periods through interpolation.

The social service requirement submodels. HEALTH, EDUC and HOUSE, derive projections of health services, educational service and public housing requirements. These submodels are quite similar to the corresponding TEMPO submodels.

The economic simulation submodel, ECSIM, is

14/ J. Quinn, "The use of the LRPM and PDM models for structural analysis and development planning" (United States Bureau of the Census, 1975, Washington D.C.,) (mimeographed).

15/ Albert Green, "LRPM 2: a system of perspective planning submodels" (United States Bureau of the Census, Washington D.C., 1974) (mimeographed).

designed to facilitate flexible specification of equations to simulate behaviour in individual countries. The user is required to specify his own economic structure. The ECSIM submodel will accept up to 20 simultaneous equations. In addition to specifying other values exogenously, the user may incorporate population, labour force and social service programme data derived in the preceding submodels.

Since the LRPM models are segmented into submodels which can run separately, some versions can be run on machines as small as the IBM 360-40. Furthermore, it allows the user to employ any of the submodels without reference to the results of any other submodels.16/

Among the major models only LRPM-3 has a routine to generate families. It can also generate income distributions either through a user specified distribution or a human-capital-plus-a-random-process approach. Among the routines which are to be added to the LRPM system are a specific public sector budget, work, education and marriage life tables; a submodel for energy demand, routines for calculating Pareto curves and income distribution coefficients. In the future a regional version of LRPM-2 and LRPM-3, and employment tables by industry will be added.

In summary, the LRPM models (other than LRPM-4) are flexible, small enough to be run on most computers, easy to use even by non-computer technicians, segmented so that submodels can be run separately, and useful to treat a wide range of relevant problems.

LRPM-4 is an adaptation of the Purdue Development Model which is capable of simulating population dynamics, economic development and economic-demographic interaction.17/ Like the FAO/UNFPA model it emphasizes the agricultural sector. It was constructed with sufficient generality to accommodate a diversity of economic and demographic conditions which may be encountered in the less developed countries. It can deal with many different country situations involving a wide variety of economic and demographic policies.

There are three major submodels in the Purdue Development Model which interact among themselves and with the exogenous variables: the public sector submodel, the private economy submodel and the population submodel. The population submodel provides the private economy submodel with demands for goods and services, supplies of labour and savings. The private economy submodel in turn provides a number of the determinants of demographic variables. It also provides the public sector submodel with taxes, services, the demand for public services and various inputs. In return, the public sector provides the private economy with services, demands for its products and payments. The public sector submodel provides the population submodel with explicit social services and receives from the population submodel labour and the demands for public services. Each of these components of the model may then engage in dealing with the rest of the world.

The population submodel is designed to project the number of persons into single-year age cohorts by sex, levels of educational attainment and locations of residence. Population growth is projected on a yearly basis by applying annually projected birth, death and migration rates to the population of the previous time period to form a disaggregated age/sex/education subpopulation in each of the locations in the submodel.

Birth, death and migration rates are calculated from a set of predictive equations composed of fixed user-specified coefficients and variable values generated by other components of the model. For example, fertility is determined by such factors as household income, levels of infant and child mortality and the direct pecuniary costs of child rearing. Mortality is determined by such factors as income, nutrition and the availability of medical services. Rates of school enrolment and graduation are forecast on the basis of expected wage rates, household income and currently prevailing levels of education. Rates of domestic migration are predicted on the basis of relative differences between locations with regard to various social and economic characteristics.

The private economy submodel is a multisectoral interactive system operating within a linear programming framework. Given the demand relationships, the resource constraints and a technology described as a set of

---

16/ *Because of this feature, it may be questioned as to whether the LRPM series are truly economic-demographic models.*

17/ *T. Kelley White and others, "The PDM: a systems approach to modeling demographic-economic interaction in economic development" (Department of Agricultural Economics, Purdue University, 1976) (mimeographed). See also "Users' guide to the Purdue Development Model Computer program," **Station Bulletin No. 94** (Department of Agricultural Economics, Agricultural Experiment Station, Purdue University, September 1975); and "Input form for the Purdue Development Model", **Station Bulletin No. 95** (Department of Agricultural Economics, Agricultural Experiment Station, Purdue University, August 1975).*

production activities, the submodel simulates the operation of a competitive price system by finding the solution which yields maximum net social welfare in the sense that it maximizes the sum of producer and consumer surplus.18/.

Domestic production occurs in one of two private economic sectors, agriculture and non-agriculture. Agriculture is disaggregated into five subsectors. Non-agriculture is divided into manufacturing and service industries. For each of the seven product categories, up to 12 production activities define the manner in which the product can be produced. Explicit final consumption and world export demands as well as world import supply functions are specified for each subsector.

The primary factors of production (land, labour and capital) are disaggregated and viewed as constraints on current production. Land is of five types (and is a constraint only on agricultural production). Labour is divided into agricultural and non-agricultural labour force groups. Each labour force group is further disaggregated into labour skill classes based on the level of educational attainment. It is possible for labour in this model to be considered as either unemployed or underemployed. During any given year capital stocks are specific to each economic subsector. The returns to capital vary among subsectors and determine the pattern of investment. The available supply of research and extension services also constrains agricultural output. This supply may be expanded by the public sector.

Final demands for the seven categories of domestic goods and services are generated by the population. Shift variables include a quantitative population effect and purchasing price. Price elasticity of demand is determined by changes in population composition and lagged product prices.

Inter-temporal changes in resource availability are also predicted by the submodel. Labour forces are calculated by multiplying a set of endogenously determined participation rates by the appropriate subpopulations. Capital is increased by assuming equality between savings and investment. In each of the three domestic sectors, *per capita* savings rates are a function of *per capita* income, old age dependency ratios and average levels of education.

The public submodel of the Purdue Development Model provides critical services which influence the course of economic development and population growth. Educational services change the educational composition of the labour force. Medical services affect rates of mortality and internal migration. Research and extension services influence rates of growth of agricultural output. The public sector also purchases products and labour services. The total public sector wage and product bill flows back into the private economy as returns to factors and producers in the relevant domestic subpopulation. These public expenditures are matched by adjusting tax rates so as to maintain a balanced government budget. Thus, within a time period , the public sector competes with the private sector for resources and with final consumption expenditures for income. Over time, however, public sector production augments productive capacity and thus income and consumption.

The Purdue Development Model (LRPM-4) is clearly unlike the other models of the LRPM series. It is a fully integrated model in the sense that sectors of the model cannot be run independently. It is unique among the models considered in that it uses a linear programming framework to maximize a variable defined as net social welfare. The data and research requirements for implementing this model are considerable. Thus far there have been no applications of the model.

D. The population dynamics group model

In making a choice among economic-demographic simulation models planners have a wide variety of sophisticated options available to them. However, planners in countries which have less developed statistical data systems may find it easier to use a simpler model such as that developed by the Population Dynamics Group (PDG).19/

The Population Dynamics Group at the University of Illinois have developed a multilayered system of models in which population plays simple but important role. Though designed to improve decision-makers' awareness

---

18/ For purposes of this model, producer surplus could be defined as the difference between the minimum price required by the producer and the amount he actually receives. Consumer surplus could be defined as the difference between the maximum price the household is willing to pay and the amount it actually does pay.

19/ Paul Handler and Chaisung Roh, "The Population Dynamics Group economic-demographic model and its relationship to planning", paper presented at SEADAG seminar on the role of economic-demographic models in development planning, New York, 1975.

of population problems, recent interest has focused on its possibilities as a planning aid.

In the PDG system of models, demographic variables are exogenous and do not directly influence the level of savings. The set of models includes a simple economic model which seeks to make all economic and population variables as explicit as possible. In contrast to the Purdue Development Model, it was designed to use a minimum of data so that the data base could be updated easily and economically.

At the heart of the economic model lies a Cobb-Douglas production function which makes output a function of the capital stock, employed labour and the rate of technical progress. The rate of net capital formation is exogenously determined. The labour force is determined by the application of age-specific labour force participation rates to the population which is projected by a population submodel attached to the economic model. Total employed labour is obtained by multiplying the labour force by a constant. Alternatively, this constant can be used to convert a natural unit of labour into an efficiency unit. The rate of technical change is an exogenously determined constant which is neutral with respect to capital or labour.

This model is capable of projecting the following values: gross domestic product (GDP), rate of growth of GDP, *per capita* income, total available labour force, employed labour force, the capital-labour ratio and the capital required to generate employment for new workers.

The implications of the basic economic model are supplemented and amplified by the auxiliary submodels of the system. The population projection submodel can be used as a separate subprogramme apart from the main economic model. It projects the population by five-year cohorts for each five-year interval. In so doing, the age-specific fertility rates, the total fertility rate, the mortality schedule, the infant and child mortality rates and the life expectancy can be changed gradually over time or instantaneously.

The labour force analysis submodel obtains its population input from the population projection submodel. It then applies one of four model labour force participation rate schedules constructed to correspond to the level and age pattern of labour force participation at a specific level of *per capita* income.

The education submodel also obtains its population input from the population projection submodel. Enrolment at each of three levels is computed by applying the net age-specific enrolment ratio to the respective age groups. Educational costs are then computed on the basis of enrolment and unit cost. The food submodel projects the production of and demand for foodstuffs, as well as level of investment in agriculture needed to meet a specified percentage of the total demand out of domestic production.

