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Title

TOWARDS AN INTEGRATED MULTI-OBJECTIVE PLANNING FOR NATIONAL DEVELOPMENT IN SAUDI ARABIA

Presented by Faisal M. AL-Tamimi

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THESIS ABSTRACT

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Throughout this effort, our guiding principle has been that the study of development is better served by explicitly including the multi-dimensional and the multi-objective properties of development plans into policy relevant models. In order to be of operational use in policy analysis and guidance, the models should closely fit the substantive context and, where required, include relevant subsystems and their interdependencies. The extent of the required flexibilities for a multi-objective planning for national development, which our models readly accommodates, are generally dependent on proper integration of system characteristics (and exhibited behaviors) with decision making (which includes consideration of policy makers attitudes and the extent of their ability to exercise influence over the system's behavior). In this thesis we represent mixed planning situations, observed in a large class of developing countries, by integrating models and information about system behaviors with planning activities affecting the inputs, the outputs and, in some cases, aspects of that behavior. Additionally, our framework and its analytical foundation accommodate the potential flexibilities required in modelling issues applicable to many development situations, particularly the simultaneous consideration of multiple objectives and their mixed impacts.

The models presented in this thesis utilize the principles of input-output modelling to represent relationships between and within economic and social-demographic systems for both internal activities and dynamic flows over time. However, straightforward application of input-output models is not enough. Since planning is a goal-setting and decision-making activity, we need to modify input-output models to permit the satisfaction (as closely as possible) of these goals which involves compromise and adjustments of goals and preferences during the planning process. To do this we join input output analysis with the ideas of goal programming as a more faithful representation of the characteristics of development planning and decision making. Hence, we are able to structure an integrated system for national development with multiple and possibly conflicting goals.

By integrating among input-output and goal programming principles, in thesis, we specifically introduce the elements of a policy making system adequate to deal with the many dimensions that need to be simultaneously considered when planning the development of a nation such as Saudi Arabia. Such a nation has many features not encountered in the usual planning-development literature. Generally speaking it has the

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status. characteristics and constraints particular to a "developing country," but it also has financial resources which are. theoretically. adequate for rapid development. These resources come largely. however. in the form of foreign exchange. Although Saudi Arabia may continue for some time to enjoy large foreign exchange surpluses. it must nevertheless consider shortages in human resources--in the domestic labor force--and in certain industrial outputs. An implicit objective of this proposed thesis is to provide a means for directing and controlling the balance between domestic and expatriate labor in a way that ensures that longer run capabilities within Saudi Arabia will be produced.

Since policy directions and development programs are implemented on a variety of socio-economic as well as physical dimensions. another objective of this thesis is to clarify the interdependence among several of these subsystems and the cross impacts of their planning activities. The criteria to be used are not solely economic. Social and demographic characteristics must be simultaneously considered for long-run as well as short-run consequences in any reasonably adequate approach to development planning for Saudi Arabia. This. in turn. requires the development of adequate planning tools. This thesis addresses two subsystems namely Economic-Manpower and Housing development models. These subsystems in turn will form part of a multi-objective framework within which different aims and policies may be reconciled.

Specifically. planning in Saudi Arabia is regarded as a process in which objectives and criteria evolve rather than as a situation in which they have already been established. Impact analyses and implementability are part of the criteria of evaluation. Decisions emerge after a number of opinions. conflicts, and dissents are resolved. more or less. with a combining and recombining of information. Information feedback about the achievement of goals and their possible effects on others plays an important role. in our context. for the successive adjustments of preferences and reconciliation of conflicting goals between different decision-makers. In our context. the Ministry of Planning is seen to be the primary user of our models. Their interest is in the analysis of alternative solutions and the consequences of various subsystem requirements along with the trade-offs among planning activities. The Ministry of Planning's role extends from coordination (among subsystem and government agencies' planning activities) to arbitration (reflecting policy directions from a higher authority-the Council of Ministers) among the alternative preferences and planning goals. As such. several preferences within and between subsystems (initially defined by planners in the various areas) could be indicated and thereafter adjusted in an iterative process. We have.

therefore, shown in various prototypes how the resulting effects of selected changes in goals and preferences including trade-offs among several of the goals can be traced and evaluated.

All of the work in this thesis is anchored in the substantive context of Saudi Arabia. Data were collected from several sources and, because of the usual lacunae, used as prototypic (rather than actual) representation of Saudi Arabia's development characteristics. We had several objectives for our use of these prototype data: 1) to illustrate our model's capabilities', 2) to point to areas for data collection, and 3) in some cases, to examine tools and methods that could be used to provide necessary estimates. We may recall that one set of purposes of the models we selected is directed towards their use when the requisite data are available. An equally important set of uses, however, involves the use of these models to systematize the collection of data. The latter can help guide the needs for data quality in terms of the uses to which they are to be put.

To portray all relevant aspects of the development situation characteristic of Saudi Arabia is a task beyond the scope of this thesis: therfore, we were rather selective.

In Chapter One a review of the properties of multidimensional accounting and planning is presented in a way that is pertinent to this thesis. An outline of the planning and decision making structure in Saudi Arabia is also provided. This chapter concludes with a summary of models for socio-economic and housing development to be presented in detail in the following chapters of the thesis.

In Chapter Two, we present the detailed development of a socio-economic model incorporate issues specific to the development of Saudi Arabia such as the changes in the structure of production with industrialization and the role of imports in supplementing domestic production. In addition, specific attention is accorded to the demographic and social aspects of labor inputs and outputs, particularly expatriate labor's participation in production and in government. Moreover, we introduce government agencies' plans for capital development and for their own operation.

The planning problem is presented in Chapter Two as a multi objective goal program dealing simultaneously with expatriate labor and government planning goals. Finally, we examine multi period numerical applications of alternative policies to evaluate between alternative priorities and conflicting goals.

In Chapter Three we develop a model for housing development indicating the various planning activities and behavioral changes influencing family-to-house distributions. Housing development in this model is guided mainly by the criterion (of which the aim is to improve conditions) for families whose housing is considered to be within the government's direct or indirect responsibility. We also consider the inputs and outputs of families as well as their changing characteristics over time. This includes the migration and immigration of expatriate families and the ensuing housing requirements and/or vacancies. We then link this model to the overall socio-economic model developed in Chapter Two to examine the cross impacts as well as the multiplier effects of housing development on the rest of the system.

The planning problem is presented in Chapter Three as a multi objective goal program dealing simultaneously with goals related to the housing distribution of new families and the redistribution of existing families. Further, by linking this model to the socio-economic model developed in Chapter Two, we consider also those goals dealing with expatriate labor and with government plans.

Finally, we examine numerical applications of alternative policies to evaluate alternative priorities and goals.

Chapter Four focuses on the input-output characteristics of houses, population, and families: it presents a multi period model to deal with the transitions and changes affecting the joint family-to-houses distributions. Further we examine demographic, family, and houses input-output properties to project changes in families and houses and in turn estimate future housing conditions and housing needs. The recursive impacts from these changes are then considered in connection with the housing development model developed in Chapter Three. Further, to support our model, we examine prototypical data for changes in family characteristics in Saudi Arabia. In effect we develop a model to estimate the non-stationary transition probabilities needed to project the future distribution of families. Finally we extend the applications in Chapter Three to include the recursive effects resulting from the transitions.

Despite their complexity, our models are of necessity partial in their breadth and depth. Hence, we conclude this thesis by examining its developments and also by pointing to areas for future research.

"... The study of "systems" is an increasingly popular activity.....a response to a need for synthesizing and analyzing complexity ..... necessity will have to master invention and *also* provide substance to go with the name"[1]

"In art as in science there is no delight without the detail, and it is on details that I have tried to fix reader's attention. Let me repeat that unless these are throughly understood and remembered, all 'general ideas' (so easily acquired, so profitably resold) must necessarily remain but worn passports allowing their bearers shortcuts from one area of ignorance to another"[2]

---

1 H. Simon, "The Architecture of Complexity", Proceeding of the American Philosophical Society, 106, Dec 1962.

2 Vladimir Nabokov, Translators Introduction to Pushkin's Eugene onegin, Patheer Publishers, New York 1972.

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TABLE OF CONTENTS

1. INTRODUCTION, OBJECTIVES, AND DIRECTIONS 2

1.1 BACKGROUND AND OBJECTIVES 2
1.2 INTRODUCTION AND PREVIEW 4
1.3 THESIS OUTLINE 7
1.4 MULTIDIMENSIONAL ACCOUNTING FOR MULTIPLE SYSTEMS 9
1.5 MULTI OBJECTIVE PLANNING FRAMEWORK 15
1.5.1 In The Course of Planning 15
1.6 OVERVIEW OF MODELS AND THEIR CHARACTERISTICS 23

2. A MULTI DIMENSIONAL SOCIO-ECONOMIC DEVELOPMENT MODEL 29

2.1 INTRODUCTION 29
2.2 MODEL DEVELOPMENT 30
2.2.1 Sectoral Material Balance 35
2.2.1.1 Base year Prototype Data and Input Output Relationships 39
2.2.2 Labor Inputs and Links to Manpower Systems 43
2.2.2.1 Base Year Prototype Data, Labor Requirements, and Expected Labor Inputs 48
2.2.3 Household Consumption 57
2.2.4 Government and Its Roles 59
2.2.5 Imports and Exports 63
2.2.6 Sector Project Planning 64
2.3 SOLUTION METHOD AND APPLICATION 68
2.3.1 Government Goals and their Impacts 72
2.3.2 Expatriate Labor and Government Plans 77
2.3.3 Expatriate Labor and Agency Plans 86
2.4 SUMMARY AND CONCLUSIONS 91

3. MULTI OBJECTIVE PLANNING FOR HOUSING AND LINKAGES TO SOCIO-ECONOMIC DEVELOPMENT 94

3.1 INTRODUCTION 94
3.2 BACKGROUND 95
3.3 MODEL DEVELOPMENT 98
3.3.1 Housing Distributions and Accounting Relations 102
3.3.1.1 Base Year Family-House Distribution Data 104
3.3.2 Distribution Criteria and Goals 109
3.3.2.1 Prototype Data for Alternative Criteria 112
3.3.3 Domestic and Expatriate Family Inputs 112
3.3.4 Input-Output Linkages To the Socio-Economic Model 120
3.4 SOLUTION METHOD AND NUMERICAL ILLUSTRATIONS 122
3.4.1 Housing Goals and Their Impacts 125
3.4.2 Housing Goals, Expatriate Labor, and Government Plans 136
3.5 SUMMARY AND CONCLUSIONS 137

4. A JOINT FAMILY HOUSE DISTRIBUTION MODEL AND MULTI-PERIOD RELATIONSHIPS 139

4.1 INTRODUCTION 139
4.2 HOUSES INPUTS AND OUTPUTS 140
4.3 POPULATION INPUT-OUTPUT AND FAMILY ASSOCIATION 144
4.3.1 Population-Family Association 146
4.3.1.1 Prototype Data 149
4.4 FAMILY INPUTS AND OUTPUTS 153
4.4.1 Estimation of Family Transitions 154
4.5 A JOINT FAMILY-HOUSING INPUT-OUTPUT MODEL 160

4.5.1 Recursive Relationships 161
4.6 MULTI-PERIOD APPLICATION AND NUMERICAL ILLUSTRATION 164
4.7 Summary and Conclusions 169

5. CONCLUSIONS AND FUTURE DIRECTIONS 171

5.1 INTRODUCTION 171
5.2 THE OVERALL MODELS 172
5.3 HOUSING MODELS 175
5.4 COMPUTATION AND APPLICATION 177
5.5 A PROLOGUE TO FIELD IMPLIMENTATION 178

6. APPENDICES 182

1-A Selected Notes on Manpower-Education and Housing Systems and Quality of Life Issues 184

1-A.1 Manpower-Education 184
1-A.2 Housing 188
1-A.3 A Taxomony of Several Quality of Life Issues 190

1-B Notes on Data Activities 197

1-C Notes on Some Aspects of Decision Making 204

2-A Simulation Of Alternative Scenarios 209

2-B Intermediate and Labor Input Output coefficients 213

2-C Labor Income and Household Consumption 219

2-D Outputs of Alternative Applications 228

2-D.1 Numerical Illustration: Government Goals and Their Impacts(ECN11 229
2-D.2 Numerical Illustration: Total Government Plans and Labor Goals (ECN13 231
2-D.3 Numerical Illustration: Government Agencies Plans and Labor Goals (ECN14 237

3-A Appendix 241

3-B Housing Development and Expatriate Labor Multiplier 244

3-C Solution Outputs for Alternative Housing Development Goals 247

3-C.1 Numerical Results For ECHSE1 Illustration 247
3-C.2 Numerical Results For ECHS11 Illustration 254
3-C.3 Numerical Results For ECHSS1 Illustration 261

3-D Solutions For Initial Housing Goals and Labor-Government Trade-offs 268

3-D.4 Numerical Results For ECHS101 Illustration 268
3-D.5 Numerical Results For ECHS102 Illustration 277
3-D.6 Numerical Results For ECHS103 Illustration 286
3-D.7 Numerical Results For ECHS104 Illustration 295
3-D.8 Numerical Results For ECHS105 Illustration 304

3-E Solutions For Alternative Housing Goals and Labor-Government Trade-offs 313

3-E.9 Numerical Results For ECHS201 Illustration 313
3-E.10 Numerical Results For ECHS202 Illustration 322
3-E.11 Numerical Results For ECHS203 Illustration 331

4-A Estimation Approaches of Input Output Coefficients 341

4-B Data For Multi Period Illustrations 347

4-B.1 Base Year (1976 347
4-B.2 Expected Distrubutions at 1980 348
4-B.3 Projected Output Data for Alternative Illustrations 349

7. BIBLIOGRAPHY

LIST OF FIGURES

Figure 1-1:	Multiple Systems Interactions	11
Figure 1-2:	Multiple System Cycle Of Interactions	13
Figure 1-3:	A List Of Government Agencies	16
Figure 1-4:	The Structure Of Planning	19
Figure 1-5:	Decision Making Process	22
Figure 2-1:	Factors Considered In Model Development	31
Figure 2-2:	Model Functional Relationships	33
Figure 2-3:	One Period Planning Model	34
Figure 2-4:	Base Year And Changes In Input Output Coefficients	44
Figure 2-5:	Proportion Of Labor In Sectors And Government	50
Figure 2-6:	Projected Changes in Labor Input Ratios	52
Figure 2-7:	Alternative Applications	69
Figure 2-8:	Expected Growth in Output, import, and Consumption	74
Figure 2-9:	Labor inputs, outputs, imports, and consumption: ECN11	75
Figure 2-10:	Domestic/Expatriate Labor Ratio and Related Variables	76
Figure 2-11:	Domestic and Expatriate Labor in Production Sectors	78
Figure 2-12:	Government And Labor Net Deviations: ECN13	80
Figure 2-13:	Deviation Of Government Plans And Labor Goals	81
Figure 2-14:	Sector Outputs For Alternative Applications: ECN13	83
Figure 2-15:	Alternative Expatriate Labor Inputs: ECN13	85
Figure 2-16:	Expected Growth In Output, Imports, And Consumption: ECN13	87
Figure 2-17:	Government and Labor Net Deviations: ECN14	90
Figure 3-1:	Factors Considered In Housing Development	99
Figure 3-2:	Model Functional Relationships	100
Figure 3-3:	One Period Planning Model	101
Figure 3-4:	Base Year Family Proportional Distribution To Houses	108
Figure 3-5:	Distribution Criteria for New Families	114
Figure 3-6:	Size Compatibility Criteria	116
Figure 3-7:	Ownership Criteria	118
Figure 3-8:	Outline of Alternative Applications	123
Figure 3-9:	Family-To-House Distribution Ratios: ECHS11	131
Figure 3-10:	Family-To-House Distribution Ratios: ECHSS1	133
Figure 4-1:	Multi-Period Denotations	164
Figure 4-2:	Multi-Period Relationships: ECHSE1 Illustration	166
Figure 4-3:	Multi-Period Relationships for Family Size (2)	168
Figure 4-4:	Unhoused families Size (2)	168
Figure 1-A-1:	Components In Manpower System Development	185
Figure 1-A-2:	Input Output Framework For Labor And Job Flows	187
Figure 1-A-3:	Family-Housing Activities And Considerations	189
Figure 1-B-1:	DECISION SUPPORT ACTIVITIES	198
Figure 1-B-2:	Flow Of Data And Solution Process	200
Figure 1-B-3:	Flow Of Data And Planning Activities	201
Figure 2-A-1:	Alternative Scenarios For Domestic Outputs	211

LIST OF TABLES

Table 2-1:	Base Year Input Output Data	40
Table 2-2:	Operation Requirements For Projects	41
Table 2-3:	Base Year And Projects Outputs	41
Table 2-4:	Base Year Input Output Coefficients	42
Table 2-5:	Projects Expected Input Output Coefficients	42
Table 2-6:	Base Year Labor Data	49
Table 2-7:	Labor Input Per Unit Output: 1976	53
Table 2-8:	Project Labor Requirments	53
Table 2-9:	Government Labor Requirements	54
Table 2-10:	Expected Domestic Labor Inputs	55
Table 2-11:	Expatriate Labor Forecasts	56
Table 2-12:	Government Operations And Capital Requirements	62
Table 2-13:	Sector Project Requirements	67
Table 2-14:	Summary Of Constraint Rows	70
Table 2-15:	Summary Of Activity Columns	71
Table 2-16:	Computational Statistics	72
Table 2-17:	Projected Sector Supplies and Demands: ECN11	73
Table 2-18:	Projected Labor in Government and Sectors: ECN11	73
Table 2-19:	Goals And Deviations In Government Plans And Labor Goals	79
Table 2-20:	Alternative Sector Outputs: ECN13	82
Table 2-21:	Total Expatriate Labor By Job Category: ECN13	84
Table 2-22:	A Summary Of Model's Indicators: ECN13	86
Table 2-23:	A Summary Of Model Indicators: ECN14	89
Table 3-1:	Base Year Family Distribution To Houses	106
Table 3-2:	Base Year Family Proportional Distribution To Houses	107
Table 3-3:	Distribution Criteria For New Families	113
Table 3-4:	Distribution Criteria With Emphasis On Family-House Size Compatibility	115
Table 3-5:	Distribution Criteria With Emphasis On Ownership	117
Table 3-6:	Estimated Number of Domestic Families To Be Housed	119
Table 3-7:	Summary Of Constraint Rows	124
Table 3-8:	Summary Of Activity Columns	124
Table 3-9:	Family-To-House Distribution: ECHSE1	126
Table 3-10:	Family-To-House Distribution: ECHS11	127
Table 3-11:	Family-To-House Distribution: ECHSS1	128
Table 3-12:	Family-To-House Distribution Ratios: ECHS11	130
Table 3-13:	Family-To-House Distribution Ratios: ECHSS1	132
Table 3-14:	Vacant and Newly Required Houses	134
Table 3-15:	Expatriate Labor Recruiting Requirements	135
Table 3-16:	Domestic Output, Imports, and Consumption	135
Table 4-1:	Inputs And Outputs Of House Stocks	141
Table 4-2:	Base Year (1976) Population Data	147
Table 4-3:	Domestic Population Projections	147
Table 4-4:	Dependent-Family Association Ratios	150
Table 4-5:	BASE YEAR FAMILY DATA	152
Table 4-6:	PROJECTED DOMESTIC FAMILIES	152
Table 4-7:	Domestic Family Movments	159
Table 4-8:	FAMILY-HOUSE DISTRIBUTION INPUT OUTPUT	160
Table 4-9:	Family Distributions, "Expected" and "Projected"	165
Table 4-10:	Projected "unhoused" Families	165
Table 2-A-1:	Base Year And Projects Expected Outputs	210
Table 2-A-2:	Outputs Under Alternative Scenarios	210
Table 2-B-1:	Base Year Input Output Coefficients	215
Table 2-B-2:	Expected Input Output Coefficients Period 1	215
Table 2-B-3:	Expected Input Output Coeffecients Period 2	215

Table 2-B-4: Base Year Labor Input Per Unit Output 216
Table 2-B-5: Expected Labor Input Per Unit Output Period 1 216
Table 2-B-6: Expected Labor Input Per Unit Output Period 2 216
Table 2-C-1: Average Income Of Labor In Government 222
Table 2-C-2: Average Income Of Labor In Sectors 222
Table 2-C-3: Labor Income Distribution To Housholds 224
Table 2-C-4: Houshold Consumption Coefficients 224
Table 2-C-5: Consumption Coefficients For Housholds Related To Domestic Labor In Sectors 225
Table 2-C-6: Consumption Coefficients For Households Related To Expatriate Labor In Sectors 225
Table 2-C-7: Consumption Coefficients For Housholds Related To Domestic Labor In government 226
Table 2-C-8: Consumption Coefficients For Housholds Related To Expatriate Labor In government 226
Table 3-A-1: Proportions Of Domestic Families Distribution To Houses 242
Table 3-A-2: Proportions Of Expatriate Families Distribution To Houses 243

CHAPTER ONE

INTRODUCTION, OBJECTIVES,AND DIRECTIONS

CHAPTER 1
INTRODUCTION, OBJECTIVES, AND DIRECTIONS

1.1 BACKGROUND AND OBJECTIVES

Isolated for a long period of time, by geography and choice, Saudi Arabia has recently acquired some of the means for building a "modern" state. Changes that usually have spread out over several generations are being compressed into a few short years. As a consequence, the tribal characteristics and the traditional life styles are changing, with some resistance, to accommodate new flows of information. Modern transportation and communication systems being introduced to the country and continuing contacts with the outside world have resulted in a rapid interchange and flow of goods, people and ideas. Some of the subsequent changes have already occurred in several ways including rapidly growing cities as well as social and economic changes. To promote these transitions, the government has offered incentives to sectors of the population to improve their quality of life, including housing, education, and work.

Saudi Arabia exhibits some aspects of a rapidly developing nation with varied successes and mixed (positive and negative) impacts in adaptation to local situations. Among the many planning objectives that have prevailed during recent periods are:

- Acceleration of economic, physical, and social development beyond what most developing (underdeveloped) nations have experienced
- Expansion of the capability to undertake rapid development
- Reduction of economic and other constraints and an opportunity to implement different types of plans and proposals
- The need for developing a comprehensive information base and methods and procedures for improved planning and plan development to whatever degree of sophistication might be required.

The purpose of this thesis is to introduce the elements of a policy making system model which is adequate to deal with the many dimensions that need to be simultaneously considered when planning the development of a nation such as Saudi

Arabia. Such a nation has many features not encountered in the usual planning-development literature. Generally speaking it has the status, characteristics and constraints particular to a "developing country," but it also has financial resources which are, theoretically, adequate for rapid development. These resources come largely, however, in the form of foreign exchange.

In the case of Saudi Arabia, no other major natural (domestic) resource besides oil and some of its byproducts are available. This means that there must be large amounts of imports of both foreign resources and labor with which to undertake immediate development. Although Saudi Arabia may continue for some time to enjoy large foreign exchange surpluses, it must nevertheless consider shortages in human resources--in the domestic labor force--and in certain industrial outputs. An implicit objective of this proposed thesis is to provide a means for directing and controlling the balance between domestic and expatriate labor in a way that ensures that longer run capabilities within Saudi Arabia will be produced.

Since policy directions and development programs are implemented on a variety of socio-economic as well as physical dimensions, another objective of this thesis is to clarify the interdependence among several of these subsystems and the cross impacts of their planning activities. The criteria to be used are not solely economic in character. Social and demographic, as well as economic characteristics must be simultaneously considered for long-run as well as short-run consequences in any reasonably adequate approach to development planning for Saudi Arabia. This, in turn, requires the development of adequate planning mechanisms, including new varieties when necessary. This forms the main subject of this thesis which will be addressed in two subsystems namely economic-manpower and housing development. These subsystems in turn will form part of a multi-objective framework and to aid in planning activities and resolution of different aims and policies.

1.2 INTRODUCTION AND PREVIEW

More generally, the purpose of the proposed thesis is to develop a multidimensional planning capability for countries which, like Saudi Arabia, have the possibilities of relatively rapid development open to them. The central idea for this thesis is the need for developing a multidimensional planning framework and methodology to structure these separate areas of planning into an integrated system. This includes accommodating impacts and feedbacks between the component systems as well as the internal dynamics of each.

Planning for national development has been and still is being studied in a fragmented way by researchers in a diversity of fields, including economics, sociology, health, and education. There is a lack of any real synthesis, especially with respect to impacts of one area's planning on another's. This can result in frustration of objectives as well as waste of resources and possible loss of potential. The lack of integration, which is present in most country development planning, makes it especially important to explore these issues in a case like Saudi Arabia where the resources and opportunities are available for the implementation of such systems thinking without being frustrated because of lack of adequate resources to develop these capabilities.[1] The planning system developed in this thesis could be useful for other countries besides Saudi Arabia, which have adequate resources and are at early stages of development. For concreteness, however, the focus here will be geared to the specific characteristics of the Saudi Arabian situation. The use of expatriate labor will thus be given a prominent place at various stages of development since this is a salient characteristic of the Saudi Arabian problem. It forms part of the strategic planning which is directed towards the substitution of expatriate labor by domestic labor at later dates.

The desired national supply of labor is to be produced through the educational and training systems. At each stage, we may observe that housing and other services which are tied to newly located or growing industries will also be components of this national accounting and planning system. This, in turn, will require still more expatriate labor and this, too, will need to be explicitly accommodated in the plans.

The following three systems constitute a minimum basis guiding this thesis

---

[1] For a more complete discussion on the systems approach and interdisciplinary modelling See [1, 35, 104, 107, 157, 166, 256, 257, 283].

development: 1- economic development and industrial diversification, 2- manpower development including importation of expatriate labor and/or training of domestic labor and 3- housing development including family-to-housing distributions and the matching of housing stock to population growth and derived or inevitable changes of family characteristics. The objective is to deal with all of these dimensions simultaneously. However, each is to be developed separately with linkages identified en route to an integrated system planning model.

For purposes of this thesis the focus will be on the first --economic development-- and the third --housing development-- as components for detailed model analysis. The development of an adequate planning framework and methodology being our central concern, only the appropriate linkages to the second area --manpower development and use-- will be dealt with.

Besides helping to coordinate planning activities, this integrated approach to an accounting system for national planning could also be a guide for improving the data development and modelling efforts of government agencies involved in planning. It could help such agencies develop analytical models for their own use in some cases and even when they have their own models, it can provide a basis for jointly examining the pertinent parameters and common data requirements or at least make it possible to consider the interfaces between different models. To demonstrate how this might be done, our research strategy will be to select two closely related systems, namely, socio- economic and housing development models. These will be developed separately, but we shall also develop uniform methodological concepts and related statistics and data for servicing both.

Prototypical data representing characteristics and properties of development planning in Saudi Arabia will be supplied to provide insights as to a) structure and availability of data for these planning-coordination purposes, b) quality of data and sensitivity of models to the data quality that is likely to be available, and c) the further modelling and data assembly developments that may be required. The data utilized here were drawn from two main sources: the Ministry of Planning. [218, 219], and the Department of Census and Vital Statistics, [####, ####], of Saudi Arabia. The Ministry of Planning data for the economic accounts were assembled by the firm of Coopers and Lybrand and for education and manpower by the Division of Technical Assistance and Special Studies at the World Bank. Some of these data were based on sample surveys or on census data.[2] Others, including

[2] Data are presented in both physical and in value terms. The unit of measurement for economic accounts and transactions is in thousands or in millions of Saudi Riyals, sometimes as a surrogate for physical units, while labor is measured as number of laborers in each category.

some of the trends, were based on "learned guestimates" and expert opinions. These data should not be considered as definitive. Several questions about the sampling activities and observation and mapping errors remain to be resolved. Additionally some of these data may be already obsolete.

Our exercise here is not directed to immediate use. It is rather to consider data that are sufficient to test and illustrate the model's possibilities for planning and decision making. Hence we use these data as a prototype of the Saudi Arabian development situation.

All of this is seen as appropriate first steps and as guides to further the development of adequate planning systems for countries such as Saudi Arabia.

1.3 THESIS OUTLINE

In this chapter a review of the properties of multidimensional accounting and planning is presented in a way that is pertinent to this thesis An outline of the planning and decision making structure in Saudi Arabia is also provided. This chapter conclude with a summary of models for socio-economic and housing development to be presented in detail in the following chapters of the thesis.

In Chapter Two, we present the detailed development of an overall Socio-Economic model with specific issues in the development of Saudi Arabia such as the changes in the structure of production with industrialization and the role of imports in supplementing domestic production. In addition, specific attention is accorded to the demographic and social aspects of labor inputs and outputs, particularly expatriate labor's participation in production and in government. Moreover, we introduce government agencies' plans for capital development and for their own operation. The model's formulation in Chapter Two will be supported by prototype data indicative of pertinent aspects of Saudi Arabia's economic, social, and demographic characteristics.

The planning problem is presented in Chapter Two as a multi objective goal program dealing simultaneously with expatriate labor and government planning goals. Finally, we examine multi period numerical applications of alternative policies to evaluate between alternative priorities and conflicting goals.

In Chapter Three we develop a model for Housing Development indicating the various planning activities and behavioral changes influencing family-to-house distributions. Housing development in this model is guided mainly by the criterion (of which the aim is to improve conditions) for families whose housing is considered to be within the government's direct or indirect responsibility. We also consider the inputs and outputs of families as well as their changing characteristics over time. This will include the migration and immigration of expatriate families and the ensuing housing requirements and/or vacancies. In progression, we link this model to the overall socio-economic model developed in Chapter Two to examine the cross impacts as well as the multiplier effects housing development has on the rest of the system.

The planning problem is presented in Chapter Three as a multi objective goal program dealing simultaneously with goals related to the housing distribution of new families and the redistribution of existing families. Further, by linking this model to

the socio-economic model developed in Chapter Two, we consequently consider also those goals dealing with expatriate labor and with government plans. Finally in Chapter Three, we examine numerical applications of alternative policies to evaluate between alternative priorities and conflicting goals.

Chapter Four will focus on the input-output characteristics of houses, population, and families; it will present a multi period model to deal with the transitions and changes affecting the joint family-to-houses distributions. Further we examine demographic, family, and houses input-output properties to project changes in families and houses and in turn estimate future housing conditions and housing needs. The recursive impacts from these changes are then considered in connection with the housing development model developed in Chapter Three. Further, to support our model, we examine prototypical data for changes in family characteristics in Saudi Arabia. In effect we develop a model to estimate the non-stationary transition probabilities needed to project the future distribution of families. Finally we extend the applications in Chapter Three to include the recursive effects resulting from the transitions.

We conclude this thesis by examining its developments and also by pointing to areas for future research.

1.4 MULTIDIMENSIONAL ACCOUNTING FOR MULTIPLE SYSTEMS

Stone, in [75], proposed a new approach for the development of a consistent statistical system linking major components of social and economic systems; he further suggested that, for adequate accounting of the dynamic states of any system, one should deal with information about both stocks and flows. We shall follow this point of view and start by joining the input-output principles of the Leontief economic accounting model [185, 214, 280] with Stone's social systems accounting [278, 279] and then extending them in ways needed to deal with the distinctive characteristics of our substantive situations(Saudi Arabia).[3]

Stone's approach to linking social and economic statistics was subsequently given an optimization orientation by Schinnar [251, 252] who used a goal programming approach to link an economic input-output model to a demographic input-output model. This, in turn, made it necessary to expand the "value added" component of the economic model to embrace the multi-dimentional accounts of the population's activities. This is achieved by linking the activity-demographic characteristics of the economically active population to production requirments. Schinnar's goal programming approach, to what he refers to as "eco-demographic planning," opened a variety of other possibilities (besides linking economic and demographic inputs and outputs). This approach enabled Schinnar to allow for different degrees of consistency in goal achievements (as measured by the goal discrepancies) between economic and demographic plans as a planning issue in its own right. And as such, the goal programing approach allows for trade-offs that could be related to production transactions and demographic development programs. The demand for complete consistency among the different goals, therefore, was regarded as only one possibility that might be less desired than other alternatives in some of its consequences.

Economic, demographic and social process systems have to be dealt with along with their linkages in contexts different from those considered by Schinnar. For example, in the case of Saudi Arabia, industrial development is at the beginning stages and the input output structure is "evolving" through the incorporation of new

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[3] In national economic accounts, input output analysis is generally recognized as an appropriate tool to examine the effects of changing demand behaviors of the gross national product of a country. See Leontief [181-187], Stone [273-282], Merniek [214], Rogers [247-245], Dorfman, Samuelson and Solow [92], Chenery [47], Carter [31-32]. Input output principles are also used in representing active social processes, e.g. population demographic activities [245, 275, 276], social accounting [18, 274], educational sequences [277], organizational analysis [12, 18], and in general transitions and admissions in "socially active" sequences [273].

industries and additions to old ones. Therefore we cannot assume stable structures, as in Schinnar's application, and we will need to allow for alternative production activities including the expected, ex ante, input output changes.

The models developed in later chapters explicitly allow for substantive linkages so that planning for each of the systems and their cross-impacts on one another may be dealt with as desired. Thus, via this modeling, the issues pertinent to the design for the data base system are developed. The emphasis throughout is placed on the economic and demographic components in three distinct socio-economic systems: (1)- a national economic accounting model that is particularly concerned with issues of economic aspects of development, (2)- a manpower and training accounting system, and (3)- a family-housing accounting system. The first and third of these systems are detailed in a way that recognizes the linkage supplied by the second. All three components are, of course, strongly related. For if a country is to develop, it must be active economically; it must train and educate for movement from one stage to another; and it must provide jobs, houses, and other social amenities of an appropriate scale and variety for its population.

The general scheme of the integrated system of accounts that we desire to construct and its initial linkages are shown in Figure 1-1 where the three main components are labeled I, II, and III. I, the Economic-Manpower interaction, deals with the demand for labor for both industrial development and for government and public services. Under II the Education-Manpower links includes both individuals moving from the education system to the manpower system and those who rejoin the education system from the manpower system. Finally III, Housing-Family includes interactions that allow for the fact that family association is a major component in the need and demand for houses.

These three components I, II, and III are further linked through inputs and outputs that indicate relationships among them. These are difficult to portray schematically, and no attempt to do this is made in Figure 1-1 although the principle is clear. Socio-demographic characteristics must also be considered in further detail such as age-sex, education type-level, occupation-grade, family size-composition, and housing type-size. The individual characteristics in these accounts are related to the manpower system, to the education system, and to their family association-- the accounts also relate family characteristics to houses, etc. -- in a way that will enable us to precipitate the requisite details when required.

Other distinctive features that are also not portrayed in Figure 1-1, may be recorded as follows:

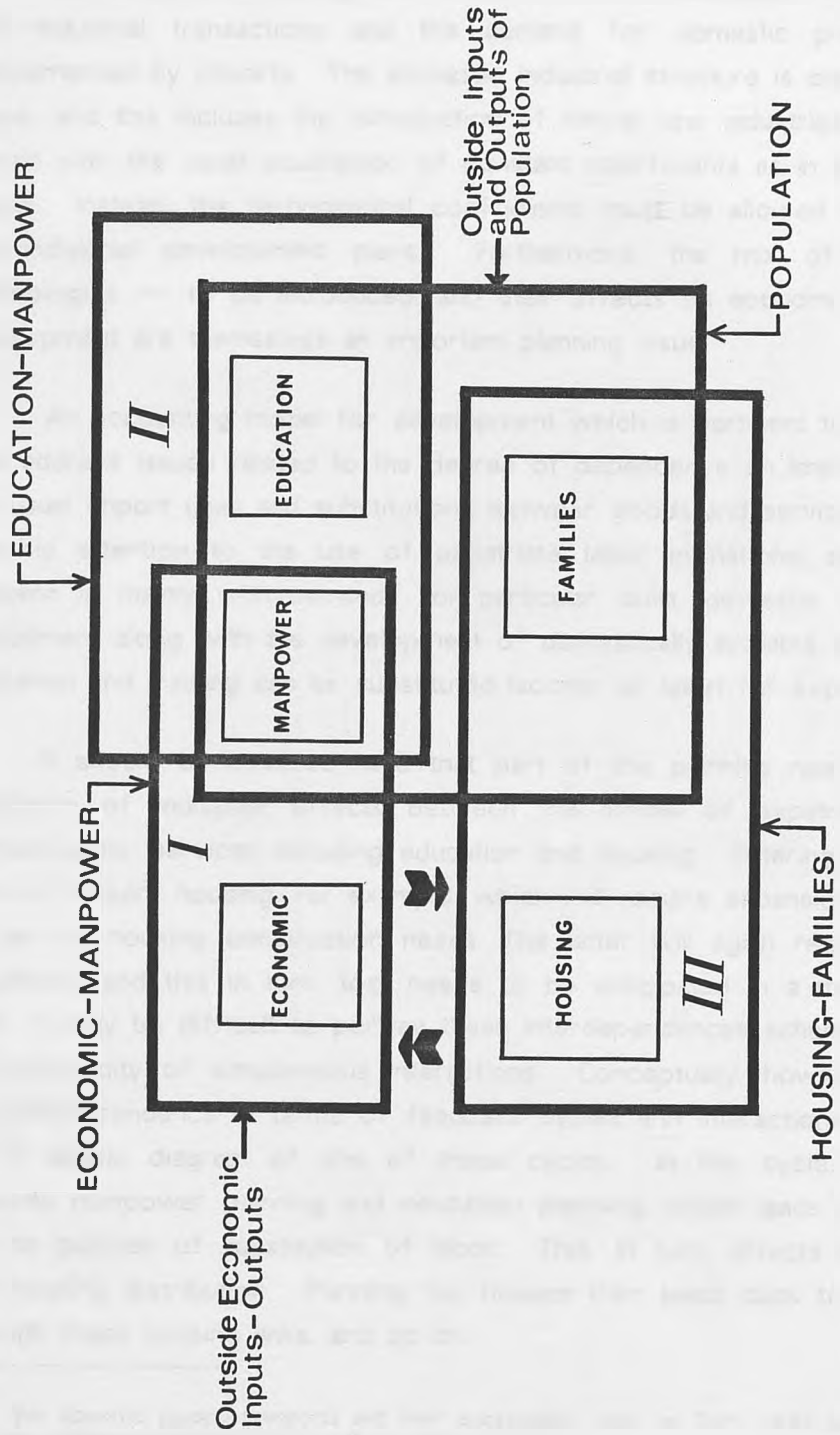


FIGURE 1-1: MULTIPLE SYSTEMS INTERACTIONS

For industrial planning and socio-economic accounts in Saudi Arabia, the inter-industrial transactions and the demand for domestic products are largely supplemented by imports. The domestic industrial structure is only beginning to take shape, and this includes the introduction of whole new industries. Thus one cannot remain with the usual assumption of constant coefficients as in an ordinary Leontief model. Instead, the technological coefficients must be allowed to vary as part of the industrial development plans. Furthermore, the mix of industries -- or technologies -- to be introduced, and their effects on economic growth and labor development are themselves an important planning issue.

An accounting model for development which is pertinent to Saudi Arabia must also address issues related to the degree of dependence on imports.[4] In addition to the usual import uses and substitutions between goods and services, we also require specific attention to the use of expatriate labor in national development.[5] The concern is mainly with demands for particular skills, domestic supply and foreign recruitment along with the development of domestically available labor which through education and training can be substituted (sooner or later) for expatriate labor.[6]

It should be stressed here that part of the planning needs to consider the possibility of multiplier effects between the inflow of expatriate labor and the various public services including education and housing. Entering expatriate population will require housing, for example, which will require expansion in industrialization to service housing construction needs. The latter will again require labor, perhaps expatriate, and this in turn, too, needs to be anticipated in a more comprehensive plan. It may be difficult to portray these interdependences schematically because of the multiplicity of simultaneous interactions. Conceptually, however, one may view the interdependence in terms of feedback cycles and interactions. See Figure 1-2 for a simple diagram of one of these cycles. In this cycle, industrial planning requires manpower planning and education planning, which leads to import of labor and to policies of substitution of labor. This, in turn, affects family composition and housing distribution. Planning for houses then leads back to industrial planning through these housing links, and so on.

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[4] For specific study of imports and their substitution refer to Clark [55] and Cameron [29], and for their influence on the growth rate see Reyes [241].

[5] It should be noted here that industrial goals have been generally constrained by the labor market (which, in turn, is subject to the flow from the education sector). Golladay in [123], for example, considers both a constrained education model and a steady state economic model and attempts to deal with their development parametrically.

[6] This points to the further need to develop linkages to an education-manpower planning. In Figure A-1, Appendix A the diagram proposes general relationships to further structure manpower, education, and population interactions.