The model output is set forth in graphic as well as tabular form. The use of computer generated graphics gives the PDG model an advantage over others as a mode of communication. It may thus be a superior tool as a means of providing planners with an appreciation of the role of population in some development problems.

The PDG model provides the planner with a tool that can trace out and present in graphic form the broad implications of his policy interventions in terms of the major economic and demographic variables.[20] It could complement rather than substitute for the more detailed models described in this report.

E. BACHUE

The development of the BACHUE model began in 1972 as part of the World Employment Programme of the International Labour Organisation (ILO).[21] The ultimate aim of this project is to identify specific policies and development strategies which give appropriate weight to the employment objective. In particular, it sought to increase understanding of the interrelationships between employment growth and changes in population size, structure and location, with primary emphasis on the policy dimensions. This work sought to indicate to planners those development policies and strategies which most effectively mobilize productive manpower, prevent or reduce disparities between population growth and the growth of employment opportunities and ensure that income growth is both rapid and equitable.

20/ For the application of this model to the analysis of a country situation, see William P. McGreevey and Stephen W. Sending, "Population and the future of Bahrain" (Washington D.C., Smithosonian Institution Interdisciplinary Communications Program, 1973) (mimeographed).

*21/ See R. Blandy and R. Wery, "Population growth and employment: BACHUE-I," **International Labour Review**, vol. 107, No. 5, May 1973.*

Three steps were involved in the ILO project. First, a speculative or theoretical model was designed for a hypothetical less developed country. Then, the model was calibrated for a number of countries to determine specific behavioural and structural relationships for each country and to test the model's sensitivity. Finally, the calibrated and tested model was used for testing and evaluating ideas.

The original prototype model was called BACHUE-I. It was composed of interacting economic-demographic and educational subsystems. This model was later applied to the Philippines at which time it was modified and renamed BACHUE-II.[22/]

BACHUE-II is composed of an economic submodel and a demographic submodel.[23/] The former may be described as a multisectoral, bilocational, dualistic, demand-based submodel which generates output by sector subject to constraints imposed by plan targets for output, employment and income. It is multisectoral in that the model employs an input-output framework which necessarily divides the economy into a number of productive sectors. It is bilocational in that both productive sectors and persons are classified as rural or urban. It is dualistic in that sectors are classified as modern or traditional (absorptive). It is demand-based in the sense that sectoral output is determined by sectoral demand, but supply factors set upper limits to the production of sectors.

Essentially BACHUE-II is a model of over-all economic development weighted to emphasize the employment and income distributing subsystems. Thus the labour market behaviour is covered in detail, while the generation of output and investment is only partly endogenous and is treated as partly the result of planning policy decisions.

The economic submodel is designed to simulate the behaviour of a number of key variables in economic development, with the principal emphasis in employment, income distribution and the structure of final demand. It has two major components: (a) product market behaviour, including consumption, investment and total output; and (b) labour market behaviour, including the distribution of income.

At the core of this system is a 13-sector input-output table the coefficients of which are assumed to be constant over the projection period.[24/] Sectors which may be termed "formal" or "modern" are distinguished from "traditional" or "absorptive" sectors. In the former, wages are higher, there is less self-employment and production is primarily in larger units. In the latter, entry is easier, incomes are lower and self-employment is more common. Sectors are also classified as rural or urban because production, income and employment problems differ greatly between these two areas and because the link with rural-urban net migration is significant in the generation of income inequality. Final demand is estimated in each sector. The input-output submodel is solved for total output and value added by sector. The components of final demand are household consumption, fixed private capital formation and stock changes, investment in dwellings, government consumption, government investment and net exports.

Household consumption in each sector is estimated in three steps. First, total savings is estimated via an aggregate savings function which employs average family size as one of its variables. Savings is then subtracted from income to get aggregate consumption. Finally, sectoral consumption is computed for each income class using total consumption and the number of children and adults in the family as independent variables.

Total investment is exogenous and therefore independent of domestic savings. The difference between the two would be met by capital inflows. Plan targets determine the total level of investment. Private investment is allocated to capital formation in each sector on the basis of the rate of growth of output of each sector in proportion to the incremental capital output ratios.

Like total investment, government consumption is a policy variable. Exports in all sectors are assumed to be functions of the exchange rate and time. Imports are assumed to vary with output and are subtracted from final demand before total output is computed.

22/ See R. Wery, G.B. Rodgers and M.D. Hopkins, "BACHUE-II: version I, a population and employment model for the Philippines," World Employment Programme, Research Population and Employment working paper (Geneva, International Labour Organization, 1975).

23/ Alternatively it may be said that BACHUE is composed of three submodels: economic, labour and demographic. However it is convenient to subsume the second into the first.

24/ BACHUE is intended to be a medium-term model, whose projections are to cover a 10- to 50-year period. The assumption of constant input-output coefficients ever such a long period can be questioned.

The labour market submodel of BACHUE-II generates projections of employment and wages by sector, skill category, employment status and location. In the modern sectors the normal market demand for labour predominates. In the absorptive sectors, employment is largely a function of labour supply. The modern sectors are neo-classical in behaviour. For all but one of the modern sectors (export agriculture), employment is generated within the framework of a Cobb-Douglas production function. Given sectoral output and the sectoral capital stock, the amount of labour required is computed. Labour demand in export agriculture is assumed to vary in proportion to output. All of the remaining labour supply is used in the absorptive sectors in such a way that the ratio between incomes per worker in each sector remains constant. Employment in the government sector is a policy variable.

The labour market is assumed to operate so as to exclude unemployment other than functional unemployment. BACHUE-II is an underemployment model. Those who cannot find work in the modern sectors must take employment in the absorptive sectors. The labour supply is not determined by the attraction of the labour market but rather is predicted on the basis of population size and structure, case of access to employment, type of employment available, the opportunity cost of time and the education level. All male household heads are assumed to be working. The participation of other family members is a function of an income effect, the labour market situation, family activity type, education and child care activities in the case of married females. Wage and employment levels determined in the labour market are transformed into household incomes and aggregated into over-all rural and urban income distributions. These, in addition to being a major output of the model, feed into the household consumption functions allocated by sector.

With the exception of labour supply and household consumption, the economic submodel uses macro relationships. By contrast, the demographic system of BACHUE-II is micro-oriented, through it uses some macro-level components. This system partly explains and evaluates policy impacts on marriage, fertility, migration and mortality. Education levels are generated within a simplified system in which enrolment and completion rates are exogenous (essentially policy variables), although ideally they should be related to household decisions.

People are accounted for in the BACHUE-II demographic system as they are born, die, migrate, receive an education, supply labour and become older. The time path of fertility was made a function of female labour force participation, literacy, life expectancy and the proportion of the population employed in agriculture. The functional relationship was estimated from the experience of 20 countries in the Asian region. Mortality was made a function of income. Life expectancy at age zero was estimated as a function of mean income and the Gini coefficient of income inequality. The life expectancies were then transformed to age-sex specific mortality rates by the use of life tables.

It is important in an economic-demographic model to have an estimate of marital status by age because that variable influences consumption, savings, labour force participation, migration and household formation. Furthermore, simulations are improved by using marital-specific fertility rates. The model employs empirically estimated age at marriage functions which have as arguments the levels of education and female labour force participation. The age at marriage is then converted into age-specific marital propensities. Education levels are generated by assuming that the entire population enters primary school and that dropouts occur at the ages of 13 and 17 with a specified degree of probability. Rural-urban migration is a key component of economic-demographic interaction. BACHUE-II projects these movements both as a function of macro-level economic differentials and micro-level characteristics of individuals.

In summary, the BACHUE model considers, to the greatest extent possible, the interrelationships between economic-demographic and social requirements. It makes heavy demands on data resources and requires a thorough understanding of underlying relationships. It is primarily concerned with issues of employment and income distribution over the medium to long term. A wide variety of policies can be examined using this model and it should be possible to reorient the model so as to take into account other issues of direct concern to planners.

F. The FAO/UNFPA model

As part of the FAO/UNFPA activities on population dynamics, the Policy Analysis Division of FAO undertook a project to assist developing countries in integrating more fully the population components and agricultural programme into their development planning. A prototype socio-economic-demographic model has been developed and has been adapted for country specific experimental studies with existing data on Egypt and

Pakistan.[25] The objective of this effort is to provide policy-makers and planners with a practical tool for exploring the implications of population growth and for evaluating the socio-economic consequences of alternative development strategies.

The FAO/UNFPA model consists of two major submodels. One describes the demographic characteristics of a nation and the other describes the economic characteristics. There is interaction between the two submodels. Population growth affects economic development and *vice versa*.

The economic submodel is made up of economic, agricultural and employment sections. The submodel also distinguishes between three sectors: the traditional sector which includes agriculture and informal non-agricultural production, the modern sector which includes industry, capital goods, construction and services; and a government sector which includes education and other government services such as health.

The economic submodel is divided into four sections: production, consumption, foreign trade and investment. Three alternative forms of the production function may be used. The first option involves the use of a Cobb-Douglas function. The other two options employ variants of the Harrod-Domar production function. The second option involves constant capital-GDP ratio. The third involves an incremental capital-output ratio which varies with time thus representing an embodied technical progress.

Total consumption is the sum of government and private consumption. Government consumption grows proportionately to government investment in education and health. Private consumption depends on the number of equivalent adult consumers and *per capita* consumption. The number of equivalent adult consumers is equal to the sum of the total population weighted by the nutritional requirements for different age and sex groups. The level of *per capita* consumption during a given period is determined by *per capita* consumption in the previous period and a policy-determined growth rate in that variable.

In the foreign trade section of the economic submodel, imports of consumer goods are a user-specified fraction of the level of consumption. Capital goods are imported when domestic production cannot meet demand. The level of exports is a policy determined variable.

Investment is the strategic factor in planning development. Two aspects must be considered: the mobilization of resources for the purpose of productive investment and the direction of investment into the proper sectors. For the mobilization of investment funds, investment is a residual which is equal to GDP plus imports, less consumption and exports. All sectoral investment is autonomous, predetermined by exogenous policy variables. Together with land reclamation programmes and export targets, these different sets of investment allocation coefficients represent alternative development strategies.

The agricultural submodel is divided into two sectors: (a) land; and (b) investment and production. Land reclamation is an exogenous policy variable and land withdrawal is determined by construction output. Two alternative forms of the agricultural production function may be used. In the first, output is equal to the product of land under cultivation and yield per unit of land which is in turn a linear function of intensive agricultural capital and raw materials. In the second option, agricultural output is determined by a modified Cobb-Douglas production function which includes land under cultivation and raw materials as input.

The employment submodel is divided into four sections: labour force, hired employment in the formal sector, self-employment and employment in the informal sector and labour productivity. The total labour force is calculated from sex- and age-specific population and the participation rate. The labour forces in the traditional and modern sectors are considered separately. The transfer of persons from the traditional to the modern labour force occurs because of migration.

The submodel treats separately employment in the government, modern and traditional sectors. Government employment grows proportionally with government consumption. The growth of modern employment, except for modern agriculture, is proportional to investment in

---

25/ Wuu-Long Lin and M.G. Ottaviani-Carra, ***A Systems Simulation Approach to Integrated Population and Economic Planning*** *(WS/H2518/E/11.75/1/300) (Rome, FAO, August 1975). See also Institute of National Planning, Arab Republic of Egypt, "Population employment and productivity in Egyptian agriculture" (Cairo, December 1974) (mimeographed); and "A systems simulation approach to integrated population economic planning with special emphasis on agricultural development and employment: an experimental study of Pakistan" (PA 4/1 INT/73/P02), Working Paper Series No. 11 (Rome, FAO, March 1976) (mimeographed).*

the modern sector. The traditional sectors are assumed to absorb the remainder of the labour force. Unemployment is defined as the difference between the modern labour force and modern employment. The proportion unemployed will determine the trend in the capital-employment ratio.

Labour productivity in the modern sector is obtained by dividing the sectoral GDP by modern employment. Labour productivity in the traditional sector is obtained by dividing sectoral GDP by the traditional labour force.

The demographic submodel projects total population by age and sex, rural-urban residence and educational attainment. The component method is used to project population by sex and by five-year age group and is interpolated for single-year intervals. The submodel uses the general fertility rate which can be given exogenously or generated endogenously as a function of the level of adult education and modern job opportunities. The linkage between the fertility rate and the level of education is given by a population policy multiplier. This multiplier may implicitly reflect everything from the rising age at marriage to government family planning activities.

Life expectancy at birth can be given exogenously or generated endogenously as a function of the level of consumption (a proxy for nutrition) and the investment in government services (a proxy for health and sanitation). Survival rates by age and sex are determined from life expectancy at birth.

Net rural to urban migration is determined by the growth rate of the rural population, the fraction of the population which is rural, and relative productivity in the modern and traditional sectors. The model is constructed in such a way that there will be an initial acceleration in the propensity to migrate followed by a declining propensity as population becomes more urbanized.

Population growth thus affects the economy through increasing consumption requirements which reduce the amount of resources available for investment. It will also determine the size and age-sex composition of the labour force. The level of capital formation and labour determine production and employment. Productivity differentials between modern and traditional sectors determine migration. In this submodel it is postulated that the fertility rate will decline as education increases and as more women are employed outside the home. Increases in *per capita* consumption and government services in turn result in higher survival rates. In these ways, economic development has a feedback effect on population growth.

The FAO/UNFPA model has been designed to be simple enough to be applicable in countries where data resources are extremely limited and yet sophisticated enough to yield meaningful results with regard to the effect of alternative policy packages thus assisting planners in choosing appropriate future development strategies. It deals on a detailed basis with the linkage between demographic variables and the agricultural sector which remains the primary sector in most countries of the ESCAP region.

G. Conclusion

A wide variety of economic-demographic models are available for potential use in the planning process. Certain models such as TEMPO I and the PDG model could be readily estimated and put into operation. Because of their simplicity, they could be relatively easily understood by potential users. However, such models would serve a limited variety of purposes, primarily informational in nature. However, they are so designed as to guarantee that reductions in the rate of population growth will always result in increased *per capita* income and therefore they may not be considered trustworthy by planners.

It is clear that the TEMPO II "budget allocation and human resources" model can be adapted to meet a wide range of planning and policy concerns. However, the very extensive nature of these adaptations calls into question the value of the prototype model itself. It could be argued that it would be more expeditious for countries to design models to suit their own requirements rather than adapting TEMPO II extensively.

The LRPM series of models, with the exception of the Purdue Development Model can be run as a series of separate submodels. In that form, they may prove to be extremely useful to planners concerned with the demographic aspects of certain sectors considered in isolation from the plan as a whole. They also provide for linking these sectors to the economic model, the structure of which must be specified by the using country.

The three fully integrated economic-demographic models are the Purdue Development Model, BACHUE and the UNFPA/FAO model. The first of these has not yet been applied to any specific country and therefore remains to be tested in that sense. It has the advantage of providing an optimum solution but has extensive input requirements in terms of specifying the technical coef-

ficients of alternative productive activities.

At the present time it would appear that BACHUE and the UNFPA/FAO models offer the greatest promise as tools for planning. Both models have been applied to developing countries in the ESCAP region. They can be used to examine a wide variety of policy packages taking into account a wide range of demographic and economic interactions. Since the BACHUE model is primarily concerned with employment and the distribution of income and the UNFPA/FAO model is primarily concerned with agriculture which is the largest single sector in most developing countries of the region, a case could be made for incorporating both models into the planning process.

V. CHOICE OF MODEL STRUCTURE AND APPLICATION TO PLANNING

A. Alternative structures

A wide range of alternative model structures are available. There are significant disagreements among experts as to which of these is optimal. Four major issues with regard to model structures are: (a) the choice of a central core; (b) the trade-off between simplicity and complexity and the appropriate degree of endogeneity; (c) the choice of a demand or supply orientation; and (d) the criteria for selecting a particular model for use.

1. The choice of a central core

The central core of all of the economic-demographic models is composed of two dynamic equations. The first describes the growth of population and the labour force. The second describes the accumulation of capital through production and investment. [1/] Despite its seeming complexity, a large part of a model's outcome is derived from the economic component of the core. The TEMPO and PDG models make use of the Cobb-Douglas production function. If output takes place under such a function, *per capita* output will always decline as the labour input increases. Thus an increase in population will always tend to reduce welfare.

The BACHUE model makes use of a linear Leontief production function. Given this function, individual shares of output normally would be decreased as the number of persons increased. Thus inherent properties of the production function will determine the outcome of the population question. If the central core predetermines the results, then the type of production function which drives each economic-demographic model must be made explicit in order that the potential users can assess the degree to which the central core of the model mirrors the reality of the development process.

In the case of the TEMPO model, the basic results do not depend on the form of the function but rather on the assumption of a supply-constrained model. Furthermore, the Cobb-Douglas form is a better choice for a heuristic model because it contains in simple compact form most of the relevant economic properties: [2/] (a) the exponents have a simple interpretation as elasticities of productivity; (b) the sum of the exponents indicates the returns to scale; and (c) the marginal product of either factor decreases with increases in that factor. Moreover, while the numerical coefficients must be estimated, the role they play in the model is clear: they are few in number and the sensitivity of the final projection results to changes in the coefficients is easily analysed. Furthermore, there is a wealth of literature available on the estimation and application of Cobb-Douglas production functions.

The PDG model is often criticized on the grounds that it always indicates that slowing the rate of population growth yields higher rates of growth of *per capita* income. However, if this feature is carefully explained to the user, the model can still serve as a useful basis for decision making by policymakers concerning the options facing them.

The FAO/UNFPA model gives the user the option of using the Harrod-Domar production function which has been criticized as having an antinatalist bias because the marginal productivity of labour is implicitly zero. However, the developers of this model feel that this is a plausible assumption in a labour surplus economy.

The use of an input-output structure as the central core of the BACHUE model does not allow for the substitution of inputs with changing factor prices and technological developments. [3/] This is particularly important for factors related to long-run demographic changes. The use of fixed input-output coefficients in the formulation of the production activities may also be inappropriate since changing these relationships is very much a part of the growth process itself. [4/]

Economic-demographic development models should be so designed as to seek either consistent or optimum solutions. There are a number of techniques by which it is possible to optimize the variables of an economic-demographic model. [5/] This would indicate to the planner

---

1/ W. Brian Arthur and Geoffrey McNicoll, **loc.cit.,** *p. 255.*

2/ Henry Cole and Richard Brown, "The Tempo models as a basis for development planning" (Washington D.C., General Electric Corporation, TEMPO, March 1975) (mimeographed), p.9.