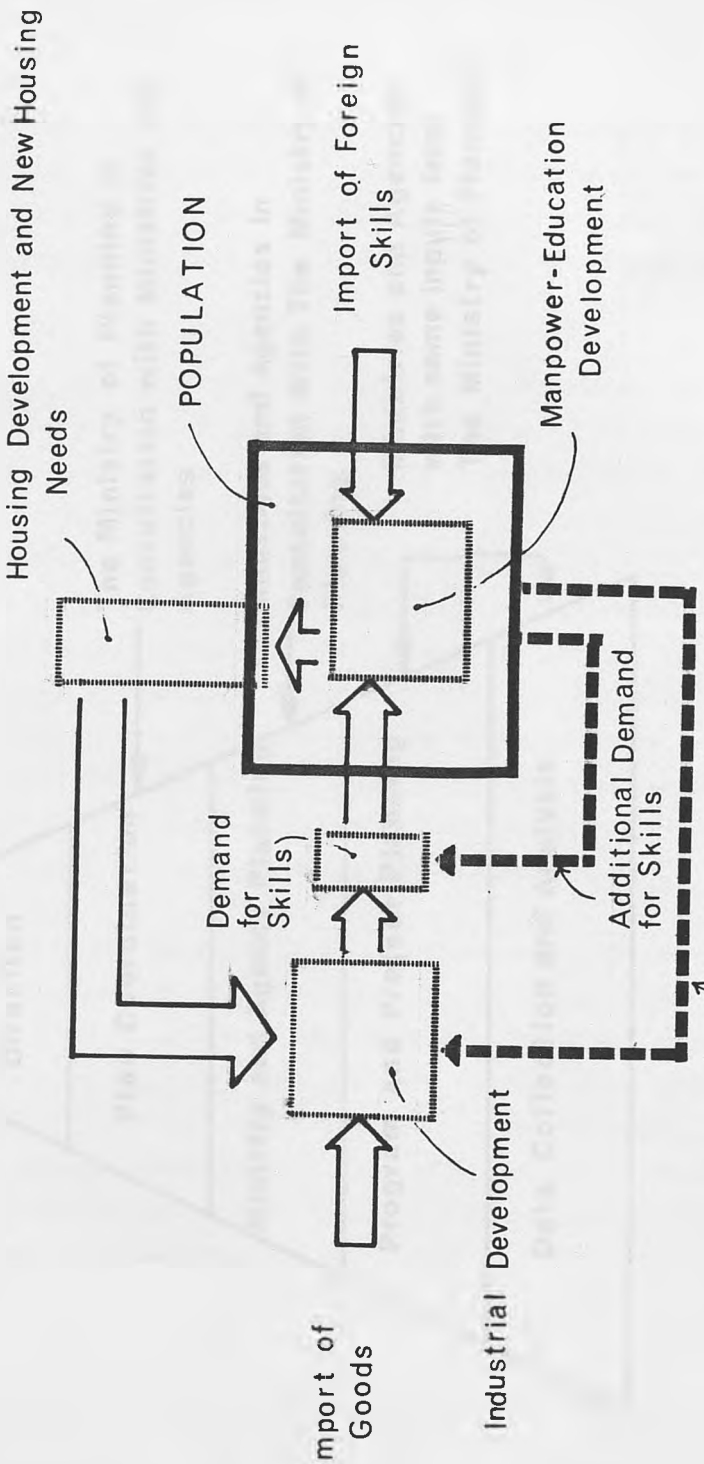


FIGURE 1-2: MULTIPLE SYSTEM CYCLE OF INTERACTIONS

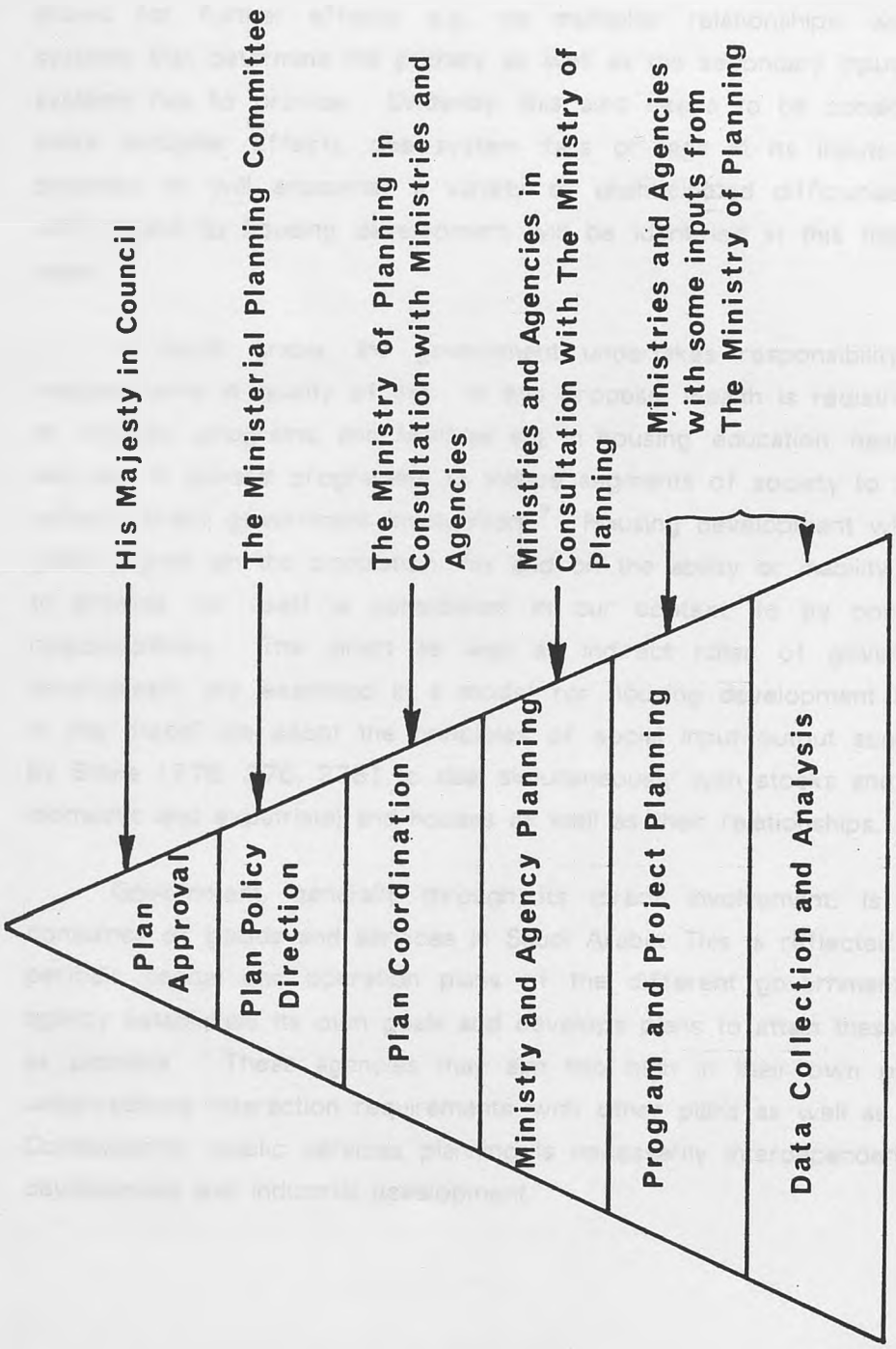


FIGURE 1-4: THE STRUCTURE OF PLANNING
Source: Second Development Plan

Formally, one may also characterize these interdependencies in a way that allows for further effects, e.g., via multiplier relationships, within and between systems that determine the primary as well as the secondary inputs that each of the systems has to provide. Evidently, this also needs to be considered. For if, via these multiplier effects, one system fails or lags in its inputs, the rest will be distorted or will encounter a variety of unanticipated difficulties. The multipliers with regard to housing development will be identified in this thesis and studied in detail.

In Saudi Arabia, the government undertakes responsibility for guiding the improvements in quality of life. In this process, wealth is redistributed in the form of services, programs, and facilities e.g. in housing, education, health, communication, and also in general programme to induce segments of society to improve their own without direct government involvement.[7] Housing development which depends to a great degree on the population mix and on the ability or inability of the population to provide for itself is considered, in our context, to be one of government's responsibilities. The direct as well as indirect roles of government in housing development are examined in a model for housing development in a later chapter. In this model we adopt the principles of social input-output accounting developed by Stone [275, 276, 278] to deal simultaneously with stocks and flows of families (domestic and expatriate) and houses as well as their relationships.

Government, generally through its direct involvement, is in fact a major consumer of goods and services in Saudi Arabia. This is reflected in the annual and periodic capital and operation plans of the different government agencies. Each agency establishes its own goals and develops plans to attain these goals "as closely as possible". These agencies may aim too high in their own plans or they may underestimate interaction requirements with other plans as well as multiplier effects. Consequently, public services planning is necessarily interdependent with manpower development and industrial development.

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[7] In Appendix 1-A, we present a taxonomy of issues involved in the "quality of life" considerations organized to indicate both qualitative and quantitative dimensions.

1.5 MULTI OBJECTIVE PLANNING FRAMEWORK

Planning in Saudi Arabia may be regarded in terms of a process in which objectives and criteria evolve rather than as a situation in which the latter have already been established. Impact analyses and implementability are part of the criteria of evaluation. Decisions emerge after a number of opinions, conflicts, and dissents are resolved, more or less, with a combining and recombining of information. The resulting decisions reflect the organization of the planning process, its management, and its context over time.

In the course of the following discussion, the planning activities in Saudi Arabia are presented followed by aspects of the decision environments. Also, analytical concepts and methodologies are related to these planning activities. First, planning and its objectives are discussed followed by delineation of general principles related to the multi-level framework in which it occurs. To illuminate some of the principles, we shall find it useful to employ a framework from goal programming and the literature of multi-objective decision making.

1.5.1 In The Course of Planning

Attempts to formalize and organize planning activities in Saudi Arabia began with the gradual establishment and expansion of several government agencies. See Figure 1-3 for a list of these agencies. Each agency participates in the planning process through an annual listing of its requirements in the form of services, programs, and facilities.[8] When the government started efforts to develop its first five year plan, it became apparent that yet another part of the process would involve coordination among agency plans. In 1960, the central planning organization, (CPO), was established under which the first 5-year plan was developed with the following key objectives for the period 1970-1975:

- More rapid economic growth;
- Development of human resources;
- Diversification of the economy.

Prior to the second development plan of 1975, the Central Planning

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[8] Refer to the taxonomy of issues presented in Appendix 1-A.

MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF INFORMATION
MINISTRY OF JUSTICE
MINISTRY OF PILGRIMAGE AND WAQFS
MINISTRY OF POSTS,TELEGRAM, AND TELECOMMUNICATIONS
MINISTRY OF INTERIOR
MINISTRY OF INDUSTRY AND ELECTRICITY
MINISTRY OF TRANSPORTATION
MINISTRY OF DEFENSE
MINISTRY OF PLANNING
MINISTRY OF HIGHER EDUCATION
MINISTRY OF PUBLIC WORKS AND HOUSING
MINISTRY OF MUNICIPAL AND RURAL AFFAIRS
MINISTRY OF FINANCE AND NATIONAL ECONOMY
MINISTRY OF PETROLEUM AND MINERAL RESOURCES
MINISTRY OF AGRICULTURE AND WATER
MINISTRY OF COMMERCE AND INDUSTRY
MINISTRY OF LABOR AND SOCIAL AFFAIRS
MINISTRY OF EDUCATION
MINISTRY OF HEALTH

FIGURE 1-3: A LIST OF GOVERNMENT AGENCIES

Organization developed into a full cabinet office which became the Ministry of Planning. The second 5-year plan for 1975-80, prepared by the Ministry of Planning, included the following objectives:[9]

- Maintain a high rate of economic growth by developing economic resources, maximize oil earnings, and conserve depletable resources;
- Reduce economic dependence on exports of crude oil;
- Develop human resources through education, training, and improved health standards;
- Increase the well-being of all groups within the society and foster social stability under circumstances of rapid social change;
- Develop the physical infra-structure to support achievement of these goals.

Notice the 70-75 vs 75-80 plan's difference in objectives. In the 75-80 plan added emphasis was placed on conservation of oil resources, stability under rapid change, and the building of the infra-structure.

To focus the attention of the various agencies on these objectives, the Ministry of Planning serves as the center for coordination of national planning programs -- acting both as tool for integration and the examiner of possible policy directions. In other words, the Ministry of Planning receives plans from other agencies of government and also initiates plans of its own.

To guide its tasks, the Ministry of Planning has the following as its objectives:

- Accelerate the economic and social development of the country;
- Expand the capability of the country to absorb rapid development by mobilizing and augmenting scarce managerial, manpower, construction and other resources and directing them toward the achievement of goals;
- Eliminate physical and organizational constraints on planned implementation by forecasting the potential problems and taking action to prevent them from occurring;
- Develop the statistical and information base for improved planning and plan development;
- Strengthen the ministry's capabilities to plan, schedule, and to follow-up the implementation of programs and projects;

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[9] Source: Second Development Plan, [217].

- Ascertain the degree of success achieved in meeting plan targets and the extent to which national objectives are not being attained.
- Formulate corrective action recommendations and/or new plans as required.

The first steps were taken to establish an information base and develop the tools necessary to help the ministry of planning in coordinating various agencies as well as identifying the impact of agency plans and other policies on national development. It became necessary, then, to employ quantitative and analytical models to provide insights into several of these complex issues. Hence, our attempt in this thesis is to present models and methods to handle some of these problems.

To appreciate aspects in the complex background within which the Ministry of Planning must operate, the following would be of assistance:

1. Spatially the country can be "differentiated" into interrelated components, e.g. regions, districts, etc.; within each we could represent decision making activities and analyze region specific social and economic aspects as well as inter-regional activites.[10]
2. Pertinent socio-economic systems can be disaggregated into smaller components for detailed analyses i.e. industrial sectors into industries, firms, etc.
3. Decision making activities could be represented as a complex multilevel system in relation to both spatial differentiation and system disaggregation.

The structure of the national planning process as shown in Figure 1-4 is intended to portray not only the hierarchy of organizations but also lateral relationships that are involved in the planning process.[11] The vertical dimension reflects the role of the Ministry of Planning and the other agencies in preparing data, project planning, agency plans, coordination, review, and approval. The accompanying

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[10] In this thesis the focus is on the country as one spatial system related to the outside world through the flow of people and economic services. Hence, the added need to identify those spatial linkages among the respective systems. For example, interregional migration, trade, transportation,..etc. The subject of internal spatial differentiation is, of course, the target for further study as will be discussed in the concluding chapter of this thesis.

[11] Source: Second Development Plan,[217].

descriptions depict an interdependent multi-level process of decision making.[12] At one level, the projects are prepared by the respective agencies indicating their goals and aspirations. At another level, these plans are coordinated by the agency's representatives and the staff of the Ministry of Planning under the general policy directions of the "higher" levels of the hierarchy. The Ministry of Planning, jointly with the various responsible agencies of government, perform the lateral relationships of integration and coordination. At this stage, too, trade-offs among different socio-economic objectives and goals are made by reference to their cross-impacts and national-level consequences.

There are many aspects of the national planning process which could be aided by adequate tools for comprehensive planning. For example, without such aids the government may vigorously pursue the industrialization process but fail to consider the required housing. Similarly, government programs for housing developments might be undertaken without studying their impacts on the multiplying needs from economic sectors. The same is evidently true for many other facets of the planning process.

Thus, one of the functions of an adequate planning mechanism, such as the one proposed in this thesis, is to enable the government to be informed in a way that enables it to determine when to act directly on some activities and indirectly on others. To be of maximum use, such a planning mechanism should also tie into the various levels of government, each provided with adequate detail without simultaneously losing the overall integration and coordination effects. For example, consider the Ministry of Planning and the Housing Ministry. The latter may be interested in allocation of houses to people and development of criteria for determining the resulting distributions. The Planning Ministry may be interested in the result of the Housing Ministry's plans for their impact on the overall national situation. The Ministry of Planning may, therefore, be serviced adequately with aggregated information while the more specialized Ministry of Housing may require much more detail.

In any case, the Ministry of Planning is actively involved not only in

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[12] See Kornai [159-163] for the development of analytical and quantitative methods suitable for multi level decision structures utilizing partitioning principles of mathematical programming. See Lasdon [170] for a summary of these principles. Applications of these principles were examined in the case of Hungary in Kornai [160] and Mexico in Goreux et al [126]. Particularly worth attention is Kornai's [162] critical evaluation of the methods and their representation of the planning situation. See also Charnes et al [41] and Reufli [248] for goal programming applications in manpower and organization planning respectively.

coordination but also in the other aspects of planning. It provides the planning mechanism which incorporates the plans, projects, and goals of a multitude of government agencies. It also attempts to incorporate private sector plans in which the concern is with mechanisms for evaluation of multiple plans, private as well as public, for their aggregate effects. To be useful in such an environment, a framework and methodology of planning should:

1. Identify the effects of project input requirements on major national policy indicators;

2. Identify cross impacts between plans;

3 Facilitate trade-off evaluations among alternative planning objectives and goals at various levels of concern.

In this thesis we draw upon the goal programming approach as a flexible tool for decision analysis which has workable computational power both for planning and tradeoff evaluations in systems with multiple (possibly inconsistent) objectives.[13] In goal programming one encounters a set of conditions in which inconsistent goals can neverthless be met "as closely as possible" along with specific measures of the deviations (over or under) from the desired goals with penalties assigned in terms of priorities where desired. It draws upon the highly developed and tested technique of linear programming and, hence, is relatively easy to apply to the large scale problems involved in the overall planning process in Saudi Arabia.

At the beginning of the planning process, decision makers may not even want to consider contradictory aims or they may not wish to have them coordinated beforehand. Instead, one of the purposes of the planning process is to provide a flow of information from which the trade-offs involved in "coordination" can be evaluated. Figure 1-5 is a representation of such an interactive sequence, including both the learning process of step by step adaptation as well as a dynamic sequence of focusing activities.

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[13] The original method was first developed by Charnes and Cooper [37, 45, 162, 177] and has received impetus from many contributors. Some of those contributions have centered on investigations of non-linear [222], integer [175], stochastic properties [62], and to provide flexibility in the definitions of goals, goal interval programming [148]. Other approaches have addressed themselves to the interactive properties [98, 122, 176, 222, 238] to help the decision maker in iterative sreach for solution(s). Several other contributions have examined the decision environment and/or the context of application and attempted to present the appropriate methodology for it. These efforts have taken a variety of directions, for example, joint eco-democratic planning [251-252], multi-level manpower planning [41], investment planning [254], and multi-level organization planning [248].

Generally, for a review of alternative multiple objective decision approaches see Cohon [59]; For the relationship to to multiple utility, Fishburn [109, 110] and Dyer [96]; For general classification of approaches, MacCrimmon [196]; For review of the state of the art, starr and Zeleny [266]; And for classification of optimization approaches, Wendell [302].

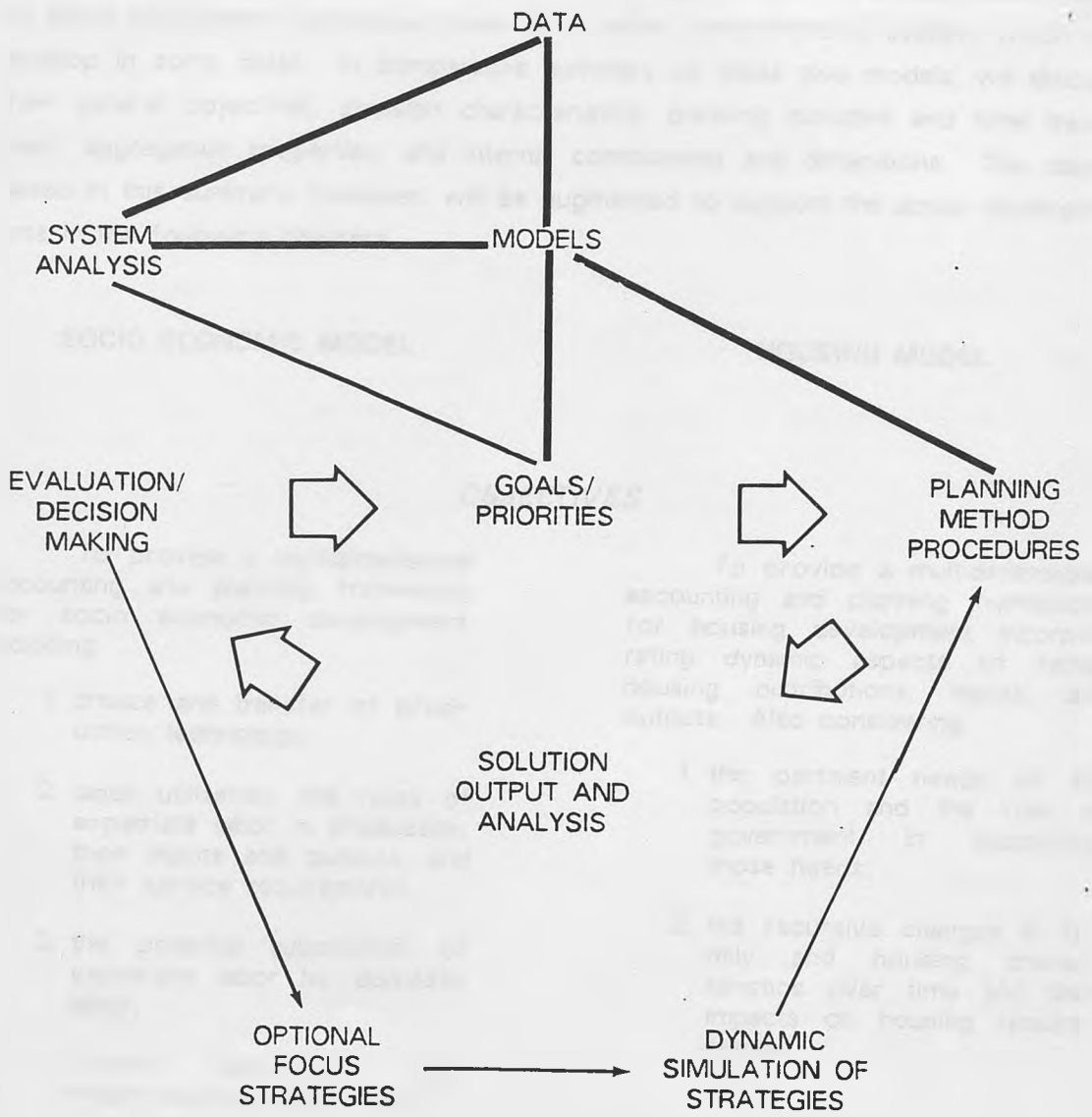


FIGURE 1-5: DECISION MAKING PROCESS

1.6 OVERVIEW OF MODELS AND THEIR CHARACTERISTICS

The following summaries provide backgrounds for assessment and comparison between the industrial–economic and the housing development models that will be presented. Each of these subsystems may have different goals or objectives which need to be considered simultaneously as well as separately. As already noted, each of these subsystems constitutes parts of a more comprehensive system, which we develop in some detail. In comparative summary of these two models, we discuss their general objectives, decision characteristics, planning horizons and time treatment, aggregation properties, and internal components and dimensions. The issues raised in this summary, however, will be augmented to support the actual developments in the following chapters.

SOCIO ECONOMIC MODEL

OBJECTIVES

To provide a multidimensional accounting and planning framework for socio economic development, including:

1. choice and transfer of production technology;
2. labor utilization, the roles of expatriate labor in production, their inputs and outputs, and their service requirements;
3. the potential substitution of expatriate labor by domestic labor;
4. import substitution and import–export relationships;
5. project planning and capital development; and finally,
6. the role of government in development planning and the impacts of these plans on national development.

HOUSING MODEL

OBJECTIVES

To provide a multidimensional accounting and planning framework for housing development incorporating dynamic aspects of family housing distributions, inputs, and outputs. Also considering:

1. the pertinent needs of the population and the role of government in supporting those needs;
2. the recursive changes in family and housing characteristics over time and their impacts on housing requirements.

DECISION CHARACTERISTICS

Models are presented in a multi-objective framework reflecting the desire to achieve a variety of goals such as the degree of expatriate labor utilization as well as the achievement of government plan targets. Alternative goal treatment could further be accorded to production level targets, diversification of industries and technology, import substitution, capital and labor development.

The focus here is on reconciling the potential conflicts between labor and government goals. And since government plans are generated by several agencies, other relevent issues includes the reconciliation of their respective goal achievement and the simultaneous consideration of cross impact on other indicators of national accounts.

Decision making is treated as an iterative process of goal adjustment and objective changes in response to the model's information feedback.

Models are presented in a multi-objective framework reflecting the desire to satisfy the requirements of the "unhoused" families and the improvements of the housing conditions of the 'uderhoused'. Goals are related to the distribution of new families as well as the redistribution of the existing families to meet, as closely as possible, the alternative criteria established.

The goals and objectives for housing development can be in conflict with the other socio economic development targets and objectives Hence, in the decision process we examine the cross impacts of housing development, for example, on the use of expatriate labor and on imports. The focus is then on the reconciliation among these multiple objectives in an iterative process of goal and objective adjustments.

PLANNING HORIZON AND TIME TREATMENT

The planning horizon considered is devided into 5 year planning intervals with periodic change in technology and its expected inputs and outputs. Also periodic changes in labor attrition and inputs. Projected plans are grouped into the 5 year spans and averaged to indicate the expected annual plan requirements.

Recursively, expatriate labor attrition influences consumption levels in the succeeding periods. Recursively also, the degree of implementation of project construction influences the expected increase in outputs in the succeeding periods.

Time horizon is devidev into 5 year planning intervals. Changes in houses and families are periodically computed through the use of their respective transition probabilities. And since family transitions are not assumed to be stationary, periodic probabilities are used.

Recursively, the previous period's planning results as well as the effects of the transitions are considered to be part of the following period's inputs.

AGENCY INVOLVEMENT

The major agencies considered to be directlty involved in industrial development are the Ministries of Planning, Industry, Trade, Labor. Other agencies are also responsible for industrial resarch and financing,i.g. the Industrial Research Center and the Industrial Development Bank.

Several agencies are involved directly and indirectly in housing development; they are the Ministries of Planning, Housing, Municipal Affairs, Industry.

SYSTEM AGGREGATION

Establishments are grouped into two job systems, government and private sector. Sector establishments are grouped into 35 sectors, including those inputs from "null" sectors indicating the non-existing industries in each sector. For purposes of illustrations in this thesis, these sectors are aggregated into 9 sectors. They are agriculture, oil-gas, manufacturing, utilities, construction-building, construction-others, retail, transportation, and services.

Government establishments are considered for the agencies listed in Figure 1-3. They are further aggregated into 4 government agency groups: public administration, health, education, and others. Plans and programs in each agency are therefore identified by the agency of demand and the sector of supply. The data base therefore allows for alternative treatments: by government agency, by group, by project, or a cross classification, agency/ project for example.

Industrial projects are individually defined and aggregated into their sector of demand in a similar grouping to the sector establishment aggregation. This again allows the individual treatment of projects and/ or the sector association.

The housing situation is indicated by the distribution of families to houses. Families are grouped in 48 categories under family size, family income, and nationality. Houses are classified according to their type, size, and ownership properties and grouped into 52 categories. The initial planning model considers the illustrative aggregation of families into 8 categories for domestic and expatriate households, and 29 categories for houses.

OTHER CHARACTERISTICS

PRODUCTION: Initial model development requires multiple technologies for each sector. Choice of alternative production technologies may indicate continuation of, or transfer from, past practices. Such transformation (of production) is supported by consideration of primary factors included in industrial plans and labor inputs and outputs.

Capacity levels are considered in sectors. Some of these levels are predetermined (oil) or related to the completion of industrial projects from previous periods.

CONSUMPTION: requirements from each sector are considered for government plans, project construction, household consumption , and exports. Government planning requirements for capital development as well as operations are given for several periods. Household requirements, on the other hand, are edogenously determined as a function of labor activities in the two job systems–private and government. Household income, and hence consumption, is determined by labor income redistribution and augmented by other sources.

Exits and entries of expatriate labor are considered in terms of their effects on the changes in consumption patterns.

REQUIREMENTS: In this model new housing requirements are determined as a result of family to housing distributions. The resulting requirements form part of the consumption vector in the production system. The requirements vector specifies the number of houses to be produced.

Housing stocks may be classified on the basis of ownership, type, size, vacancy, and construction type. They are considered transient in some of these characteristics. New houses are added to the stock when needed and wastage is subtracted.

NEEDS: Housing is defined as a social need for non–market portions of society. Housing is then developed to satisfy, as best as possible, desired goals for housing distributions. These goals are set by housing planners with reference to criteria established to guide the goal developments. For the market portion of society, we use, a consumption function to determine for the choice of houses.

Housing requirements vary from one period to the other according to changes in family characteristics.

LABOR ACTIVITIES: Labor requirements are defined to fit into an overall input-output accounting framework and can be linked to the analysis of overall manpower planning. This enables us to include additions and attritions of expatriate labor. The emphasis here, however is on labor in two job systems, private and government sectors. Labor requirements in industries are set by means of coefficients that relate labor inputs to the output of each private sector. Government labor is determined from government planned operation requirements for the various periods.

For the purpose of this thesis we consider only exogenous supplies of labor, exogenous educational activities and controlled migration of expatriate labor. The inputs of domestic labor is constrained by the ability of the training systems to provide additional trained labor.

IMPORTS: Imports are treated in three ways, unlimited for some sectors-- agriculture for example, as related to output-- for oil and service sectors, and constrained-- for utilities and construction. As an extension to our model, these imports can be initially allowed when domestic production of non-competitive products is restrained. These imports are then considered as candidate for substitution by domestic products with the development of their needed capital, labor and intermediate inputs.

EXPORTS: Exports from the oil sector are considered to be a function of international demand and are in some cases controlled by the government. Other sector are treated alternatively by imposing export bounds on some, construction for example, or relate it to output, services.

FAMILY ACTIVITIES: Family units are described by size, income, citizenship, and age of the head of the household. Families are considered transient in some of these characteristics. Immigration - migration is considered for expatriate labor and their families. Social accounting methods are used ,to study family transitions, inputs and outputs.

IMPORTS: Only housing components as well as raw materials for the overall production of houses may be imported.

EXPORTS: No exports are considered for housing.

Chapter TWO

A MULTI-DIMENSIONAL SOCIO-ECONOMIC ACCOUNTING AND DEVELOPMENT MODEL

CHAPTER 2
A MULTI DIMENSIONAL SOCIO-ECONOMIC DEVELOPMENT MODEL

2.1 INTRODUCTION

This chapter examines aspects of the development process with special refence to the characteristics of Saudi Arabia in labor utilization, industrialization, and government's role. One striking difference between countries like Saudi Arabia and other developing countries is its ability to direct the pace of development. This, in turn, is connected with the employment of expatriate labor, an issue that carries social and political as well as economic impacts. Another purpose of this chapter will become clear when, in chapter three, we develop a joint accounting model for housing development and link it to this chapter's socio-economic development model. This linkage facilitates examination of the cross impacts between housing development and economic development and labor utilization.

In section 2 we begin with the overall model and discuss in detail each component set of substantively related equations. In section 3 we demonstrate the use of this model for a selected set of alternative policies and summarize, in section 4, the development and its application.

2.2 MODEL DEVELOPMENT

In Chapter 1, issues related to the economic and social components of a multi-objective planning system for national development were conceptually discussed. The problem was stated as one with many dimensions indicative of multi period economic accounts, of labor demographic and input-output accounts, and of government institutional involvement. In Chapter 1, development planning was shown to be a multi-objective problem with inter-dependencies among planning activities which require coordination. Hence, planning was viewed as an iterative process of goal adjustment and objective reconciliation; i.e., an initial state of competitive preferences and conflicting goals modified through the coordination and arbitration activities of the Ministry of Planning.

The model's components developed here intend to capture the pertinent dimensions and relationships, emphasing those exemplified by Saudi Arabia's development problem and policy planning.

The basic guidelines considered in developming such a multi dimensional accounting model are shown in Figure 2-1. They implicitly include the criteria to:

1. Overcome the restrictions of the usual static technology assumptions by specifying a number of potential alternatives;

2. Examine the role of industrial development on changing the production capabilities;

3. Indicate the relationships between domestic production and labor availability--domestic and expatriate;

4. Examine the expatriate labor contributions to domestic production and the latter's sensitivity to labor goals (related to the amount and degree of expatriate labor participation);

5. Allow imports of final goods, unless otherwise specified, to supplement projected shortages in domestic production;

6. Analyze the effects of government agency's target programs, as in the five year plan, on various aspects of national accounts.

These criteria could be accommodated by extending the concepts of activity

COMPONENTS

1. **Production of Outputs**
   a. Multiple technology for production
   b. Output targets and constraints
2. **Project Planning**
   a. Project construction requirements for existing and alternative technologies
   b. Effects of projects achievements on production of domestic output
3. **Labor Development**
   a. Labor requirements for existing and alternative technologies
   b. Productivity of labor in production
   c. Domestic-expatriate labor inputs and relationships
   d. Goals for expatriate labor participation
   e. Attrition and recruitment of expatriate labor
   f. Attrition and supply of domestic labor
   g. Government labor requirements and considerations
   h. Education-manpower models and inputs
4. **Household consumption**
   a. Labor-Household relationships and distribution of income
   b. Government and other income transfers
   c. Government subsidies to household consumption
   d. Temporary visitors
5. **Government Plans and requirements**
   a. Operation requirements
   b. Capital development plans
   c. Agency and/or project specific goals
6. **Import-Export**
   a. Import and export bounds and policies
   b. Trade relationships
   c. Import substitution policies
   d. Competitive-noncompetitive imports

POLICY DIRECTIONS

1. Achievement of government goals
2. Achievement of labor goals
3. Arbitration and conflict resolution among plans and agencies of government

FURTHER CONSIDERATIONS

1. Inclusion of an Education-Manpower planning model
2. Inclusion of import substitution aspects, goals, and their capital requirements
3. Inclusion of several monetary relationships relating wages and project costing to demands and supplies and in turn to potential inflationary aspects
4. Further analysis of both domestic and expatriate labor productivity
5. Further analysis of government's labor efficiency and related policies

FIGURE 2-1: FACTORS CONSIDERED IN MODEL DEVELOPMENT

analysis to the basic input-output relationships [92, 126, 159, 198, 223].[14] Thus, in the overall programming considerations, alternative sources of production activities and imports are considered. Further, goals and objectives that prevail in the decision making environment are examined in a planning optimization framework, on their influence and impacts on policy and dependent indicators.

In Figure 2-2 we present the one period variables and their functional interactions. In Figures 2-3 we further present the linear programming matrix used for the one period solution.[15] The model's components, in Figures 2-2 and 2-3, are shown in several substantively related groups: material balance, production capacities, sector labor requirements, domestic and expatriate labor balance, government labor requirements, expatriate labor inputs and goals, household consumption, government stipulated goals, imports, exports, and industrial projects requirements.

The model developed here is a multi objective goal programming model, allowing for alternative prefences over subsets of decision variables. The preferences here are oriented to a variety of goals. They are: (1) goals regarding the extent of use of expatriate labor, and (2) goals regarding government expenditure levels. These goal-related activities may not be necessarily compatible. For example, while each government agency is concerned with meeting its specified goals and plans, some specific agency may be concerned with the extent and levels of the use of expatriate labor. Both of these concerns, in the aggregate, may not conform to industrialization targets and plans. Hence, we have both multiple objectives and conflicting goals. Therefore, in the goal programming context, the desire is to get "as close as possible" to these goals by the minimization of a weighted sum of deviations from their stipulated values. Goal deviation variables for these subsets are presented as the deviation vectors δ_l^+ and δ_l^- for the positive and negative deviations from expatriate labor goals, as well as δ_g^+ and δ_g^+ and for government plans respectively. These decision variables are assigned relative weights ω_l^+, ω_l^-, ω_g^+, and ω_g^- for the subsets of decision

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14 Traditionally, approaches to country development planning have utilized a unique technological matrix with or without known capital ratios to study the effects of final demand, consumption, government expenditures, and international trade on outputs and economic growth. Such an approach is likely to result in a long term expanding economic growth rate. In such cases the rate(s) of growth is(are) determined by the values of the observed input-output and capital coefficients [25, 156, 158, 183, 207, 209, 293]. It is also evident that an economy with fixed amounts of labor or capital cannot grow at a rate faster than the slower of the growth rates of either capital or labor. Dynamic transformation of the economy is achieved by the accumulation and development of the right type of capital and/or labor [56, 92, 281].

15 In the multi-period formulation we should consider several of the first period's outputs as the second's inputs. These variables are adjusted, when applicable, to indicate behavioral changes such as attrition of expatriate labor.

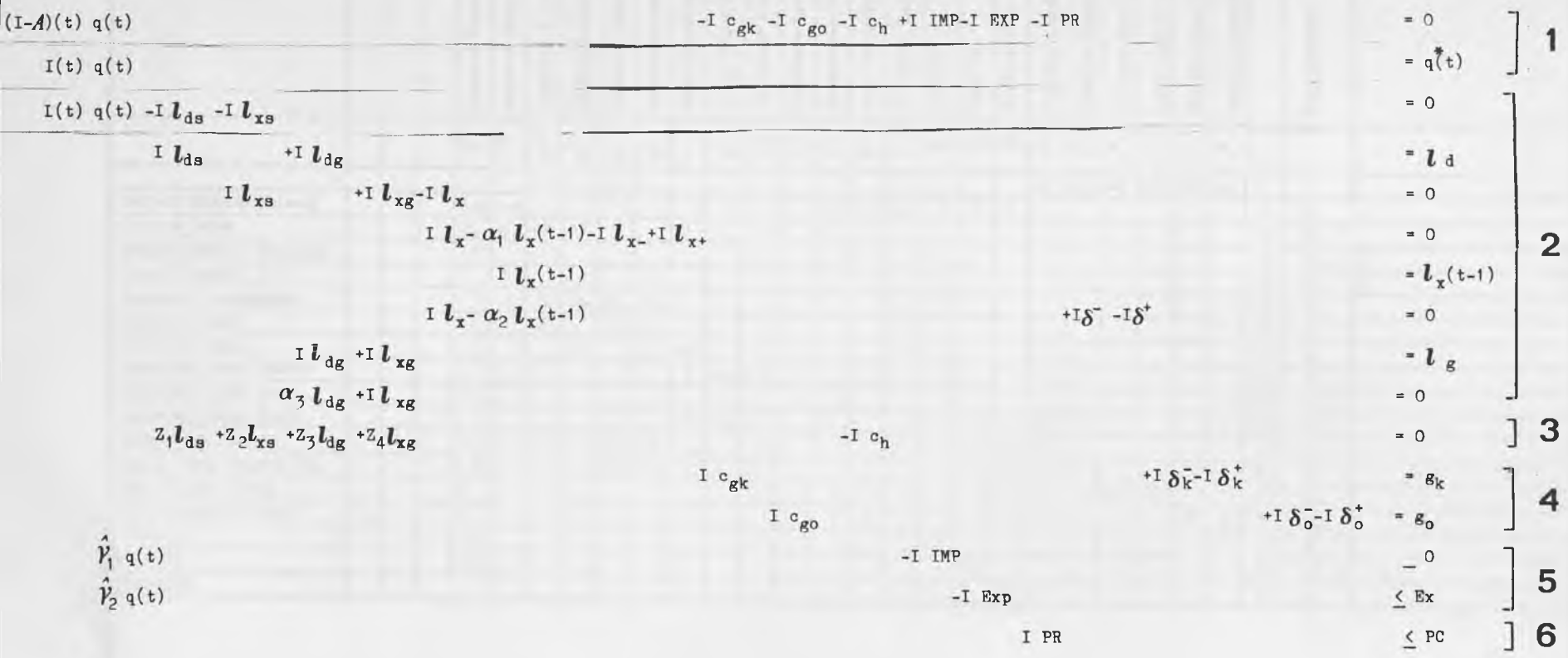


FIGURE 2-2: MODEL FUNCTIONAL RELATIONSHIPS

	q_0	q_1	l_{d_0}	l_{x_0}	l_{dp}	l_{0x}	l_x	l_{x_0}	l_{x^+}	l_{x^-}	c_{0_k}	c_{0_0}	c_h	IMP	EXP	PR	δ_i^+	δ_i^-	δ_k^+	δ_k^-	δ_0^+	δ_0^-		
																	ω_i^+	ω_i^-	ω_k^+	ω_k^-	ω_0^+	ω_0^-		
Sectural Material Balance		$I-A_0$	$I-A_1$								$-I$	$-I$	$-I$	I	$-I$	$-I$							=	0
Sectoral Labor		L_0	L_1	$-I$	$-I$																		=	0
Output Capacity- Baseyear		I																					=	q_0
Output Capacity T=1			I																				=	q_1
Household Consumption				Z_1	Z_2	Z_3	Z_4						$-I$										=	0
Domestic Labor				I		I																	=	l_0
Expatriate Labor				I			I	$-I$															=	0
Expatriate Labor Balance							I	$-a_1$	$-I$	I													=	0
Expatriate Labor Input								I															=	l_{x0}
Expatriate Labor Goals							I	$-a_2$									$-I$	I					=	0
Government Labor					I	I																	=	l_0
Expat. Labor share in Gov.					$-a_3$	I																	=	0
Gov. Capital Goals											I						$-I$	I					=	g_{kc}
Gov. Operation Goals												I								$-I$	I		=	g_{oc}
Imports			Y_1											$-I$									=	0
Exports			Y_2												$-I$								=	EX
Projects																I							=	P

ONE PERIOD MODEL

FIGURE 2-3: ONE PERIOD PLANNING MODEL

concerns. The different degrees of emphasis one is willing to place on a subset of goals or on a subset of decision variables can result in different goal achievements and impacts. These relative priorities may, for example, indicate the desire to satisfy some or all government requirements at the expense of increased immigration of expatriate labor. This, in turn, could change the population mix and hence the needs of the population. Alternatively, emphasis could be placed on desired levels of expatriate labor in specific occupation–nationality categories which may alter the achievement of government goals to levels compatible with labor goals.

Taking these issues into account, the following six subsections will examine in detail the accounting for the economic relationships and related components:

1. Sectoral material balance indicating alternative supplies, including present and planned productions, as well as import and demands;
2. Labor requirements and suggested links to manpower systems;
3. Household consumption;
4. Government goals and plans;
5. Exports and imports;
6. Sector project requirements.

In each of these subsections we will discuss the variables involved in the Saudi Arabian situation (followed by their formulation) along with prototype data used to illustrate the models.[16]

2.2.1 Sectoral Material Balance

The first component of Figure 2–2 is the sectoral material balance of all supplies and demands on the various production sectors. Supply sources include present and potential as well as imports. Demands are from government, households, exports, and development activities–private and public. Component (1) also captures several characteristics of the Saudi Arabian situation:

1. The system is open since it is dependent on imports and exports.

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[16] See appendix 1–B for data types needed to support the formulations in this chapter. We make use of the resulting data as a prototype indicative of several characteristics in Saudi Arabia as well as to guide future data collection for planning purposes.

2. There are additional interdependencies among variables which, by their inclusion, help explain information feedback. As such these feedback further identifies 'proper" multipier relationships. For example, output and household consumption are related directly and indirectly through the mix of domestic and expatriate labor required to produce total domestic output; the mix affects income distribution to households, which in turn affects final household consumption. Consequently household consumption is partially endogenized in this model.