3/ The use of input-output structure does not necessarily preclude factor substitution. A Leontief technology can be adopted for intermediate inputs but a binding Cobb-Douglas or Constant Elasticity of Substitution production function can characterize the contribution of factors in the productive process.

4/ W. Brian Arthur and Geoffrey McNicoll, **loc.cit.,** *p. 259.*

5/ For a discussion of optimizing economic-demographic models, see Nancy Birdsall and Rashid Faroquee, "Population-development relationships approaches to analysis" (World Bank, April 1977) (mimeographed), pp. 74-32.

the optimum levels of investment over time in alternative programmes to achieve specified goals subject to a set of constraints. However, it is not clear that the welfare criterion adopted by the planner is of any simple form. Under these circumstances it may be better to use a consistency model which provides a number of feasible solutions. From these, the planner can determine the trade-offs involved in the analysis of long-run programmes. Since the emphasis is on the trade-offs, the user is concerned not with the absolute numbers resulting from two or more projections, but with the relative effects of alternative development strategies. However, if a planner can identify (and make quantitative) the goals of the planning exercise, an optimizing model will provide him with insights on means to achieve the best possible outcome.

2. The trade-off between simplicity and complexity

Potential users must consider the trade-offs between simplicity and the complexity created by comprehensiveness in economic-demographic models. Economic-demographic models should ultimately give detailed guidance in the interactions between population and other economic processes. Therefore, population variables should be incorporated in the general economic planning model in an explicit way so that planners can anticipate the changing requirements of the population as well as the impact of economic progress on demographic behaviour.

It can be argued, however, that until planners understand economic-demographic interactions, more complex models would merely obscure the major points. Ultimately planners may wish to use small-scale models for quick answers while using large-scale models for policy simulation.

The FAO/UNFPA model makes a clear distinction between economic policy and the means and tools for implementing it. While considering alternative policies, the model disregards the means by which this policy is carried out. This made possible a simpler model structure. However, specification of the means of implementation would greatly restrict the number of countries where the model was applicable. Since the means can be changed in the short and medium term without changing the long-run strategy, the choice of means was not considered a long-run planning problem.

The BACHUE model is among the most developed and most interesting of the economic-demographic models; nonetheless, it raises problems of estimating functions. [6] It might be well to look at the model by subsections to see how it could be simplified. While greater complexity increases the chances of understanding the development process, it also leaves the user more open to data errors and to the influence of exogenous forces.

Data requirements are a disadvantage of complex models. However, planners are often interested in and demand complex answers. For instance, health planning officials may wish to consider the implications and trade-offs of programmes with different disease emphasis. Yet, a long-run economic-demographic model need not be the only planning model. It could retain much of its simplicity by being coupled to more complex short- and medium-term models which could address specific areas not touched in the long-run model.

The selection of a model should take into account the time constraints under which planners are often required to function. In response to changing events, planners may be asked for an immediate detailed analysis. Under these conditions planners may have no time for an elaborate modelling exercise. Planning is always a process of successive approximations, and no plan should ever become "the plan". New data will require regular readjustment of any planning model. In any event, the question of complexity versus simplicity has to be resolved in relation to the planning situation and to the questions with which the planner is forced to deal.

A major source of this complexity is the attempt to achieve a high degree of endogeneity within the model. In particular, the attempt by some models to incorporate feedbacks from the economic sector to the demographic sector is a most controversial source of complexity. The developers of TEMPO decided to minimize the number of endogenous variables. [7] They did this for a number of reasons: there is a lack of statistical data to test these relationships. [8] Planners in the less developed countries may not accept their functional specifications; and the compounding of errors which occurs when a number of

---

6/ For a critique of the methods used in estimating the functions in the BACHUE model, see United Nations, "Population factors in development modelling: an evaluative review" (POP/SC/WP/86).

7/ It could be argued that where there are powerful analytical reasons supporting the existence of feedback mechanisms the use of a "best available" estimate may improve the accuracy of the model.

8/ For a critique of data sources used in large scale economic-demographic models, see W. Brian Arthur and Geoffrey McNicoll, ***loc.cit.,*** p. 260.

unknown relationships are introduced in a single model. The problem of selecting endogenous variables is one of conflict between the theoretical requirements of the model determined by the researcher and the policy input needs expressed by the planner. In general, the planner is concerned with a simple set of well-understood relationships. 9/

Demographic variables have been treated as exogenous in the TEMPO models on the grounds that changes in the levels of fertility and mortality have been largely due to improvements in nutrition and public health rather than improvements in economic conditions, so that population growth has tended to be independent of economic growth. Different economic conditions might alter fertility and mortality behaviour which would in turn affect economic variables and so on in a dynamic interaction process. However, the inclusion of this type of interaction in a model may be premature until functional and quantitative specifications of the determinants of demographic factors are further advanced.

Models such as BACHUE may have failed to influence planners because they included so many feedback linkages that their complexity compromised their usefulness. Integration of a vast array of linkages between variables with only marginal support from relevant empirical evidence may weaken rather than support the whole system and hinder effective communication. Thus it could be argued that until more empirical evidence is available, these models should treat demographic components exogenously. In most developing countries of the region, there are significant direct or indirect governmental efforts to affect fertility. Under such active fertility reduction programmes, there will be structural changes in the relationships by which economic variables will reinforce the programme influence on demographic variables.

These models may tend to give the impression that much more is known about the development process than is actually the case. In trying to establish linkages between important socio-economic processes, model builders have introduced an increasing degree of endogeneity into their models. This may be an unfortunate development because these models may use up such a large portion of the available data about past experience in estimating their parameters that it is not possible to validate the models by using them to retrace the historical experience. Finally, it should be noted that feedback linkages appear as policy instruments to planners. Therefore, there is a bias towards including these linkages when building these models.

There may be a demand for applications of economic-demographic models to planning which require the inclusion of feedbacks from the economic to the demographic subsystems. For instance, a country may wish to undertake an analysis of the likely impact of its projected development plan on its population. The purpose of such a study would be to understand how the implementation of government programmes could affect the principal determinants of fertility rather than to assess the consequences of alternative rates of population growth. What would be needed in this case is an analysis of the activities, in addition to family planning, which would yield demographic changes consistent with plans for economic development. Such a model could be used to determine the expected rate of decline in fertility given various levels of expenditure on female education, an increase in average years of schooling and increased employment opportunities for women. Questions such as these cannot be addressed satisfactorily with a simple model in which population is exogenous. What is necessary in this instance is an interactive model with feedback mechanisms such as those provided by BACHUE, LRPM-4, the FAO/UNFPA model and certain variants of the TEMPO model. Under these circumstances a range of model types, adaptable to the specific needs of policy makers, is required. The long-term planning process would then involve the application of several models or a single model which has a set of submodels oriented to different aspects of development, with different degrees of aggregation and different solution techniques.

3. The choice of a demand or supply orientation

The BACHUE model stands apart from the others in that it is demand-oriented. This orientation was adopted on the grounds that the theoretical base for linking long-term supply and demand relationships is weak, whereas demand is an important link between savings and consumption. The pattern of demand and its sectoral composition determine the distribution of employment between modern and traditional sectors. Thus, demand variables constitute a crucial link between population growth on the one hand, and employment and income distribution on the other.

Although the BACHUE model is demand-oriented, it employs labour force and plan targets as output con-

---

9/ The problem of model construction is to be abstract from the complexities of the real world the planner is trying to influence in such a way that the problem is tractable yet accuracy is retained.

straints. [10] The SERES model, however, fills the gap between demand and supply through imports. The BACHUE model is supply-constrained which is reflective of the condition facing most less developed countries. At the same time, the supply orientation is among the more controversial features of the TEMPO model. It assumes that output can be increased only by increasing the availability of labour and capital and therefore demand factors are not central to the long-term analyses of less developed countries.

In the FAO/UNFPA model the level of production in each sector is determined solely by its capacity. Demand plays no role. The developers did not wish to include both supply and demand because this would require a system of simultaneous equations rather than the sequential model actually used. [11] Furthermore, the long-run development of a less developed country depends much more on increasing capacity than on increasing aggregate demand. Finally, it was felt that the BACHUE model had sufficiently explored the implications for production of projected demand.

4. Criteria for selecting particular models

There is a wide variety of economic-demographic models from which the planner may choose. However, there is no agreement upon a methodology for determining which of the various alternative economic-demographic models is most applicable, at what time and place and under which circumstances. [12] Furthermore, the development and maintenance of a data base, the estimation of parameters, and the running of these models is expensive. What is needed is a rigorous analysis of the costs and benefits associated with each of these models. (However, it is not possible to measure the benefits of alternative models without some knowledge of their productive power). It would be useful to set forth the inputs, the intermediate and final products, and the costs of the various models. This would let model users know the trade-offs between the different options available to them.

However, the projections made by a model are merely an intermediate output since most of the usefulness of the exercise is derived from what happens after they are generated. The "model-to-ministry" image is too simplistic as in actual practice the chain of communication between model builders and their most effective users is more complex. Therefore, the costs of such an effort depend much more on the situation than on the model. The problem of measuring costs and benefits of model output is, therefore, a most complex one.

B. Using models as a tool of the planning process

Perhaps the most difficult and important issue with regard to these models is using them as a tool of development planning. It is clear that local participation in the development of these models is an essential part of the process.