3. Through the incorporation of potential additions to production processes, a changing economic structure (i.e. coefficient matrix) is permitted.[17]

Saudi Arabia is starting its development with little experience; hence, the expected transfer and implementation of new technology or industry enables us to forecast potential growth and other economic transformations.[18] The basic issue here is that during this process, the structure of production continues to take shape through the gradual building of industries and by the introduction and modification of technologies. In other words, the technological coefficients of domestic economic production, which are usually assumed to be constant, here depend on industrialization plans and on the cumulative choice of of alternative technologies. In the approach undertaken here, inter-industrial development is determined by the choice

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[17] Structural and technological changes in economic structures could be defined in the following manner: structural changes refer to the changing proportionate shares of various sectors or industries; technological changes refer to the changes in the input-output coefficients themselves. These should both be distinguished from changes which may also result from capital and labor programs.

[18] The study of technological change was approached from two vantage points: an ex post perspective, evaluating and explaining changes due to past experience and an ex ante perspective, attempting to predict changes in production activities due to alternative planned courses of future developments.

Ex post analysis of the changing economic structures has depended largely on accumulated time series information indicative of change in the inter-sector technological matrix. Estimation of changes in input-output coefficients began with Leontief's [184] descriptive formulation of the multi period biproportional effects on a given input-output matrix. This was followed by Stone's [281] development of the RAS estimation method solving for the two biproportional vectors and fitting the new input-output coefficients to the observed margins of total intermediate inputs and outputs. See Lecomber [171] for evaluation of the RAS method and Bacharach [7] for analytical presentation of biproportional matrices and alternative estimation techniques and procedures. Carter [30], on the other hand, approached the problem as a multi production input-output process and augmented the sectoral balance with equations that described the rate at which coefficients changed as new or modified capital embodied techniques replaced older ones. Carter [33] further attempted to explain these changes using a linear programming model to choose an optimal mix structure with a ceiling on total capital investment associated with new and old techniques. In other approaches Forsell [114] attempted to underline causes of input-output changes in Finland, and Staglin [265] attempted to explain changes in the West German economy and compared them with those of the United States.

of the mix of production technologies to produce the desired output.[19]

Turning now to model specification, we first define a multiple-technology input-output coefficient matrix A_T and I_T (I is the identity matrix) such that:

$$A_T = \begin{bmatrix} a_{111} \cdots a_{1j1} \cdots a_{1n1} & \cdots\cdots & a_{11T} \cdots a_{1jT} \cdots a_{1nT} \\ \vdots \quad \vdots \quad \vdots & & \vdots \quad \vdots \quad \vdots \\ a_{i11} \cdots a_{ij1} \cdots a_{in1} & \cdots\cdots & a_{i1T} \cdots a_{ijT} \cdots a_{inT} \\ \vdots \quad \vdots \quad \vdots & & \vdots \quad \vdots \quad \vdots \\ a_{n11} \cdots a_{nj1} \cdots a_{nn1} & \cdots\cdots & a_{n1T} \cdots a_{njT} \cdots a_{nnT} \end{bmatrix}$$

and

$$I_T = \begin{bmatrix} 1 \cdots 0 \cdots 0 & \cdots\cdots & 1 \cdots 0 \cdots 0 \\ \vdots \quad \vdots \quad \vdots & & \vdots \quad \vdots \quad \vdots \\ 0 \cdots 1 \cdots 0 & \cdots\cdots & 0 \cdots 1 \cdots 0 \\ \vdots \quad \vdots \quad \vdots & & \vdots \quad \vdots \quad \vdots \\ 0 \cdots 0 \cdots 1 & \cdots\cdots & 0 \cdots 0 \cdots 1 \end{bmatrix}$$

so that A-[T] is an n x Tn matrix and so is I_T.

Then write the first 2 components of Figure 2-2, the material balance and the output capacity levels predicted for the respective technologies as:

$$(I_T - A_T)\, q_T - I\, c_{gk} - I\, c_{go} - I\, c_h + I\, IMP - I\, EXP - I\, PR = 0 \qquad (2.1)$$

$$I_T\, q_T = q_T^* \qquad (2.2)$$

Where

---

[19] One way to approach these problems would be via the reprocessing, restructuring, and repricing theory of Charnes and Cooper [48]. In this case, the technology is allowed to change simultaneously with output variables to reflect reprocessing, subject to budget limitations on the cost of reprocessing for securing technological change. These will then be augmented by reference to pricing variations in these budgeting limitations and capacity alterations as a part of the total planning process to deal with changes in a total planning system.

This will not be the approach used as a guide here; hence the reference to other approaches. Simon [261] defines technological change as a transformation, partial or total, in production so that for a combination of inputs a greater output is produced. This transformation can be the result of change in one or more of the coefficients and/or changes in the lower limits on the primary factors. Morgenstern and Thompson [224] present an alternative approach for the transfer of production technology. In this approach they have considered imposing constraints on the desired proportion of output using alternative production possibilities, thus allowing for the transformation from one technology to the other.

A_T = (nxnT) matrix of input output coefficients for sectors i, i =1,.....,n; inclusive of existing and planned technology at time t, t=1,.....T;

q_T = nTx1 vector of domestic outputs for sectors i, i=1,.....,n using technology at time t, t=1,....,T.;

c_{gk} = nx1 vector of government's capital consumption from sectors i, i=1,.....,n;

c_{go} = nx1 vector of total government's operations consumption from sectors i, i=1,.....,n;

c_h = nx1 vector of total household consumption from sectors i, i=1,.....,n;

IMP = nx1 vector of total imports for sectors i, i=1,.....,n;

EXP = nx1 vector of total exports from sectors i, i=1,....n;

PR = nx1 vector of the aggregated requirements arising from project construction in sectors i, i=1,....n;

q_T^* = nx1 vector of expected or targeted output capacities for present and planned technologies.

In equation (2.1), the supply side is determined by the domestic output, q_T, and the imports, *IMP*. The demands are from government capital programs, c_{gk}, government operations requirements, c_{go}, household consumption, c_h, exports, *EXP*, and project requirements, *PR*. *PR* here is the vector of the requirements of projects which are planned to increase outputs to the desired levels q^*.[20] In equation (2.2), production of domestic output is related to present and alternative (expected) project outputs.[21]

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[20] Follow up of completed construction will adjust future values of q^* to those which would be achieved with the finished construction. Hence the recursive relationships, in the multi period formulation, consider the succeeding period's targets to be a function of the preceding period's project implementation. This particular issue is examined in section 2.2.6 of this chapter.

[21] The formulation presented in equation (2.2) implies the desire to achieve multiple output goals, q^*, given multiple input and other factors affecting that output. In other words, it implies the desicion maker's desire to be as close as possible to a "production frontier" including the possibility of over achievments and under-achievments (which could indicate possible decision making "discrepancy"). The detailed treatment of this issue is left for further study as will be discussed in the concluding chapter.

2.2.1.1 Base year Prototype Data and Input Output Relationships

In Table 2-1 the economic transactions showing the inter-sector input requirements and the several components in final demand of 1976 are presented in three groups, (1) total transactions, (2) domestic share of these transactions, and (3) imported inputs.[22] On the demand side Table 2-1 shows the base year figures for household consumption, government operation, capital requirements (including government programs), and exports. Notice that approximately 43% of intermediate inputs, 34% of household consumption, 40% of government operations requirements, and 52% of capital development--government and business-- are imported. These imports are grouped into 1) imports of products of non-null sectors (and hence competitive with domestic industries) and 2) null (non-competitive) products. Total final output can be broken down as follows: 46% for capital for industrial development and government use, 34.5% for household consumption, and 14.1% for exports with the remainder for intermediate inputs and government operation. Thus, one can expect any decline in government capital programs in future periods to cause changes in domestic outputs, imports, and, as a result of the potential decline in the number of expatriate labor and their households, household consumption. These and other relationships will be numerically illustrated in section 3 of this chapter.

In addition to the base year information, the expected operation requirements for the planned projects in three sectors, oil-gas, manufacturing, and utility, are presented in Table 2-2 for two time periods, 1976-1980 and 1980-1985.[23] Data on current outputs and expected additions from new projects for the base year and the succeeding two periods are shown in Table 2-3.

Using the data described above, we develop necessary input output coefficients. These are shown in Tables 2-4 and 2-5. Notice that the agriculture sector

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[22] Source: The Macro Economic Modelling Project, [218]. As shown in Table 2-1, data are presented here and throughout this thesis for nine aggregated sectors. The sample data however was arranged in a more detailed sector breakdown, a total of 35 sectors of which 26 were non null and 9 were null. The definition of null and non-null, due to [218], is made to distinguish non existing industries from those already existing.

Data base manipulations for this thesis allows for alternative clusters of sectors and/or their disaggregation when specific emphasis is desired on certain industry types- or on variations in production technologies.

[23] Project specific data presented were selected from the xxxxx projects surveyed in the Macro Economic Modelling Project [218]. They are associated with their respective sector of production and their requirements are associated with the respective sector of supply. They are grouped into two periods of time from the original 10 year program beyond the base year.

TABLE 2-1: BASE YEAR INPUT OUTPUT DATA

TOTAL TRANSACTIONS

	INTERMEDIATE REQUIRMENTS										CONSUMPTION			GOV. OPERATION			CAPITAL				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(T)	N.NULL	NULL	(T)	N.NULL	NULL	(T)	N.NULL	NULL	(T)	EXPORT	TOTAL
(1)	280.1	0.0	4.2	0.0	1.3	0.0	0.0	112.1	36.7	434.4	0.0	0.0	11228.0	0.0	0.0	13.0	0.0	0.0	161.0	57.0	11893.4
(2)	60.3	208.8	45.4	44.7	49.0	101.1	35.4	222.5	88.1	815.3	0.0	0.0	1968.6	0.0	0.0	276.9	0.0	0.0	75.0	21152.0	24287.8
(3)	140.1	1105.5	3411.1	119.5	3586.3	3351.5	211.9	547.7	1166.9	13640.5	0.0	0.0	17676.0	0.0	0.0	3669.5	0.0	0.0	36802.0	146.0	7193.4
(4)	0.0	24.5	73.9	4.9	40.0	48.6	92.3	19.3	44.2	347.7	0.0	0.0	514.0	0.0	0.0	89.4	0.0	0.0	0.0	0.0	951.1
(5)	0.0	5.8	4.8	6.2	44.6	10.4	24.0	3.1	67.7	166.6	0.0	0.0	153.0	0.0	0.0	375.4	0.0	0.0	14878.0	0.0	15573.0
(6)	0.0	29.3	114.7	4.9	402.1	1199.3	0.2	759.5	0.0	2510.0	0.0	0.0	193.0	0.0	0.0	1679.2	0.0	0.0	17925.0	0.0	21707.2
(7)	69.8	12.4	523.6	38.4	583.7	359.3	279.2	127.1	204.7	2198.2	0.0	0.0	15776.0	0.0	0.0	548.9	0.0	0.0	1639.0	328.0	20490.1
(8)	0.0	451.8	241.3	108.6	261.6	414.0	9666.5	684.7	211.5	3340.0	0.0	0.0	2935.0	0.0	0.0	1316.7	0.0	0.0	641.0	918.0	9150.7
(9)	30.0	708.4	378.5	97.3	1567.3	394.3	749.6	593.1	599.8	5118.3	0.0	0.0	7177.0	0.0	0.0	1667.4	0.0	0.0	4801.0	884.0	19647.7
(T)	580.3	2546.5	4797.5	426.5	6535.9	5878.5	2359.1	3669.1	2419.6	28571.0	0.0	0.0	57593.6	0.0	0.0	9036.4	0.0	0.0	76772.0	23485.0	195458.0

DOMESTIC TRANSACTIONS

(1)	14.1	0.0	0.2	0.0	0.3	0.0	0.0	5.1	0.0	19.7	0.0	0.0	9007.0	0.0	0.0	1.0	0.0	0.0	1.0	57.0	9085.7
(2)	46.3	161.8	35.4	34.7	38.0	79.1	27.4	172.5	68.1	663.3	0.0	0.0	947.0	0.0	0.0	214.9	0.0	0.0	66.0	21152.0	23043.2
(3)	15.0	161.5	1177.9	28.5	434.3	739.5	34.6	105.8	229.6	2926.0	0.0	0.0	2329.0	0.0	0.0	649.5	0.0	0.0	2729.0	146.0	8780.2
(4)	0.0	24.5	73.9	4.9	40.0	48.6	92.3	19.3	44.2	347.7	0.0	0.0	514.0	0.0	0.0	89.4	0.0	0.0	0.0	0.0	951.1
(5)	0.0	5.8	4.8	6.2	44.6	10.4	24.0	3.1	67.7	166.6	0.0	0.0	153.0	0.0	0.0	375.4	0.0	0.0	14878.0	0.0	15573.0
(6)	0.0	29.3	114.7	4.9	402.1	1199.3	0.2	759.5	0.0	2510.0	0.0	0.0	193.0	0.0	0.0	1679.2	0.0	0.0	17925.0	0.0	21707.2
(7)	69.8	12.4	523.6	38.4	583.7	359.3	279.2	127.1	204.7	2198.2	0.0	0.0	15776.0	0.0	0.0	548.9	0.0	0.0	1639.0	328.0	20490.1
(8)	0.0	446.8	225.9	89.6	234.2	383.6	939.2	483.4	178.1	2980.8	0.0	0.0	2003.0	0.0	0.0	1197.0	0.0	0.0	641.0	918.0	7740.5
(9)	15.0	466.4	349.5	74.3	1447.3	252.3	709.6	555.1	534.8	4404.3	0.0	0.0	7047.0	0.0	0.0	1109.4	0.0	0.0	1018.0	884.0	14462.7
(T)	160.2	1308.5	2515.9	281.5	3224.5	3072.1	2106.5	2230.9	1327.2	16217.3	0.0	0.0	37969.0	0.0	0.0	5265.5	0.0	0.0	36896.0	23485.0	121833.7

IMPORTED TRANSACTIONS

(1)	266.0	0.0	4.0	0.0	1.0	0.0	0.0	107.0	36.7	414.7	2221.0	0.0	2221.0	12.0	0.0	12.0	160.0	0.0	160.0	0.0	2807.7
(2)	14.0	47.0	10.0	10.0	11.0	22.0	8.0	50.0	20.0	152.0	0.0	994.6	994.6	62.0	0.0	62.0	9.0	0.0	9.0	0.0	1244.6
(3)	125.1	944.0	2233.2	91.0	3152.0	2612.0	177.3	441.9	937.3	10713.6	9585.4	5761.6	1534.7	0.0	1138.0	3020.0	5276.7	28796.3	34073.0	0.0	63153.8
(4)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(5)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(6)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(7)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2001.0	0.0	2001.0	0.0	2001.0
(8)	0.0	5.0	15.4	19.0	27.4	30.4	27.3	201.3	33.4	359.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(9)	15.0	242.0	29.0	23.0	120.0	142.0	40.0	36.0	65.0	714.0	932.0	0.0	932.0	119.0	0.0	119.0	0.0	0.0	0.0	0.0	1410.2
(T)	420.1	1238.0	2281.6	145.0	3311.4	2806.4	252.6	838.2	1092.4	12353.7	130.0	0.0	130.0	558.0	0.0	558.0	3633.0	0.0	3633.0	0.0	5185.0
											12868.4	6755.2	19624.6	751.0	1138.0	3771.0	11079.7	28796.3	39876.0	0.0	73624.3

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5) CONST:BLDG (6) CONST:OTHERS
(7) RET/WHOLESALE (8) TRANS/COMMUNICATION (9) SERVICES
(T) TOTAL

TABLE 2-2: OPERATION REQUIREMENTS FOR PROJECTS

	(1980)		(1985)		
TO / FROM	(2)	(4)	(2)	(3)	(4)
(1) AGRICULTURE	0	0	0	0	0
(2) OIL-GAS	4.5	54.1	731.7	392.5	936.8
(3) MANUFACURING	23.7	12.8	331.8	298.6	193.7
(4) UTILITY	.23	6.0	39.9	68.7	92.1
(5) CONST:BLDG.	.11	.1	1.5	.6	1.4
(6) CONST:OTHE.	.6	.97	10.1	1.1	12.04
(7) RET/WHOLESALE	.13	.2	1.9	1.1	3.4
(8) TRANSP/COMMUN	6.9	3.6	89.3	24.0	52.1
(9) SERVICES	15.3	8.6	220.5	53.9	122.7

TABLE 2-3: BASE YEAR AND PROJECTS OUTPUTS

	(1976)	(1980)	(1985)
(1) AGRICULTURE	9085.7	0	0
(2) OIL-GAS	23043.2	495.2	7423.4
(3) MANUFACTURING	8780.0	0	3410.76
(4) UTILITIES	951.7	33.29	2046.65
(5) CONST:BLDG	15573.0	0	0
(6) CONST:OTHERS	19706.2	0	0
(7) RET/WHOLESALE	20490.1	0	0
(8) TRANSP/COMMUN	7740.5	0	0
(9) SERVICES	14462.7	0	0
TOTAL	119833.1	528.49	12890.8

* No data were available for sectors with zero values.

TABLE 2-4: BASE YEAR INPUT OUTPUT COEFFICIENTS

FROM \ TO	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) AGR.	.03083	.00000	.00048	.00000	.00008	.00000	.00000	.01448	.00254
(2) OIL	.00664	.00906	.00517	.04697	.00315	.00513	.00173	.02874	.00609
(3) MANU.	.01542	.04798	.38852	.12556	.23029	.17007	.01034	.07076	.08068
(4) UTIL.	.00000	.00106	.00842	.00515	.00257	.00247	.00450	.00249	.00306
(5) CNS:B	.00000	.00025	.00055	.00651	.00286	.00053	.00117	.00040	.00468
(6) CNS:D	.00000	.00127	.01306	.00515	.02582	.06086	.00001	.09812	.00000
(7) RT/W.	.00768	.00054	.05964	.04035	.03748	.01823	.01363	.01642	.01415
(8) TRNS.	.00000	.01961	.02748	.11411	.01680	.02101	.04717	.08846	.01462
(9) SERV.	.00330	.03074	.04311	.10224	.10064	.02001	.03658	.07662	.04147
	.06837	.11051	.54641	.44604	.41969	.29831	.11513	.39650	.16730

TABLE 2-5: PROJECTS EXPECTED INPUT OUTPUT COEFFICIENTS

	(1980)		(1985)		
FROM \ TO	(2)	(4)	(2)	(3)	(4)
(2) OIL	.0091	1.6255	.0986	.1151	.8555
(3) MANU.	.0479	.3832	.0420	.0876	.1769
(4) UTIL.	.0005	.1790	.0043	.0201	.0841
(5) CNS:B	.0002	.0028	.0002	.0002	.0012
(6) CNS:D	.0013	.0290	.0014	.0020	.0110
(7) RET/W	.0003	.0054	.0003	.0003	.0031
(8) TRNS.	.0139	.1067	.0120	.0070	.0476
(9) SERV.	.0309	.2594	.0297	.0158	.1121
	.1041	2.645	.1885	.2476	1.2915

is the smallest user of intermediate inputs followed by the oil sector. In Table 2-5 notice also that the utility sector's projects are nominally producing at a loss, the result of intermediate inputs being used internally during construction testing rather than for actual production.[24] This is expected to improve when actual production begins, as shown by the 1985 data. See Figure 2-4 for a comparison of the column sum values for the base year vs the expected changes in the succeeding periods.[25] Notice here that, while the manufacturing sector is expected to improve its use of intermediate inputs, the oil and utility sectors are not. This may be due to inefficient use of inputs during construction stages or due to alternative processes such as, for example, in gas production.[26]

2.2.2 Labor Inputs and Links to Manpower Systems

Economic and demographic links are, without doubt, essential to any planning framework that deals with the multidimentional issues of national development.[27] To facilitate these links,[28] we classify manpower using presently known demographic, input, and output characteristics of Saudi Arabia. In lieu of explicitly including a manpower planning system, we make use of the outputs of the mathematical models

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[24] The Hawkins-Simon condition will be satisfied when base-year technology is additively augmented by project technologies.

[25] See Appendix 2-B for a presentation of the input-output coefficients and their expected changes due to project planning.

[26] In Appendix 2-A we simulate alternative scenarios indicating two extreme cases of 1) total decrease in import of intermediate inputs into production and 2) total decrease in expatriate labor in production sectors. These cases are compared with the expected growth due to those industrial projects discussed above. However, in the section on model application, we consider other factors in a multi objective policy planning framework.

[27] Labor inputs in economic models have been usually treated as a "value added" component. The labor component was further accorded specific attention in Schinnar's formulation [251, 252], linking economic input-output, Leontief [185], to demographic input-output, Stone [276], to examine issues of joint "eco-demographic" planning. Labor demography, in Schinnar's formulation, begins with the population's cohort-activity classification and links them to the labor demand of the various sectors. Eco-demographic planning was then examined under conditions of long term stability and consistency in the input-output transactions and in the population's activity transformations.

[28] To account for the various national labor-manpower relationships, Figures 1-A.1 and 1-A.2 in Appendix 1-A, Chapter 1, attempt to delineate the issues involved. This delineation can be considered as the basis for further detailed study of the overall manpower system. It further indicates areas potentially ripe for planning and incorporates links to the education and training subsystems. Clearly, there is more than one force influencing educational policy developments, one of which is industrial planning. Hence conflicting goals and objectives may also exist in relating economic planning to educational objectives. The details of such activities are not be undertaken here.

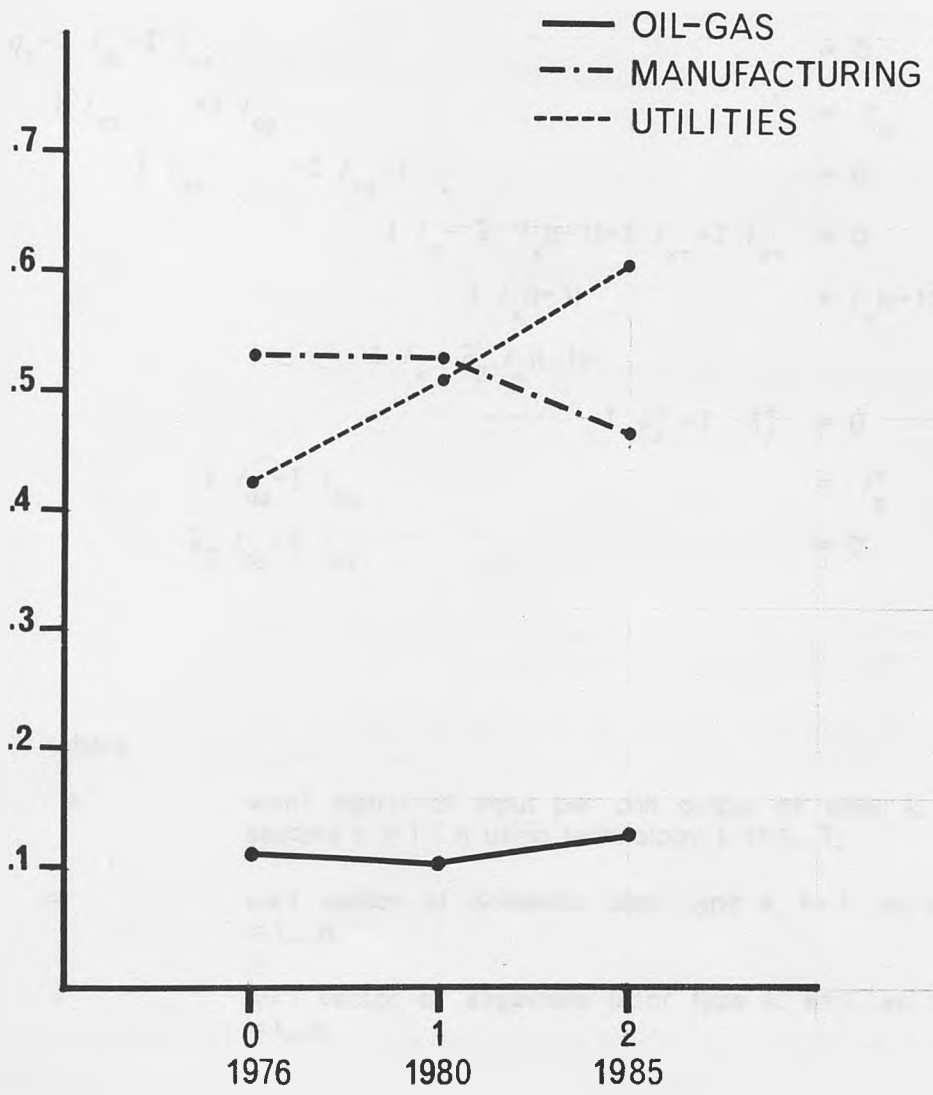


FIGURE 2-4: BASE YEAR AND CHANGES IN INPUT OUTPUT COEFFICIENTS

developed in a previous study [218].[29]

Turning now to the second component in Figure 2-2 (reproduced below for convenience), we focus on the following labor issues: (1) sectoral needs, gover-nment requirements and their potential relationships; (2) domestic and expatriate labor inputs and outputs; and (3) goals related to the extent of expatriate labor utilization.

$$L_T\, q_T - I\, /_{ds} - I\, /_{xs} = 0 \qquad (2.3)$$

$$I\, /_{ds} + I\, /_{dg} = /_d \qquad (2.4)$$

$$I\, /_{xs} + I\, /_{xg} - I\, /_x = 0 \qquad (2.5)$$

$$I\, /_x - \hat{a}_1\, /_x(t-1) - I\, /_{x-} + I\, /_{x+} = 0 \qquad (2.6)$$

$$I\, /_x(t-1) = /_x(t-1) \qquad (2.7)$$

$$I\, /_x - \hat{a}_2\, /_x(t-1) + I\, \delta_/^- - I\, \delta_/^+ = 0 \qquad (2.8)$$

$$I\, /_{dg} + I\, /_{xg} = /_g^* \qquad (2.9)$$

$$\hat{a}_3\, /_{dg} + I\, /_{xg} = 0 \qquad (2.10)$$

where

L_T = wxnT matrix of input per unit output of labor k, k=1,....,w; in sectors i, i=1,....,n using technology t, t=1,....T;

$/_{ds}$ = wx1 vector of domestic labor type k, k=1,....,w in sectors i, i=1,....,n;

$/_{xs}$ = wx1 vector of expatriate labor type k, k=1,....w, in sectors i, i=1,....n;

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[29] This study was conducted by the Technical Assistance and Special Studies Division, The World Bank under contract to the Ministry of Planning, Saudi Arabia. The models were designed to account for the admission, transition, dropouts, and outputs of the educational system(s) and to estimate inputs to a domestic manpower pool. The estimates indicate occupation, age, and sex of the new domestic labor at each period. In this thesis no attempts are made to examine the assumptions or consistency of the education-manpower pool models; only their resulting forecasts are utilized as inputs.

l_{ds} = wx1 vector of sector domestic labor type k, k=1,...,w;

l_{xs} = wx1 vector of sector expatriate labor type k, k=1,...,w;

l_{dg} = wx1 vector of government domestic labor type k, k=1,....,w;

l_{xg} = wx1 vector of government expatriate labor type k, k=1,....,w;

l^{*}_{g} = wx1 vector of stipulated government labor requirement type k, k=1,....,w;

l_{x} = wx1 vector of total expatriate labor type k, k=1,....,w;

$l_{x}(t-1)$ = wx1 vector of expatriate labor available from time (t−1) type k, k=1,....,w;

l_{d} = wx1 vector of total domestic labor available in category k; k=1,....,w;

l_{x+} = wx1 vector of additional expatriate labor inputs type k, k=1,....,w;

l_{x-} = wx1 vector of expatriate labor exits type k, k=1,....,w;

$\hat{a}_{1}$ = wxw diagonal matrix of the proportion of remaining expatriate labor;

$\hat{a}_{2}$ = wxw diagonal matrix of the desired proportion and change in expatriate labor levels;

$\hat{a}_{3}$ = wxw diagonal matrix where $\hat{a}_{ii}$ elements are the proportions of domestic labor to expatriate labor in government;

δ^{+}_{l} = wx1 vector of positive deviations from the desired levels in expatriate labor force;

δ^{-}_{l} = wx1 vector of negative deviations from the desired levels in expatriate labor force.

In equation (2.3) labor required by the production sectors is composed of domestic and expatriate inputs, l_{ds} and l_{xs}. The domestic labor, l_{d}, in equation (2.4) is distributed as follows: l_{ds} to private sector and l_{dg} to government. Similarly, in equation (2.5), expatriate labor, l_{x}, is distributed to the two sectors according to l_{xs} and l_{xg} respectively.

Next in equation (2.6), the net expatriate labor needed to fulfill the needs of

both sectors is defined as the algebraic sum of those remaining from previous periods, $\hat{a}_1 \; /_x(t-1)$,[30] the new input of recruits from abroad, $/_{x+}$, and the exits, $/_{x-}$.[31]

Equation (2.8)[32] implicitly considers issues of social concern arising from changes in expatriate labor and their households, these changes being related to expatriate labor goals. The setting of these goals is guided by the previous period's levels while goal achievement influences the occupation, age, and nationality mix of expatriate labor. Under these assumptions, policy may favor the maintenance, or slow change, in the size or the mix of the expatriate labor force. The objective here is to get as close as possible to the desired levels of expatriate labor by minimizing the deviations, indicated by δ_l^- and δ_l^+. These goals may be in conflict with the industrialization plans and operations of both private sectors and government. Resolution of such conflicts is one of the bases for the use of multi-objective planning as our framework (the application is presented in section, 2.4).

Equations (2.9-2.10) further establish the relationships between domestic and expatriate labor in government. Within government, the proportion of the domestic to expatriate labor is considered to be policy parameters-- $\hat{a}_3$, a priori determining government's share of domestic labor and allocating the balance to the private sector.[33] In cases of decline in private sector growth, or unpredicted increases in certain labor categories, the value of these parameters could be changed to allow the government to absorb surplus domestic labor-- rather than allow an increase in unemployment.[34] These parameters could be adjusted to reflect the desired size,

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30 $\hat{a}_1$ here is a diagonal matrix whose elements are the proportion of expatriate labor expected to remain. Due to [218], the attrition of expatriate labor, which is closely related to their occupation and nationality, indicates that close to 50% of the expatriate labor are replaced every five years.

31 Expatriate labor exits, $/_{x-}$, are due to a decline in demand or the availability of sufficient domestic labor. This could have the effect of a "reverse multiplier" of expatriate labor and its secondary effects on the economy.

32 Equation (2.7) is a technical requirement for the multi period version of this model.

33 Base year data indicates that the government has the largest Saudi-to-expatriate ratio which suggests the government's desire to conduct public affairs--policy making and implementation-- using domestic labor. The willingness of government to absorb large portions of the domestic labor in certain categories or the desire of Saudi labor to enjoy the securities offered by government employment seems to be indicated by the government's disproportionate share of Saudi labor.

34 Such an assumption, further, require careful examination of both actual decision behavior as well as the study of the effecient size in government emloyment (in comparison to actual practices).

occupation, and nationality mix of expatriate labor in government.[35] This has the effect of decreasing the number of expatriates in government and substituting them with the additionally available domestic labor.

2.2.2.1 Base Year Prototype Data, Labor Requirements, and Expected Labor Inputs

In the following we introduce and discuss the prototype data of Saudi Arabia. We present base year (1976) data estimates followed by requirements for government operations and projects.[36] Then we present domestic labor inputs and expatriate labor attritions examined with the aid of the manpower simulations in [218].

Base Year Data (1976)

Table 2-6 shows the overall base year data for domestic and expatriate labor in production sectors and in government arranged by type of occupation and sector of employment. Government agencies are gathered into four groups: public administration, health, education, and others (including defense). The measurement unit here is the number of laborers in each occupation-nationality category working in each of the two distinct job systems.

Figure 2-5 shows the proportionate shares of non agricultural labor in the sectors- private and government. Notice that the government sector represents about 36% of the total employment of which 83% is domestic and 17% is expatriate. On the other hand, production sectors represent about 64% of which 42% is domestic and 58% is expatriate. This disproportionate amount of domestic labor could be the result of the government's aim to conduct public services, as much as possible, using domestic labor. Satisfying this aim could be assisted by the desire of domestic labor to enjoy the security of government employment and the

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[35] Obviously, any such adjustable parameters can be re-formulated as goals. The choices made throughout this effort were based on the desire to keep the number of goals in the illustrations at a minimum.

[36] Macro Economic Modelling Project, [218].

TABLE 2-6: BASE YEAR LABOR DATA

DOMESTIC LABOR

	PRODUCTION SECTOR LABOR										GOVERNMENT LABOR					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(TS)	(PA)	(HL)	(ED)	(OT)	(TG)	(T)
(A)	0.	165.	1583.	245.	346.	796.	1809.	1344.	1625.	7931.	2785.	562.	144.	3485.	7876.	15857.
(B)	0.	895.	866.	878.	199.	395.	1560.	1406.	878.	6899.	16853.	33821.	3538.	18325.	72537.	79436.
(C)	0.	2168.	845.	570.	453.	849.	3124.	4502.	2584.	15095.	26117.	6989.	1000.	13764.	47871.	62966.
(D)	0.	9862.	2593.	1714.	2693.	4518.	5275.	5319.	3321.	35295.	19042.	1107.	345.	37445.	57939.	93234.
(E)	0.	3546.	6037.	1688.	23685.	18043.	2931.	5372.	3969.	65271.	64245.	19857.	3800.	19880.	107782.	173053.
(F)	711979.	0.	0.	0.	0.	0.	0.	0.	0.	711979.	0.	0.	0.	0.	0.	711979.
(G)	0.	0.	12954.	344.	5575.	511.	65687.	31368.	21943.	138382.	0.	0.	0.	0.	0.	138382.
(TD)	711979.	16636.	24700.	5439.	32969.	25112.	80386.	49311.	34320.	980852.	129042.	62336.	8827.	93800.	294605.	1274907.

EXPATRIATE LABOR

(A)	0.	392.	48.	95.	298.	899.	283.	389.	904.	3741.	175.	51.	50.	0.	276.	4017.
(B)	0.	2584.	4361.	1304.	2159.	5396.	7852.	2002.	12122.	37780.	7767.	31266.	8817.	1800.	49650.	87430.
(C)	0.	2258.	1892.	230.	1582.	3176.	11852.	3420.	4143.	28559.	2935.	2100.	200.	260.	5495.	34053.
(D)	0.	3164.	21587.	904.	19942.	36676.	10909.	6292.	17210.	116684.	1901.	261.	20.	40.	2222.	118906.
(E)	0.	275.	26215.	981.	49712.	41330.	12983.	3579.	20628.	155703.	2248.	184.	247.	100.	2779.	158482.
(F)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
(G)	0.	0.	8422.	102.	1865.	173.	4299.	449.	6507.	21817.	0.	0.	0.	0.	0.	21817.
(TE)	0.	8673.	62958.	3616.	75558.	87680.	48178.	16137.	61314.	364284.	15026.	33862.	9334.	2200.	60422.	423306.

TOTAL LABOR

(T)	711979.	25309.	87658.	9055.	18527.	112762.	128546.	65448.	95834.	1345136.	144068.	96198.	18161.	96080.	354427.	1699572.

(1) AGRICULTURE
(2) GAS-OIL
(3) MANUFACTURING
(4) UTILITIES
(5) CONST:BLDG
(6) CONST:OTHER
(7) RET/WHOLESALE
(8) TRENS/COMM
(9) SERVICES

(A) MANAGERS
(B) PROFESSIONAL
(C) CLERICAL
(D) SKILLED
(E) UNSKILLED
(F) AGRICULTURE
(G) PROPRIETERS

(PA) PUBLIC ADMINSTRATON
(HL) HEALTH
(ED) EDUCATION
(OT) OTHERS
(TS) TOTAL LABOR IN SECTORS
(TG) TOTAL LABOR IN GOVERNMENT
(TD) TOTAL DOMESTIC LABOR
(TE) TOTAL EXPATRIATE LABOR
(T) TOTAL

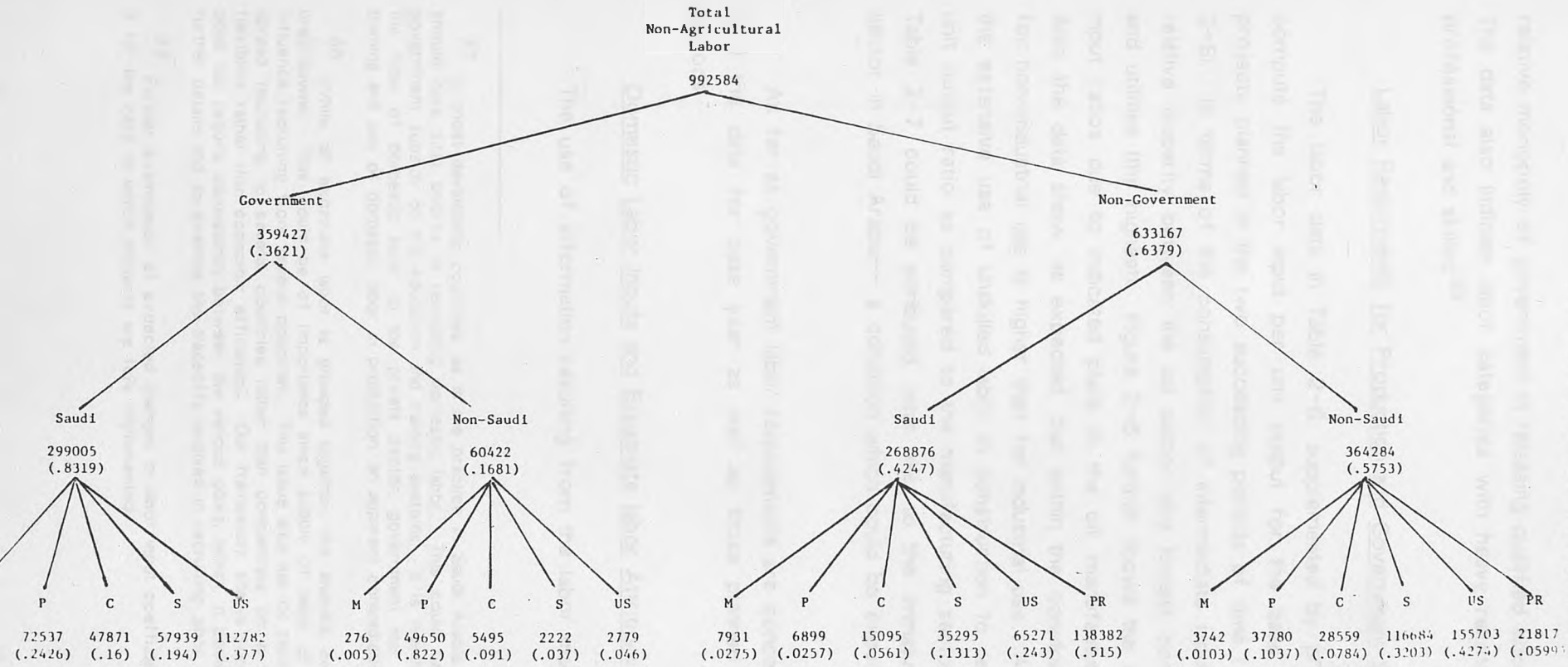


FIGURE 2-5: PROPORTION OF LABOR IN SECTORS AND GOVERNMENT

relative monopoly of government in releasing qualified labor to the private sectors.[37] The data also indicate labor categories with heavy reliance on expatriates such as professional and skilled.[38]

Labor Requirments for Production and Government Sectors

The labor data in Table 2-6, supplemented by project data, were used to compute the labor input per unit output for the base year as well as for the projects planned in the two succeeding periods of time (shown in Tables 2-7 and 2-8). In terms of the consumption of intermediate inputs, these tables show the relative disparity between the oil sector (the lowest consumer) and manufacturing and utilities (the highest). Figure 2-6 further shows the expected changes in labor input ratios due to indicated plans in the oil, manufacturing, and utility sectors.[39] Also the data show, as expected, that within the construction sector, construction for non-industrial use is higher than for industrial use. A priori, one would expect the extensive use of unskilled labor in construction to result in a higher input per unit output ratio as compared to the manufacturing sector. The contrary values in Table 2-7 could be attributed, inter alia, to the immaturity of the manufacturing sector in Saudi Arabia-- a condition which could be expected to improve with time.

As far as government labor requirements are concerned, we present in Table 2-9 the data for base year as well as those planned for the succeeding two periods.

Domestic Labor Inputs and Expatriate labor Attritions

The use of information resulting from the labor market and manpower study,

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[37] In most developing countries, as is the practice in Saudi Arabia, the government feels that they should have first priority in recruiting domestic labor. This could be attributed to the almost total government subsidy of the education and training systems. It is worth noting here that by restricting the flow of domestic labor to the private sector, government may inadvertently delay on-the-job training and use of domestic labor in production, an apparent contradiction in policies.

[38] While all expatriate labor is grouped together, the analysis could be extended to nationality breakdowns. This could be of importance since supply of labor of certain skills and training may influence recruiting from several countries. This issue also has its political side. It may be desirable to spread recruiting to several countries rather than concentrate on a few (On the basis of political flexibility rather than economic efficiency). Our framework allows such conflicting considerations and does not require consistency between the various goals; hence, it could be extended to accommodate further details and to examine the tradeoffs involved in recruiting labor from several countries.

[39] Further examination of expected changes in labor input coefficients is available in Appendix 2-B for the case in which projects are fully implemented.