The key to the ultimate success of any given model is the active involvement of planners in the modelling exercise. A model will not play an important role in planning if it is designed in a developed country and then applied by those who are not citizens of a country fully familiar with its problems. A planning minister would be more likely to accept the application of a model if it has been fully examined by his own people and adapted in the light of the national problems and development planning; otherwise, the model is likely to remain a prototype, something left behind by the foreigner who developed it. This is especially true when it comes to linking the macro-model with sectoral planning efforts which are the core of the planning process.

The efficiency of a model could be defined in terms of the degree of its successful application to the planning process. [13] Therefore, it is necessary to consider the political and institutional context in which the applications of any prototype model will be made. A model developed by an outsider is bound to arouse suspicions in the country as to the neutrality of its structural assumptions. These suspicions can only be overcome when model builders and users communicate and interact on a personal basis.

There are a number of reasons why such models should be developed in the country. Not only are the models more easily received, used and applied locally, but also the effort creates a cadre of locally trained people to

---

10/ It should be noted however that BACHUE's constraints are nearly always binding thus undermining its demand orientation.

11/ The LRPM-4 model and the Purdue Development Model consider both supply and demand factors by taking price adjustments into account.

*12/ A discussion of guidelines for evaluating these models can be found in "Population factors in development modelling: an evaluative review," **op.cit.**, pp. 9-17.*

13/ However, the construction of a model which is not actually used may provide national economists with useful guidance for their own work on models which are more appropriate for their national requirements.

operate the model. Furthermore, the local model builders, being more sensitive about their own planning and development problems, will more readily respond to local needs, objectives and goals. They know the limitations of their resources and they are more aware of what is expected from future development.

In applying the BACHUE model to the Philippines, a workshop discussion was held with Philippine experts in the field of population, economics and planning. This process stimulated criticism and debate which led to modifications in the model. The application of the model for testing and evaluating ideas requires that the model should be exposed to considerable examination and debate. This is the point BACHUE-II has currently reached. To facilitate utilization of the model, other applications of BACHUE (in Kenya, Brazil and Yugoslavia) have been obtained entirely with collaboration maintained with local institutes, universities and governments.

Before accepting a model developed abroad, a planner should ask a number of questions. First, does the model address itself to the particular concerns of his country, or can it be adapted to them? Secondly, can he trust the relationships about development that are implied by the model? Thirdly, can the model be adapted to the data available in his country? Finally, can the model cope with the many discontinuities with which he as a planner has to deal? Using these criteria, complex models brought in from outside may not do as well as simpler ones which are built from the ground up within the country.

Still another question to be asked is can these models be made operational within the existing structure of government bureaucracy and decision making? If a model does not fit the implementation mechanism, it will not work even though it may accurately reflect a country's development problems. This is especially true when models cast problems in terms of national aggregates while actual dicisions are made and programmes implemented on a regional or local level.

Yet it should be noted that there are a number of obstacles facing those who would develop or adapt an economic-demographic model in a less developed country. There is often a shortage of technically qualified personnel. Planning techniques in vogue may not always be methodologically consistent. Furthermore, if technical assistance in this respect is being given from outside the system, it can be insulated from political demands and pressures.

Communication is a key to the success of a model. This communication is best achieved by putting country personnel into the modelling process from the very beginning. In order to gather more information about future development policies, national panels could be created of those potential users of the model who will have responsibility for making decisions that serve as the major exogenous input to the model.

Models can win greater acceptance by planners by broadening the scope of questions they are able to answer. These questions should be determined by both the model builder and user. A model is an instrument to help planners make decisions which must be in part political. If a model is to be effective as a political tool, the understanding of that model must go beyond the planning ministry. By comparing the outcomes of alternative demographic policies, these models can show politicians the high costs associated with certain decisions they might make.

Among the key requirements for employing models in the planning process are: the model must be adapted to the important decision points in the planning system, and planners must be persuaded to use those models. The key decision points in many countries are expenditure and revenue policies, credit allocation, foreign exchange allocation and infrastructure investment. However, the power to make these decisions is often dispersed among various implementing agencies. Therefore, the planning effort within government is widely dispersed at all levels. Under these circumstances the role of the planning unit becomes one of allocating resources subject to the constraint of limited foreign exchange, domestic savings and limited amounts of arable land. These models must be designed so as to function under such conditions.

C. Conclusions

Three methodological questions were considered. They were the choice of a central core for the model, the trade-off between simplicity and complexity and the choice of a supply or demand orientation. The choice of a central core for an economic-demographic model is a crucial one and can predetermine the results to be obtained from the model. In general the production functions used in the major models examined thus far tend to yield reduced *per capita* income in response to any growth in population. In choosing between simple models which are easily understood and complex models which more accurately reflect the real world, the user must weigh for himself the relative costs and benefits. Although the

BACHUE model is ostensibly demand-oriented when the effect of constraints on that model are considered it can be said that all the models considered have a supply orientation with the exception of the Purdue Development Model which utilizes the price mechanism to equate supply and demand. Ideally this is the direction in which future modelling effort should move. However great practical difficulties would have to be overcome in developing and applying such models.

As important as the construction of a model is its application to the policy making and planning processes of countries. In general this would be facilitated if the model were designed and developed in the country in which it was to be used. Such models would be more closely attuned to country-specific problems and the creation of the model would create a cadre of people within the country who were capable of operating and adapting the model.

BIBLIOGRAPHY

Adelman, I., and others. *The political economy of egalitarian growth,* International Labour Organisation, Geneva, 1976.

Ando, A., and F. Modigliani. The life cycle hypothesis of saving: Aggregate implications and tests. *American economic review,* LIII: 55-84, March 1963.

Arthur, W. Brian, and Geoffrey McNicoll. Large-scale simulation models in population and development: what use to planners? *Population and development review,* 1: 2: 251-265, December 1975.

Ayida, A.A., and G.P.O. Chikelu. Demographic aspects of development planning. United Nations. *The population debate: dimensions and perspectives* (vol. 1) (Sales No. E/F/S.75.XIII.4), 555-561.

Barlow, Robin. *The economic effect of malaria eradication,* Ann Arbor, University of Michigan School of Public Health, 1968.

Barlow, Robin, and Gordon W. Davies. Policy analysis with a disaggregated economic-demographic model. *Journal of public economics,* 3: 1: 43-70, February 1974.

Bennett, James P., Richard A. Brown and William E. McFarland. *Description of the economic-demographic model,* revised edition, June 1972. (68TMP-120 Revised).

Bhagwati, Jagdish N., and Richard S. Eckaus (eds.). *Development and planning; essays in honour of Paul Rosenstein Rodan.* London, George Allen & Unwin, Ltd.;and Cambridge, Mass. Massachusetts Institute of Technology Press, 1972.

Bilsborrow, Richard E. Fertility, Savings rates and economic development in less developed countries. *International Population Conference, Liege, 1973.* Liège, Belgium, International Union for the Scientific Study of Population, 1974. 1: 445-461.

. Dependency rates and aggregate saving rates: corrections and further analyses. Chapel Hill, University of North Carolina, 1973. Mimeo.

. *The preparation of inventory of demographic data for social and economic planning,* Chapel Hill, University of North Carolina, 1974.

Blandy, Richard. Population and employment growth: an introductory empirical exploration. *International labour review,* 106: 4: 347-366, October 1972.

Blandy, Richard, and Rene Wery. Population and employment growth: BACHUE-I. *International labour review,* 106: 4, October 1972.

. Population and employment growth: BACHUE-I. *International labour review,* 107: 5: 441-449, May 1973.

. BACHUE-I: the dynamic economic-demographic model of the population and employment project of the World Employment Programme. *International Population Conference, Liege, 1973,* Liège, Belgium, International Union for the Scientific Study of Population, 1974. 1: 17-51.

Blitzer, Charles R., Peter B. Clark and Lance Taylor (eds.) *Economy-wide models and development planning.* London, Oxford University Press, 1975.

Bolnick, Bruce R. *Demographic effects on tax shares during economic development.* International Labour Organisation World Employment Programme working paper, WEP 2-21/WP.35, March 1976.

Boserup, E. *The conditions of agricultural growth.* Chicago, Aldine, 1965.

. Population and agricultural productivity. United Nations. *The population debate: dimensions and perspectives,* (vol. 1) (Sales No. E/ES.75.XIII4), 498-501.

Boulier, Bryan L. *Population policy and income distribution.* Princeton, NJ, Office of Population Research, Princeton University, 1974.

Brown, Lester R. *In the human Interest.* New York, W.W. Norton and Company, 1974.

Brown, Richard A. *Survey of TEMPO, economic-demographic Studies.* Washington D.C., General Electric Corporation TEMPO, July 1974. (GE74TMP-19).

and Henry Cole. The TEMPO model as a Basis for Development Planning. Washington, D.C., General Electric Corporation TEMPO, 1975 (Mimeographed).

Cassen, Robert H. Population growth and public expenditure in developing countries. *International Population Conference, Liege, 1973,* Liège, Belgium, International Union for the Scientific Study of Population, 1974. 1: 333-350.

. Review of population and development planning, *People.* 3: 2: 47.

Chenery, Hollis B. (ed). *Studies in development*

planning. Harvard economic studies. 136. Cambridge, Mass., Harvard University Press, 1971.

Clark, D.H. Manpower planning in Singapore. *Malayan Economic Review*. October 1971.

Coale, Ansley J., and Edgar M. Hoover, *Population growth and economic development in low-income countries*. Princeton, Princeton University Press, 1968.