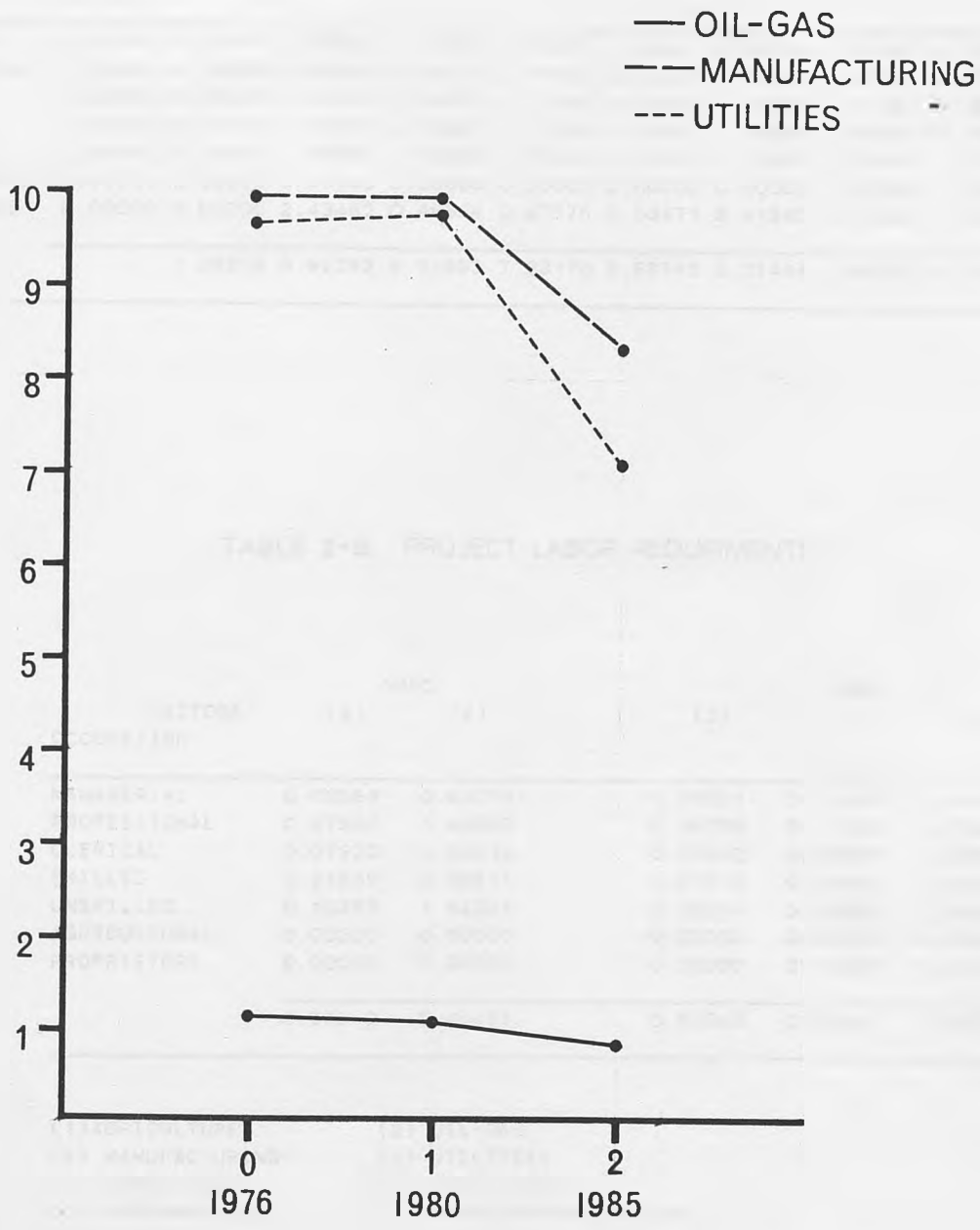


FIGURE 2-6: PROJECTED CHANGES IN LABOR INPUT RATIOS

TABLE 2-7: LABOR INPUT PER UNIT OUTPUT: 1976

SECTORS / OCCUPATION	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
MANAGERIAL	0.00000	0.02417	0.23508	0.35726	0.04251	0.08601	0.10210	0.22389	0.17486
PROFESSIONAL	0.00000	0.15098	0.57506	2.29274	0.15142	0.29387	0.45934	0.44028	0.89886
CLERICAL	0.00000	0.19207	0.31173	0.84060	0.13067	0.20425	0.73089	1.02422	0.46513
SKILLED	0.00000	0.56529	2.75399	2.75087	1.45348	2.09041	0.78984	1.50003	1.41958
UNSKILLED	0.00000	0.16582	3.67335	2.80446	4.71309	3.01291	0.77667	1.15639	1.70072
AGRICULTURAL	78.36259	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
PROPRIETORS	0.00000	0.00000	2.43462	0.46864	0.47775	0.03471	3.41560	4.11046	1.96713
	1.08933	9.98383	9.51923	7.33170	5.68745	6.27444	8.45522	6.62628	

TABLE 2-8: PROJECT LABOR REQUIRMENTS

SECTORS / OCCUPATION	1980 (2)	1980 (4)	1985 (2)	1985 (3)	1985 (4)
MANAGERIAL	0.03586	0.63079	0.03521	0.04890	0.30011
PROFESSIONAL	0.07980	1.48686	0.08059	0.11258	0.70980
CLERICAL	0.07222	1.32916	0.07070	0.09839	2.03827
SKILLED	0.21869	4.08511	0.21619	0.30304	2.03827
UNSKILLED	0.10253	1.92241	0.10074	0.14050	0.98781
AGRICULTURAL	0.00000	0.00000	0.00000	0.00000	0.00000
PROPRIETORS	0.00000	0.00000	0.00000	0.00000	0.00000
	0.50910	9.45433	0.50343	0.70341	4.67036

(1)AGRICULTURE (2) OIL-GAS
(3) MANUFACTURING (4) UTILITIES
(5) CONST:BLDG (6) CONST:OTHER
(7) RET/WHOLESALE (8) TRANS/COMMUNICATION
(9) SERVICES

TABLE 2-9: GOVERNMENT LABOR REQUIREMENTS

BASE YEAR (1976)

	PUBLIC ADM.	EDUCA TION	HEALTH	OTHERS	TOTAL
MANAGERIAL	2885	194	613	4385	8077
PROFESSIONAL	24620	12355	65087	20125	122187
CLERICAL	29052	1200	9089	14025	53366
SKILLED	20943	365	1368	37485	60161
UNSKILLED	66493	9047	20041	19980	115561
TOTAL	143993	23161	96198	96000	

PROJECTED (1980)

	PUBLIC ADM.	EDUCA TION	HEALTH	OTHERS	TOTAL
MANAGERIAL	3022	255	788	4784	8849
PROFESSIONAL	17430	9815	59309	14044	100598
CLERICAL	24379	1219	9492	12061	47151
SKILLED	40413	4570	13462	53558	112003
UNSKILLED	55689	8904	20492	16713	101798
TOTAL	140993	24763	103543	101160	

PROJECTED (1985)

	PUBLIC ADM.	EDUCA TION	HEALTH	OTHERS	TOTAL
MANAGERIAL	3650	306	950	5781	10687
PROFESSIONAL	21065	11262	71693	16974	120994
CLERICAL	29465	1742	11472	14577	57256
SKILLED	48821	5523	16271	64742	135357
UNSKILLED	67315	16761	24770	20201	123047
TOTAL	170316	35594	125156	122275	

which was concerned with the development of a set of models to estimate the domestic manpower pools, was indicated above. In these models, the determination of domestic manpower begin with forecasts of the movement of the population through the education process, finally forming manpower pools.[40] These forecasts included the transition and attrition in the education system as well as the attrition from the labor force of current labor, domestic and expatriate. Such forecasts are the basis for the prototype domestic labor inputs and expatriate labor attrition.

Table 2-10 shows the domestic labor at t=0 base year (1976), and at t=1 and t=2.

TABLE 2-10: EXPECTED DOMESTIC LABOR INPUTS

	BASE YEAR 1976	NET GROWTH * 80	TOTAL T= 1 1980	NET GROWTH * 85	TOTAL T= 2 1985
MANAGERIAL	15807	1875	17682	3747	21429
PROFESSIONAL	79436	9423	88859	18830	107689
CLERICAL	62966	9432	70435	14926	85361
SKILLED	93234	11060	104294	22101	126395
UNSKILLED	173053	20528	193581	41022	234603
AGRICULTURAL	711979	-113917	598062	-65786	532276
PROPRIETORS	138382	16415	154797	32803	187600
TOTAL	1274852		1227710		1295353

* These figures are a prototype for the net growth in domestic labor. See footnote 40.

Table 2-11 further shows the expatriate labor's attrition and expected stocks (using the labor stocks at t=0 as a base) at the periods considered. Notice the high attrition rate of expatriate labor, due to their temporary commitment and to short term contracts. One could reasonably expect such high replacement levels costly

[40] Reference: The Manpowr Study, the Ministry of Planning, Saudi Arabia [219]. In the initial application of the model, developed in subsection 2.2 of this thesis, the expansion rates of domestic labor, which is given from the Manpower Study, indicated a significant decrease in reliance on expatriate labor, especially professional and skilled laborers. This has raised questions regarding the education-manpower pool model as well as the validity of mapping the manpower models, [219], output as data input to this model. Rigorous examination of the assumptions and procedures of that model could not be tested at this time. However, a sensitivity analysis is conducted for a discrete distribution of alternative growth ratios in domestic labor. Based on a discussion with model developers regarding the education-manpower pool model's assumptions and procedures, one growth ratio was chosen to develop the data in table 2-10.

TABLE 2-11: EXPATRIATE LABOR FORECASTS

	BASE YEAR 1976	EXPECTED TO REMAIN T= 1 1980	EXPECTED DOMESTIC INPUT 1980	MIN. TARGETS T= 1 1980	EXPECTED EXPATRIATE LABOR 1980
MANAGEIAL	4017	2043	1875	99	2142
PROFESSIONAL	87430	44467	9423	33540	78007
CLERICAL	34054	17320	7469	9265	26585
SKILLED	118906	60518	11060	47428	106946
UNSKILLED	155482	79134	20526	55820	134954
PROPRIETORS	21817	11104	16415	-5702	5402
TOTAL	421706	214586			355036

	EXPECTED TO REMAIN T= 2 1985	EXPECTED DOMESTIC INPUT 1985	MIN. TARGETS T= 2 1985	EXPECTED EXPATRIATE LABOR 1985
MANAGERIAL	920	3747	-920	0
PROFESSIONAL	33504	18830	25673	51177
CLERICAL	11418	14926	241	11659
SKILLED	46363	22101	39482	85845
UNSKILLED	57964	41022	35969	93933
PROPRIETORS	2320	3283	-2320	0
TOTAL	152489			242614

* ASSUMING THE SAME 1976 LEVELS OF OUTPUT FOR ALL PERIODS AND THE SAME NUMBER OF EXPATRIATE LABOR IN GOVERNMENT

due to both continuous recruitment efforts and to adaptation time to work environments.

2.2.3 Household Consumption

Judging from the distribution of outputs,[41] a substantial gain in the model's coverage and explanatory power would be obtained if household consumption could be made endogenous.[42] However to lump all households as a homogeneous sector falls out of favor since, in contrast with the usual input-output assumption,[43] household consumption is not independent of the amount or source of income. Incorporating household behavior in the input-output framework, therefore, could be achieved by the disaggregation and reclassification of households into subgroups on the basis of socio-economic characteristics.[44] While there is more than one source of household income (see Appendix 2-C for detail), earned income is the major source. However, a one to one relationship does not exist in Saudi Arabia between the incomes of employed individuals and households. Each household may obtain income from several employed individuals while a given individual might allocate his income across several households. Consequently, we can link consumption to the several labor groups characterized by occupation, nationality, and job

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41 Household consumption comes to approximately 35% of total output. See Table 2-1.

42 By such inclusion, we provide, in effect, an additional segificat linkage. This and other linkages in our model provide us with informative dependencies leading to a "proper" multiplier relationships.

43 That the coefficients are independent of the level and the distribution of output.

44 Building upon the efforts of Berman [15] and Miyazawa [221], Artle in [5] attempts to design an input-output model which permits manipulation of household demands without interfering with inter-sector coefficients and yet allowing the disaggregation of households. In this attempt, he define 1) a diagonal matrix B_h whose elements are the household share of total value added in industrial sector i, i=1,.....n; which is absorbed by household h; and 2) square matrices c_h, whose elements are the structure of consumption for each subgroup of households. His model is finally written as:

$$[\, I - A - \sum_h c_h (I - A) B_h \,]\, q = y$$

which could be rewritten as:

$$q = (I - A)^{-1} [\, I - \sum_h c_h (I - A) B_h (I - A)^{-1} \,]^{-1} y$$

system (government and private).[45] Hence, we can specifically distinguish the consumption of expatriate labor and their households which in effect links the entry and exits of expatriate labor to changes in consumption patterns. This linked relationship between consumption and labor is captured in the following equation.

$$Z_1 \; /_{ds} + Z_2 \; /_{xs} + Z_3 \; /_{dg} + Z_4 \; /_{xg} - I \; c \; = 0 \qquad (2.11)$$

Where

Z_1 = nxw matrix of consumption coefficients of households related to sectors domestic labor in activity k, k=1,....,w, to demand sector i, i=1,....,n;

Z_2 = nxw matrix of consumption coefficients of households related to sectors expatriate labor in activity k, k=1,....,w, to demand sector i, i=1,....,n;

Z_3 = nxw matrix of consumption coefficients of households related to government's domestic labor in activity k, k=1,....,w, to demand sector i, i=1,....,n;

Z_4 = nxw matrix of consumption coefficients of households related to government's expatriate labor in activity k, k=1,....,w, to demand sector i, i=1,....,n,

$/_{ds}$ = wx1 vector of sector domestic labor in activity k, k=1,....,w;

$/_{xs}$ = wx1 vector of sector expatriate labor in activity k, k=1,....,w;

$/_{dg}$ = wx1 vector of government domestic labor in activity k, k=1,....,w;

$/_{xg}$ = wx1 vector of government expatriate labor in activity k, k=1,....,w.

and c is, as explained earlier, a vector of total household consumption.

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[45] In deriving our labor related household consumption coefficients we reduce several equation groups into one for illustrative purposes. See Appendix 2-C for the derivation of a reduced function relating labor in the various nationality-job system groups to household consumption. The formulations in Appendix 2-C represented the distribution of labor income to household income, subsidies to household income, and consumption propensities. As a subject for future research one may be interested in changes in these subcomponents themselfs i.e., to examine, changes in incomes, in government subsidies, in labor share of household income, or in consumption propensities.

In Appendix 2-C we present the data used for the derivation of the coefficients of Z_i.

2.2.4 Government and Its Roles

In the case of Saudi Arabia most of the national income, produced by oil exports, is directly associated with government income.[46] The government, in turn, attempts to redistribute its revenues to the population through a variety of subsidies to households, production sectors, and business, as well as through its operation and capital development programs.[47] Government is treated as the ultimate consumer, allocating revenues to agencies to undertake development plans. These plans are considered to be the goals they desire to improve the quality of life.[48] These goals may be in conflict with each other, competing for scarce labor resources, or in contradiction with other desired economic policies.

Consistent with the input-output approach, government final demand components are reclassified to indicate the government agency making the demand as indicated by individual projects. Thus we define GSR, as an nx(uxp) matrix of the agency j, j=1,....,u, project k, k=1,....,p, requirements from sector i, i=1,....,n. Hence GS is an nxu matrix of agency specific requirements, GR is an nxp matrix of project specific requirements and $g = \sum_k \sum_j GSR$ is the nx1 vector of total

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46 121830 Million SR in commodity taxes are reported earned in 1976, [218].

47 Refer to subsections 2.2.3 and 2.3.3 of this chapter.

48 See Chapter One , Section 1.3 for a discussion of government roles and Appendix 1-A for a taxonomy of quality of life dimensions that could be used as a guide to agency planning in their jurisdictions, e.g. Health, Education, Transportation, Housing, Culture, etc.

government stipulated requirements.[49] Such a disaggregation conforms with our basic objective-- to present a framework to deal with the multiple and potentially conflicting goals and aspirations of government agencies.[50]

We now move to the fourth component in Figure 2-2 reproduced below:

$$I\,c_{gk} \quad +I\,\delta_k^- - I\,\delta_k^+ \quad = g_k \qquad (2.12)$$

$$I\,c_{go} \quad +I\,\delta_o^- - I\,\delta_o^+ \quad = g_o \qquad (2.13)$$

Which are aggregated government demands. Agency specific requirements could be obtained from:

$$I\,c_{gk} \quad -E\,c_{gsk} \quad = 0 \qquad (2.14)$$

$$I\,c_{go} \quad -E\,c_{gso} \quad = 0 \qquad (2.15)$$

$$I\,c_{gsk} \quad +I\,\delta_{gsk}^- - I\,\delta_{gsk}^+ \quad = g_{gsk} \qquad (2.16)$$

$$I\,c_{gso} \quad +I\,\delta_{gso}^- - I\,\delta_{gso}^+ \quad = g_{gso} \qquad (2.17)$$

where

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[49] If our only interest is to apply the input-output approach with given fixed coefficients and to examine the effect of changes in government expenditure patterns, we can summarize the basic relationships as follows:

$$\begin{matrix} (I-A)q & +I\,/MP-I\,c & = Ge & + EXP \\ Lq\ -I\ / & & = 0 & \\ Z\ / & -Ic & = 0 & \end{matrix}$$

where G is a matrix relating the respective program or government agency to its requirement from sectors, and e is the identity vector. These equations could be rewritten as

$$(I-A-ZL)q + /MP = G + EXP$$

If M, a diagonal matrix of the import requirements per unit of domestic output, is estimated, then the above equation is written as

$$(I+M-A-ZL)q = G + EXP$$

such that

$$q = (I+M-A-ZL)^{-1}G$$

[50] We accomplish this by identifying the cross impacts and relationships which government goals have on other concerns, e.g., the importation of expatriate labor(which as discussed in sections 2.2.1 and 2.2.2 is guided by a different set of goals and policies).

c_{gk} = nx1 vector of aggregate government capital consumption from sector i, i=1,...n;

c_{go} = nx1 vector of aggregate government operation consumption from sectors i,i=1,...n;

g_{kc} = nx1 vector of aggregate government capital stipulated requirements (plans);

g_{ko} = nx1 vector of aggregate government operations stipulated requirements (plans);

$\delta^{-}_{k,o}$ = nx1 vector of the aggregate negative deviations of capital, k, or operations, o, from their respective stipulated goals;

$\delta^{+}_{k,o}$ = nx1 vector of the aggregate positive deviations of capital, k, or operations, o, from their respective stipulated goals;

c_{gsk} = nux1 vector of capital consumption of government agency j, j=1,...,u for sectors i, i=1,...,n;

c_{gso} = nux1 vector of operation consumption of government agency j, j=1,...,u from sectors i, i=1,...,n;

E = nxnu matrix with p=1,.....,j identity submatrices of direction (nxn) such that E=[I,I,I,....I];

$\delta^{-}_{gsk,o}$ = nux1 vector of negative deviations of agency's capital, k, or operation, o, from their respective stipulated goals;

$\delta^{+}_{gsk,o}$ = nux1 vector of positive deviation of agency's capital, k, or operation, o, from their respective stipulated goals.

Equations (2.12-2.13) stipulate that government expenditures be as close as possible to the stated requirements for capital (g_k) and operations (g_o). Equations (2.16-2.17) stipulate that agency expenditures be as close as possible to their stated requirements g_{gsk} and g_{gso}. Equations (2.14-2.15) aggregate agency requirements into total sector requirements.

In direct relation to the above formulation, the data in Table 2-12 show government expenditure patterns t=0 (base year), 1, and 2. Government agencies were gathered into four groups, Public Administration, Health, Education, and Others. Public Administration includes agencies like information, public works, social security, interior, communications, etc. Education includes all education levels and research. The "Others" category includes defense. Capital development specifically for

TABLE 2-12: GOVERNMENT OPERATIONS AND CAPITAL REQUIREMENTS

		T = 0 (1976)				T = 1 (1980)					T = 2 (1985)				
		Public Administration	Health	Education	Others	Total Requirements	Public Administration	Health	Education	Others	Total Requirements	Public Administration	Health	Education	Others	Total Requirements
Operation Requirements		5.9	1.5	3	4.1	13	6	0	3.0	4.1	13.1	7.1	1.9	3.6	4.9	15.6
		25.8	258.9	2	243.6	276.9	26.7	1.6	2.1	255.4	285.8	31.8	1.9	2.5	304.9	340.1
		715.5	4.7	614.7	2080.4	3669.5	742.6	268.3	606.7	2164.3	3781.9	883.5	319.3	721.8	2575.1	4499.7
		59.5	2.7	14.3	10.9	89.4	53.3	2.8	49.2	288.4	393.7	316.9	3.4	58.5	343.1	721.9
		50.8	8.6	46.9	275	375.4	1060.6	9.02	55.5	14.9	1140.02	1261.9	42.9	65.9	17.7	1388.4
		1011.5	31.3	52.9	6.2	1079.2	0	0	0	0	0	0	0	0	0	0
		93.5	40.7	100.8	323.3	548.9	98.04	32.8	105.7	339	575.54	116.7	39.1	125.8	401.3	684.9
		965.4	50.3	209.3	101.3	1316.7	729.9	38.4	166.4	85.5	1020.2	868.4	45.7	197.9	101.7	1213.7
		603.1		368.3	645.7	1667.4	632.4	52.7	386.2	677.1	1748.4	752.4	62.8	459.5	805.5	2080.2
		3531	398.7	1412.2	3690.5	9032.4	3349.54	405.62	1374.8	3828.7	8958.66	4238.7	515.1	1633	4554.6	10941.4
Capital Requirements		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2673.7	47.6	452.4	12674.5	15848.2	6647.7	30.3	262.1	12674.5	19614.6	9672.6	60.0	478.8	126745	22385.9
		0	0	0	0	0	4088.5	136.2	780.2	0	5004.9	7379.7	265.7	1446.3	0	9091.7
		1818.2	220.3	1116.9	3461	6836.4	7457.7	3.1	22.2	3461	10944	9974.9	9.5	46.4	3461	13491.8
		12986.1	0	19	97.2	13102.3	0	0	0	0	0	0	0	0	0	0
		85	5.2	38	140.2	268.4	178.9	3.1	21.6	142.2	343.8	275.3	5.8	39.4	140.2	460.7
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1968.8	35.9	242.4	666.1	2916.2	1745.9	22.1	141.4	664.1	2575.5	2849.4	41.4	263.5	664.1	3818.3
		19551.8	309	2071.7	17017	38971.5	20118.7	191.7	1229.5	16939.8	38479.7	30151.9	382.4	2274.4	16939.8	49748.5
Total		23082.8	707.7	3483.9	20707.5	48003.9	23468.24	597.32	2604.3	20768.5	47438.36	34390.6	897.5	3907.4	21494.4	60689.8

government is high; however, one would expect this emphasis to change when government needs are met. Note that since these may not be achieved due to other system constraints and objectives, we indicate goal deviations in the above formulation.

2.2.5 Imports and Exports

An evident characteristic of the Saudi Arabian economy is the reliance on exports for government income and the reliance on imports to satisfy the needs of government plans and other economic activities. The new surges in export prices of oil and the relatively smaller needs of the Saudi society for imports have resulted in a large surplus in the balance of payments.[51] Exports are mainly the product of the oil and gas sector. Nevertheless, certain sector's exports could be set at predefined levels (e.g. oil); some could be related to output levels (e.g. services); and yet others could have no exports (e.g. utilities and construction). Imports, on the other hand, are spread over many sectors of the economy. These imports are used as inter-industrial inputs, or direct demands of households and government. The data in Table 2-1 indicate several properties of imports that will be assumed to be constant in our illustration. First, imports are restricted in some sectors--such as construction and utilities. Second, the levels of imports in certain sectors are allowed to fully supplement domestic production (e.g. manufacturing or agriculture). Further, certain imports may be functionally related to domestic output (e.g. oil sector).[52]

Import and Export components could be written as follows (see the Fifth component in Figure 2-2):

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[51] Because of such surpluses, and due to the desire to balance international economic transactions, some may desire that Saudi Arabia should balance its trade through additional imports. Indeed some may urge that, to stabilize the economy and to balance the payments of other countries, Saudi Arabia should: (1) import more than it actually needs, or could absorb, in the short and intermediate terms, and/or (2) help in the development of other countries through financial assistance and development planning.

[52] Imports plays an important role in national development since they usually lead to import substitution policies, [29, 51, 104, 236, 281], which are in turn linked to capital programs oriented towards the development and diversification of the domestic production capabilities. Of particular interest here is Reyes [241] linking the growth rate of capital investment, in a dynamic model, to import levels and investment constraints.

It is not the intention of the formulation here to explicitly consider these alternative policies. We restrict ourselves here to the inclusion of import considerations discussed above. Increases in imports are attributable to both present expenditure programs and increase in expatriate households. Since their households have different tastes than domestic households, it remains to be seen if the latter population's tastes become more import dependent.

$$\hat{\gamma}_1 \, q - I \, IMP \geq 0 \qquad (2.18)$$

$$\hat{\gamma}_2 \, q - I \, EXP \leq EX \qquad (2.19)$$

where

$\hat{\gamma}_1$ = nxn diagonal matrix whose elements are the proportion of import per unit output such that $0 \leq \hat{\gamma}_{ii} \leq 1$, i=1,....,n;

$\hat{\gamma}_2$ = nxn diagonal matrix whose elements are the proportion of export per unit output such that $0 \leq \hat{\gamma}_{ii} \leq 1$, i=1,....,n;

IMP = nx1 vector of imports to supplement supplies from sectors i, i=1,...,n;

EX = nx1 vector in which the non zero components are the stipulated export levels in sectors i, i=1,....,n;

EXP = nx1 vector of exports from sectors i, i=1,...n.

In equations (2.18) and (2.19) imports and exports of individual sectors are defined to be proportionate to domestic output (these proportions ranges from 0 to 1 and in part are policy-determined). Note also that for certain sectors the equalities are strictly maintained to reflect government import and export policies. Obviously, these equations do not capture any import substitution policies or trade balance relationships; however, the extensions required to accommodate such activities are straight forward and are left for future research.

2.2.6 Sector Project Planning

In this subsection we discuss project planning for industrial development. Projects here are developed to add to, or to improve upon, current production practices. The implementation of these projects, or a subset thereof, affects

economic trajectories and has implications on the attainment of social goals.[53] Project have two effects: (1) direct demands on current production, and (2) technological changes in productivity i.e. in the inter sector transactions. We refer to these effects as construction and operations requirements. The requirements for project operations were discussed and related data were presented in the form of intermediate input and labor inputs in section 2.2.1. In the following therefore we will focus on extending construction requirements required to maintain or to increase outputs.

We define PCR to be an nx(nxp) matrix whose entries are the requirements from sectors i, (i=1,.. ..,n), by projects s, (s=1,.. ..,p) in sector j, (j=1,.. ..,n). By aggregating, we get $CR = \sum_s P_s CR$, an nxn matrix of sector specific demands.[54] Then, $P = \sum_s \sum_j PCR$ is an nx1 vector of the total stipulated requirements from sectors i, i=1, .. ,n. The actual demands for project construction, PR, may differ from the stipulated demands, P.

$$I\ PR(t-1) \leq P(t-1) \qquad (2.20)$$

where

PR(t−1) = nx1 vector of the total project requirements from sector i, i=1,.. ..,n, actually used at t−1.

Further, for the purpose of relating the implementation of projects to the production of outputs in the succeeding periods, we define

$$K = PC / \hat{q}''$$

such that

$$K\ q^*(t) = PR\ (t-1) \qquad (2.21)$$

---

53 General policy issues involved in the choice and adaptation of technologies are discussed in [233], and alternative approaches to project investment and selection criteria are discussed in Kendrick [155], Daniel [69], Papandreou [236], Wanhill [299], and Sfeir-Younis [254]. Of particular interest is Sfeir-Younis's application of goal programming for proper representation of conflicting goals and objectives involved in investment planning. A related alternative can also be found in Reyes [241], linking capital development targets to import substitution objectives, implying the selection of projects only if they conform to a particular import substitution criterion.

54 Maintaining project specific demands (which allow project level planning) would require extending our model by using mixed-integer programing approaches [121, 200].

$\hat{q}$ here is an nxn diagonal matrix whose non zero elements are the estimated output levels. K is then an nxn matrix of coefficients of capital required to produce that level of output. Total output, $q^*(t)$, is, through equation 2.21 directly related to the completion of project construction in the previous periods, PR(t−1).

As an example, Table 2−13 contains the construction requirements for projects planned in the oil−gas, manufacturing, and utility sectors for two time periods, 1980 and 1985.

TABLE 2-13: SECTOR PROJECT REQUIREMENTS

1980 REQUIREMENTS

FROM \ TO	(2)	(3)	(4)	TOTAL
(1)AGRICULTURE	0	0	0	0
(2)OIL-GAS	0	0	0	0
(3)MANUFACTURING	4750.77	444.33	760.00	5955.00
(4)UTILITIES	0	0	0	0
(5)CONST:BLDG	5716.16	805.05	1283.60	7804.80
(6)CONST:OTHER	0	0	0	0
(7)RET/WHOLESALE	329.70	29.91	45.49	405.10
(8)TRANSPORTATION	0	0	0	0
(9)SERVICES	803.97	171.00	380.07	1355.04

1985 REQUIREMENTS

FROM \ TO	(2)	(3)	(4)	TOTAL
(1)AGRICULTURE	0	0	0	0
(2)OIL-GAS	0	0	0	0
(3)MANUFACTURING	875.75	1044.54	1426.39	3346.68
(4)UTILITIES	0	0	0	0
(5)CONST:BLDG	2242.26	1892.16	2204.96	6339.38
(6)CONST:OTHER	0	0	0	0
(7)RET/WHOLESALE	59.89	70.33	86.23	216.45
(8)TRANSPORTATION	0	0	0	0
(9)SERVICES	264.18	361.55	333.71	959.44

2.3 SOLUTION METHOD AND APPLICATION

This section will demonstrate and compare the results of alternative applications of the model. These applications are designed to represent several activities likely to be conducted in the process of planning for national development in Saudi Arabia. The structure of our search for alternatives is guided by concepts discussed in Chapter One, Section 1.4. Therein, we suggested that, in the process of planning, policy makers not only ask the question: what if? but are involved in an iterative process of changing goals and preferences.

First, we will address the case in which there is no other goal competing with the achievement of government plans. Second, we will examine the case in which the objective is to get "as close as possible" to both expatriate labor and government goals, the former fixed at base year levels. Finally, we will extend government goals to include agency specific goals. These alternative applications, shown in Figure 2-8, are coded ECN11, ECN13, and ECN14, indicating changes in stipulations, preferences, and problem aggregation. Table 2-14 is a summary of relevant linear programming constraint rows (see Figure 2-3) characteristic of these applications. Table 2-15 similarly summarizes the activity columns and shows both indicator and decision variables. For example, in ECN13 deviation variables from government goals are related to the aggregate demand from sectors while in ECN14, they are related to the corresponding agency breakdown.

While the computational problem could be solved using partitioning procedures, we used a large scale linear program to generate the needed solutions. The problem was implemented using the MPSX-370 extended linear programming package developed by IPM. [143].[55] Table 2-16 contains several computational statistics resulting from a typical application of each of the above mentioned alternative applications for the one period formulation. A tentative indication of these statistics is the relatively low time-cost of exploring alternative policies.

We do not undertake here the illustration of all of our model's potential, but focus on selected characteristics. For example, we illustrate the results and impacts of changes in time periods, in goals, and in trade-offs among goal achievement levels while ignoring the impacts on changing the structure of technology. Summaries of the chosen alternative numerical applications (ECN11, ECN13, and ECN14) follow.

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[55] Computations were conducted at Rice University's Computation Center, Houston, Texas.

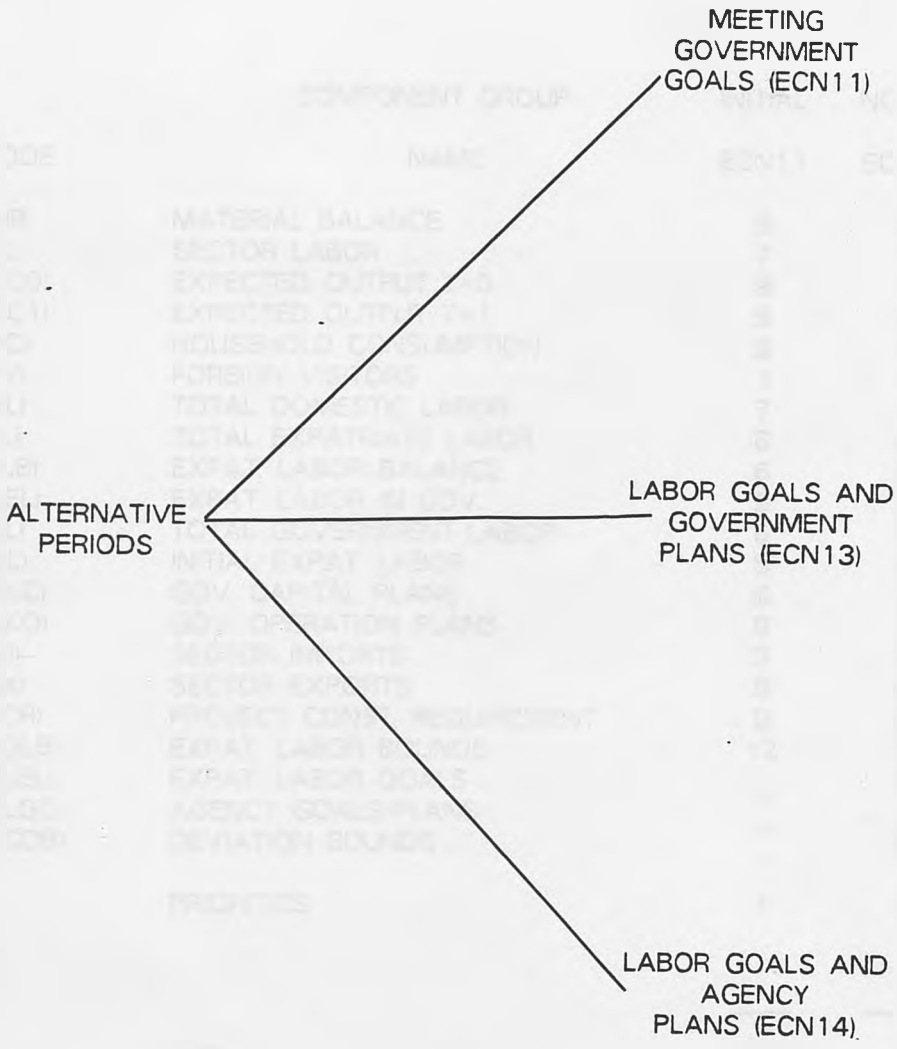


FIGURE 2-7: ALTERNATIVE APPLICATIONS

TABLE 2-14: SUMMARY OF CONSTRAINT ROWS

CODE	COMPONENT GROUP NAME	INITIAL ROWS, ECN11	NO. OF ROWS, ECN13	ROWS, ECN14
(MB)	MATERIAL BALANCE	9	9	9
(SL)	SECTOR LABOR	7	7	7
(OC0)	EXPECTED OUTPUT T=0	9	9	9
(OC1)	EXPECTED OUTPUT T=1	9	9	9
(HC)	HOUSEHOLD CONSUMPTION	9	9	9
(FV)	FOREIGN VISITORS	1	1	1
(DL)	TOTAL DOMESTIC LABOR	7	7	7
(EL)	TOTAL EXPATRIATE LABOR	6	6	6
(ELB)	EXPAT. LABOR BALANCE	6	6	6
(GEL)	EXPAT. LABOR IN GOV.	5	5	5
(GL)	TOTAL GOVERNMENT LABOR	5	5	5
(IEL)	INITIAL EXPAT. LABOR	5	5	5
(GKC)	GOV. CAPITAL PLANS	9	9	9
(GKO)	GOV. OPERATION PLANS	9	9	9
(IM)	SECTOR IMPORTS	9	9	9
(EX)	SECTOR EXPORTS	9	9	9
(PCR)	PROJECT CONST. REQUIREMENT	9	9	9
(BOLB)	EXPAT. LABOR BOUNDS	12	12	12
(GLEL)	EXPAT. LABOR GOALS	–	6	6
(GLGC)	AGENCY GOALS/PLANS	–	–	72
(GCDB)	DEVIATION BOUNDS	–	18	72
	PRIORITIES	1	3	10
	TOTAL	137	163	296
	TOTAL: for 26 production sectors and 5 nationality groups	405	489	548
	TOTAL: including 20 agency groups			964

TABLE 2-15: SUMMARY OF ACTIVITY COLUMNS

CODE	NAME	COMPONENT GROUP ECN11	INITIAL ECN13	NO. OF ECN14	COLUMNS
(OTP0)	OUTPUT (BASE YEAR TECH.)		9	9	9
(OTP1)	OUTPUT (ALTERNATIVE TECH.)		9	9	9
(DLS)	DOMESTIC LABOR IN SECTORS		7	7	7
(ELS)	EXPATRIATE LABOR IN SECTORS		7	7	7
(DLG)	DOMESTIC LABOR IN GOVERNM.		5	5	5
(ELG)	EXPATRIATE LABOR IN GOV.		5	5	5
(TEL)	TOTAL EXPATRIATE LABOR		6	6	6
(IEL)	INITIAL EXPATRIATE LABOR		6	6	6
(ELI)	EXPATRIATE LABOR INPUTS		6	6	6
(ELO)	EXPATRIATE LABOR OUTPUTS		6	6	6
(CKG)	GOV. CAPITAL PLANS		9	9	9
(COG)	GOV. OPERATION PLANS		9	9	9
(HHC)	HOUSEHOLD CONSUMPTION		9	9	9
(IMP)	IMPORTS		9	9	9
(EXP)	EXPORTS		9	9	9
(PR)	PROJECT REQUIREMENTS		9	9	9
(AGC)	AGENCY DISAGGREGATION		–	–	72
(DVEL)	DEVIATIONS: EXPAT. LABOR		–	12	12
(DVGO)	DEVIATIONS: GOV. OPER.		–	18	72
(DVGK)	DEVIATIONS: GOV. CAPITAL		–	18	72
	STIPULATIONS		3	3	3
	TOTAL		123	171	339
	TOTAL: for 26 production sectors and 5 nationality groups		347	504	575
	TOTAL: including 20 agency groups				1837

TABLE 2-16: COMPUTATIONAL STATISTICS

TYPE	CPU *	ACTIVE TIME *
ECN11	4.67	50.52
ECN12	4.95	48.80
ECN13	5.33	66.55
ECN14	7.92	53.88

* In seconds

2.3.1 Government Goals and their Impacts

The objective of the following application is to examine the impacts resulting from the exclusive satisfaction of government goals (formally, this is accomplished by assigning zero values to other goals including expatriate labor goals). Table 2-17 presents the numerical results for the two periods of concern, 1980 and 1985. They are arranged to show production sector's supplies-domestic outputs and imports, and demands and requirements-exports, household consumption, government capital and operation, and project requirements. Table 2-18 contains labor statistics arranged to show occupation-specific domestic and expatriate labor in production sectors and government.[56] The data in these tables were used to produce Figures 2-8 to 2-10. In Figure 2-8 we show the expected growth in domestic outputs, imports, and household consumption. The decrease in the growth rates of imports and consumption is attributable to the increase in the use the domestic laborers whose household consumption behavior is different from expatriate households. The disparity between the two growth rates is the result of other demands for imported goods (e.g. government). Figure 2-9 shows the relationship between the non-agricultural domestic and expatriate labor, and domestic outputs, imports, and consumption. To clarify further, the reduction in the domestic/expatriate labor ratios, Figure 2-10, are shown to affect reduction in both imports and consumption. The reduction in imports is however lower than that of consumption.

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[56] See Appendix 2-E.1 for the detailed outputs of these illustrations.

TABLE 2-17: PROJECTED SECTOR SUPPLIES AND DEMANDS: ECN11

(1980)

	DOMESTIC OUTPUT	IMPORTS	EXPORTS	CONSUMP-TION	GOV. CAPITAL	GOV. OPERATION	SECTOR PROJECTS
(1)	8287.32	5027.41	57.00	12579.57	0.00	13.10	161.00
(2)	23515.70	1382.59	22067.29	1134.85	0.00	285.80	75.00
(3)	8780.00	79130.29	146.00	21343.79	19614.60	3781.90	26908.00
(4)	6420.75	0.00	0.00	593.00	5004.90	393.70	0.00
(5)	28407.16	0.00	0.00	204.85	10944.00	1140.02	15846.30
(6)	6890.26	689.03	0.00	163.51	0.00	0.00	4822.60
(7)	22767.13	0.00	328.00	17861.30	343.80	575.54	777.70
(8)	12859.12	2443.23	552.94	4434.83	0.00	1020.20	641.00
(9)	21996.83	7038.98	1253.81	12700.69	2575.50	1748.40	3239.84
(T)	139924.27	95711.53	24405.04	71016.39	38482.80	8958.66	52471.44

(1985)

	DOMESTIC OUTPUT	IMPORTS	EXPORTS	CONSUMP-TION	GOV. CAPITAL	GOV. OPERATION	SECTOR PROJECTS
(1)	7375.71	7767.13	57.00	14385.41	0.00	15.60	161.00
(2)	32489.36	1503.43	28575.20	1329.49	0.00	340.10	75.00
(3)	12190.76	93720.87	3556.76	24416.79	22885.90	4499.70	30255.48
(4)	11240.20	0.00	0.00	725.45	9091.70	721.90	0.00
(5)	37651.79	0.00	0.00	228.01	13491.80	1388.40	22185.65
(6)	7401.32	740.13	0.00	181.69	0.00	0.00	4822.60
(7)	26430.70	0.00	328.00	20409.33	460.70	684.90	994.15
(8)	15151.77	2878.84	651.53	5270.15	0.00	1213.70	641.00
(9)	27484.80	8795.13	1566.63	14803.03	3818.40	2080.20	4199.28
(T)	177416.41	115405.53	34735.12	81749.35	49748.50	10944.50	63334.16

(1) AGRICULTURE (2) OIL-GAS
(3) MANUFACTURING (4) UTILITIES
(4) CONST:BLDG (5) CONST:OTHER
(7) RET/WHOLESALE (8) TRANS/COMM
(9) SERVICES (T) TOTAL

TABLE 2-18: PROJECTED LABOR IN GOVERNMENT AND SECTORS: ECN11

	DOMESTIC LABOR	EXPATRIATE LABOR	GOV.EXP LABOR	GOV.DOM. LABOR	SECTOR EXP.LAB.	SECTOR DOM.LAB.	TOTAL GOV.LABOR	NEGATIVE DEVIATION	POSOTIVE DEVIATION	GOALS	RECRUITMENT
(A)	17682.	6958.	300.	8549.	6658.	9133.	8849.	2941.	0.	4017.	4915.
(B)	88859.	77216.	40877.	59721.	36339.	29138.	100598.	0.	10213.	87430.	32749.
(C)	70435.	34488.	4855.	42296.	29633.	28139.	47151.	434.	0.	34054.	17168.
(D)	104294.	186916.	47195.	64808.	139721.	39486.	112003.	68010.	0.	118906.	126398.
(E)	193581.	186924.	1493.	100305.	185431.	93276.	101798.	29542.	0.	157382.	107790.
(F)	598062.	0.	0.	0.	0.	598062.	0.	0.	0.	0.	0.
(G)	154797.	57274.	0.	0.	57274.	154797.	0.	35457.	0.	21817.	46170.
(T)	1227710.	549776.	94720.	275679.	455056.	952031.	370399.	136384.	10213.	423606.	335190.

(1985)

	DOMESTIC LABOR	EXPATRIATE LABOR	GOV.EXP LABOR	GOV.DOM. LABOR	SECTOR EXP.LAB.	SECTOR DOM.LAB.	TOTAL GOV.LABOR	NEGATIVE DEVIATION	POSOTIVE DEVIATION	GOALS	RECRUITMENT
(A)	21429.	9643.	362.	10425.	9281.	11004.	10787.	5626.	0.	4017.	6655.
(B)	107689.	99011.	49165.	71829.	49846.	35860.	120994.	11581.	0.	87430.	65847.
(C)	85361.	44017.	5896.	51360.	38121.	34001.	57256.	9963.	0.	34054.	29204.
(D)	126395.	234130.	57035.	78322.	177095.	48073.	135357.	115224.	0.	118906.	153850.
(E)	234603.	240718.	1805.	121242.	238913.	113361.	123047.	83336.	0.	157382.	148658.
(F)	532275.	0.	0.	0.	0.	532275.	0.	0.	0.	0.	0.
(G)	187600.	63399.	0.	0.	63399.	187600.	0.	41582.	0.	21817.	35192.
(T)	1295352.	690918.	114263.	333178.	576655.	962174.	447441.	267312.	0.	423606.	439405.

(A) MANAGERS (B) PROFESSIONAL
(C) CLERICAL (D) SKILLED
(E) UNSKILLED (F) AGRIGULTUR
(G) PROPRIOTES (T) TOTAL

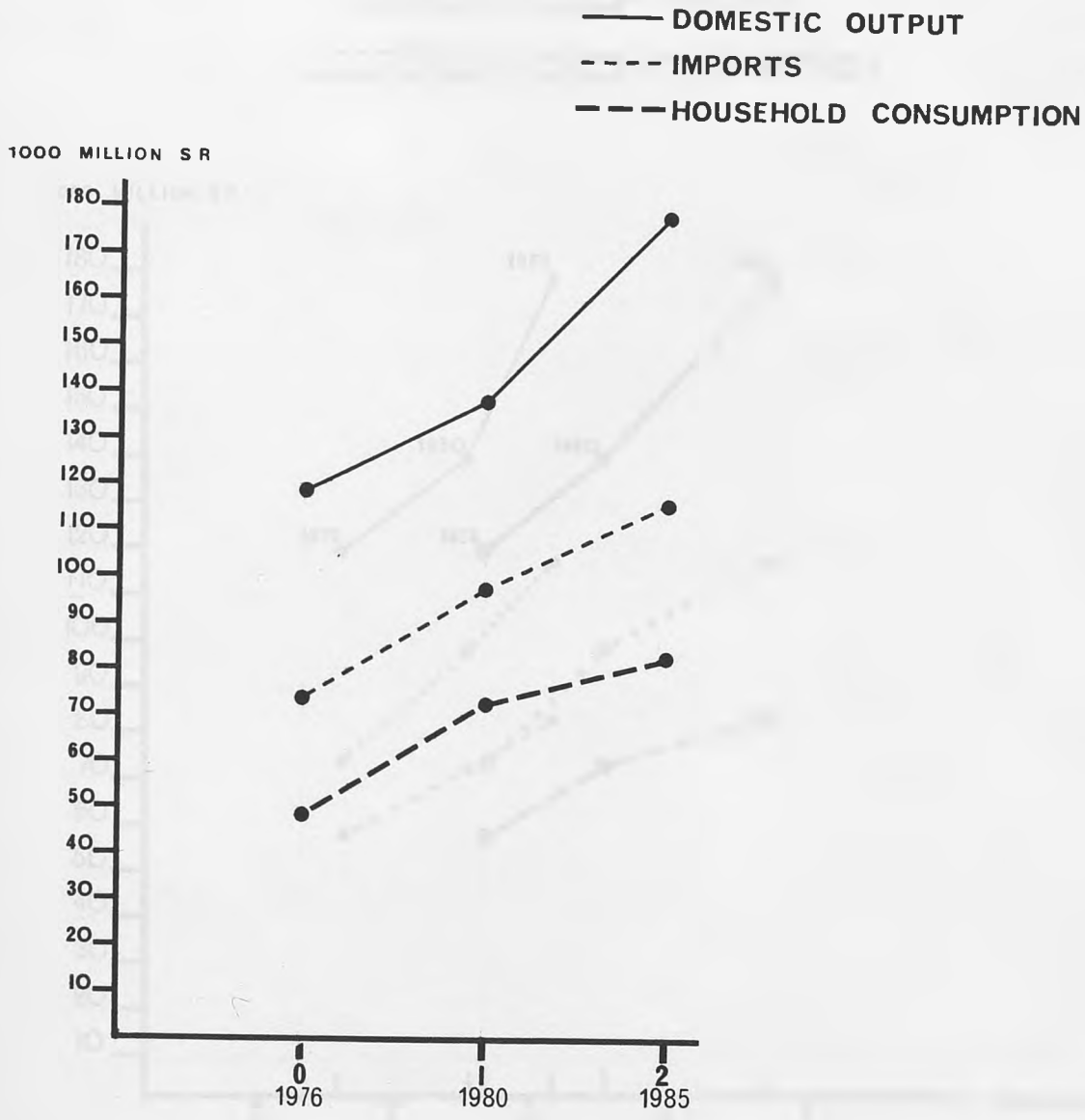


FIGURE 2-8: EXPECTED GROWTH IN OUTPUT, IMPORT, AND CONSUMPTION

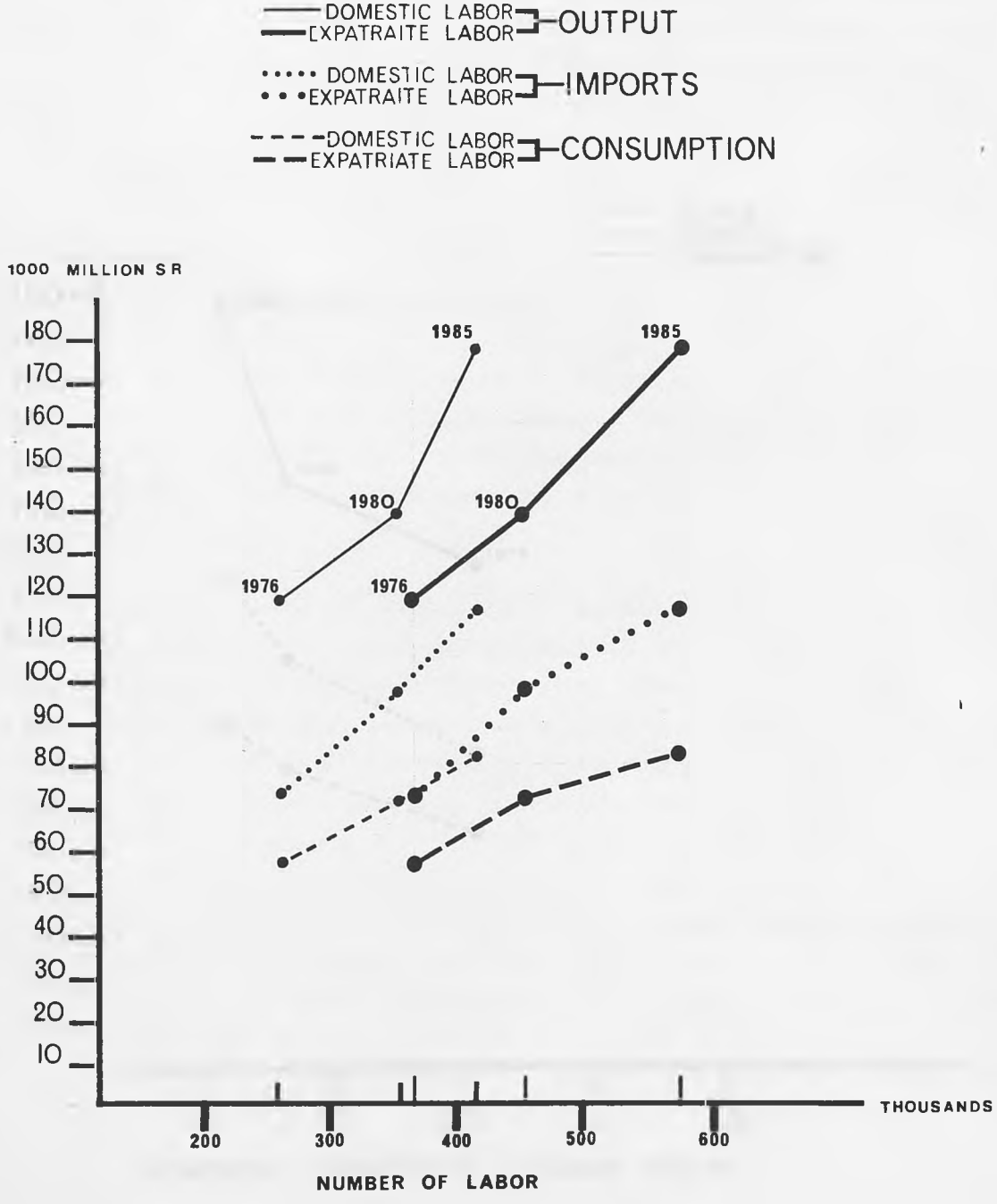


FIGURE 2-9: LABOR INPUTS, OUTPUTS, IMPORTS, AND CONSUMPTION ECN11

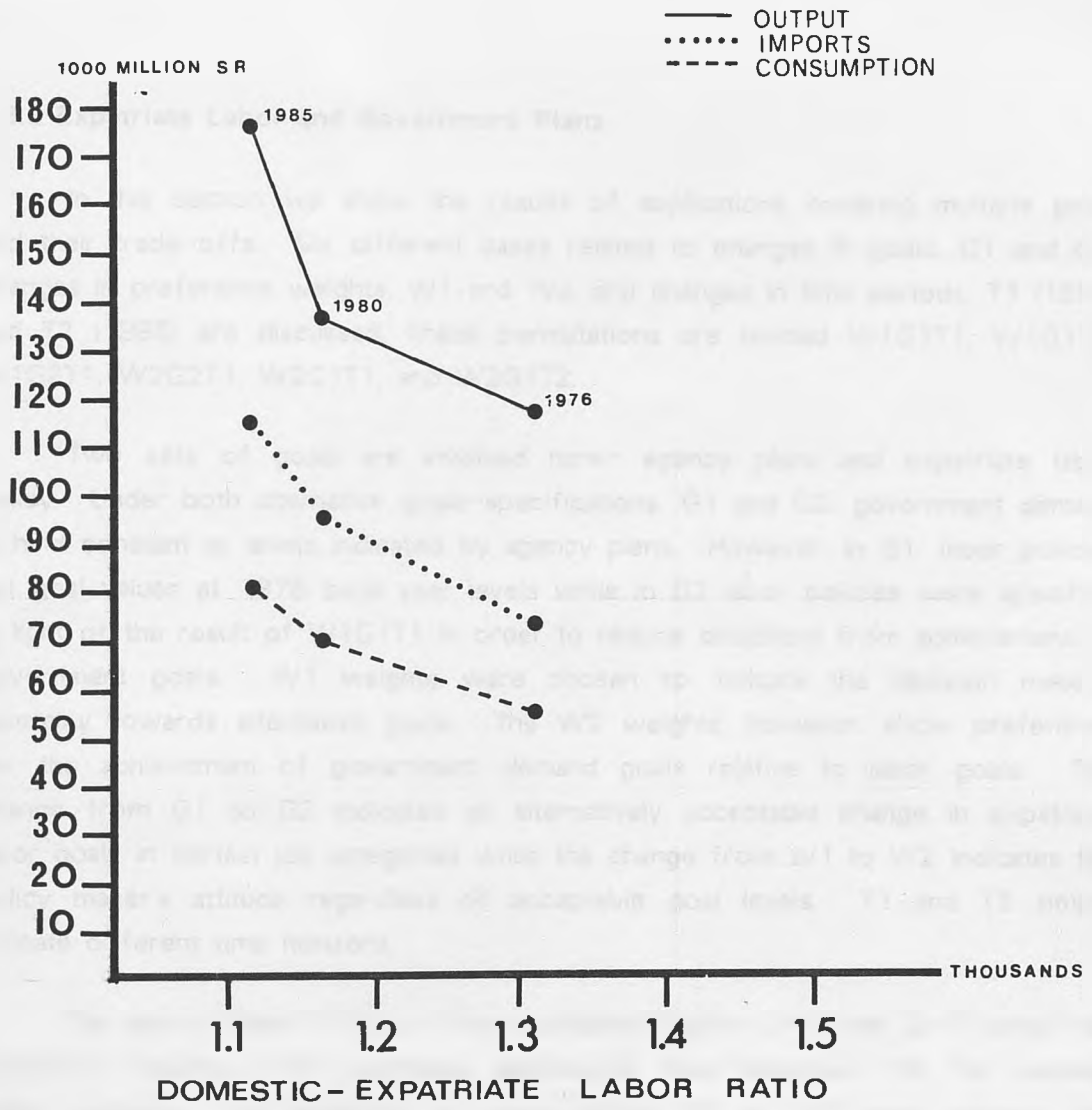


FIGURE 2-10: DOMESTIC/EXPATRIATE LABOR RATIO AND RELATED VARIABLES

These expatriate and domestic labor inputs in non-agricultural production sectors are shown in Figure 2-11. In this figure notice that, due to both the government absorption of domestic labor and the increase in demands in the second period, relatively more expatriate labor is required than in the first period (See Table 2-18). Hence, substantial changes could be affected if the government decides to decrease its labor requirements or encourage more domestic labor to join the production sector by leaving government service.

2.3.2 Expatriate Labor and Government Plans

In this section we show the results of applications covering multiple goals and their trade-offs. Six different cases related to changes in goals, G1 and G2, changes in preference weights, W1 and W2, and changes in time periods, T1 (1980) and T2 (1985) are discussed. These permutations are termed W1G1T1, W1G1T2, W1G2T1, W2G2T1, W2G1T1, and W2G1T2.

Two sets of goals are involved here- agency plans and expatriate labor policy. Under both alternative goals-specifications, G1 and G2, government demand is held constant at levels indicated by agency plans. However, in G1, labor policies set goal values at 1976 base year levels while in G2 labor policies were specified in light of the result of W1G1T1 in order to reduce directions from achievement of government goals. W1 weights were chosen to indicate the decision maker's neutrality towards alternative goals. The W2 weights, however, show preference for the achievement of government demand goals relative to labor goals. The change from G1 to G2 indicates an alternatively acceptable change in expatriate labor goals in certain job categories while the change from W1 to W2 indicates the policy maker's attitude regardless of acceptable goal levels. T1 and T2 simply indicate different time horizons.

The data in Table 2-18, and the associated Figures 2-12 and 2-13 show the deviations resulting from alternative applications (see Appendix 2-E for detailed model outputs). As expected, in cases where G2 or W2 were applied, the government's under-achievement of goals decreases at the expense of increases in the recruitment of expatriate labor as compared to base year levels. This trade-off between agency plans and government policies may be attractive to those who advocate increased domestic production and/or increased imports. The impact of different time horizons is itself dependent on other conditions (see Figure 2-12).

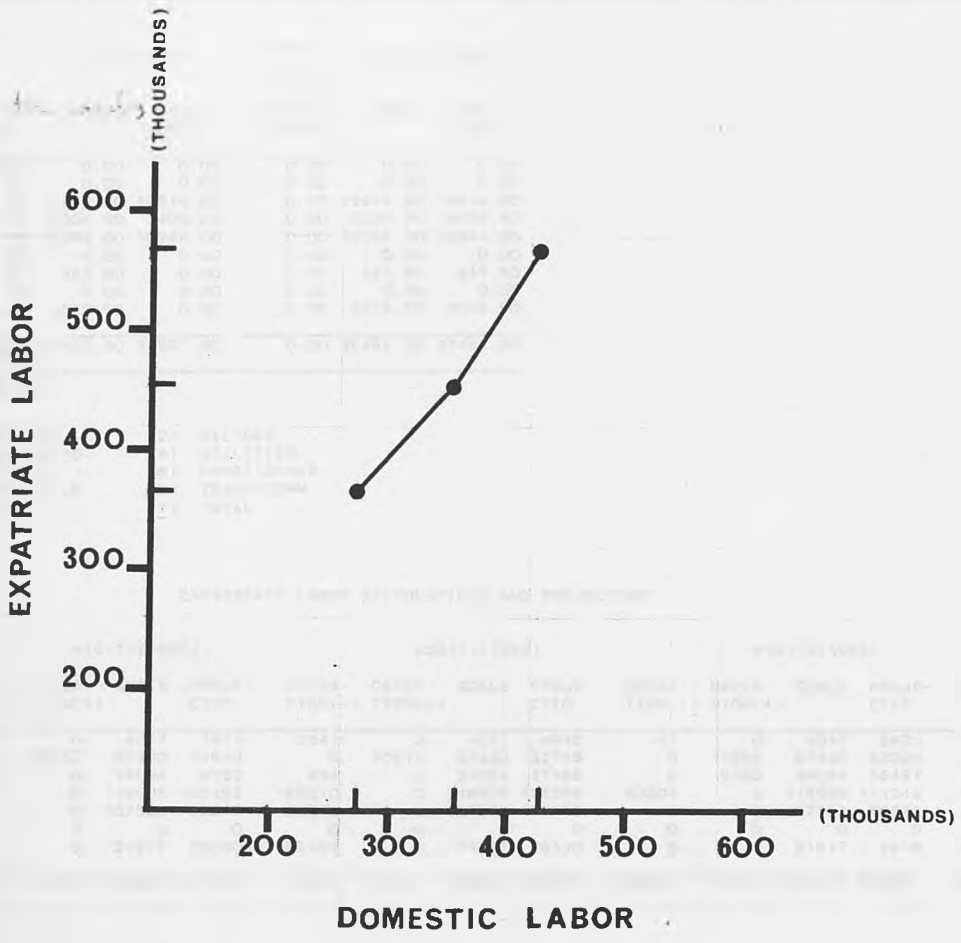


FIGURE 2-11: DOMESTIC AND EXPATRIATE LABOR IN PRODUCTION SECTORS

TABLE 2-19: GOALS AND DEVIATIONS IN GOVERNMENT PLANS AND LABOR GOALS

GOVERNMENT CAPITAL STIPULATIONS AND PROJECTIONS

	W1G1T1(1980)			W2G1T1(1980)			W1G1T2(1985)			W2G1T2(1985)		
	DEVIATIONS	GOALS	PROJECTED	DEVIATIONS	GOALS	PROJECTED	DEVIATIONS	GOALS	PROJECTED	DEVIATIONS	GOALS	PROJECTED
(1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(3)	0.00	19614.60	19614.60	0.00	19614.60	19614.60	0.00	22885.90	22885.90	0.00	22885.90	22885.90
(4)	5004.70	5004.70	0.00	0.00	5004.70	5004.70	8338.25	9091.70	753.45	0.00	9091.70	9091.70
(5)	10391.52	10944.00	557.48	0.00	10944.00	10944.00	8684.33	13491.80	4807.47	0.00	13491.80	13491.80
(6)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(7)	343.80	343.80	0.00	0.00	343.80	343.80	460.70	460.70	0.00	0.00	460.70	460.70
(8)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(9)	2579.50	2579.50	0.00	0.00	2579.50	2575.90	3818.40	3818.40	0.00	0.00	3818.40	3818.40
(T)	18315.52	38482.80	20172.08	0.00	38482.80	38482.80	21301.68	49748.50	28446.82	0.00	49748.50	49748.50

	W1G2T1(1980)			W2G2T1(1980)		
	DEVIATIONS	GOALS	PROJECTED	DEVIATIONS	GOALS	PROJECTED
(1)	0.00	0.00	0.00	0.00	0.00	0.00
(2)	0.00	0.00	0.00	0.00	0.00	0.00
(3)	0.00	19614.60	19614.60	0.00	19614.60	19614.60
(4)	1595.54	5004.90	3409.00	0.00	5004.90	5004.90
(5)	0.00	10944.00	10944.00	0.00	10944.00	10944.00
(6)	0.00	0.00	0.00	0.00	0.00	0.00
(7)	343.80	343.80	0.00	0.00	343.80	343.80
(8)	0.00	0.00	0.00	0.00	0.00	0.00
(9)	2575.50	2575.50	0.00	0.00	2575.50	2575.50
(T)	4424.84	38482.80	33967.60	0.00	38482.80	38482.80

4424.84

(1) AGRICULTURE (2) OIL-GAS
(3) MANUFACTURING (4) UTILITIES
(5) CONST:BLDG (6) CONST:OTHER
(8) RET/WHOLESALE (9) TRANS/COMM
(9) SERVICES (T) TOTAL

EXPATRIATE LABOR STIPULATIONS AND PROJECTIONS

	W1G1T1(1980)				W2G1T1(1980)				W1G1T2(1985)				W2G1T2			
	DEVIATION(-)	DEVIATION(+)	GOALS	PROJECTED	DEVIATION(-)	DEVIATION(+)	GOALS	PROJECTED	DEVIATION(-)	DEVIATION(+)	GOALS	PROJECTED	DEVIATION(-)	DEVIATION(+)	GOALS	PROJECTED
(A)	17	0	4017	1911	2941	0	4017	4915	147	0	4017	2431	5626	0	4017	6654
(B)	0	26552	87430	16410	0	10213	87430	32749	0	17958	87430	43324	11581	0	87430	64847
(C)	3658	0	34054	8733	434	0	34054	17168	0	6383	34054	16481	9963	0	34054	29204
(D)	43764	0	118906	102153	68010	0	118906	126396	62204	0	118906	111243	115224	0	118906	153850
(E)	0	0	157382	78247	29542	0	157382	107790	0	0	157382	79872	83336	0	157382	144658
(F)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(G)	15547	0	21817	26260	35457	0	21817	36130	0	0	21817	3415	41582	0	21817	35211
(T)	62986	26532	423606	233794	136384	10213	423606	335150	62351	24341	423606	256767	267312	0	423606	438424

	W1G1T1(1980)				W2G1T1(1980)			
	DEVIATION(-)	DEVIATION(+)	GOALS	PROJECTED	DEVIATION(-)	DEVIATION(+)	GOALS	PROJE-
(A)	1222	0	4504	3683	2454	0	4504	4915
(B)	0	27509	98021	26045	0	20804	98021	32749
(C)	0	7355	38179	13504	0	3091	38179	17168
(D)	43921	0	133310	116714	53606	0	13310	126398
(E)	0	0	176447	97313	10477	0	176447	107790
(F)	0	0	0	0	0	0	0	0
(G)	2256	0	24460	35612	32814	0	24460	36130
(T)	47399	34864	474921	292871	99351	24495	474921	335150

(A) MANAGERS (B) PROFESSIONAL
(C) CLERICAL (D) SKILLED
(E) UNSKILLED (F) AGRICULTURE
(G) PROPRIOTERS (T) TOTAL

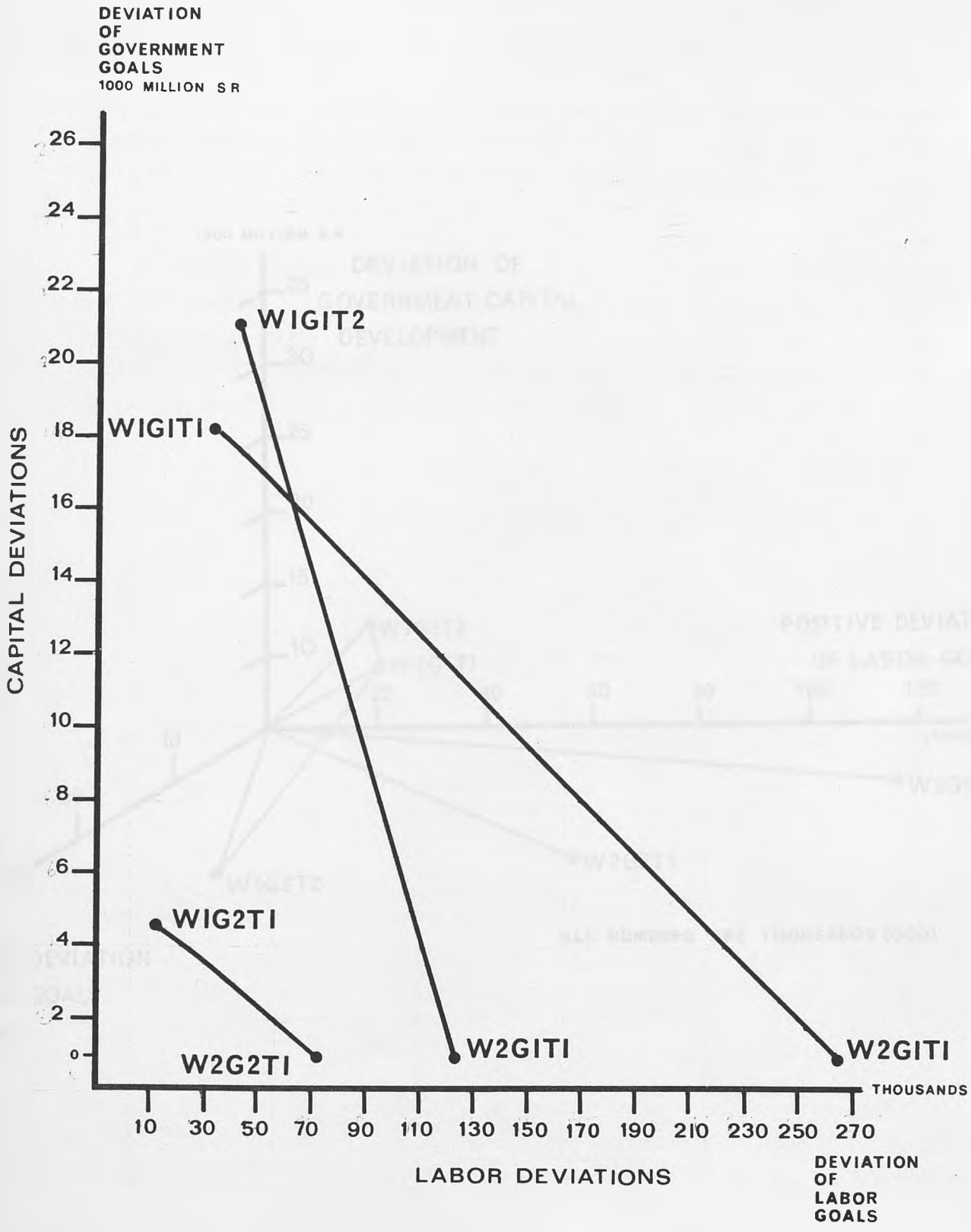


FIGURE 2-12: GOVERNMENT AND LABOR NET DEVIATIONS: ECN13

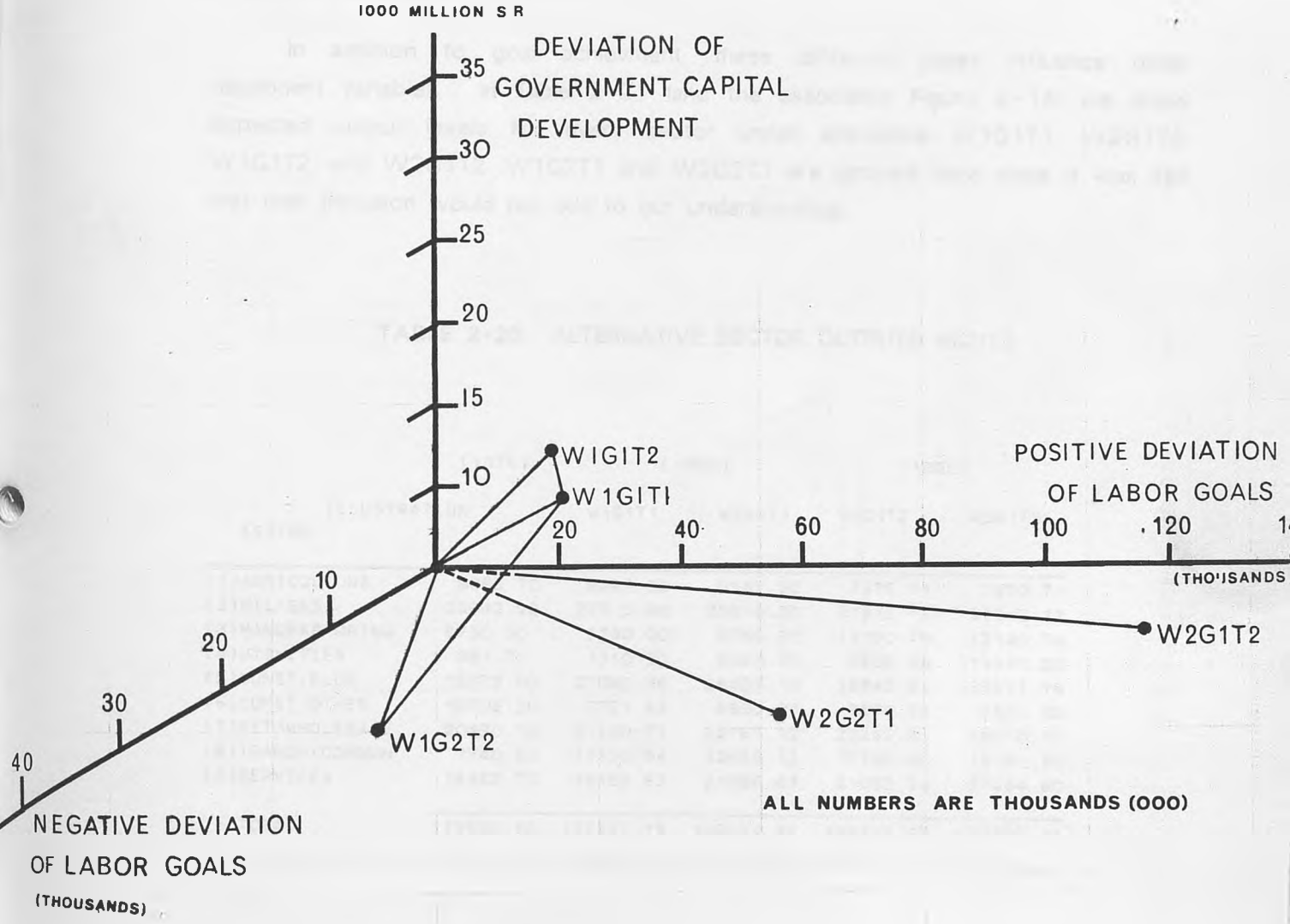


FIGURE 2-13: DEVIATION OF GOVERNMENT PLANS AND LABOR GOALS

For example the difference in deviations between T1 and T2 with W1G1 is substantially different from the difference in deviations between T1 and T2 with W2G1 as a result of the indications between the time path of agency plans and preference weights. We provide in Figure 2-13, without interpretation, a three dimensional equivilent of Figure 2-12 where positive and negative rather than net labor goal deviations are mapped.

In addition to goal achievment, these different cases influence other dependent variables. In Table 2-21 (and the associated Figure 2-14) we show expected output levels for every sector under alternative W1G1T1, W2G1T1, W1G1T2, and W2G1T2 (W1G2T1 and W2G2T1 are ignored here since it was felt that their inclusion would not add to our understanding).

TABLE 2-20: ALTERNATIVE SECTOR OUTPUTS: ECN13

	(1976)	(1980)		(1985)	
ILLUSTRATION SECTOR		W1G1T1	W2G1T1	W1G1T2	W2G1T2
(1)AGRICULTURE	9085.70	8287.32	8287.32	7375.71	7375.71
(2)OIL-GAS	23043.20	23515.00	23515.00	31812.17	31812.17
(3)MANUFACTURING	8780.00	8780.00	8780.00	12190.76	12190.76
(4)UTILITIES	951.70	1310.20	6420.75	2669.69	11240.20
(5)CONST:BLDG	15573.00	27090.96	28407.16	28843.64	37651.79
(6)CONST:OTHER	19706.20	6721.83	6890.26	6909.32	7401.32
(7)RET/WHOLESALE	20490.10	21220.77	22767.12	23233.80	26470.70
(8)TRANSP/COMMUN	7740.50	11720.54	12859.12	12785.05	15151.77
(9)SERVICES	14462.70	18499.83	21996.83	21032.34	27484.80
TOTAL	119833.10	127127.15	139924.26	146852.48	177407.41

Note specifically: (1) the decrease in agricultural output,[57] (2) the decrease in sector(6), other construction, due to the assumed decrease in government demand (see Table 2-12), (3) the increased output of sectors (2), (3), and (4), to planned levels of output, and finally (4) the increases in the remaining sectors to satisfy the final demand and associated multiplier effect.

[57] This decrease should be contrasted with the assumed increased productivity in succeeding periods (see Appendix 2-B). The observed results could be due to productivity gains being offset by the estimated increase in the attrition of agricultural labor [219].

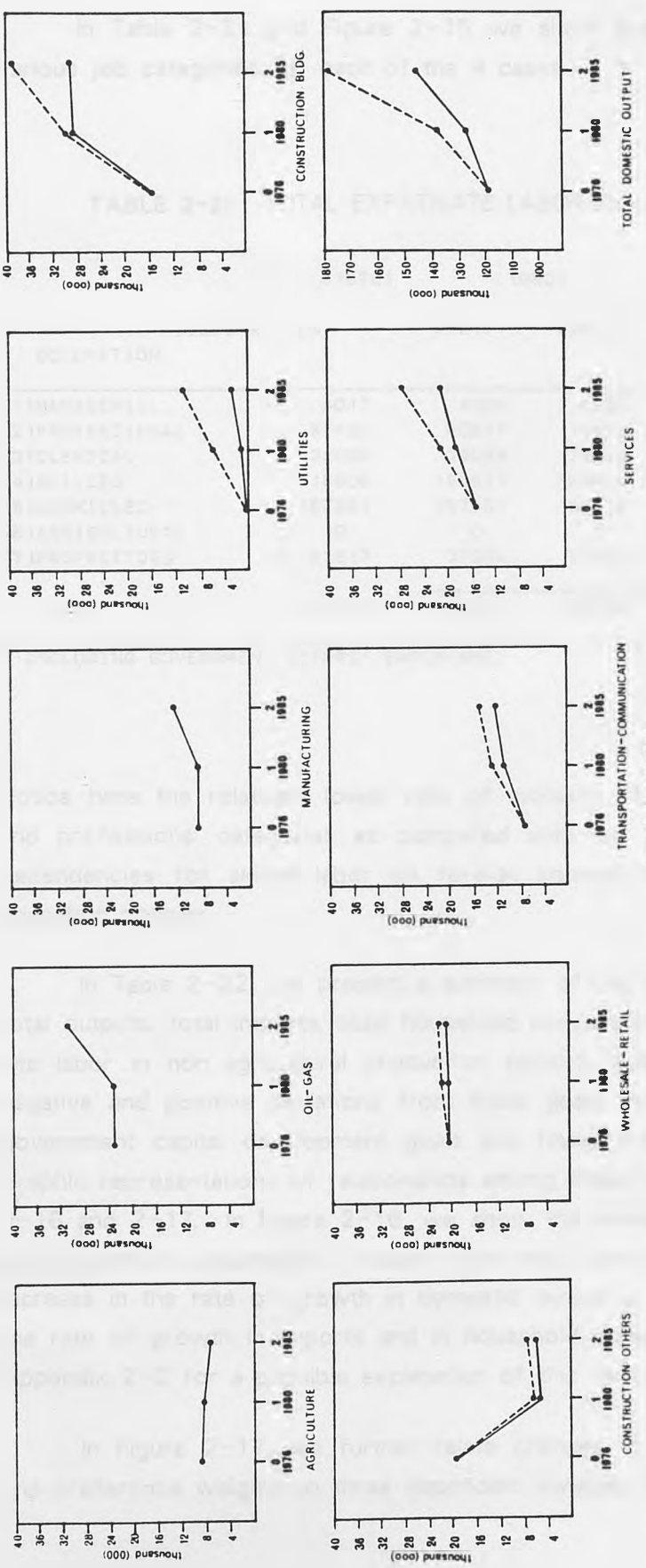


FIGURE 2-14: SECTOR OUTPUTS FOR ALTERNATIVE APPLICATIONS: ECN13

In Table 2-21 and Figure 2-15 we show the levels of expatriate labor in various job categories for each of the 4 cases.

TABLE 2-21: TOTAL EXPATRIATE LABOR BY JOB CATEGORY: ECN13

	(1976)	(1980)		(1985)	
ILLUSTRATION / OCCUPATION		W1G1T1	W2G1T1	W1G1T2	W2G1T2
(1)MANAGERIAL	4017	4304	6958	4164	9643
(2)PROFESSIONAL	87430	60877	77216	69471	98101
(3)CLERICAL	34054	26053	34488	27671	44017
(4)SKILLED	118906	162671	186916	181110	234130
(5)UNSKILLED	157381	157381	186924	157382	240718
(6)AGRICULTURAL	0	0	0	0	0
(7)PROPRIETORS	21817	37364	57234	21817	63399
TOTAL *	423606	446380	549736	461615	689918

* INCLUDING GOVERNMENT SCTORS' EMPLOYMNET

Notice here the relatively lower rate of increase of expatriate labor in managerial and professional categories as compared with the skilled category. The relative dependencies for skilled labor on foreign sources could be expected to further education policies.

In Table 2-22, we present a summary of the major indices for the 4 cases: total outputs, total imports, total household consumption, total domestic and expatriate labor in non agricultural production sectors, goals for expatriate labor levels, negative and positive deviations from these goals, recruitments of expatriate labor, government capital development goals and finally the deviations from these goals. Graphic representations of relationships among these indicators are shown in Figures 2-16 and 2-17. In Figure 2-16, we show the periodic changes in output, imports and household consumption. Notice from this figure that by the second period the increase in the rate of growth in domestic output is accompanied by a decrease in the rate of growth in imports and in household consumption (see section 2.2.3 and Appendix 2-C for a possible explanation of this relationship).

In Figure 2-17, we further relate changes in domestic and expatriate labor and preference weights to three dependent variables: output, imports, and household

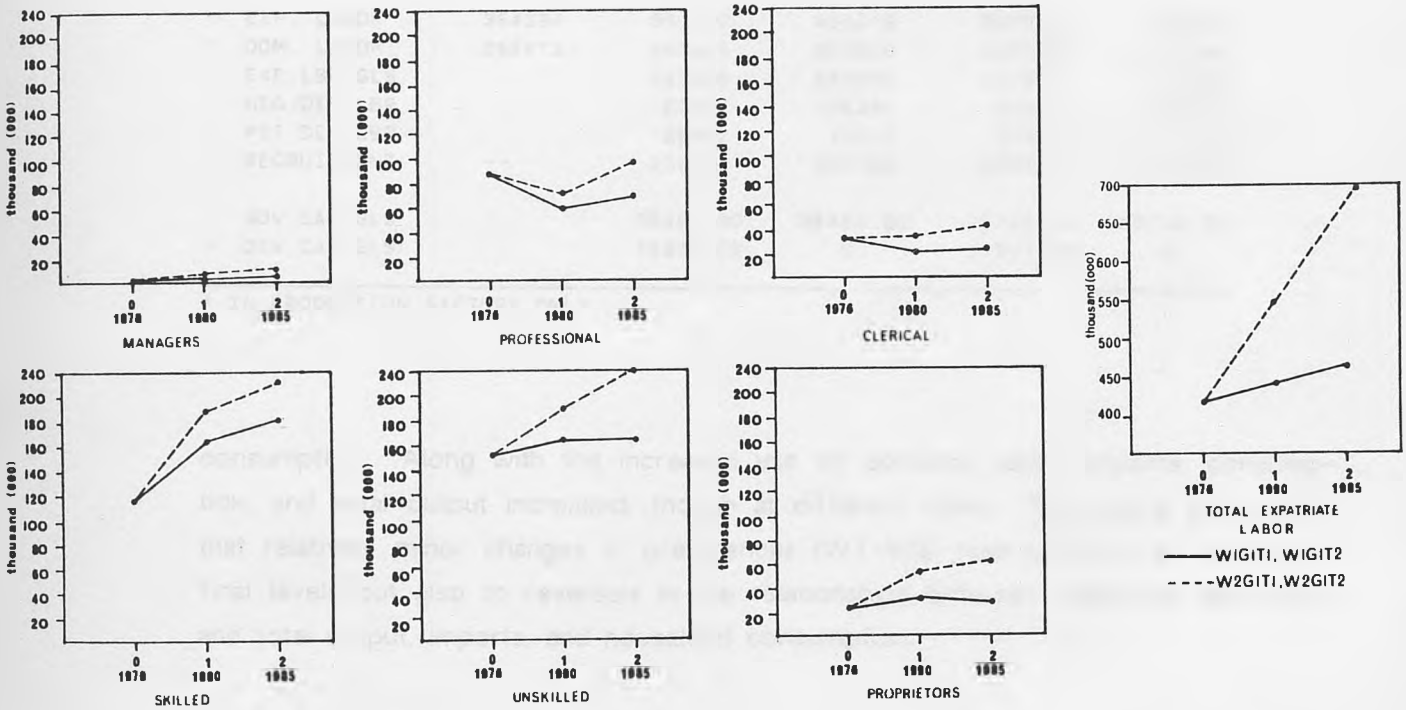


FIGURE 2-15: ALTERNATIVE EXPATRIATE LABOR INPUTS: ECN13

TABLE 2-22: A SUMMARY OF MODEL'S INDICATORS: ECN13

	(1976)	(1980)		(1985)	
		W1G1T1	W2G1T1	W1G1T2	W2G1T2
OUTPUT	119833.10	127127.15	139924.26	146852.48	177407.41
IMPORTS	73624.30	91332.11	95711.57	105200.26	115405.54
CONSUMPTION	57593.60	67953.36	70977.39	80004.19	81750.01
* EXP. LABOR	364284	353660	455016	347352	575655
* DOM. LABOR	268873	353969	353969	429999	429999
EXP.LBR.GLS		423606	423606	423606	423606
NEG.DEV.LBR		62986	136384	62351	267312
PST.DEV.LBR		26552	10213	24341	0
RECRUITMENT		233794	335150	256767	438424
GOV.CAP.GLS		38482.80	38482.80	49748.50	49748.50
DEV.CAP.GLS		18315.52	0	21301.68	0

* IN PRODUCTION SECTORS ONLY

consumption. Along with the increased use of domestic labor, imports, consumption, and total output increased, though at different rates. This figure also shows that relatively minor changes in preferences (W1–W2) lead not only to changes in final levels but also to reversals in the relationships between expatriate labor used and total output, imports, and household consumption.