Coale, Ansley J. (ed). *Economic factors in population growth: proceedings of a conference held by the International Economic Association at Valescure, France*. New York, John Wiley & Sons, 1975.

Cochrane, S. Population and development — a more equal Model, *Economic development and cultural change*. April 1973.

Cole, R.E. Optimal population and increasing returns to scale. *Demography*. May 1972.

Corsa, L., and D. Oakley. Consequences of population growth for health services in less developed countries — an initial appraisal. National Academy of Science. *Rapid population growth: consequences and policy implication*. Baltimore, Johns Hopkins Press, 1971. 368-402.

Demeny, Paul. The economics of government payments to limit population: a comment. *Economic development and cultural change*. 9: 2: 641-644.

. Investment allocation and population growth. *Demography*. 2: 203-233.

. The economics of population control. National Academy of Sciences, *Rapid Population Growth Consequences and Policy Implication*. Baltimore, Johns Hopkins Press, 1971. Ch. 5.

Denton, Frank T., and Byron G. Spencer. A simulation analysis of the effects of population change on a neoclassical economy. *Journal of political economy*. March-April 1973: 356-375.

Dewit, Y.B. Fitting manpower planning to overall development planning. *Malayan economic review*. October 1971.

Easterlin, Richard. Effects of population growth on the economic development of developing countries. *Annuals of the American Academy of Political and Social Science*. 369: 98-108. 1967.

Edwards, Edgar O. *Employment in developing nations*. New York, The Ford Foundation, 1974.

Eilenstine, Donald. The savings consequences of reducing rates of population growth. Paper presented at the SEADAG seminar on the role of population planning in general economic planning, November 1973. Mimeographed.

Eizenga, Wenge. *Demographic factors and savings*. Amsterdam, North Holland Press, 1961.

Ekanem, Ita. A further note on the relation between economic development and fertility. *Demography*. 9: 3: 383-398.

Encarnacio, Jose, Jr. *An economic-demographic model of the Philippines*. Paper presented at the SEADAG population panel seminar on the role of population planning in general economic planning, San Francisco, 14-16 November 1973. Publication No. 74-2. New York, South East Asia Development Advisory Group of the Asia Society, 1973.

Enke, Stephen. The economic aspects of slowing population growth. *Economic journal*. 76: 301: 44-56.

. Economic consequences of rapid population growth. *Economic journal*. 81: 324: 800-811.

. Reducing fertility of accelerate development. *Economic journal*. 84: 334: 349-366.

. A budget allocation and human resources model, TEMPO II. Washington D.C., General Electric Corporation TEMPO. April 1973. (GETMP-12).

. *Population growth and economic development: background and guide*. Prepared for United States. Agency for International Development. Santa Barbara, General Electric's Center for Advanced Studies, TEMPO, 1968.

Erland, Hofsten. Population data needed for development planning in countries of the third world. *Public affairs information service bulletin*. 11 May, 1974. 33-34.

Evans, M.K. The importance of wealth in the consumption function. *Journal of political economy*. February 1968, 150-161.

Farooq, Ghazi M. Population growth, manpower, and employment. By Warren C. Robinson (ed). *Population and development planning*. New York, Population Council, 1975. 46-68.

Fei, John C.H., and Gustav Ranis. *Development of the labor surplus and economy: theory and policy*.

Chicago, Illinois, Richard D. Irwin, Inc., 1964.

. Development and employment in the open dualistic economy. *The Malayan economic review*. 16: 2: 91-116.

Food and Agricultural Organization of the United Nations. FAO/UNFPA seminar on methodology, research and country case studies on population, employment and productivity (FAO/UN/TF154). Rome, 1975.

Forrester, Nathan B. *The life cycle of economic development*. Cambridge, Mass., Wright-Allen Press, 1973.

Friend, I., and P. Taubman. The aggregate propensity to save; some concepts and their application to international data, *The review of economics and statistics*, XLVIII (May, 1966): 113-123.

Fromm, Gary, and Paul Taubman. *Policy simulations with an econometric model*. Washington D.C., Brookings Institution, 1968.

Green, H. Albert. LRPM2: a system of perspective planning submodels. Washington D.C., International Statistical Programs Center, Bureau of the Census, May 1972, revised March 1974.

Guest, Avery M. The relationship of the crude birth rate and its components to social and economic development. *Demography*. 11: 3: 457-472.

Hahn, Frank H., and R.C.O. Mathews. The theory of growth: a survey. *Economic journal*. 74: 4: 787-793.

Handler, Paul. Seminars in population dynamics and economic development. Urbana, Illinois, The Population Dynamics Group, University of Illinois at Urbana-Champaign.

and Chaisung Roh. The Population Dynamics Group economic-demographic model and its relationship to planning. Urbana, Illinois, Population Dynamics Group, University of Illinois, 1975. Mimeographed.

Hashmi, Sultan. Constraints in economic development: the problem of population growth in South Asia. E.A.G. Robinson and M. Kidson (eds.). *Economic development in South Asia*. New York, MacMillan Co., 1970.

Heal, G.M. *The theory of economic planning*. Advanced textbooks in economics, vol. 3. Amsterdam, North-Holland Publishing Company; and New York, American Elsevier Publishing Company, 1973.

Heilbroner, Robert L. *An inquiry into the human prospect*. New York, W.W. Norton and Company, 1974.

Hein, Dale. Aggregate effects of population on consumption in developing countries. Paper presented at the SEADAG seminar on the role of population planning in general economic planning, November 1973. Mimeographed.

Herrera, Amilcar O., and others. *Catastrophe or new society? a Latin American world model*. Ottawa, International Development Research Centre, 1976.

Hirschman, Albert O. *The strategy of economic development*. New York, McGraw-Hill, 1958.

Holmes, David N., Jr. A simplified approach to economic-demographic simulation. *Studies in family planning*. 3: 12: 297-305.

Hoover, Edgar M., and Mark Perlman, Measuring the effects of population control on economic development: Pakistan as a case study . *Pakistan development review*. 6: 4: 545-566.

Hopkins, M.J. D., G.B. Rodgers and R. Wery. A structural overview of BACHUE-Philippines. International Labour Organisation World Employment Programme working paper, WEP 2-21/WP.20, May 1975.

and H. Scolnik. *Basic needs, growth and distribution: a quantitative approach*. International Labour Organisation World Employment Programme working paper, WEP 2-21/WP.29, December 1975.

Hyrenius, Hannes. *On the use of models as instruments in formulating population policies*. Demographic Research Institute, University of Gothenburg, Sweden, 1974.

Institute of National Planning, Arab Republic of Egypt. *Population, employment and productivity in Egyptian agriculture*. Cairo, 1974.

Inter-Governmental Co-ordinating Committee, Southeast Asian Regional Co-operation in Family and Population Planning. Population and development planning. Kuala Lumpur, 1975.

International Bank for Reconstruction and Development. *Population policies and economic development*. Baltimore, Johns Hopkins University Press, for the International Bank for Reconstruction and Development, 1974.

International Labour Office, *Sharing in development: a*

programme of employment, equity and growth for the Philippines. Geneva, 1974.

Jones, Gavin W. Population growth and educational development in developing nations. New York, Halsted Press/Wiley, 1975 .

. Population growth and health and family planning, edited by Warren Robinson. *Population and development planning*.New York, Population Council, 1975.

. Effect of population change on the attainment of educational goals in developing countries. *Rapid population growth: consequences and policy implication*. Baltimore, National Academy of Sciences, Johns Hopkins Press, 1971.

Jones, Gavin W., and S. Selvaratnam. *Population growth and economic development in Ceylon*. Colombo, Hansa (in association with Marga Institute), 1972.

Kantner, John F., and Lee McCaffrey, *Population and development in southeast Asia*, Lexington, Mass., D.C. Heath and Co., 1975.

Keeley, Michael C. (ed). *Population, Public policy and economic development*. Praeger special studies in international economics and development . New York, Praeger, 1976.

Kelley, Allen C. Population growth, the dependency rate and the pace of economic development. *Population studies*. 27: 3: 405-414. The role of population in models of economic growth. *American economic review*. 64: 2: 39-44.

. *Demographic change and the size of the government sector*. International Labour Organisation World Employment Programme working paper, WEP 2-21/WP.32, February 1976.

. Jeffrey G. Williamson and Russell J. Cheetham. Biased technological progress and labor force growth in a dualistic economy. *Quarterly journal of economics*. 86: 3: 426-447.

and Jeffrey G. Williamson. Household savings behaviour in the developing economies. *Economic development and cultural change*. XVI: 385-403.

King, Timothy. Private savings. Keith Griffin (ed). *Financing development in Latin America*. London, MacMillan, 1971.

Kintanar, Agustin, and others. *Studies in Philippine economic-demographic relationships*. Quezon City, Philippines, Economic Research Associates, Inc. and Institute of Economic Development and Research, School of Economics, University of the Philippines, 1974.

Klein, Lawrence. What kind of macro-econometric model for developing economies? *Econometric annual of the Indian economic journal*. 13: 3: 313-324.

Kocher, James. *Rural development, income distribution, and fertility decline*. New York City, The Population Council, 1973.

Kosobud, Richard F., and William D. O'Neill. A growth model with population endogenous. *American economic review*. 64: 2: 27-32.

Kuznets, Simon S. Population and economic growth. *Proceedings of the American Philosophical Society*. 111: 3: 170-193.

. Rural-urban differences in fertility: an international comparison. *Proceedings of the American Philosophical Society*. 118: 1: 1-29.