2.3.3 Expatriate Labor and Agency Plans

In this application we disaggregate government into agencies and deal with their goals while maintaining aggregate labor policy goals. Government agencies are grouped into: Public Administration, Health, Education, and Others (including Defense). We intended to show the degree to which agency goals are achieved under alternative policy directions. These directions are termed W1, W2, W3, and W4. In W1 no priority is given to one agency over another or over labor goals. In W2, Public Administration is given the highest priority among government agencies while the total government (or the sum of agencies) and labor goals are treated equally. W3 differs from W2 in that total government goals are given priority over labor

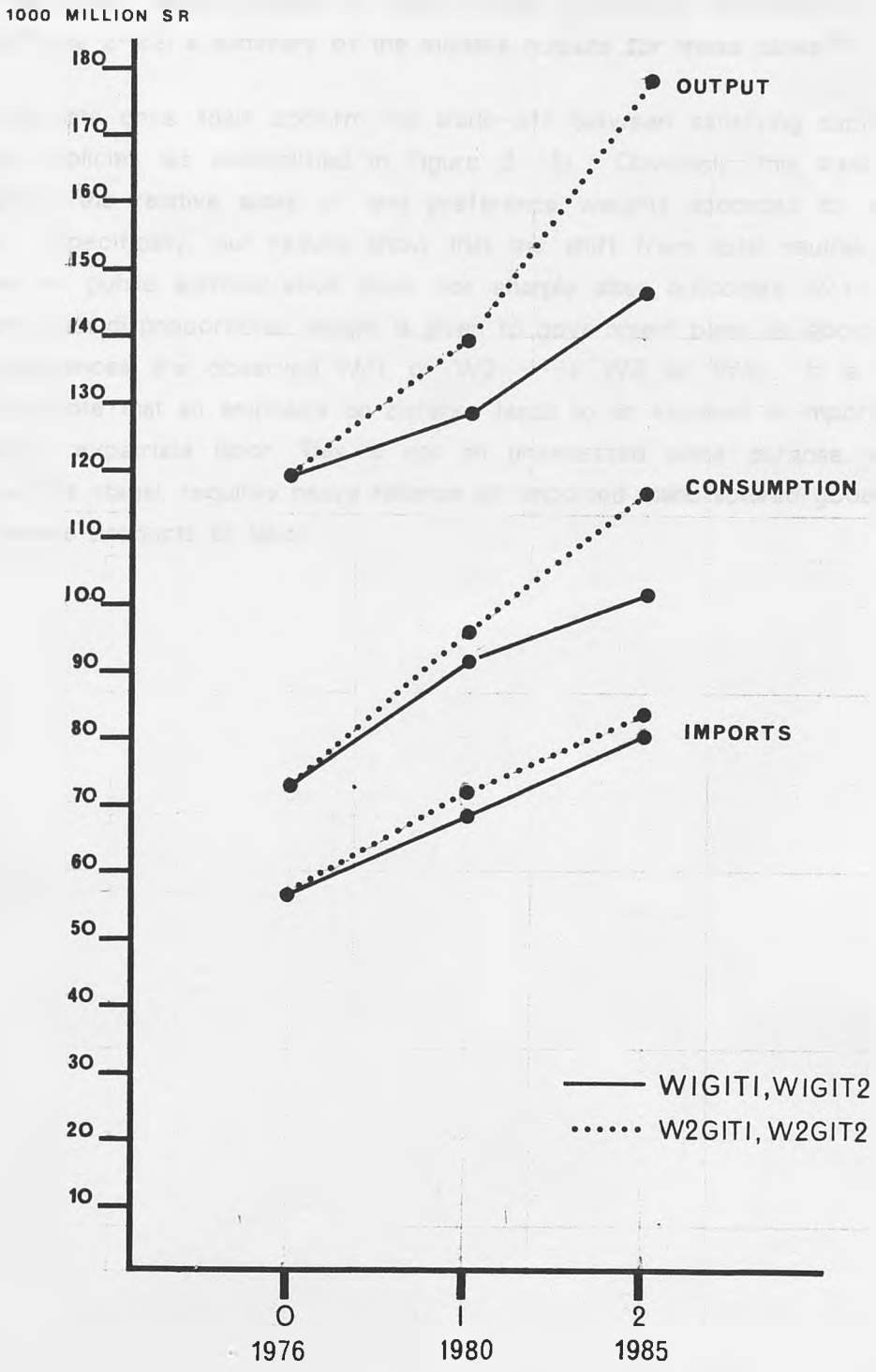


FIGURE 2-16: EXPECTED GROWTH IN OUTPUT, IMPORTS, AND CONSUMPTION: ECN13

goals. W4 is the same as W3 except for higher priorities for defense goals. Rather than show results parallel to those shown in previous illustrations, we only show (in Table 2-22) a summary of the model's outputs for these cases.[58]

The data once again confirm the trade-off between satisfying capital goals and labor policies (as exemplified in Figure 2-18). Obviously, this trade-off is modified by the relative sizes of, and preference weights accorded to, individual agencies. Specifically, our results show that the shift from total neutrality to an emphasis on public administration does not sharply alter outcomes (W1--->W2). However when disproportional weight is given to government plans vs labor policies, sharp differences are observed (W1 or W2 ---> W3 or W4). It is also of interest to note that an emphasis on defense leads to an increase in imports and a decrease in expatriate labor. This is not an unexpected since defense, in Saudi Arabia (at this stage), requires heavy relience on imported manufactured goods rather than domestic products or labor.

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58 Appendix 2-E contains the detailed outputs.

TABLE 2-23: A SUMMARY OF MODEL INDICATORS: ECN14

		ALTERNATIVE ILLUSTRATIONS			
	(1976)	(1980)		(1985)	
		W1	W2	W3	W4
OUTPUT	119833.10	131326.00	132153.13	140800.37	137508.82
IMPORTS	73624.30	97579.45	97798.65	100702.15	98084.73
CONSUMPTION	57593.60	68130.80	68488.75	71339.74	68601.14
EXP. LABOR	364284	381103	389498	460119	392389
DOM. LABOR	268873	353969	353969	353969	353969
EXP.LBR.GLS.		423606	423606	423606	423606
NEG.DEV.LBR.		80090	84469	139416	86798
POS.DEV.LBR.		27670	23857	8182	4985
RECRUITMENT		261439	269632	340253	282523
TOTAL GOV.GLS.		38482.80	38482.80	38482.80	38482.80
GOV. CAPITAL		27871.23	28195.30	34217.50	28335.12
NEG.DEV.PA		8700.70	4915.49	0.00	6947.68
NEG.DEV.HL		161.40	161.40	0.00	0.00
NEG.DEV.ED		945.20	945.20	0.00	0.00
NEG.DEV.OT		804.30	4265.30	4265.30	0.00

(PA) PUBLIC ADMINISTRATION
(HL) HEALTH
(ED) EDUCATION
(OT) OTHERS

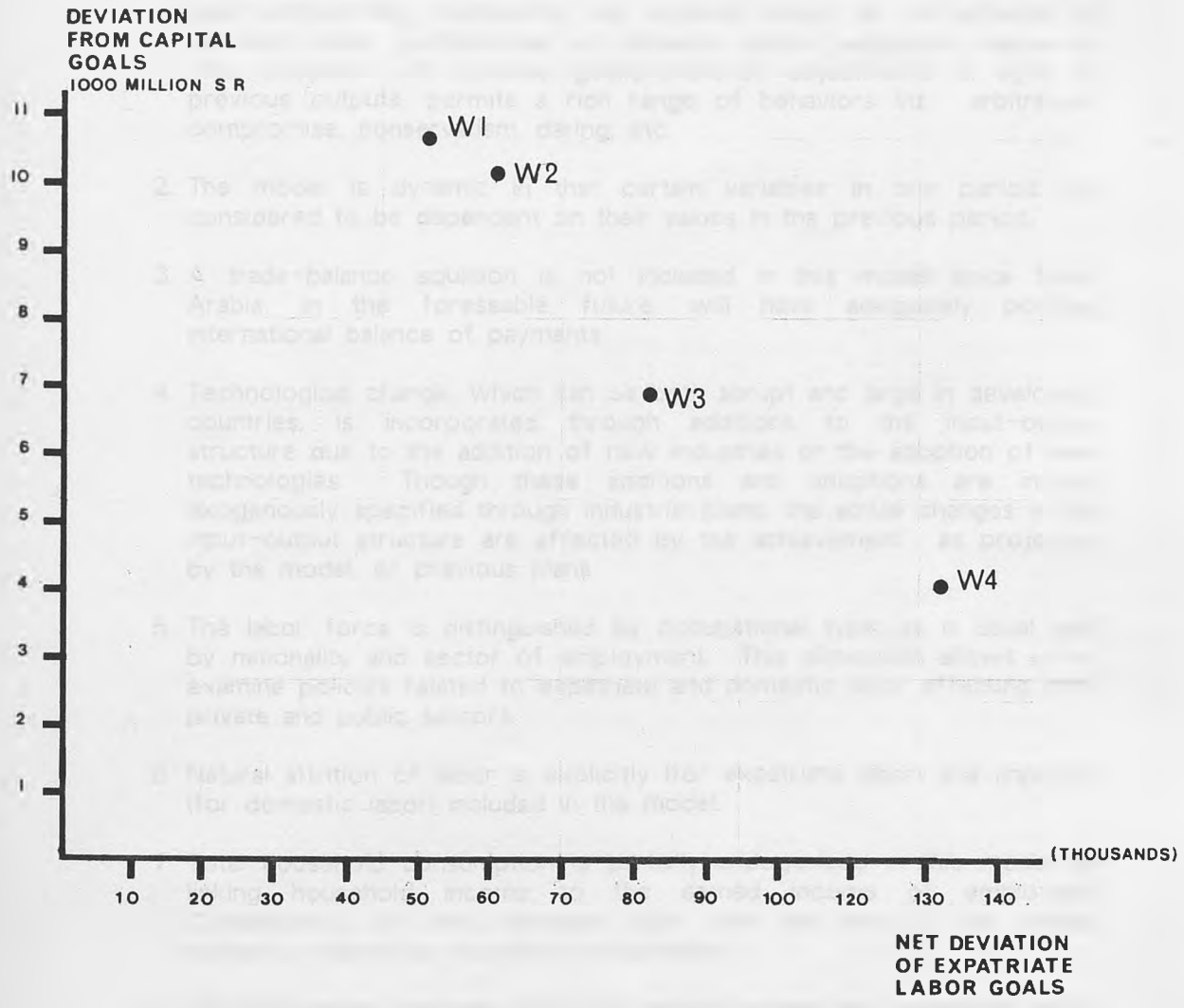


FIGURE 2-17: GOVERNMENT AND LABOR NET DEVIATIONS: ECN14

2.4 SUMMARY AND CONCLUSIONS

The model developed in this chapter, we believe, exhibits many of the desirable characteristics of a national planning model discussed in Chapter 1. In addition, the model attempts to faithfully portray several of the unique social and economic features of Saudi Arabia. The model is, consequently, quite complex and large; these characteristics of the model forced us to be rather selective in the model features discussed and in the range of applications described. We conclude this chapter with a rather terse summary of the model's features and the insights gained from the applications.

Some of the features of this formulation are:

1. By embedding a comprehensive national development model within a goal-programming framework, we explicitly allow for the effects of decision-maker preferences on relevant socio- economic accounts. This, coupled with iterative goal/preference adjustments in light of previous outputs, permits a rich range of behaviors viz. arbitration, compromise, conservatism, daring, etc.

2. The model is dynamic in that certain variables in one period are considered to be dependent on their values in the previous period.

3. A trade-balance equation is not included in this model since Saudi Arabia, in the foreseable future, will have adequately positive international balance of payments.

4. Technological change, which can be both abrupt and large in developing countries, is incorporated through additions to the input-output structure due to the addition of new industries or the adoption of new technologies. Though these additions and adoptions are initially exogenously specified through industrial plans, the actual changes in the input-output structure are affected by the achievement , as projected by the model, of previous plans.

5. The labor force is distinguished by occupational type, as is usual, and by nationality and sector of employment. This distinction allows us to examine policies related to expatriate and domestic labor affecting both private and public sectors.

6. Natural attrition of labor is explicitly (for expatriate labor) and implicitly (for domestic labor) included in the model.

7. Total household consumption is partially endogenized in this model by linking household income to the earned income of employees. Consequently, all links between labor and the rest of the model indirectly extend to household consumption.

8. The relationship between individual earned income and household income in Saudi Arabian society is not the simple one-to-one relationship thought to exist, for example, in the U.S. The model reflects the

observation that a given individual might distribute his income to several households and, therefore, that a given household might have several sources of earned income.

9. Income transfers to households from both private and public sources are included.

10. Household consumption and final demand is allowed to be modified through direct price subsidies from the government to selected sectors.

11. The treatment of government demand as some of the goals of the model, permits the identification of trade-offs between development policies and other goals. Disaggregating the government into individual agencies permits the identification of trade-offs at finer levels.

Clearly, such a complex formulation would require far more applications to demonstrate, empirically, these features than could conceivably be presented here. The small set of applications we have chosen to discuss reveal, in sum, the following:

1. The inter-dependencies allowed in this model are non-trivial in that any given goal or policy has major impacts on other goals and variables.

2. Model outputs are sensitive to alternate goals and preferences, supporting our contention that goals and preferences be explicitly allowed in a planning framework.

3. Given the significance of the inter-dependencies, goals and preferences, it is not surprising to find that allowing decision-makers to iteratively adjust their goals and preferences has a major effect on final outcomes in comparison to one-shot decision-making.

Obviously, several directions for improving this model can be identified. While we defer discussing these future directions to the last chapter, one such direction has, in part, been explored further in this thesis. Specific models could be developed for socially important sub-systems such as health, education, training, housing etc. Of these, we have developed a model of the housing sub-system. This model, and its linkage to the national development model of this chapter, is the substance of succeeding chapters.

CHAPTER THREE

MULTI OBJECTIVE PLANNING FOR HOUSING DEVELOPMENT AND LINKAGES TO SOCIO-ECONOMIC DEVELOPMENT

CHAPTER 3

MULTI OBJECTIVE PLANNING FOR HOUSING AND LINKAGES TO SOCIO-ECONOMIC DEVELOPMENT

3.1 INTRODUCTION

This chapter is examines aspects of housing development and the potential role of government in improving the quality of life through housing development in Saudi Arabia.[59] We, therefore, consider demographic and social, as well as physical dimensions of housing situations and their interdependence with economic dimensions of development by linking the housing development model to the socio economic model developed in Chapter Two. This, in turn, allows us to examine their cross relationships in a multi objective planning framework.

We begin in section 2 with the background which provides the substantive basis for both model development and model needs. This is followed in section 3 with the model and its description. In section 4 we parallel the numerical illustrations by describing selected applications of this model. Finally, we end this chapter with a summary of model's features and conclusions. The model relationships in this chapter are developed in reference to a joint family–housing input–output model indicating the dynamic changes and the recursive relationships in both family and housing characteristics. These dynamic aspects will be made explicit in Chapter Four when we specifically study the multi period input output characteristics of families, houses, and their distributions.

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[59] See Cooper and Tamimi [61] for an earlier study of the problem of housing development and planning in Saudi Arabia upon which the detailed treatment and analysis in this and the following chapters were based.

3.2 BACKGROUND

Housing is a universally acknowledged issue in the life of communities. In some countries, housing is provided by private developers who respond to estimates of demands. Such demands express a desire for houses supported by economic ability to satisfy the desire. In purely economic approaches this demand can be formulated in terms of effective demand,(i.e. demand backed up by the needed wherewithal to pay for it) therefore it is possible to use well developed measures such as coefficients of elasticity in relation to price or income, to determine the demand for housing at various prices and income levels. This solves many problems with a well developed body of economic theory to serve for guidance if one is willing to stay with the resulting assumptions.

On the other hand, in the case of developing countries, large sectors of the population are inadequately housed but without sufficient economic resources to have any immediate prospects of improving their housing situation. Moreover, because the situation is "changing" it may be better now to provide for the future than to await an appearance of the corresponding effective demand. The latter, in fact, may never appear. The majority of the population may be in low or middle income groups living in overcrowded, makeshift or substandard houses, and great social unrest may ensue unless this is promptly attended to.

Housing needs or requirements can also be expressed, in the social sense, with respect to the extent to which housing conditions fall below levels or norms considered necessary by some authoritative, or potentially authoritative, group. This social sense may also reflect an estimated inability to finance housing adequately for family living in the sense of the economics of "effective demand." In many situations, therefore, it seems preferable, at least insofar as lower and middle income groups are concerned, to define the problem in terms of housing criteria and objectives rather than to express it solely in terms of market or "effective demand."

In developing countries housing is an integral part of country development planning; various agencies try to meet the housing needs of "every" family. The governments of these countries have often assumed a "comprehensive commitment" to the solution of their housing problems. The objectives and methods of these governments may differ widely, but their housing policies show certain common characteristics. For instance, they are not willing to allow the market to be the sole determinant of the response to these perceived needs. In some cases all of the

activity is governmental; in other cases a mixed approach is used in which the proportions directly contributed by the government may vary from time to time. The government itself may or may not build, but it assumes responsibility for the housing requirements of the entire country, and it takes account of the entire housing situation in making its plans. Thus even with mixed approaches-- where housing is built by other than the government itself-- the government may nevertheless restrict or promote the output of certain types of housing when, it deems this to be necessary.

In most developing countries, the ability to provide adequate resources for housing and related requirements is inadequate, and acutely so. This is not the case for areas like Saudi Arabia and related countries, however, which are the concern of this thesis. Here the same elements of housing shortage and government participation are present and, of course, there are other factors, too, that must also be considered which countries like Saudi Arabia have in common with less developed segments of the world. What they do not have in common with other less developed countries is a relative abundance of resources in addressing their underdeveloped housing needs. This mixture of relative abundance in developing country context is relativly new.

This thesis explores the possibility of synthesizing models which will make it easy for resource rich (in monetary terms) governments to plan their housing and other programs and to do so in ways that will enable them to balance these programs against other considerations. One such consideration is an opportunity to balance housing and population types accomodating a variety of actual opportunities resulting from dynamic changes in families and housing. This is done in a manner that may be used as a prototype for still other considerations that governmental policy ought to take into account in these developments.

Issues like these will be brought to the fore in this chapter. First, model development and a description of the accounting components are delineated. Then goals and directions for housing development are discussed as the basis for directing and focusing government policies.

Since an objective of this thesis is to identify the interdependence of housing development with other national development systems, the relationships of the models developed are also linked to the economic and labor components developed earlier in Chapter 2. Multiplier effects for housing development and the cross impacts of multiple system planning in housing and economics can thereby be

accommodated. More than formalaizations are required, however, and so prototype data and characteristics of the present situation in Saudi Arabia are discussed in relation to those variables and parameters explained in model development. Finally, models and data are combined in several numerical applications to show how the effects of alternative policies can be examined and the sensitivity of the model's output to varieties of policy directions can be tested and evaluated.

3.3 MODEL DEVELOPMENT

We develop our proposed planning model with particular attention to several factors indicated in Figure 3-1. They include:

- The joint distribution of families to houses, indicating specific demographic and physical dimensions pertinent to both,
- Standard criteria for housing development, indicating desired distributions of new families as well as the potential redistribution of existing families,
- The interdependence with other socio-economic development, issues including expatriate labor considerations.

The model developed here is a multi objective goal program, indicating the relative preferences between housing development goals and among housing development and other socio economic goals presented in chapter 2. The relative emphasis on housing could be taken to indicate the desire to alleviate housing shortages for the new families and housing deficiencies for the existing families, in one or more planning periods. Housing planners may even argue that if housing is not attended to properly, the situation could only get worse by accumulation of sub-standard housing and inadequate size compatibility due to the changing family characteristics and sizes. The achievement of these objective is not without multiplying impacts on the rest of the socio economic aspects of national development. Such an achievement can also be in conflict with other policy directions regarding, for example, labor or government plans. In an interactive sequence, these conflicts are examined to adjust goals and preferences.

In Figure 3-2 we show pertinent relationships and dimensions: (1) the distribution balances across rows, (houses); and across columns, (families); (2) the goals for distribution of new and unhoused families followed by the goals for the redistribution of under-housed families; (3) the accounting for the new family inputs and the remaining families from the previous period; and (4) the components linking housing to the socio-economic model developed in chapter 2.

The first row in Figure 3-3, for instance, indicates the policy and decision variables considered in our problem. These are really vectors and matrices of variables which are related to each other through the remaining rows in the following manner. The vectors of variables δ^+, δ^- show the goal deviation which, as already noted, are planning issues in their own right. These goal deviations are here related to housing for the "unhoused", δ^+_d, δ^-_d, the "under

FAMILY-TO-HOUSE DISTRIBUTION

- Dependent/Houshold Association
- houshold Size
- Houshold Income
- Expatriate/Domestic Housholds

HOUSES

- House Size
- House Type (attached, detached, appartment, etc.)
- Construction (regural, traditional, hut, tent, etc.)
- Ownership/Rental
- Age

OTHER CONSIDERATIONS

Family Changes and Transitions

Houses Changes and Transitions

Family Formation, Inputs, and Outputs

Linkages To Other Socio-Economic Activities

Housing Development Multipliers

MODEL OBJECTIVES

To meet goals and criteria for housing development as closley as possible

FURTHER CONSIDERATIONS

- Goals and constraints related to other activities (in the over all Socio-Economic models) including trade-off with their joint achievment of their respective goals
- Housing construction capacities and multi-period stabilily of the housing industry

FIGURE 3-1: FACTORS CONSIDERED IN HOUSING DEVELOPMENT

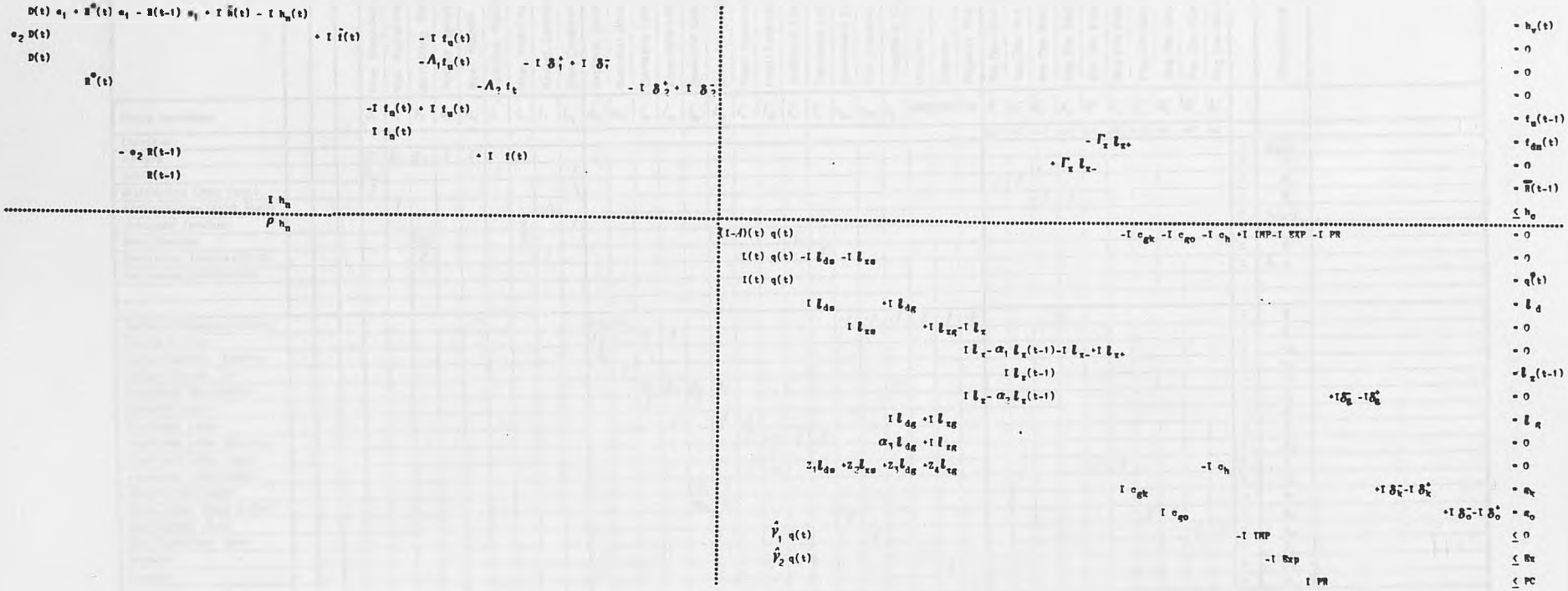
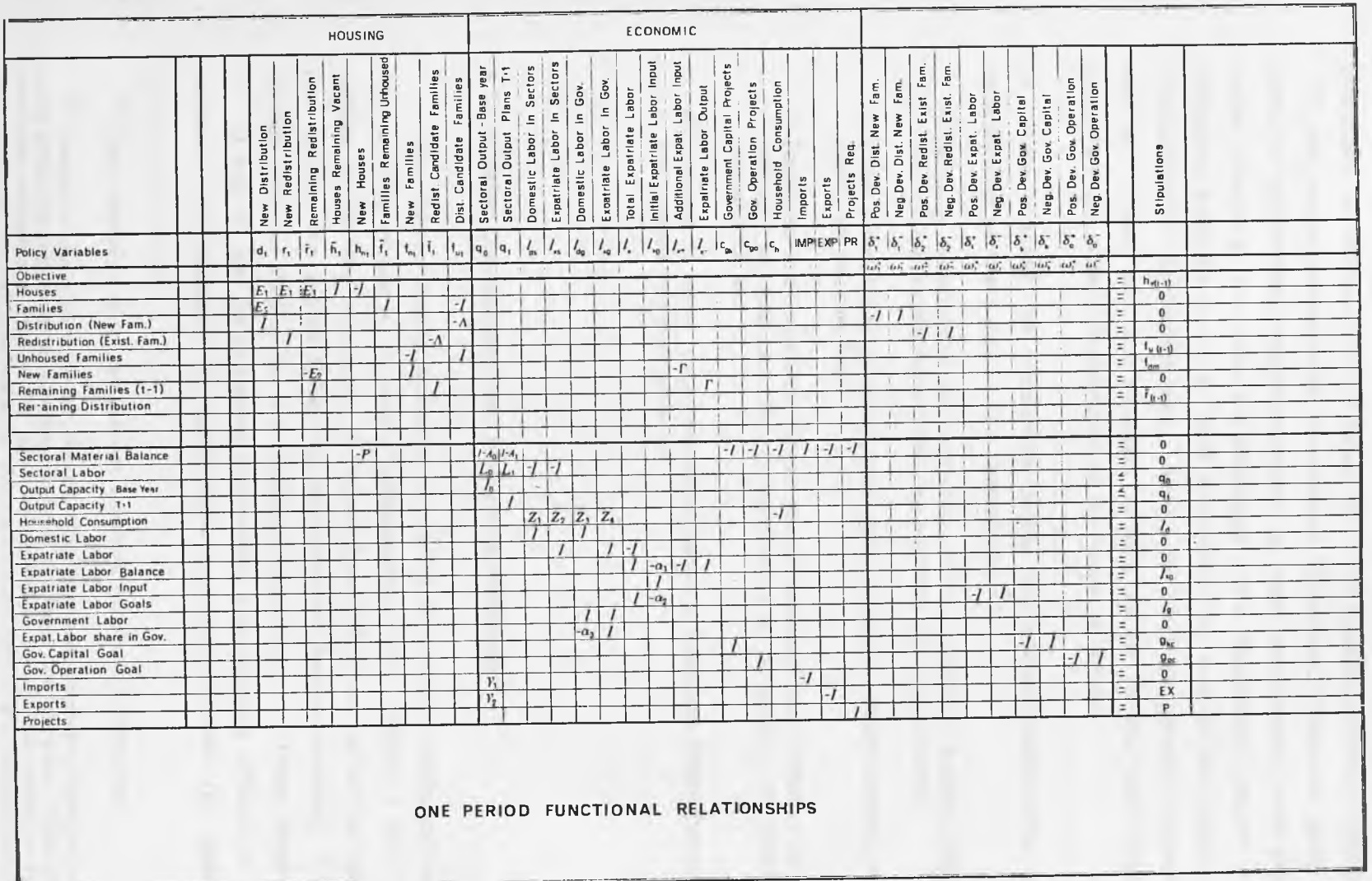


FIGURE 3-2: MODEL FUNCTIONAL RELATIONSHIPS



ONE PERIOD FUNCTIONAL RELATIONSHIPS

FIGURE 3-3: ONE PERIOD PLANNING MODEL

housed", $\delta_{r'}^{+}$ $\delta_{r'}^{-}$, and to the expatriate labor and government goals discussed previously. In the next row of Figure 3-3, the related prefernce weights ω^{+} and ω^{-}, are vector entries in the row labeled "Objective". These are given ab initio in terms of government stipulated criteria, at least provisionally, with allowance for further change as the plans are developed. The "Stipulations" column on the right represents both the goals, in "soft constraints," as well as the capacity limitations incorporated in "hard constraints," along with other exogenous requirements to be satisfied. These, too, are stipulated at least as far as the "soft constraints" are concerned and subject to alteration as the model is utilized.

We examine the accounting details for housing relationships and related variables and pertinent data in four subsections:[60]

1. Housing distributions and accounts of new families, existing families, the housing vacancies and the requirements for new houses;

2. Criteria for housing distributions and the desired improvements of the quality of housing life;

3. Domestic and expatriate family inputs indicating the formation of new families as well as the immigration and emigration of expatriate households; and

4. Linkages to other socio economic aspects, indicating interdependencies and related multiplier effects.

3.3.1 Housing Distributions and Accounting Relations

For family-housing accounts we define three mxk distribution matrices $D(t)$, $R(t)$, and $R^{*}(t)$ whose d_{ij}, r_{ij}, and r^{*}_{ij} components i, (i=1,... ..,m) and j, (j=1,... ..,k) are the number of families in cohort j in houses type i. The first is for the distribution of new families, the second is for the distribution of families remaining, from previous periods, and the third is for the projected redistribution of these remaining families.[61] D and R^{*} are the projected distributions indicating the effects of government policies. For example, the government may want provide for families without

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60 See Appendix 1-B for data activities supporting this chapter's formulation.

61 Implicit in our presentation of $R(t)$, the family-to-house distribution from the previous period, is the effect of change due to transitions in family and house characteristics. These changes will be specifically addressed in Chapter four when we develop an input-output model for family-to-house distributions and provide the estimation of their multi period changes and recursive relationships.

houses and influence their assignment to the appropriate ones (by either building or encourage the development of the required types of houses. It may also encourage the use of vacant houses that are under government control, or it may want to influence the change in the family-to-house distribution indicated by the matrix $R(t)$.

As shown in Figure 3-2, these distributions are written in matrix form as $D(t)e_1$ and $e_2D(t)$, where $D(t)$ is an mxk matrix with entries d_{ij} and e_1 a vector with all elements equal to 1 (a so-called unity vector) summing across families to indicate total houses of each type. Similarly in $e_2\ D(t)$, e_2 is a unity vector summing across houses to indicate the total families of each type. The same alternative matrix expressions could be used for other vectors in Figure 3-3.

The following equations contain the vector representation of the above matricies (see Figures 3-2 and 3-3)

$$E_1\ d(t) + E_1\ r^*(t) - E_1\ r(t-1) + I\ \tilde{h}(t) - I\ h_n(t) = h_v(t) \qquad (3.1)$$

$$E_2\ d(t) + I\ \tilde{f}(t) - I\ f_u(t) = 0 \qquad (3.2)$$

where the first expression (3.1), relates the indicated decision variables, as captioned in Figure 3-3, to the vector $h_v(t)$, an mx1 vector of remaining housing vacancies from t-1 at time t. The second expression in (3.2) refers to the satisfaction of family needs for housing.[62] To see what these expressions mean and also to study their structure, let e_1 be the row unity vector and define

$$E_1 = \begin{bmatrix} e_1 & & & \\ & e_1 & & \\ & & \ddots & \\ & & & e_1 \end{bmatrix}$$

where E_1 has the dimensions required to conform with $h_v(t)$, the vacant houses from the previous period, and the matrix multiplications indicated in (3.1). Then we define E_2 as follows:

$$E_2 = [I, I, \ldots I]$$

---

62 We should remark here that families which are unhoused are in reality considered to be living in temporary housing--e.g. tents, wood huts, or else these families are crowded in with others, etc.--but for planning purposes they are classified as being "unhoused" while awaiting the planned construction of more satisfactory permanent housing.

where I is, as usual, the identity matrix. Hence,the decision variables for $d(t)$ in (3.1) and (3.2) are related to each other as in a transportation model.

To continue our interpretation of (3.1) we define $d(t)$ as vector with (mxk)x1 rows. Its component entries d_{ij} represent the planned distribution of new family types j, (j = 1,....k), to be housed in dwellings of type i, (i = 1,....,m). For instance, j=1 may represent expatriate, 4-member, middle-income families and i=1 may represent 3-bedroom, rental apartments, ...etc.

The new families and their housing requirements are represented by the expression $E_1\ d(t)$. This vector comes partly from projections of new domestic families formed at time t and partly as a consequence of plans--including plans for housing--that are being undertaken. The symbol I in (3.1) and (3.2) represents the identity matrix and $I\ f_u(t)$ is the number of the unhoused new families that we plan to house, including the expatriates. Hence $E_2\ d(t) - I\ f_u(t)$ represents the net amount of new families to be housed in each type of housing and $I\ \tilde{f}(t)$ represents the remnants who are not housed with all components of $\tilde{f}(t)$ constrained to be non negative.

We also, however, need to consider the presently under housed families, their possible redistributions, and their housing requirements. Thus we define $r^*(t)$ as a vector with mxk rows whose elements represent the planned redistribution of housed families and $r(t)$ the present number of families of each type j, (j = 1,.....k), in houses of type i, (i = 1,.....m). Because E_1, as already defined, represents a collection of summing operators, the differences $E_1\ r^*(t) - E_1\ r(t)$ are the negative or positive discrepancies between planned and existing housing for the already housed families.

The mx1 vectors $\tilde{h}(t)$ and $h_n(t)$, in equation (3.1), represent remnant vacancies and required new houses, respectively, which are needed to relate the expressions to the vector $h_v(t)$ with stipulated components that represent the existing vacancies available at time t.

3.3.1.1 Base Year Family-House Distribution Data

Initially, from the 1976 household survey, data were developed for the proportional distribution of families, of certain nationality (Saudi-Expatriate), income (Low-Middle-High), and size (1-13 members) characteristics, who are housed in houses of certain type (Attached, Detached, Apartment), construction (Regular, Hut,

Tents, Traditional), ownership (Owned-Rented), and size (1-10 rooms).[63] For illustrative purposes, the data were aggregated on both family and housing characteristics. This resulted in one family income group, four family sizes, five house sizes for regular and traditional construction and three sizes for tents and huts.[64] The resulting base year distributions of families to houses are shown in Table 3-1.[65]

The data in Table 3-1 show that 856,779 families live in regular houses, 7,383 families live in wood huts, 30,605 live in tents, and 98,826 in traditional adobe houses (see final column in rows labelled total reg, total tnt, total hut and total trd). The majority of expatriate families live in smaller rented houses. An examination of this table also shows that the majority of expatriate families live in rented houses, mostly of the regular construction type. Table 3-2 contains the distributions of families to houses; Figure 3-4 graphically shows this distribution. Using Table 3-2 and Figure 3-4, we can distinguish differences within and between domestic and expatriate family housing. Within domestic families, comparing rent vs ownership, the size of owned regular houses is relatively more compatible with the family size than those rented; owner-occupied homes more adequately fit family sizes than rental houses. When Saudi-expatriate rentals are compared, we find that expatriate families are relatively better housed than Saudi families. Thus, there appears to be over-crowding in rentals--a sign of inadequate supply.

Observations such as these could be the basis for establishing the goals of the housing subsystem. These goals are operationalized through changes in proportional distributions of families to houses from the initial state (shown in table 3-2 and Figure 3-3) to more desirable ones. We discuss these below.

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63 The sample data descriptive of households and their housing characteristics was originally prepared for detailed nationality and income groups. They were then grouped into 78 family categories for which the proportional distribution of families to houses were developed. See Appendix 3.A for these proportions. These were obtained using the household description components of the Household Survey of the Macro Economic Modelling Project [217].

64 Families are grouped as 1=(1-4), 2=(5-9), 3=(9-13), and 4=(13-above) family members and houses are grouped as 1=(1-2), 2=(3-4), 3=(5-6), 4=(7-8), and 5=(9-above) rooms per house.