Leff, Nathaniel H. Dependency rates and savings rates. *American economic review*. 59: 5.

Leibenstein, H. *A theory of economic-demographic development*. Princeton, Princeton University Press, 1954.

. The impact of population growth on economic welfare-nontraditional elements. *Rapid population growth: consequences and policy implication*. Baltimore, National Academy of Sciences, John Hopkins Press, 1971. 175-198.

Lewis, W. Arthur. *Development planning: the essentials of economic policy*. New York, Harper & Row, 1976.

Lin, Wuu-Long, and M.G. Ottaviani-Carra. *A systems simulation approach to integrated population and economic planning*. Food and Agricultural Organization of the United Nations, WS/H2518/E/11.75-5/1/300.

Lloyd, Peter J. A growth model with population and technological change as endogenous variables . *Population studies*. 23: 3: 464-478.

Maddison, Angus. *Economic progress and policy in developing countries*. New York, W.W. Norton Co. Inc., 1970.

Maxwell, Douglas L. *The TEMPO educational projection model*. Washington D.C., General Electric Corporation TEMPO, July 1974 (GE74TMP-15).

McFarland, William E. *Sensitivity analysis of the*

economic-demographic model. Santa Barbara, Center for Advanced Studies, General Electric Corporation TEMPO, 1969.

McFarland, William E., James P. Bennett and Richard A. Brown. *Description of the TEMPO II, budget allocation and human resources model. Washington D.C., General Electric Corporation TEMPO, April 1973 (GE73TMP-13).*

McFarland, William E., and others, *DEMOS: Demographic-economic models of society — a programmed learning system.* Washington D.C., General Electric Corporation TEMPO, July 1974 (GE74TMP-24).

McGreevey, William P., and others.*The policy relevance of recent social research on fertility.* Interdisciplinary Communications Program, Occasional Monograph Series No. 2. Washington D.C., Interdisciplinary Communications Program, Smithsonian Institution, 1974.

McGreevey, William P., and Steven W. Sinding, Population and the future of Bahrain. Washington, D.C., Interdisciplinary Communications Program, Smithsonian Institution, September 1973.

McNamara, Robert S. *One hundred countries, two billion people.* New York, Praeger Publishers, 1973.

McNicoll, Geoffrey. *On aggregative economic models and population policy.* East-West Population Institute Working Paper No. 18. Honolulu, Hawaii, East-West Population Institute, East-West Center, 1971.

Meadows, Dennis L., and others. *Dynamics of growth in a finite world.* Cambridge, Mass., Wright Allen Press, 1974.

Meadows Donella H., and others. *The limits to growth.* London, Pan Books Ltd, 1972 .

Minami, Ryoshin and Akira Ono. *Population change and economic growth: a long-term econometric model of the Japanese economy.* International Labour Organisation World Employment Programme working paper, WEP 2-21/WP.14, April 1975.

Mirrlees, James A., and N.H. Stern (eds). *Models of economic growth.* New York, John Wiley, 1973.

Myrdal, Gunnar. *Asian drama: An inquiry into the poverty of nations.* New York, Pantheon, 1968.

National Academy of Sciences, *In search of population policy: views from the developing world.* Washington D.C., 1974.

Newman, Peter. Population pressure and economic growth: an operational treatment. *Journal of development planning. 2: 31-57, 1970.*

Newman, Peter, and R.H. Allen. *Population growth and economic development in Nicaragua.* Prepared for the Government of Nicaragua and the United States Agency for International Development Nicaragua. Washington D.C., Robert T. Nathan,Assoc., 1967.

Ohlin, Goran. *Population control and economic development.* Paris, Organisation for Economic Co-operation and Development, 1967.

Paauw, Douglas S., and John C. Fei. *The transition in open-dualistic economies: theory and southeast Asian experience* (A publication of the Economic Growth Center, Yale University). New Haven, Conn., Yale University Press, 1973.

Pavlov, G.A. The interrelationships between development and population in the developing countries . United Nations. *The population debate: dimensions and perspectives* (vol. 1) (Sales No. E/-FIS.75.XIII.4), 549-554.

Peek, Peter. *Household savings and demographic change in the Philippines,* International Labour Organisation World Employment Programme working paper, WEP 2-21/WP.1, May 1974.

Pitchford, J.D. *Population in economic growth.* Contributions to Economic Analysis No. 85. Amsterdam, North-Holland Publishing Company, and New York, American Elsevier Publishing Company. 1974.

Purdue University Agricultural Experiment Station. *Input form for the Purdue development model.* West Lafayette, Indiana, August 1975.

. *Users guide to the Purdue development model computer program.* West Lafayette, Indiana, September 1975.

Pyatt, Graham, and Eric Thorbecke. *Planning Techniques for a Better Future.* Geneva, International Labour Office, 1976.

Quinn, Joseph E. The use of the LRPM and PDM models for structural analysis and development planning. Washington D.C., International Statistical Programs Center, United States Bureau of the Census, 1975.

. The reconstruction of age-specific disease death rates from incomplete data. Washington D.C., International Statistical Programs Center, United States Bureau of Census.

Ray, D. T. Tanahashi and B. Christian. A dynamic model of health and socio-economic development. Geneva, World Health Organization, Division of Strengthening of Health Services. (Mimeographed)

Rich, William. *Smaller families through social and economic progress*. Washington D.C., Overseas Development Council, 1973.

Robinson, E.A.G., and M. Kidson. *Economic development in south Asia*. New York, MacMillan Co., 1970.

Robinson, Warren C. (ed.). *Population and development planning*. New York, Population Council, 1975.

Robinson, Warren C., and D.E. Horlacher. Population growth and economic welfare. *Reports on Population/ Family Planning*. 6.

Rodgers, G.B., R. Wery and M.D.J. Hopkins, *On the evaluation of population and employment policy*. International Labour Organisation World Employment Programme working paper, WEP 2-21/WP.15, April 1975.

Economic-demographic modelling for development planning: BACHUE-Philippines. Geneva, International Labour Organization, 1976.

Ruprecht, Theodore D. *Rapid population growth and macro economic development: the Philippines case*. Bloomington, Indiana University, 1975.

. The introduction of a time dimension model to improve family planning administration. Paper presented at SEADAG meeting, San Francisco, November, 1973.

and Carl Wahren. *Population programmes and economic and social development*. Paris, Development Centre of the Organisation for Economic Co-operation and Development, 1970.

Sato, Kazuo, Applications of macro-economic models in national planning and projections. *Development planning*. 4: 36-63, 1972.

Saunders, Lyle, and J. Gilbert Hardee. *Rationale and suggestions for establishing a population planning unit*. Kuala Lumpur, The Ford Foundation, August 1972.

Schultz, T. Paul. An economic perspective on population growth. National Academy of Sciences. *Rapid population growth consequences and policy implications*. Baltimore, John Hopkins Press, 1971.

Shorter, Frederic C. *Computational methods for population projections: with particular reference to development planning*. New York, Population Council, 1974.

Simon, Julian L. *The effects of income on fertility*. Monograph 19. Chapel Hill, N.C., Carolina Population Center, University of North Carolina at Chapel Hill, 1974.

Simmons, George B. *The Indian investment in family planning*. New York, The Population Council, 1971.

. Public expenditure analysis and family planning programs. Leon Tabah (ed). *Population growth and economic development in the third world*. Liège, IUSSP, 1976. 561-563.

Singer, H.W. Income distribution and growth. United Nations. *The Population Debate: Dimensions and Perspectives* (vol. 1) (Sales No. E/F/S.75.XIII.4). 510-517.

Singh, S.K. *The determinants of aggregate savings*. Economic staff working paper No. 127. Washington D.C., International Bank for Reconstruction and Development, 1972.

Sinha, Jai N. Macro-models and economic implications of population growth. *International Population Conference, Liège, 1973*, Liège, Belgium, International Union for the Scientific Study of Population, 1973. 1: 477-494.

Snyder, Donald W. Econometric studies of household saving behaviour in developing countries: a survey. *Journal of development studies*. 10: 2: 138-153.

South East Asia Development Advisory Group, *Report of population panel seminar, San Francisco, 1973*, New York, SEADAG, 1974 (Mimeographed).

. *Report of population panel seminar on the role of economic-demographic models in development planning, New York 1975*, New York,SEADAG, 1975 (Mimeographed).

Spengler, J.J. Points of contact between the growth of population and the growth of national Product, United Nations. *World Population Conference, 1965* (vol. IV) (Sales No. 66. XIII. 8). 108-111.

Spengler, Joseph H. *Population change, modernization, and welfare*. Modernization of traditional societies. Englewood Cliffs, N.J., Prentice-Hall. 1974.

Stamper, B. Maxwell. Population policy in development planning , *Reports on population/family planning*. New York, Population Council, May 1973.

Stiglitz, Joseph E., and U. Uzawa (eds). *Readings in*

modern theory of economic growth. Cambridge, Mass., The M.I.T. Press, 1969.

Stone, Richard. *Demographic accounting and model-building.* (Education and development technical reports). Paris, Organisation for Economic Co-operation and Development, 1971.

United Nations. Demographic aspects of manpower (Sales No. 61.XIII.4)

. *Report of the United Nations World Population Conference, Bucharest, 19-30 August 1974* (Sales No. E.75.XIII.3).

. Department of Economic and Social Affairs. General principles for national programmes of population projections as aids to development planning. *Population Studies No. 38* (Sales No. 65.XIII.2).

. The determinants and consequences of population trends; new summary of findings on interaction of demographic, economic and social factors, vol. 1. *Population Studies No. 50.* (Sales No. E.71.XIII.5).

United Nations, Economic and Social Commission for Asia and the Pacific. Population and development in the ECAFE region. United Nations. *The population debate: dimensions and perspectives* (vol. 1) (Sales No. E/F/S.75.XIII.4), 642-647.

. Interrelation between population and manpower problems. United Nations. *Asian population study series,* No. 7 (E/CN.11/1015).

. The regional seminar on ecological implication of rural and urban population growth. United Nations. *Asian population study series,* No. 10 (E/CN.11/1043).

. Population aspects of social development. United Nations. *Asian population study series,* No. 11 (E.CN.11/1049).

. Socio-economic returns of family planning programmes. United Nations. *Asian population study series,* No. 12 (E/CN.11/1070).

. Some techniques for measuring the impact of contraception. United Nations. *Asian population studies series,* No. 18 (E/CN.11/1119).

. Population strategy in Asia. United Nations. *Asian population study series,* No. 28 (E/CN.11/1152). p. 66.

. Report of the expert group meeting on population projections. United Nations. *Asian population study series,* No. 33.

. Report of the multinational study in methodologies for setting family planning targets in the ESCAP region (in preparation).

. Population aspects of manpower and employment-A:A regional overview. United Nations. *Asian population studies series,* No. 35

. Economic and Social Council. *Report of the interregional seminar on application of demographic data and studies to development planning, Kiev, Ukranian Soviet Socialist Republic, 15-25 September 1969 (E/CN.9/223).*

. Economic-demographic models, United Nations. *The population debate: dimensions and perspectives* (vol. 1) (Sales No. E/F/S.75.XIII.4). 476-483.

United States Bureau of Census, International Statistical Programs Center, Socio-Economic Analysis Staff, Input instructions for MIGRAT2, rural-urban migration projection submodel of LRPM2, long-range planning model. Washington D.C., October 1975.

. Input instructions for DEMWA2, long-range planning model. Washington D.C., October 1975.

. Input instructions for EDUC2, educational sector projection submodel of LRPM2, long-range planning model. Washington D.C., October 1975.

. Input instructions for House2, housing sector projection submodel of LRPM2, long-range planning model. Washington D.C., October 1975.

. Input instruction for HEALTH2, health sector projection submodel of LRPM2, long-range planning model. Washington D.C., October 1975.

. Input instructions for FMPLN2, family planning program simulation submodel of LRPM2, long-range planning model. Washington D.C., October 1975.

. Input instructions for Demog2, population projection submodel of LRPM2, long-range planning model. Washington D.C., October 1975.

. Senegal, profiles of Sahelian countries. Washington D.C., October 1975.

Vernon, R. Comprehensive model building in the planning process: the case of the less developed economies. *Economic journal.* LXXVI: 55-69.

Walsh, B. Thomas. *Economic development and population control: a fifty-year projection for Jamaica.* Praeger special studies in international economics and development. New York, Praeger, 1971.

Wan, Henry Y., Jr. *Economic growth,* New York, Harcourt Brace Jovanovich, Inc., 1971.

Waterbury, John. *LRPing in the Arab world, Northeast Africa Series,* XXI: 1, Arab Republic of Egypt, Africa, May 1976.

Waterson, Albert. *Development planning.* Baltimore, Johns Hopkins Press, 1965.

Wery, R., G.B. Rodgers and M.D. Hopkins. *BACHUE-2: Version I A population and employment model for the Philippines,* International Labour Organisation World Employment Programme working paper, WEP 2-21/WP. 5, July 1974.

Wery, Rene, *Demographic factors in government expenditure: an international comparison.* International Labour Organization World Employment Programme working paper, WEP 2-21/WP.34, March 1976.

White, T. Kelley, and others. *The PDM: a systems approach to modeling demographic-economic interaction in agricultural development.* West Lafayette, Indiana, Purdue University.

White, T. Kelley. *An overview of the PDM: an interactive approach to modeling population growth and economic development.* West Lafayette, Indiana, Purdue University.

Williamson, J.G. Personal savings in developing nations: an intertemporal cross section from Asia. *Economic record.* June 1968.

Wu, Chi-Yuen. Growth models and limits-to-growth models as bases for public policymaking in economic development. *Policy sciences,* 5: 2: 191-211.

Zaidan, George. Population growth and economic development. *Finance and development.* 1 (1968): 28-8.

of Fertility Behaviour (E/CN.11/1231): 1974

No.27** *Report and Selected Papers of the Regional Project on Pre-testing and Evaluation of Educational Materials Used in Family Planning Programmes* (E/CN.11/1159): 1975

No.28** *Population Strategy in Asia — Report, Declaration and Selected Papers of the Second Asian Population Conference, November 1972* (E/CN.11/1152): 1975

No.29** *Report of the Comparative Study on the Administration of Family Planning Programmes in the ESCAP Region: Organizational Determinants of Performances in Family Planning Services in Selected ESCAP Countries* (ST/ESCAP/16): 1977

No.30 *Report of the Comparative Study on the Input-Output Relationships in Family Planning Programmes in Selected Countries of the ESCAP Region* (under preparation)

No.31** *Report of the Multinational Study in Methodologies for Setting Family Planning Targets in the ESCAP Region* (ST/ESCAP/14): 1977

No.32** *Guidelines for Preparing Subnational Population Projections* (E/CN.11/1230): 1975

No.33* *Report of the Expert Group Meeting on Population Projections* (E/CN.11/1250): 1976

No.34** *Report and Selected Papers of the Expert Group Meeting on Translation of Population Materials* (ST/ESCAP/13): 1977

No.35** *Population Aspects of Manpower and Employment*
A: A Regional Overview, 1976 (mimeographed)
B: Comparative Study of Five Countries (under preparation)

No.36 *Report of the Expert Group Meeting on Organizational Aspects of Integrating Family Planning with Development Programmes* (ST/ESCAP/38)

No.37 *Report on Evaluation of the Role of Population Factors in the Planning Process through the Application of Development Models* (ST/ESCAP/64)

No.38 *Report of the Expert Group Meeting on Migration and Human Settlements* (ST/ESCAP/46)

No.39 *Report of the Expert Group Meeting on Population and Development Planning* (ST/ESCAP/49)

No.40 *Population Growth and Economic Development in Subnational Areas — Report of an Expert Group Meeting* (ST/ESCAP/54)

No.41 *Report of the Expert Group Meeting on Socio-economic Measures Affecting Fertility Behaviour with Special Emphasis on Actionable Programmes*

B. Country Monograph Series

No.1** *Population of Hong Kong* (E/CN.11/1120): 1974

No.2** *Population of the Republic of Korea* (E/CN.11/1241): 1975

No.3** *Population of Thailand* (ST/ESCAP/18): 1976

No.4 *Population of Sri Lanka* (ST/ESCAP/30): 1976

No.5 *Population of the Philippines* (under preparation)

No.6 *Population of Japan* (under preparation)

No.7 *Population of Nepal* (under preparation)

No.8 *Population of Malaysia* (under preparation)

No.9 *Population of Bangladesh* (under preparation)

No.10 *South Pacific Series* (under preparation)

D. The Second Asian Population Conference, Tokyo, 1972

** Official report (refer APSS NO.28)
Available documents

C. Miscellaneous publications

1.** *Report of the Expert Working Group on Problems of Internal Migration and Urbanization, and Selected Papers* (SA/Dem/EGIM/L. 22): 1967

2.** *Projections of Populations of Subnational Areas — Report of a Working Group* (E/CN.11/897): 1969

3.** *Directory of Key Personnel and Periodicals in the Field of Population in the ECAFE Region* (E/CN.11/898; United Nations publication, Sales No. E.70.II.F.14): 1970

E. Asian Population Programme News

** A quarterly regional newsletter, published since 1971. Issue to date comprise Vol. 1, Nos. 1, 2, 3; Vol. 2, Nos. 1, and 2 and 3 (combined); Vol. 3, Nos. 1 and 2 (combined), Nos. 3 and 4 (combined); Vol. 4, Nos. 1, 2 and 3 (combined), No. 4; Vol. 5, Nos. 1, 2, 3 and 4 (combined); Vol. 6, Nos. 1, 2, 3 and 4 (under preparation) and occasional special issues.

F. Population Headliners

A monthly mimeographed news-sheet. Circulation is limited to ESCAP Population Correspondents and Member Government decision-makers.

G. ADOPT (Asian and World-wide Documents On Population Topics)

A monthly listing of publications with in-depth subject analysis for population libraries and reference centres in the ESCAP region. Available to institutions, professionals, libraries and reference centres on request.

HOW TO OBTAIN ESCAP PUBLICATIONS

ESCAP publications for sale may be obtained from:

(1) ESCAP secretariat, United Nations Building, Rajdamnern Avenue, Bangkok 2, Thailand

(2) Sales Section, United Nations, New York, N.Y. 10017, USA

(3) Sales Section, European Office of the United Nations, Geneva, Switzerland

ESCAP free publications may be obtained only from ESCAP at address (1) above.

Allied Printers printed by Michael [illegible]s Gorman for Post Publishing Co., Ltd.
U-Chuliang Building, 968 Rama IV R[illegible]ngkok, Thailand. Tel. 2330488, 2338030, 2338040