65 See Appendix 1-C for the data activities conducted to support this chapter's prototype data.

TABLE 3-1: BASE YEAR FAMILY DISTRIBUTION TO HOUSES

		DOMESTIC FAMILIES (1)	(2)	(3)	(4)	EXPATRIATE FAMILIES (1)	(2)	(3)	(4)	TOTAL HOUSES
REG RNT SIZ	1	3765	3595	623	0	8603	2873	0	0	19361
	2	37139	51757	16696	1532	57298	35890	10092	397	220911
	3	19829	36870	13310	2171	16172	25936	3502	732	119532
	4	2038	8023	3631	1237	979	1833	233	0	18986
	5	0	1311	1230	930	633	282	263	0	3670
TOTAL RNT		62711	101557	36511	5880	83696	76816	15090	1233	383560
REG OWN SIZ	1	3052	3585	1236	313	1773	1305	0	0	11275
	2	30333	63829	28759	3323	3030	3768	263	0	136306
	3	19132	69232	51503	12365	5778	2795	760	0	161565
	4	5081	28031	33155	12361	2329	799	263	235	83273
	5	2733	20962	27678	28811	335	0	0	270	80799
TOTAL OWN		60332	186639	133331	58173	13236	8667	1286	515	373219
TOTAL REG		123113	288206	179852	63053	97932	85383	16376	1753	856779
TNT OWN SIZ	1	3307	6933	3593	308	1357	0	0	0	16699
	2	677	1253	931	923	0	0	0	0	3785
	3	2032	3561	2767	307	333	0	0	0	10121
TOTAL TNT		6126	12738	8291	1539	1901	0	0	0	30605
HUT RNT SIZ	1	0	0	0	0	0	765	0	0	765
	2	0	331	306	0	0	0	0	0	637
	3	0	318	0	0	0	0	0	0	318
TOTAL RNT		0	639	306	0	0	765	0	0	1720
HUT OWN SIZ	1	699	631	0	0	0	253	0	0	1593
	2	0	1266	610	307	0	0	0	0	2183
	3	0	960	620	308	0	0	0	0	1888
TOTAL OWN		699	2857	1230	615	0	253	0	0	5663
TOTAL HUT		699	3516	1536	615	0	1018	0	0	7383
TRD RNT SIZ	1	1696	652	303	0	1115	0	0	0	3767
	2	3058	3853	1230	613	673	1069	0	0	11397
	3	1359	2237	627	0	335	771	995	0	6333
	4	0	637	620	0	0	0	0	0	1257
	5	705	1276	0	308	0	0	0	0	2289
TOTAL RNT		33818	9665	2781	921	2123	1830	995	0	25131
TRD OWN SIZ	1	1356	3325	2788	0	0	0	0	0	8569
	2	8153	9653	6166	920	0	506	263	0	25663
	3	1719	8007	3688	1230	0	512	0	0	15166
	4	683	5353	3073	1573	0	0	0	0	10683
	5	677	5328	5853	1533	0	0	0	0	13503
TOTAL OWN		12590	32967	21569	5278	0	1018	263	0	73685
TOTAL TRD		36308	32632	23350	6199	2123	2858	1258	0	98826
TOTAL FAMILY		139336	337103	213027	72308	101969	89356	17635	1753	993599

(REG) REGULAR (RNT) RENT SIZ 1) 1-2 ROOMS (1) 1-4 FAMILY MEMBERS
(TNT) TENT (OWN) OWNED 2) 3-4 ROOMS (2) 5-9 FAMILY MEMBERS
(HUT) HUTS 3) 5-6 ROOMS (3) 9-12 FAMILY MEMBERS
(TRD) TRADITIONAL 4) 6-8 ROOMS (4) 13-A FAMILY MEMBERS

TABLE 3-2: BASE YEAR FAMILY PROPORTIONAL DISTRIBUTION TO HOUSES

		DOMESTIC FAMILIES				EXPATRIATE FAMILIES			
		(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
REG RNT SIZ	1	.0252	.0103	.0029	.0000	.0833	.0322	.0000	.0000
	2	.2387	.1391	.0780	.0213	.5619	.5136	.5723	.2833
	3	.1328	.1062	.0622	.0300	.1586	.2903	.2553	.3230
	4	.0136	.0231	.0217	.0171	.0096	.0205	.0132	.0000
	5	.0000	.0038	.0058	.0128	.0063	.0032	.0139	.0000
REG OWN SIZ	1	.0203	.0103	.0058	.0033	.0173	.0136	.0000	.0000
	2	.2031	.1868	.1333	.0597	.0395	.0322	.0139	.0000
	3	.1281	.1995	.2306	.1708	.0567	.0313	.0331	.0000
	4	.0330	.0808	.1596	.1707	.0228	.0089	.0139	.1397
	5	.0183	.0603	.1293	.3979	.0033	.0000	.0000	.1539
TNT OWN SIZ	1	.0228	.0200	.0215	.0033	.0133	.0000	.0000	.0000
	2	.0035	.0036	.0033	.0128	.0000	.0000	.0000	.0000
	3	.0137	.0131	.0129	.0032	.0033	.0000	.0000	.0000
HUT RNT SIZ	1	.0000	.0000	.0000	.0000	.0000	.0086	.0000	.0000
	2	.0000	.0010	.0013	.0000	.0000	.0000	.0000	.0000
	3	.0000	.0009	.0000	.0000	.0000	.0000	.0000	.0000
HUT OWN SIZ	1	.0037	.0018	.0000	.0000	.0000	.0028	.0000	.0000
	2	.0000	.0036	.0029	.0032	.0000	.0000	.0000	.0000
	3	.0000	.0028	.0029	.0033	.0000	.0000	.0000	.0000
TRD RNT SIZ	1	.0113	.0019	.0013	.0000	.0109	.0000	.0000	.0000
	2	.0205	.0130	.0057	.0085	.0066	.0120	.0000	.0000
	3	.0091	.0065	.0029	.0000	.0033	.0086	.0563	.0000
	4	.0000	.0018	.0029	.0000	.0000	.0000	.0000	.0000
	5	.0037	.0037	.0000	.0033	.0000	.0000	.0000	.0000
TRD OWN SIZ	1	.0091	.0127	.0130	.0000	.0000	.0000	.0000	.0000
	2	.0536	.0278	.0288	.0127	.0000	.0057	.0139	.0000
	3	.0115	.0231	.0172	.0171	.0000	.0057	.0000	.0000
	4	.0036	.0157	.0133	.0217	.0000	.0000	.0000	.0000
	5	.0035	.0156	.0273	.0213	.0000	.0000	.0000	.0000

(REG) REGULAR (RNT) RENT SIZ 1) 1-2 ROOMS (1) 1-4 FAMILY MEMBERS
(TNT) TENT (OWN) OWNED 2) 3-4 ROOMS (2) 5-9 FAMILY MEMBERS
(HUT) HUTS 3) 5-6 ROOMS (3) 9-12 FAMILY MEMBERS
(TRD) TRADITIONAL 4) 6-8 ROOMS (4) 13-A FAMILY MEMBERS

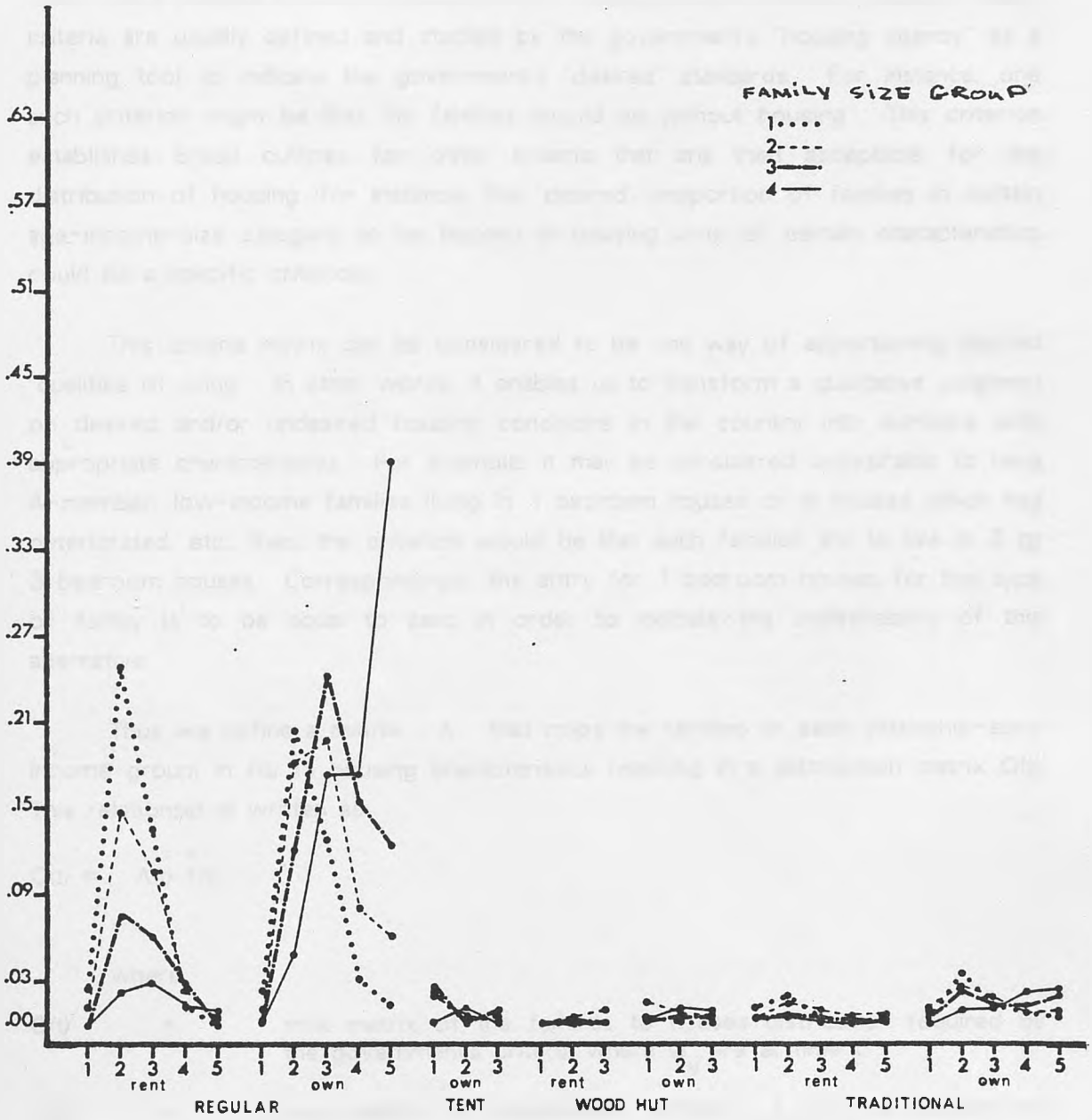


FIGURE 3-4: BASE YEAR FAMILY PROPORTIONAL DISTRIBUTION TO HOUSES

3.3.2 Distribution Criteria and Goals

Now we want to move from accounting to planning via criteria established for the distribution of housing to population which reflects the goals of policy makers and enables them to understand the consequences of these policies. These criteria are usually defined and studied by the government's "housing agency" as a planning tool to indicate the government's "desired" standards. For instance, one such criterion might be that "no families should be without housing." This criterion establishes broad outlines for other criteria that are then acceptable for the distribution of housing (for instance, the "desired" proportion of families in certain age-income-size category to be housed in housing units of certain characteristics could be a specific criterion).

This criteria matrix can be considered to be one way of apportioning desired "qualities of living." In other words, it enables us to transform a qualitative judgment on desired and/or undesired housing conditions in the country into numbers with appropriate characteristics. For example, it may be considered undesirable to have 4-member, low-income families living in 1 bedroom houses or in houses which had deteriorated, etc.; then, the criterion would be that such families are to live in 2 or 3 bedroom houses. Correspondingly, the entry for 1 bedroom houses for this type of family is to be equal to zero in order to indicate the undesirability of this alternative.

Thus we define a matrix Λ that maps the families (in each citizinship-age-income group) in f(t) to housing characteristics resulting in a distribution matrix Q(t). This relationsip is written as:

$$Q(t) = \Lambda(t)\,\hat{f}(t)$$

where

$Q(t)$ = mxk matrix of the families to houses distribution required by the government's criteria where Q_{ij} are at time t.

$\Lambda(t)$ = mxk matrix of requirement criteria λ_{ij} is the portion of families in category j who are preferred to be living in housing

type i. $\lambda_{ij} \geq 0$ and $\Sigma_i \lambda_{ij} = 1$.[66]

$\hat{f}(t)$ = mxm diagonal matrix whose f_{ii} entries are the respective entries in $f_i(t)$.

We shall refer to $\Lambda(t)$ as the "distribution criteria matrix."

Since f(t) includes both domestic and expatriate families, Λ, should be partitioned to indicate nationality. In addition, Λ contains empirically observed housing consumption behavior of high income families. We consider this group to be beyond direct government responsibility but include them in the model to account for their demands. We then let,

$$f(t) = \begin{bmatrix} f_{d,1} \\ f_{d,2} \\ f_x \end{bmatrix}$$

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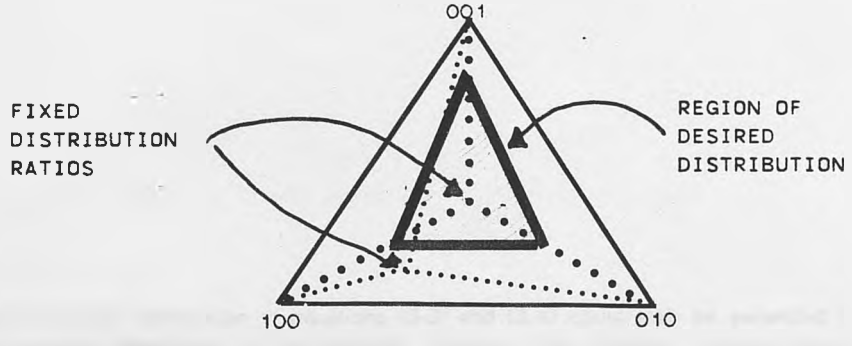
[66] As an example, for four-member low-income families, 20 and 30 percent may indicate lower and upper bounds on their distribution to 2 bedroom houses and 40 and 60 percent respective lower and upper bounds for 3 bedrooms, etc. While a fixed criteria indicate a preference proportioning to be attained, the upper and lower bounds indicates a region within which the choices of distribution of families to houses is indifferent. For a region of acceptable criteria, we arrange matters, except for those empirically defined consumptions--the high income groups, so that criteria in Λ (t) need not be fixed in precise numerical value since this is often difficult to specify in all detail. Hence we relax the $\Lambda_{ij} \geq 0$, $\Sigma_j \Lambda_{ij} = 1$ values to allow for upper and lower bounds via

$$\underline{\Lambda} \leq \Lambda \leq \bar{\Lambda}$$

Therefore

$$[\ \underline{\Lambda}_{d,1}\ \ \underline{\Lambda}_{d,2}\ \ \underline{\Lambda}_x\ ] \leq [\ \Lambda_{d,1}\ \ \Lambda_{d,2}\ \ \Lambda_x\ ] \leq [\ \bar{\Lambda}_{d,1}\ \ \bar{\Lambda}_{d,2}\ \ \bar{\Lambda}_x\ ]$$

The following figure 3-5 shows a simple one type family to three types of houses distribution.



where $f_{d,1}$ is the mx1 vector of domestic families in income group 1 and $f_{d,2}$ is the vector for income group 2; f_x are expatriate families. Then, we can rewrite Q(t) as follows:

$$Q(t) = [Q_{d,1} \mid Q_{d,2} \mid Q_x]$$

$$= [\Lambda_{d,1} \mid \Lambda_{d,2} \mid \Lambda_x] \begin{bmatrix} f_{d,1} \\ f_{d,2} \\ f_{d,x} \end{bmatrix} (t)$$

We now turn to the goals and other related distributions used here. Consider the following equations (see Figure 3-3):

$$I\ d(t) - \Lambda_d\ f_u(t) - I\ \delta_d^+ + I\ \delta_d^- = 0 \qquad (3.3)$$

$$I\ r^*(t) - \Lambda_r\ f_t - I\ \delta_r^+ + I\ \delta_r^- = 0 \qquad (3.4)$$

These expressions relate the vectors of goal deviations $\delta_d^+,\ \delta_d^-,\ \delta_r^+,\ \delta_r^- \geq 0$ to various criteria which have been deemed relevant for housing as formulated by official bodies (e.g., Ministry of Housing) and students of the subject. Criteria such as "no families should be without housing", provide broad guidelines against which detailed plans may be assessed with, perhaps, further detailed breakdowns into families of certain age-income-size categories when this is deemed necessary or desirable in terms of the deviations that the model reveals for consideration. The formulations in (3.3) and (3.4) represent the desire to get "as close as possible" to the goals by using the criteria matrices to guide the "assignment" of families to houses.[67] The expressions Λ_d and Λ_r which appear in (3.3) and (3.4). These matrices will generally have time subscripts but are here omitted to avoid cluttering that presentation. In any case, they will have entries $\Lambda_{ik} \geq 0$, $\Sigma_i\ \Lambda_{ik} = 1$ for each of their i = 1,...., mxn rows.

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67 The fixed goal formulation in equations (3.3) and (3.4) could then be extended to accommodate those goal intervals developed in the previous Footnote. See Charnes, Cooper et al [39] for the development of interval goal programming.

3.3.2.1 Prototype Data for Alternative Criteria

A review of the base year distribution in Tables 3-1 and 3-2 indicates several areas where policy may be directed. In Tables 3-3, 3-4, and 3-5 we adjust the proportional distributions, previously shown in Table 3-2, to indicate alternative criteria for housing development. This is done by changing the family-to-house distribution, following the examples set forth and their accompaning discussion (see foot- note 65). These changes are designed to match family size to house size as well as to indicate preferences for increased ownership rather than rentals. In Table 3-3, emphasis is placed on both size compatibility, and ownership for new families. Tables 3-4 and 3-5 are concerned with the redistribution of presently "under housed" families. The ratios in Table 3-4 are oriented toward size compatibility and in Table 3-5 both size compatibility and ownership are considered. In all of these criteria tables, a clear preference for the elimination of hut housing is shown.

These different criteria directions mean different requirements from gover-nment and from the construction sector. To satisfy ownership programs, either loans or houses may be made available to households. If rentals are needed, loans for rental buildings, of high or low rise variety, may be the alternative. Obviously, each house-type would have different factor requirements.

3.3.3 Domestic and Expatriate Family Inputs

The following components 3.5, 3.6, and 3.7 (see also Figures 3-2 and 3-3) are the relationships pertinent to the number of domestic and expatriate families. The vectors $f_u(t-1)$ and $f_{dn}(t)$ represent families which are considered unhoused from t-1 and projected new domestic families at time t, respectively. The latter consists of both immigrant expatriates and newly formed domestic families.

$$I\ f_u(t) = I\ f_n + f_u(t-1) \tag{3.5}$$

$$\begin{aligned} f_n(t) &= f_{dn}(t) + f_{x+}(t) \\ &= f_{dn}(t) + \Gamma''\ /_{x+}(t) \end{aligned} \tag{3.6}$$

We also include expatriate family exits through the expression

$$\begin{aligned} f_x(t) &= f_x(t-1) - f_{x-}(t) \\ &= f_x(t-1) - \Gamma''_x\ /_{x-} \end{aligned} \tag{3.7}$$

TABLE 3-3: DISTRIBUTION CRITERIA FOR NEW FAMILIES

		DOMESTIC FAMILIES				EXPATRIATE FAMILIES			
		(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
REG RNT SIZ	1	.14898	.00000	.00000	.00000	.08599	.00000	.00000	.00000
	2	.07449	.11189	.00000	.00000	.57286	.53872	.00000	.00000
	3	.00000	.05595	.06616	.00000	.16164	.29736	.57127	.00691
	4	.00000	.00000	.03308	.05756	.00938	.01675	.28062	.57902
	5	.00000	.00000	.00000	.02827	.00664	.00438	.01556	.17237
REG OWN SIZ	1	.21867	.00000	.00000	.00000	.01774	.01585	.00622	.00090
	2	.43749	.22613	.00000	.00000	.04028	.04177	.02613	.00645
	3	.00000	.46385	.24153	.00000	.05775	.04116	.04089	.01336
	4	.00000	.00000	.51405	.55243	.02328	.01424	.01386	.12983
	5	.00000	.00000	.00000	.26525	.00335	.00122	.00029	.07502
TNT OWN SIZ	1	.00590	.01758	.00000	.00000	.00379	.00264	.00024	.00002
	2	.00900	.03515	.01766	.00424	.00000	.00400	.00205	.00011
	3	.00000	.00000	.03644	.00849	.00116	.00042	.00077	.00035
HUT RNT SIZ	1	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
	2	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
	3	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
HUT OWN SIZ	1	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
	2	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
	3	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
TRD RNT SIZ	1	.01235	.00000	.00000	.00000	.00847	.00309	.00000	.00000
	2	.00618	.01680	.00000	.00000	.00512	.00771	.00065	.00000
	3	.00000	.00840	.00424	.00000	.00255	.00514	.00342	.00005
	4	.00000	.00000	.00212	.00342	.00000	.00000	.02830	.01053
	5	.00000	.00000	.00000	.00171	.00000	.00000	.00000	.00163
TRD OWN SIZ	1	.02898	.00000	.00000	.00000	.00000	.00000	.00000	.00000
	2	.05796	.02142	.00000	.00000	.00000	.00276	.00828	.00321
	3	.00000	.04283	.05681	.00000	.00000	.00280	.00145	.00024
	4	.00000	.00000	.02791	.05242	.00000	.00000	.00000	.00000
	5	.00000	.00000	.00000	.02621	.00000	.00000	.00000	.00000

(REG) REGULAR (RNT) RENT SIZ 1) 1-2 ROOMS (1) 1-4 FAMILY MEMBERS
(TNT) TENT (OWN) OWNED 2) 3-4 ROOMS (2) 5-9 FAMILY MEMBERS
(HUT) HUTS 3) 5-6 ROOMS (3) 9-12 FAMILY MEMBERS
(TRD) TRADITIONAL 4) 6-8 ROOMS (4) 13-A FAMILY MEMBERS

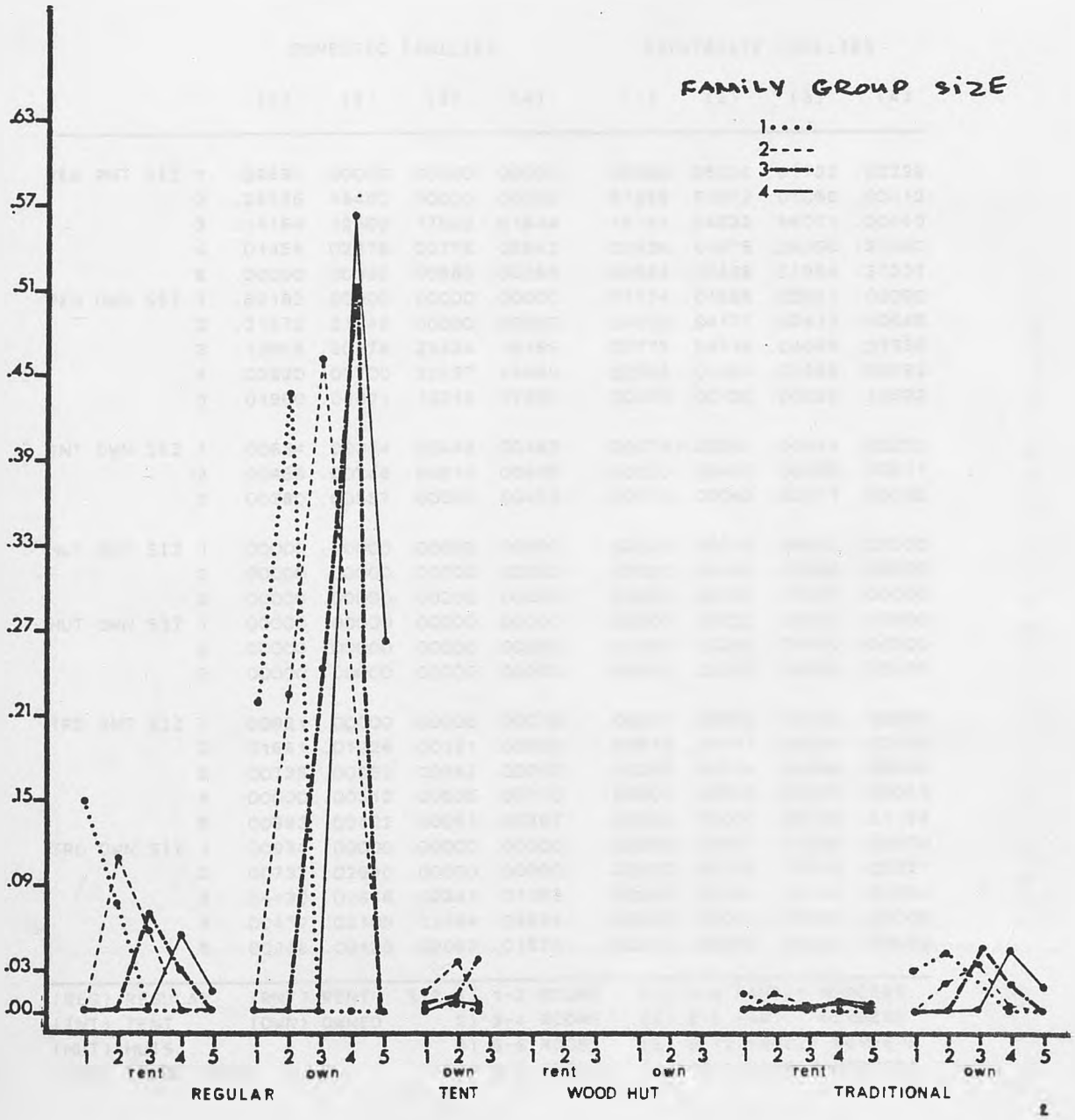


FIGURE 3-5: DISTRIBUTION CRITERIA FOR NEW FAMILIES

TABLE 3-4: DISTRIBUTION CRITERIA WITH EMPHASIS ON FAMILY-HOUSE SIZE COMPATIBILITY

EMPHASIS ON SIZE MATCHING

		DOMESTIC FAMILIES				EXPATRIATE FAMILIES			
		(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
REG RNT SIZ	1	.02690	.00000	.00000	.00000	.08599	.05204	.01732	.00226
	2	.26536	.18480	.00000	.00000	.57286	.53872	.01056	.00412
	3	.14164	.12502	.17093	.01844	.16164	.24532	.56071	.00465
	4	.01456	.02278	.02776	.05842	.00938	.01675	.26330	.37490
	5	.00000	.00330	.00580	.02095	.00664	.00438	.01556	.37237
REG OWN SIZ	1	.02180	.00000	.00000	.00000	.01774	.01585	.00622	.00090
	2	.21672	.21146	.00000	.00000	.04028	.04177	.02613	.00645
	3	.13669	.20176	.25434	.18166	.05775	.04116	.04089	.01336
	4	.03630	.07700	.32937	.45862	.02328	.01424	.01386	.09983
	5	.01960	.05621	.10218	.17836	.00335	.00122	.00029	.10502
TNT OWN SIZ	1	.00634	.00394	.00443	.00185	.00379	.00264	.00024	.00002
	2	.00485	.00746	.00614	.00635	.00000	.00400	.00205	.00011
	3	.00380	.00587	.00588	.00453	.00116	.00042	.00077	.00035
HUT RNT SIZ	1	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
	2	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
	3	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
HUT OWN SIZ	1	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
	2	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
	3	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
TRD RNT SIZ	1	.00921	.00000	.00000	.00015	.00847	.00309	.00000	.00000
	2	.01661	.01226	.00131	.00000	.00512	.00771	.00065	.00000
	3	.00738	.00852	.00582	.00000	.00255	.00514	.00342	.00005
	4	.00000	.00312	.00505	.00710	.00000	.00000	.02830	.00053
	5	.00383	.00122	.00051	.00297	.00000	.00000	.00000	.01163
TRD OWN SIZ	1	.00934	.00000	.00000	.00000	.00000	.00000	.00000	.00000
	2	.00737	.02640	.00000	.00000	.00000	.00276	.00828	.00324
	3	.04430	.02676	.02341	.01363	.00000	.00280	.00145	.00024
	4	.00472	.02109	.03624	.02821	.00000	.00000	.00000	.00000
	5	.00268	.00103	.02083	.01876	.00000	.00000	.00000	.00000

(REG) REGULAR (RNT) RENT SIZ 1) 1-2 ROOMS (1) 1-4 FAMILY MEMBERS
(TNT) TENT (OWN) OWNED 2) 3-4 ROOMS (2) 5-9 FAMILY MEMBERS
(HUT) HUTS 3) 5-6 ROOMS (3) 9-12 FAMILY MEMBERS
(TRD) TRADITIONAL 4) 6-8 ROOMS (4) 13-A FAMILY MEMBERS

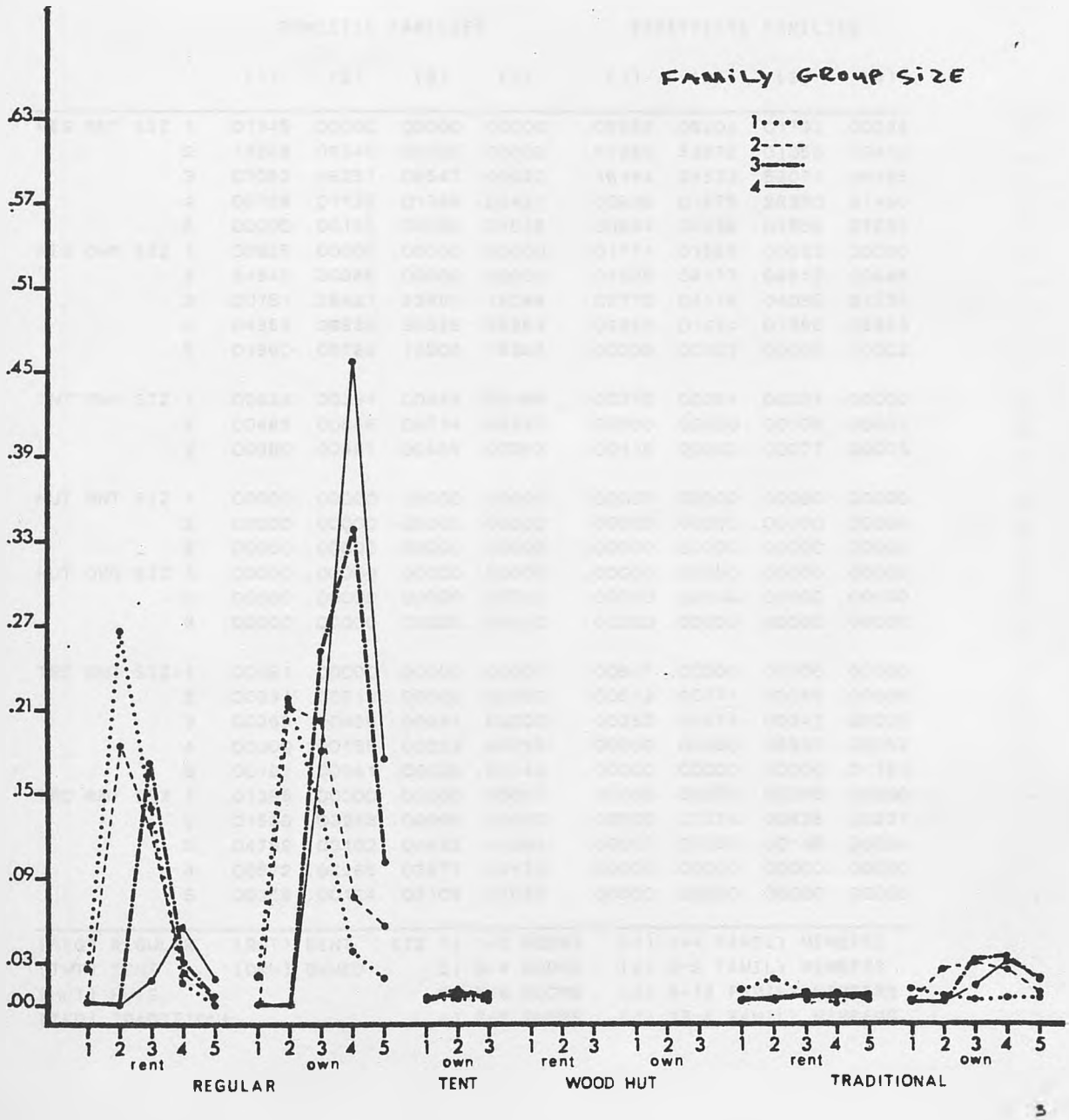


FIGURE 3-6: SIZE COMPATIBILITY CRITERIA

TABLE 3-5: DISTRIBUTION CRITERIA WITH EMPHASIS ON OWNERSHIP

EMPHASIS ON OWNERSHIP

		DOMESTIC FAMILIES				EXPATRIATE FAMILIES			
		(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
REG RNT SIZ	1	.01345	.00000	.00000	.00000	.08599	.05204	.01732	.00226
	2	.13268	.09240	.00000	.00000	.57286	.53872	.01056	.00412
	3	.07082	.06251	.08547	.00922	.16164	.24532	.56071	.00465
	4	.00728	.01139	.01388	.02421	.00938	.01675	.26330	.37490
	5	.00000	.00165	.00290	.01548	.00664	.00438	.01556	.37237
REG OWN SIZ	1	.03525	.00000	.00000	.00000	.01774	.01585	.00622	.00090
	2	.34940	.30386	.00000	.00000	.04028	.04177	.02613	.00645
	3	.20751	.26427	.33980	.19088	.05775	.04116	.04089	.01336
	4	.04358	.08839	.30325	.58283	.02328	.01424	.01386	.09983
	5	.01960	.05786	.14508	.19384	.00335	.00122	.00029	.10502
TNT OWN SIZ	1	.00634	.00394	.00443	.00185	.00379	.00264	.00024	.00002
	2	.00485	.00846	.00714	.00735	.00000	.00400	.00205	.00011
	3	.00380	.00487	.00488	.00353	.00116	.00042	.00077	.00035
HUT RNT SIZ	1	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
	2	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
	3	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
HUT OWN SIZ	1	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
	2	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
	3	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
TRD RNT SIZ	1	.00461	.00000	.00000	.00007	.00847	.00309	.00000	.00000
	2	.00831	.00613	.00066	.00000	.00512	.00771	.00065	.00000
	3	.00369	.00426	.00291	.00000	.00255	.00514	.00342	.00005
	4	.00000	.00156	.00253	.00355	.00000	.00000	.02830	.00053
	5	.00192	.00061	.00025	.00149	.00000	.00000	.00000	.01163
TRD RNT SIZ	1	.01395	.00000	.00000	.00007	.00000	.00000	.00000	.00000
	2	.01568	.03253	.00066	.00000	.00000	.00276	.00828	.00321
	3	.04799	.03102	.04632	.01363	.00000	.00280	.00145	.00024
	4	.00572	.02265	.02877	.04176	.00000	.00000	.00000	.00000
	5	.00359	.00164	.03109	.01025	.00000	.00000	.00000	.00000

(REG) REGULAR (RNT) RENT SIZ 1) 1-2 ROOMS (1) 1-4 FAMILY MEMBERS
(TNT) TENT (OWN) OWNED 2) 3-4 ROOMS (2) 5-9 FAMILY MEMBERS
(HUT) HUTS 3) 5-6 ROOMS (3) 9-12 FAMILY MEMBERS
(TRD) TRADITIONAL 4) 6-8 ROOMS (4) 13-A FAMILY MEMBERS

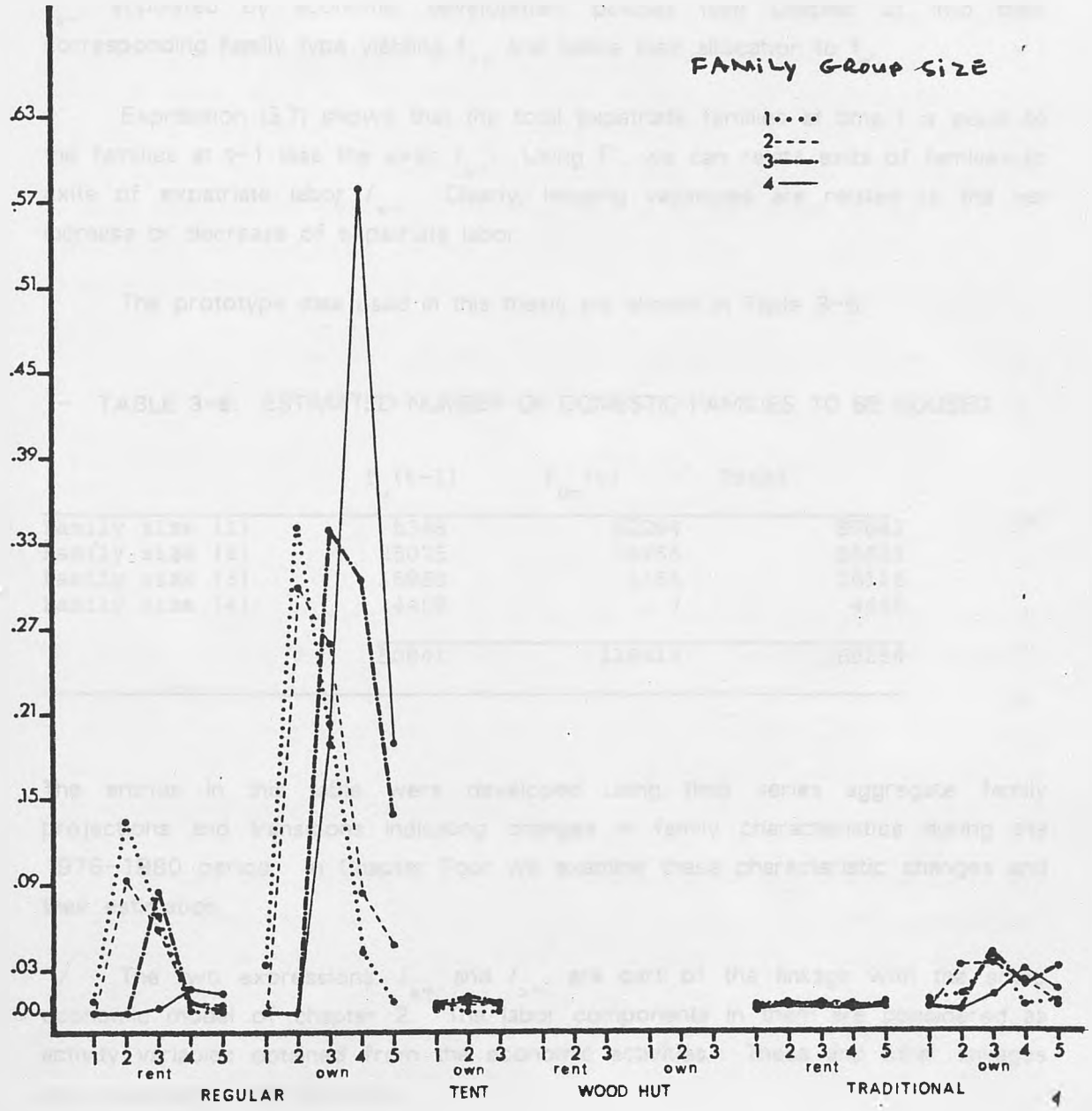


FIGURE 3-7: OWNERSHIP CRITERIA

Expression (3.5) simply states that the unhoused this period, $f_u(t)$ are those left unhoused from the previous period, $f_u(t-1)$, and the new families, $f_n(t)$. Expression (3.6) indicates that new families, f_n, is the sum of those domestic families formed during the last period, f_{dn}, and the increase of expatriate families, f_{x+}. The matrix Γ'' in this expression, distributes each type of immigrant labor, $/_{x-}$, stipulated by economic development policies (see Chapter 2), into their corresponding family type yielding f_{x+} and hence their allocation to f_n.

Expression (3.7) shows that the total expatriate families at time t is equal to the families at t-1 less the exits f_{x-}. Using Γ'', we can relate exits of families to exits of expatriate labor $/_{x-}$. Clearly, housing vacancies are related to the net increase or decrease of expatriate labor.

The prototype data used in this thesis are shown in Table 3-6.

TABLE 3-6: ESTIMATED NUMBER OF DOMESTIC FAMILIES TO BE HOUSED

	$f_u(t-1)$	$f_{dn}(t)$	Total
Family size (1)	5348	82294	87642
Family size (2)	25075	34956	50021
Family size (3)	15960	1156	16116
Family size (4)	4458	7	4465
	50841	118413	169254

The entries in this table were developed using time series aggregate family projections and transitions indicating changes in family characteristics during the 1976-1980 period. In Chapter Four we examine these characteristic changes and their estimation.

The two expressions, $/_{x+}$ and $/_{x-}$, are part of the linkage with the socio economic model of chapter 2. The labor components in them are considered as activity variables obtained from the economic activities. These and other linkages are presented in the following.

3.3.4 Input-Output Linkages To the Socio-Economic Model

Expatriate labor has a multiplier effect: expatriate labor required by the economy imposes demands on housing; this in turn leads to additional expatriate labor, and so on. This argument can evidently also be extended to include similar interdependencies between construction activity and the rest of the industrial structure. In this way we can account for the import of labor needed for other industries as a result of the increase in the production of housing construction. This can be done via an economic input-output model and its labor input ratios per unit of output.[68] This is important, especially when we see that the total amount of labor imported for other industries may depend on the output of the construction industry and vice versa. Hence we incorporate these interrelated variables and parameters discussed in chapter 2.

Begining with the row labelled "sectoral material balance" in Figure 2-3 we set t = 1 and write the private sector labor requirements as:

$$- P\, h_n(1) + (I - A(0))\, q(0) + (I - A(1))\, q(1) - I\, c_{gk}(1) - I\, c_{go}(1) - I\, c_h(1) + I\, IMP(1) - I\, EXP(1 - I\, PR(1) = 0 \qquad (3.8)$$

In this equation total demand is composed of vectors of government demand for capital development, $c_{gk}(t)$, government demand for operations, $c_{go}(t)$, exports, EXP, household consumption of domestic products, $c_h(t)$, and the demand for new houses, $P\, h_n(t)$, where P is a matrix of prevailing prices. The supply is given by $(I - A_0)\, q_0 + (I - A_1)\, q_1 + IMP$, where A_0 and A_1 are the base year and the planned industrialization coefficient matrices.

The total labor used in production is composed of domestic and expatriate components represented in $l_{ds}(t)$ and $l_{xs}(t)$. Of course, if all of the construction labor needed is available locally, then there will be no need for importing expatriate labor for construction. In this case we may set $l_{xs}(t)$ equal to the zero vector. However, if there is a capacity limitation of local labor, including construction labor, then there will be a need to import labor and house them, leading to the multiplier effect described above. The following expression, drawn from the socio economic model, represents the accounting for expatriate labor, including those entry and exit variables presented earlier in equations (3.6) and (3.7).

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[68] See Appendix 3-B for the definition of the multiplier effect and its formulation in the case of a stable input-output structure of production.

$$I/_{x} - \hat{a}_{2}/_{x}(t-1) - I/_{x-} + I/_{x+} = 0 \qquad (3.9)$$

The remaining components of Figure 3-3 should by now be self-explanatory. They can be summarized as relating labor to the associated household consumption, indicating government plans and labor requirements, total imports, exports, and the industrialization project requirements for construction. Explanation of these relationships is available in Chapter Two. The multiplier linkage effects will be demonstrated in the application detailed below.

3.4 SOLUTION METHOD AND NUMERICAL ILLUSTRATIONS

The purpose of this section is to show and compare the results of alternative applications, indicating differences due to changes in goals for housing development as well as trade offs with other goals involved in national development.

Similar to the model application of Chapter 2, the computational support and solution procedure in this chapter's application will follow the iterative procedure delineated in Chapter 1. The method of linear programming provided the computational tool for solution(s) search.

The problem is presented in two different forms. The first is designed to examine the resources required to satisfy both housing requirements and economic development plans regardless of the social consequences, of unlimited importation of expatriate labor. In the second, multi objective preferences the several planning concerns of chapter 2 and those of housing development are introduced thus allowing us to examine the effects of alternative relative preferences on the achievements of different goals. In both cases three different goal targets are examined within the housing subsystem. The first assumes no changes in housing allocation behavior from what was observed in previous periods as shown in Table 3-2. The second and the third, on the other hand, follow the alternative criteria outlined in Tables 3-3, 3-4, and 3-5, section 3.3.2. Figure 3-9, concisely, shows the alternative illustrations which are coded ECHS11, ECHS12, ECHSE1, ECHSE2, ECHSS1, and ECHSS2 for future reference.

In all of these applications, we assume the desire to achieve the respective goals within the five year plan period. We also assume first priority for the housing of expatriate families as an incentive to the recruiting of the expatriate labor. In all of these cases, except the ECHSE1 application, we have indicated the desire to eliminate wood hut housing. In Tables 3-7 and 3-8, we summarize the rows and the columns, and their sizes, used in these illustrations.

Selected outputs of these applications are described below.

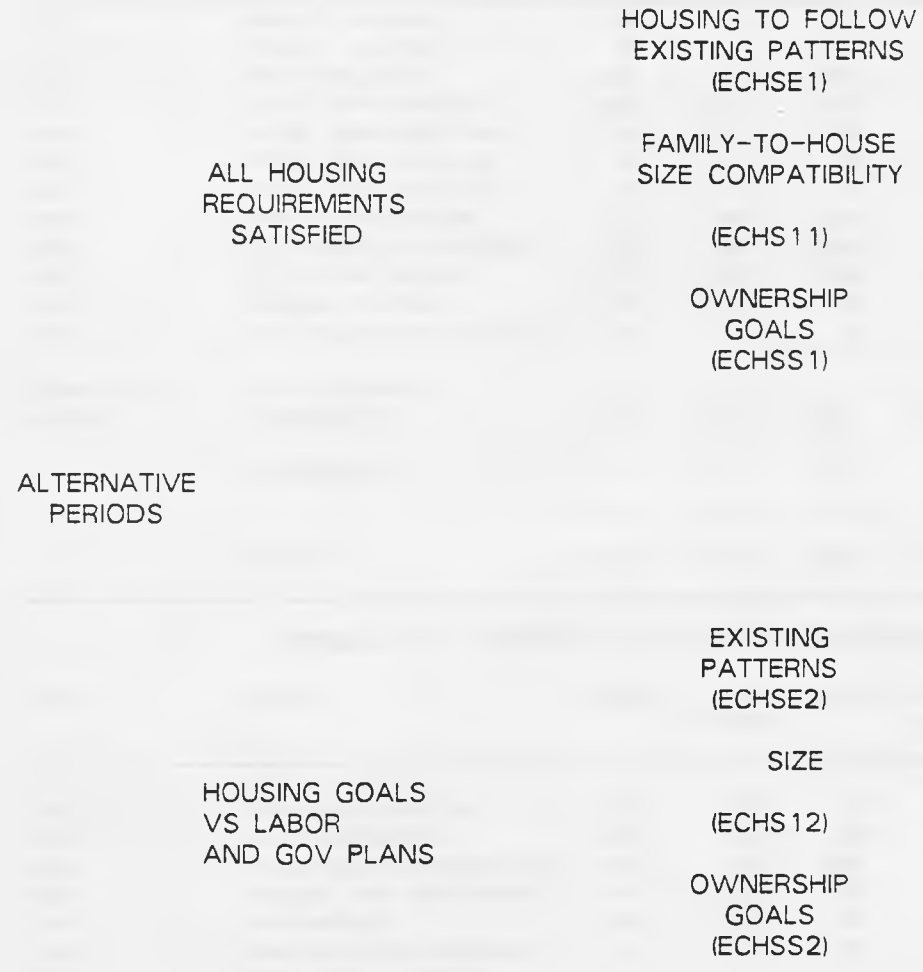


FIGURE 3-8: OUTLINE OF ALTERNATIVE APPLICATIONS

TABLE 3-7: SUMMARY OF CONSTRAINT ROWS

COMPONENT GROUP		INITIAL NO. OF ROWS			
CODE	NAME	ECHSE1	ECHS11 ECHSS1	ECHSE2	ECHS12 ECHSS2
(H)	HOUSES BALANCE	29	29	29	29
(F)	FAMILY BALANCE	8	8	8	8
(D)	NEW FAM. DIST.	232	184	232	184
(R)	EXIT. FAM. REDIST.	232	212	232	212
(UF)	TOTAL UNHOUSED FAM.	8	8	8	8
(NF)	TOTAL NEW FAMILIES	8	8	8	8
(RF)	TOTAL REM FAMILIES	8	8	8	8
(DR)	REM DISTRIBUTION	232	188	232	188
(DB)	DISTRIBUTIONS BOUNDS	464	396	464	396
(GB)	DEVIATION BOUNDS	232	205	232	205
(HB)	HOUSES BOUNDS	29	29	29	29
(HC)	TOT HOUSES CAPACITIES	3	3	3	3
(ECN11) or (ECN13)	SOCIO ECONOMIC-COMPONENTS	136	136	160	160
	PREFERENCES	1	1	10	10
	TOTALS	1622	1414	1655	1447

TABLE 3-8: SUMMARY OF ACTIVITY COLUMNS

CODE	NAME	ECHSE1	ECHS11 ECHSS1	ECHSE2	ECHS12 ECHSS2
(ND)	NEW DISTRIBUTION	232	184	232	184
(RD)	REDISTRIBUTION	232	212	232	212
(ED)	EXISTING DISTRIBUTION	232	188	232	188
(UH)	HOUSES REM UNOCCUPIED	29	29	29	29
(NH)	NEW HOUSES	29	29	29	29
(UF)	FAMILIES REM UNHOUSED	8	8	8	8
(NF)	NEW FAMILY ENTRIES	8	8	8	8
(DF)	DIST CANDIDATE FAM	8	8	8	8
(RF)	REDIST CANDIDATE FAM	8	8	8	8
(ECN11) or (ECN13)	SOCIO ECONOMIC-COMPONENTS	120	120	120	120
(DNV)	DEVIATIONS NEW DIST	232	184	232	184
(DRV)	DEVIATIONS REDIST	232	224	232	224
(DVEL)	DEVIATIONS LABOR			12	12
(DVGO)	DEVIATIONS GOV OPER			18	18
(DVGK)	DEVIATIONS GOV CAPITAl			18	18
	STIPULATION	3	3	3	3
	TOTAL	1373	1205	1421	1253

3.4.1 Housing Goals and Their Impacts

Our purpose here is to examine the effects of goal changes, associated with the desire to satisfy all housing goals through iterative application of the solution method. As discussed earlier, housing goals are guided by certain criteria influencing the distribution of families to houses, the use of vacancies, and the requirements for new houses. Changes in these criteria and their associated goals may have different impacts on other related variables. First, in application ECHSE1, we assume that there will be no change in the distribution of familie-to-house from the base year (1976). Then we move to the second, ECHS11, where housing goals are oriented towards the provision of houses compatible with family sizes. The ratio between rentals and owned houses, however, is assumed to remain the same. In the third application, ECHSS1, family-to-house size compatibility are compounded with the desire to increase the proportion of owned houses. The detailed computational output of these applications are provided in Appendix 3-C. [69]

In Table 3-9, 3-10, and 3-11 we present the total family-to-housing distribution resulting from each application. Notice the change in the number and type of expatriate families compared to the 1976 levels. The differences between ECHSE1, ECHS11, and ECHSS1 are all attributable to the changes in the criteria used for goals. As shown in ECHSE1, more tent and hut housing remains, which has the effect of reducing the demand for expatriate labor and their families. In ECHS11, where the goals were oriented towards size compatibility within each house category, rentals increased. Since multi-dwelling rentals require less labor and usually cost less per house than owned single family houses, the number of expatriate families is less than those shown in Table 3-11 (for ECHSS1-- which is oriented towards ownership). In all these tables, notice that the number of expatriate families is expected to more than double to accommodate housing and all other multiplying requirements within the first five year plan--- from 210,713 in 1976 to 559,836 for ECHSE1, 612,163 for ECHS11, and 622,979 for ECHSS1.

Another side of our summary here is related to the relative distribution of families to houses. In Tables 3-11, 3-12, and 3-13 and in their associated Figures 3-9, 3-10, and 3-12, we show the relative changes in the family-to house distribution ratios, indicating the effect of alternative planning activities on the

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[69] The data presented in Appendix 3-C are arranged to first show the distribution of new families to houses, the redistribution of existing families to houses, the combined and finally the ratios of the total family-to-house distribution. This is followed by other dependent variables such as resulting vacancies and new house requirements, economic variable and finally labor inputs and outputs.

TABLE 3-9: FAMILY-TO-HOUSE DISTRIBUTION: ECHSE1

		DOMESTIC FAMILIES (1)	(2)	(3)	(4)	EXPATRIATE FAMILIES (1)	(2)	(3)	(4)	TOTAL HOUSES
REG RNT SIZ	1	4047	4280	714	0	15251	9929	0	0	34221
	2	39945	61358	19193	1769	101533	159351	29423	1358	413930
	3	21330	43703	15330	2492	28659	90070	13131	2038	216753
	4	2185	9506	5339	1420	1735	6361	679	0	27225
	5	0	1564	1427	1063	1138	993	766	0	6951
TOTAL RNT		67507	120411	42003	6744	148316	266704	43999	3396	699080
REG OWN SIZ	1	3277	4238	1427	357	3144	4503	0	0	16946
	2	32622	76873	33071	4960	7138	13092	766	0	168522
	3	20575	82099	59203	14190	10246	9711	2216	0	198240
	4	5461	33251	39272	14181	4120	2761	766	673	100485
	5	2956	24856	31816	33055	597	0	0	741	94021
TOTAL OWN		64891	221317	164789	66743	25245	30067	3748	1414	578214
TOTAL REG		132398	341728	206792	73487	173561	296771	47747	4810	1277294
TNT OWN SIZ	1	3662	8231	5290	357	2584	0	0	0	20124
	2	722	1481	1058	1063	0	0	0	0	4324
	3	2201	5390	3174	349	795	0	0	0	11909
TOTAL TNT		6585	15102	9522	1769	3379	0	0	0	36357
HUT RNT SIZ	1	0	0	0	0	0	2668	0	0	2668
	2	0	412	345	0	0	0	0	0	757
	3	0	370	0	0	0	0	0	0	370
TOTAL RNT		0	782	345	0	0	2668	0	0	3795
HUT OWN SIZ	1	755	741	0	0	0	869	0	0	2365
	2	0	1481	714	349	0	0	0	0	2544
	3	0	1152	714	357	0	0	0	0	2223
TOTAL OWN		755	3374	1428	706	0	869	0	0	7132
TOTAL HUT		755	4156	1773	706	0	3537	0	0	10927
TRD RNT SIZ	1	1831	782	345	0	14650	0	0	0	17608
	2	3293	5761	1403	706	1192	3724	0	0	16079
	3	1462	2676	714	0	596	2668	2899	0	11015
	4	0	741	714	0	0	0	0	0	1455
	5	755	1523	0	357	0	0	0	0	2635
TOTAL RNT		7341	11483	3176	1063	16438	6392	2899	0	48792
TRD OWN SIZ	1	1462	5226	3199	0	0	0	0	0	9887
	2	8770	11440	7087	1055	0	1768	766	0	30886
	3	1847	9506	4232	1420	0	1768	0	0	18773
	4	739	6460	3543	1803	0	0	0	0	12545
	5	722	6419	6742	1769	0	0	0	0	15652
TOTAL OWN		13540	39051	24803	6047	0	3536	766	0	87743
TOTAL TRD		20881	50534	27979	7110	16438	9928	3665	0	136535
TOTAL FAMILY		160619	411520	246066	83072	193378	310236	51412	4810	1461113

(REG) REGULAR (RNT) RENT SIZ 1) 1-2 ROOMS (1) 1-4 FAMILY MEMBERS
(TNT) TENT (OWN) OWNED 2) 3-4 ROOMS (2) 5-9 FAMILY MEMBERS
(HUT) HUTS 3) 5-6 ROOMS (3) 9-12 FAMILY MEMBERS

TABLE 3-10: FAMILY-TO-HOUSE DISTRIBUTION: ECHS11

		DOMESTIC FAMILIES (1)	(2)	(3)	(4)	EXPATRIATE FAMILIES (1)	(2)	(3)	(4)	TOTAL HOUSES
REG RNT SIZ	1	15020	0	0	0	17419	6338	476	6	39259
	2	25893	71673	0	0	116043	188159	290	10	402068
	3	10337	47302	40266	1449	32743	97521	31227	31	260876
	4	1063	8007	6922	4849	1901	5850	15006	2492	46090
	5	0	1160	1328	1773	1345	1529	859	1394	9388
TOTAL RNT		52313	128142	48516	8071	169451	299397	47858	3933	757681
REG OWN SIZ	1	20756	0	0	0	3594	5536	343	4	30233
	2	54158	87901	0	0	8159	14587	1432	33	166270
	3	9975	98762	62365	14281	11698	14376	2256	69	213782
	4	2649	27065	84207	38520	4716	4973	765	599	163494
	5	1430	19757	23394	15205	678	427	16	464	61371
TOTAL OWN		88968	233485	169966	68006	28845	39899	4812	1169	635150
TOTAL REG		141281	361627	218482	76077	198296	339296	52670	5102	1392831
TNT OWN SIZ	1	980	2440	1014	145	768	922	14	0	6283
	2	1143	4732	1708	518	0	1397	113	0	9611
	3	277	2063	1970	394	235	147	42	1	5129
TOTAL TNT		2400	9235	4692	1057	1003	2466	169	1	21023
HUT RNT SIZ	1	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0
TOTAL RNT		0	0	0	0	0	0	0	0	0
HUT OWN SIZ	1	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0
TOTAL OWN		0	0	0	0	0	0	0	0	0
TOTAL HUT		0	0	0	0	0	0	0	0	0
TRD RNT SIZ	1	1754	0	0	12	1716	1079	0	0	4561
	2	1754	5318	300	0	1037	2691	36	0	11136
	3	539	3499	1405	0	516	1795	189	0	7943
	4	0	1097	1192	573	0	0	1562	29	4453
	5	280	429	117	241	0	0	0	33	1100
TOTAL RNT		4327	10343	3014	826	3269	5565	1787	62	29193
REG OWN SIZ	1	3222	0	0	0	0	0	0	0	3222
	2	5618	10565	0	0	0	964	457	17	17621
	3	3233	11977	6329	1071	0	978	80	1	23669
	4	344	7413	8775	2452	0	0	0	0	18984
	5	196	362	4769	1592	0	0	0	0	6919
TOTAL OWN		12613	30317	19873	5115	0	1942	537	18	70415
TOTAL TRD		16940	40660	22887	5941	3269	7507	2324	80	99608
TOTAL FAMILY		160621	411522	246061	83075	202568	349269	55163	5183	1513462

(REG) REGULAR (RNT) RENT SIZ 1) 1-2 ROOMS (1) 1-4 FAMILY MEMBERS
(TNT) TENT (OWN) OWNED 2) 3-4 ROOMS (2) 5-9 FAMILY MEMBERS
(HUT) HUTS 3) 5-6 ROOMS (3) 9-12 FAMILY MEMBERS

TABLE 3-11: FAMILY-TO-HOUSE DISTRIBUTION: ECHSS1

		DOMESTIC FAMILIES (1)	(2)	(3)	(3)	EXPATRIATE FAMILIES (1)	(2)	(3)	(3)	TOTAL HOUSES
REG RNT SIZ	1	14039	0	0	0	17913	6339	476	6	38773
	2	16211	39195	0	0	119334	190724	290	10	365764
	3	5168	25331	20700	725	33671	98937	31504	31	216067
	4	531	4004	3743	2160	1900	5930	15142	2520	35930
	5	0	580	664	1343	1384	1550	866	1402	7789
TOTAL RNT		35949	69110	25107	4228	174202	303480	48278	3969	664323
REG OWN SIZ	1	21737	0	0	0	3696	5612	346	5	31396
	2	63841	120379	0	0	8391	14788	1454	34	208887
	3	15144	120734	81931	15005	12030	14572	2276	70	261762
	4	3180	31068	78227	40422	4850	5041	772	605	164165
	5	1430	20337	33216	16422	698	432	16	288	72839
TOTAL OWN		105332	292518	193374	71849	29665	40445	4864	1002	739049
TOTAL REG		141281	361628	218481	76077	203867	343925	53142	4971	1403372
TNT OWN SIZ	1	980	2440	1014	145	790	935	14	0	6318
	2	1143	5084	1937	597	0	1416	114	0	10291
	3	277	1712	1741	315	242	149	43	2	4481
TOTAL TNT		2400	9236	4692	1057	1032	2500	171	2	21090
HUT RNT SIZ	1	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0
TOTAL RNT		0	0	0	0	0	0	0	0	0
HUT OWN SIZ	1	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0
TOTAL OWN		0	0	0	0	0	0	0	0	0
TOTAL HUT		0	0	0	0	0	0	0	0	0
TRD RNT SIZ	1	1418	0	0	6	1765	1094	0	0	4283
	2	1148	3164	151	0	1066	2727	36	0	8292
	3	269	2001	739	0	531	1820	190	0	5550
	4	0	548	615	294	0	0	1575	30	3062
	5	140	214	57	125	0	0	0	33	569
TOTAL RNT		2975	5927	1562	425	3362	5641	1801	63	21756
REG OWN SIZ	1	3558	0	0	6	0	0	0	0	3564
	2	6224	12720	151	0	0	950	461	17	20523
	3	3502	13474	6725	1071	650	382	41	1	25846
	4	417	7961	7065	3517	0	0	0	0	18960
	5	262	576	7118	923	0	0	0	0	8879
TOTAL OWN		13963	34731	21059	5517	650	1332	502	18	77772
TOTAL TRD		16938	40658	22621	5942	4012	6973	2303	81	99528
TOTAL FAMILY		160619	411522	245794	83076	208911	353398	55616	5054	1523990

(REG) REGULAR (RNT) RENT SIZ 1) 1-2 ROOMS (1) 1-4 FAMILY MEMBERS
(TNT) TENT (OWN) OWNED 2) 3-4 ROOMS (2) 5-9 FAMILY MEMBERS
(HUT) HUTS 3) 5-6 ROOMS (3) 9-12 FAMILY MEMBERS

improvement of the "quality of housing life". For example, the quantitative measurement of the housing dimension shows that the cumulative ratio of family size one, who were in regular houses in 1976, will change to .3252 when policies indicated in ECHS11 are applied, and will change to .2205 if the ownership goals in ECHSS1 are satisfied. This is associated with an expected increase in the ownership ratios from .4028 for the base year to .5539 under ECHS11 and .636 under ECHSS1. Notice also, that due to the increased construction of regular houses, we find the expected decline in the proportion of traditional housing from .1592 to .1054 in case ECHS11 and ECHS1.[70]

For cases ECHS11 and ECHSS1, houses are required and vacant undesired houses exist due to the redistribution of families. Table 3-14 contains the distribution of houses by type and status (occupied, vacant) resulting from these applications. Observe that relatively more houses were left vacant in cases ECHS11 than in case ECHSS1. Finally, we note the substantial demand for rental units when ownership is not stressed.

Housing policies eventually affect other socio-economic variables such as the recruiting of expatriate labor, (Table 3-15), domestic outputs, imports, and household consumption, (Table 3-16). These are self explanatory and will not be discussed here.

Alternative housing development policies can cause changes in the population policies. From Table 3-1, the total expatriate families are .2167 of the total families in 1976. This is expected to change to .3832 in the first application (ECHSE1), Table 3-9, or to .4045 in the second application (ECHS11), Table 3-10, and to .4097 in the third (ECHSS1), Table 3-11. Such increases may accelerate further changes in social customs and habits and may adversely affect the smooth transition from the traditional life styles. This, in itself, may be regarded as destablizing.

A more moderate development route would be needed to minimize "as much as possible" potentially adverse consequences. As such we now underline and examine conflicts and tradeoffs between housing and other goals caused by establishing specific goals for the expatriate labor force.

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70 This result could be changed if a regional version of the model were developed showing different regional characteristics and preferences. Hence rural families and their housing preferences combined with the encouragement of traditional methods of building construction have the effect of reducing the number of regular houses and consequently the recruitment of expatriate labor.

TABLE 3-12: FAMILY-TO-HOUSE DISTRIBUTION RATIOS: ECHS11

		DOMESTIC FAMILIES				EXPATRIATE FAMILIES				TOTAL
		(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
REG RNT SIZ	1	.0935	.0000	.0000	.0000	.0860	.0181	.0086	.0012	.0259
	2	.1612	.1742	.0000	.0000	.5729	.5387	.0053	.0019	.2657
	3	.0644	.1149	.1636	.0174	.1616	.2792	.5661	.0060	.1724
	4	.0066	.0195	.0281	.0584	.0094	.0167	.2720	.4808	.0305
	5	.0000	.0028	.0054	.0213	.0066	.0044	.0156	.2690	.0062
REG OWN SIZ	1	.1292	.0000	.0000	.0000	.0177	.0159	.0062	.0008	.0200
	2	.3372	.2136	.0000	.0000	.0403	.0418	.0260	.0064	.1099
	3	.0621	.2400	.2535	.1719	.0577	.0412	.0409	.0133	.1413
	4	.0165	.0658	.3422	.4637	.0233	.0142	.0139	.1156	.1080
	5	.0089	.0480	.0951	.1830	.0033	.0012	.0003	.0895	.0406
TNT OWN SIZ	1	.0061	.0059	.0041	.0017	.0038	.0026	.0003	.0000	.0042
	2	.0071	.0115	.0069	.0062	.0000	.0040	.0020	.0000	.0064
	3	.0017	.0050	.0080	.0047	.0012	.0004	.0008	.0002	.0034
HUT RNT SIZ	1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
HUT OWN SIZ	1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
TRD RNT SIZ	1	.0109	.0000	.0000	.0001	.0085	.0031	.0000	.0000	.0030
	2	.0109	.0129	.0012	.0000	.0051	.0077	.0007	.0000	.0074
	3	.0034	.0085	.0057	.0000	.0025	.0051	.0034	.0000	.0052
	4	.0000	.0027	.0048	.0069	.0000	.0000	.0283	.0056	.0029
	5	.0017	.0010	.0005	.0029	.0000	.0000	.0000	.0064	.0007
TRD RNT SIZ	1	.0201	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0021
	2	.0350	.0257	.0000	.0000	.0000	.0028	.0083	.0033	.0116
	3	.0201	.0291	.0257	.0129	.0000	.0028	.0015	.0002	.0156
	4	.0021	.0180	.0357	.0295	.0000	.0000	.0000	.0000	.0125
	5	.0012	.0009	.0194	.0192	.0000	.0000	.0000	.0000	.0046

(REG) REGULAR (RNT) RENT SIZ 1) 1-2 ROOMS (1) 1-4 FAMILY MEMBERS
(TNT) TENT (OWN) OWNED 2) 3-4 ROOMS (2) 5-9 FAMILY MEMBERS
(HUT) HUTS 3) 5-6 ROOMS (3) 9-12 FAMILY MEMBERS
(TRD) TRADITIONAL 4) 6-8 ROOMS (4) 13-A FAMILY MEMBERS

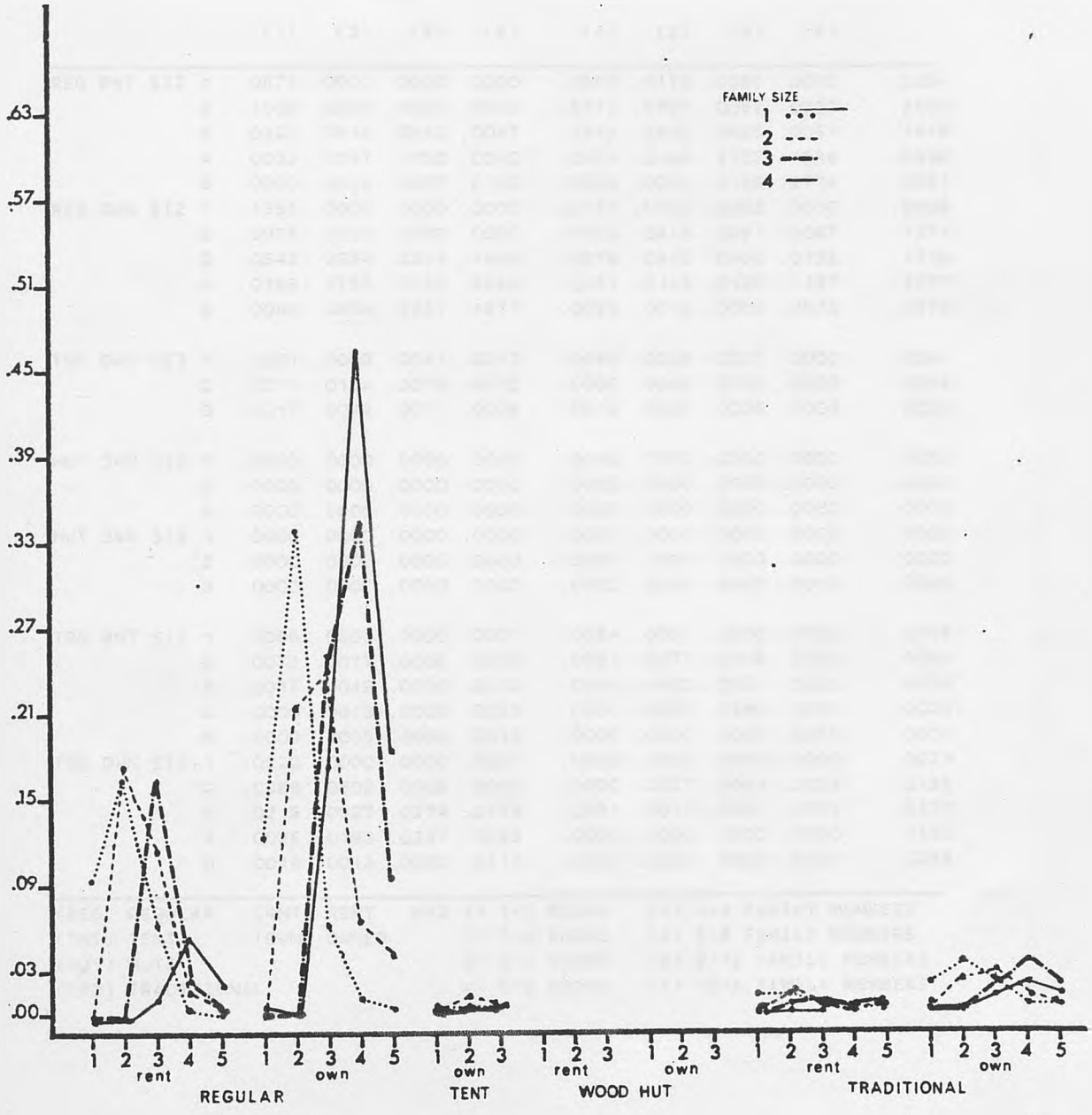


FIGURE 3-9: FAMILY-TO-HOUSE DISTRIBUTION RATIOS: ECHS11

TABLE 3-13: FAMILY-TO-HOUSE DISTRIBUTION RATIOS: ECHSS1

		DOMESTIC FAMILIES				EXPATRIATE FAMILIES				TOTAL
		(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
REG RNT SIZ	1	.0874	.0000	.0000	.0000	.0857	.0179	.0086	.0012	.0254
	2	.1009	.0952	.0000	.0000	.5712	.5397	.0052	.0020	.2400
	3	.0322	.0616	.0842	.0087	.1612	.2800	.5665	.0061	.1418
	4	.0033	.0097	.0152	.0260	.0091	.0168	.2723	.4986	.0236
	5	.0000	.0014	.0027	.0162	.0066	.0044	.0156	.2774	.0051
REG OWN SIZ	1	.1353	.0000	.0000	.0000	.0177	.0159	.0062	.0010	.0206
	2	.3975	.2925	.0000	.0000	.0402	.0418	.0261	.0067	.1371
	3	.0943	.2934	.3333	.1806	.0576	.0412	.0409	.0139	.1718
	4	.0198	.0755	.3183	.4866	.0232	.0143	.0139	.1197	.1077
	5	.0089	.0494	.1351	.1977	.0033	.0012	.0003	.0570	.0478
TNT OWN SIZ	1	.0061	.0059	.0041	.0017	.0038	.0026	.0003	.0000	.0041
	2	.0071	.0124	.0079	.0072	.0000	.0040	.0020	.0000	.0068
	3	.0017	.0042	.0071	.0038	.0012	.0004	.0008	.0004	.0029
HUT OWN SIZ	1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
HUT OWN SIZ	1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
TRD RNT SIZ	1	.0088	.0000	.0000	.0001	.0084	.0031	.0000	.0000	.0028
	2	.0071	.0077	.0006	.0000	.0051	.0077	.0006	.0000	.0054
	3	.0017	.0049	.0030	.0000	.0025	.0052	.0034	.0000	.0036
	4	.0000	.0013	.0025	.0035	.0000	.0000	.0283	.0059	.0020
	5	.0009	.0005	.0002	.0015	.0000	.0000	.0000	.0065	.0004
TRD OWN SIZ	1	.0222	.0000	.0000	.0001	.0000	.0000	.0000	.0000	.0023
	2	.0388	.0309	.0006	.0000	.0000	.0027	.0083	.0034	.0135
	3	.0218	.0327	.0274	.0129	.0031	.0011	.0007	.0002	.0170
	4	.0026	.0193	.0287	.0423	.0000	.0000	.0000	.0000	.0124
	5	.0016	.0014	.0290	.0111	.0000	.0000	.0000	.0000	.0058

(REG) REGULAR (RNT) RENT SIZ 1) 1-2 ROOMS (1) 1-4 FAMILY MEMBERS
(TNT) TENT (OWN) OWNED 2) 3-4 ROOMS (2) 5-9 FAMILY MEMBERS
(HUT) HUTS 3) 5-6 ROOMS (3) 9-12 FAMILY MEMBERS
(TRD) TRADITIONAL 4) 6-8 ROOMS (4) 13-A FAMILY MEMBERS

FIGURE 3-10: FAMILY-TO-HOUSE DISTRIBUTION RATIOS: ECHSS1

TABLE 3-14: VACANT AND NEWLY REQUIRED HOUSES

		NEW HOUSES			VACANCIES		
		ECHSE1	ECHS11	ECHSS1	ECHSE1	ECHS11	ECHSS1
REG RNT SIZ	1	15245	20204	8553	0	0	0
	2	198553	186682	66235	0	0	0
	3	100209	144333	141297	0	0	0
	4	9714	27579	60393	0	0	0
	5	2400	4836	11698	0	0	0
REG OWN SIZ	1	5980	19239	19698	0	0	0
	2	35627	33388	71114	0	0	0
	3	40717	56260	102991	0	0	0
	4	19294	82302	96414	0	0	0
	5	15243	0	0	0	17406	2787
TNT OWN SIZ	1	11775	0	0	0	2066	1963
	2	2433	7719	8377	0	0	0
	3	6849	70	0	0	0	169
HUT RNT SIZ	1	6706	0	0	0	574	574
	2	2708	0	0	0	478	478
	3	132	0	0	0	238	105
HUT OWN SIZ	1	1169	0	0	0	1579	1579
	2	607	0	0	0	1637	1637
	3	807	0	0	0	1416	1416
TRD RNT SIZ	1	1912	1546	456	0	0	0
	2	6881	1938	0	0	0	1313
	3	5947	2876	853	0	0	0
	4	449	3448	2131	0	0	0
	5	804	0	0	0	731	511
TRD OWN SIZ	1	3031	0	0	0	3634	3264
	2	10356	0	0	0	2909	552
	3	6642	11540	18756	0	0	0
	4	3919	10357	10715	0	0	0
	5	4852	0	0	0	3884	1923
TOTAL		520961	614317	619681	0	36552	28271

(REG) REGULAR (RNT) RENT SIZ 1) 1-2 ROOMS
(TNT) TENT (OWN) OWNED 2) 3-4 ROOMS
(HUT) HUTS 3) 5-6 ROOMS
(TRD) TRADITIONAL 4) 7-8 ROOMS

TABLE 3-15: EXPATRIATE LABOR RECRUITING REQUIREMENTS

	ECHSE1	ECHS11	ECHSS1
Managerial	8853	9695	10095
Professional	48404	51990	53332
Clerical	31361	34130	35832
Unskilled	203611	224805	227960
Skilled	317746	380114	383772
Agriculture	0	0	0
Proprietors	102075	112590	119554
Total	712050	813324	830545

TABLE 3-16: DOMESTIC OUTPUT, IMPORTS, AND CONSUMPTION

	DOMESTIC OUTPUT			IMPORTS			HOUSEHOLD CONSUMPTION		
	ECHSE1	ECHS11	ECHSS1	ECHSE1	ECHS11	ECHSS1	ECHSE1	ECHS11	ECHSS1
(1)	8287.32	8287.32	8287.32	7170.44	7552.39	7844.74	14672.26	15053.37	15330.40
(2)	23555.24	23639.29	23700.71	1384.96	1930.00	1393.69	1362.32	1402.95	1433.87
(3)	8780.00	8780.00	8780.00	92676.80	96175.72	96944.05	24716.51	25189.87	25777.13
(4)	6772.20	6866.65	6882.67	0.00	0.00	0.00	729.08	846.07	854.69
(5)	60528.15	80992.05	81142.11	0.00	0.00	0.00	216.16	219.10	217.71
(6)	8108.13	8400.29	8493.29	810.81	840.03	849.33	173.49	176.11	176.63
(7)	27390.63	28288.75	28787.30	0.00	0.00	0.00	20699.22	21134.55	21591.69
(8)	15078.11	14859.49	15798.03	2864.84	2823.31	3001.62	5731.82	5197.88	6139.66
(9)	27902.29	29090.45	29762.15	8928.72	9308.95	9523.89	15475.96	15638.70	16348.64
(T)	186402.07	209204.29	211633.58	113836.57	118630.40	119557.32	83776.82	84858.60	87870.42

(1) AGRICULTURE
(2) OIL-GAS
(3) MANUFACTRING
(4) UTILITIES
(5) CONST./BLDG
(6) CONST./OTHER
(7) WHOLESALE/RET
(8) TRANS/COMM.
(9) SERVICES
(T) TOTAL

3.4.2 Housing Goals, Expatriate Labor, and Government Plans

With family-to-house size compatibility as the housing goal, we consider five cases with different preferences. In case ECHS101, no specific preferences are indicated between the subsystems of concern. Case ECHS102 gives housing development second priority relative to socio-economic goals. In the remaining three cases housing development and other socio-economic goals were given equal priority, but different weights are indicated for labor vs government goals (which make up socio-economic goals). In ECHS103, labor goals are given priority over government plans. In ECHS104 and ECHS105, both government goals and labor goals are given priority but at different rates. A detailed output of these solutions is presented in Appendix 3-D. [71]What follows is a summary of the main points from these illustrations.

First, the achievements of family-to-house distribution goals vary substantially with different preference weights, implying non-trivial trade-offs. Second, the number of unhoused families is also dependent on alternative preferences. However, in almost all cases, deviations from new family housing goals were smaller than the deviations from existing family distribution goals. This finding is a reasonable consequence of resource constraints since an unhoused family can be assigned a house not explicitly denied by established criteria (e.g. mud houses). This stands in contrast with the redistribution of families where the allocation of families to houses is constrained by both family characteristics and supply of specific types of houses.

Qualitatively, similar results were obtained when housing preferences were changed to stress home ownership in addition to size compatibility. For details see Appendix 3-E.

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[71] The data tables in Appendix 3-D are organized to show first the family-to-house distributions for the new families, the existing families, the combined total, and for the ratios of the total family-to-house distribution, respectively. This is followed by information on the negative and positive deviations from new family distribution goals and existing family redistribution goals. Thereafter, we present the resulting vacancies and new house requirements, the families that could remain unhoused as well as data on the total new families, total remaining families, and total families which are candidates for housing at this period. Finally, we present data for economic variables, including deviations from government goals and labor variables, indicating deviations from labor goals as well as the required recruits for the period.

3.5 SUMMARY AND CONCLUSIONS

We have presented a multi-objective planning model for housing development and its interaction with other development goals and objectives. Housing development issues were modeled, using a transportation type model with the objective of finding the distribution of new families to houses and the redistribution of existing families to houses. Families were differentiated along several dimensions on the basis of socio-economic differences and policy relevance. Houses were similarly treated. We further structure our problem as a goal program directed at meeting family-to-house distribution goals developed with the aid of alternative criteria for housing development. Our model identifies domestic and expatriate new family additions and the exits of expatriate families; this identification affects both vacancies and new house requirements. This model is then linked to the previously developed socio-economic model (Chapter Two) to examine the multiplier effects of housing development: this linkage also allows the examination of conflicts and trade-offs between multiple goals and policies. Applications of this model were shown using prototype data from Saudi Arabia. These results of the application confirmed our belief that models of such sub-systems of national development significantly assist in planning and policy development by showing the substantive impacts of goals and preferences for different subsystems.

As such development plans progress into the future, it may be desirable to consider wider varieties of private sector (and other) types of behaviors. This, in turn, would move matters away from the mechanistic use of government sponsored criteria and stipulated goals in order to deal with a wider variety of possible behaviors. Other studies and types of data would then be indicated to supplement or supplant the ones we have been using.

The case of Saudi Arabia offers a wide variety of such alternative possibilities. For the present, however, it has been hampered in moving toward these possibilities not only by the kinds of labor difficulties we have indicated but also by data deficiencies and inadequate models for planning. In particular, what is required is some means of dealing with the multi-dimensional problems of eco-demographic planning in a manner that we have tried to indicate with respect to housing and related aspects of industrial planning. Of course, something more than a mere extension of the model will be required. In particular, it would be desirable to allow for dynamic changes in family and house characteristics and the impact of these dynamics on family-to-house distributions. These dynamic extensions are the subject of Chapter 4.

CHAPTER FOUR

MULTI-PERIOD HOUSING DISTRIBUTIONS AND RECURSIVE RELATIONSHIPS

CHAPTER 4
A JOINT FAMILY HOUSE DISTRIBUTION MODEL AND MULTI-PERIOD RELATIONSHIPS

4.1 INTRODUCTION

This chapter examines the input output characteristics of several active sequences with specific attention to population, families, houses, and their joint relationships. Building upon these separate developments, we also develop an input output model for the joint family-to-house distribution indicating multi-period changes and recursive relationships characteristic of that distribution. Prototype data from Saudi Arabia will be used to support this development in order to supplement the requirements of the housing development model of Chapter three.

In section 2 a finite difference input-output model is delineated for the housing stock; section 3 contains an input output model for population demographic flows indicating births, deaths, and age movements for various sex-age groups. These population accounts are then, in section 4, linked to family characteristics. We also present an input-output model for families, indicating changes in family characteristics, and including an estimation procedure for their multi period transitions. Building upon the components and relationships developed for the separate houses and family inputs and outputs, a model for the joint distribution of families and houses is developed in section 5. This model is designed to help in matching housing needs to housing stocks and relating these developments to population increments and decrements, including patterns of family formation, immigration, and emigration. As such, this model (1) delineates the dynamic characteristics of stocks and flows, which (2) provides the recursive relationships for the multi-period model. Finally in section 6 we show the cross impacts on selected variables when the models of this chapter were embodied within the models in Chapter 3.

4.2 HOUSES INPUTS AND OUTPUTS

Estimating housing stocks and their characteristics is recognized as an essential information base for policy makers in the kinds of models we are considering. The dynamic character of the housing situation also makes it necessary to update and periodically check these estimates. Many variables and characteristics necessarily enter into the description of housing stocks. These dimensions cover a wide range of descriptors including age, ownership, type, size, construction, and condition.[72] Housing type can be classified into attached and detached houses and low or high rise apartments.[73] Size is also considered to be an important descriptor; housing is divided according to number of rooms (e.g., into efficiency, one, two, three, and four or more bedrooms). Another important dimension, particularly for developing countries, is the construction type, (e.g., regular construction, or traditional--adobe construction). Further divisions are also possible, such as prefabricated industrialized building, or regular methods. Housing stock can also be subdivided into either owned or rented.

This in turn also produces a need for an appropriate accounting framework to handle the results. This framework should be particularly concerned with the dynamics of housing stocks (e.g., the changes from standard to substandard housing as well as changes in age, housing sizes, etc). We take this classification one step further to indicate the possible transition of houses among the various dimensions discussed above. For that purpose we intend to adopt the input output principles of active sequences presented by Stone [275, 276, 278, 282]. Basically, this requires that housing stocks be subdivided into three main categories:

1. Those units which are added to stocks (new housing).
2. Those units which are removed from the stocks (terminal unusable units).

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[72] All these dimensions are considered when determining if housing is satisfactory or substandard. Any general approach to accounting and planning must allow for the possibility that a community differs from others in the way it "defines" standard and substandard housing units [65, 76, 79, 87]. Housing structural condition, space, and supporting facilities are well known parameters used to measure "above standard" housing and to differentiate it from "substandard" housing. Differences between what are regarded as standard and substandard are based partly on tradition and partly on scientific investigation such as surveys of current housing and/or projections from past experience-- or judgment-- along with related issues of detection, measurement, and inference. These differences can vary with the economic and social situation. Further, differences between urban and rural views can change the determination of what is substandard. Hence, statistical indicators for housing conditions need to be developed [65, 76]. Finally--for planning purposes--future goals or standards may also vary as a result of current planning activities to reflect "feedback" changes in setting new goals and standards.

[73] Policy directed toward the building of new units of each type may influence the spatial clustering of the houses, hence population densities and crowding in residential areas. Zoning laws and other regulations are examples of policy tools to limit certain types of houses from being built.

3. Those units which remain in stock and are being used.

Our approach involves a finite-difference input-output model to represent the flows of housing stock from one period to the next. All transitions take place within a single period and flows serve to connect the opening and closing stocks at that period. This system can be seen in Table 4-1. Each row represents a flow input of housing stock in a particular period.

TABLE 4-1: INPUTS AND OUTPUTS OF HOUSE STOCKS

FROM / TO	NEW HOUSING	OPENING STOCK	CLOSING STOCK
UNUSABLE HOUSING		u'(t-1)	
CLOSING STOCK	$h_n(t)$	H(t)	h(t)
OPENING STOCK		h'(t-1)	

where

h(t) = mx1 column vector of the housing stock of type i, i=1,.. ..,m, at time t

h(t-1) = mx1 column vector of the housing stock at time t-1 so that its transpose h' (t-1) is 1xm

$h_n(t)$ = mx1 column vector of the newly built housing at time t

u(t-1) = mx1 column vector of the unusable--e.g., demolished--housing at time t-1 so that its transpose u' (t-1) is 1xm

H(t) = mxm matrix whose elements H_{ij} are the number of remaining housing stock in category j at time t-1 that will be in category i at time t.

Thus, e.g., h(t) in row 2 represents the housing stock at time t. It is composed of new housing, $h_n(t)$, added to H(t), the matrix representing housing stock remaining at the end of t-1. The total housing stock could be written as:

$$h(t) = h_n(t) + H(t)\, e_1 \qquad (4.1)$$

where

e_1 = mx1 column vector with unity for all of its elements.

Then, we can derive $\Omega(t)$, the transition ratios at time t, by dividing the entries in the columns of H(t) by the corresponding entry in the vector h(t−1):

$$\Omega(t) = H(t)\, \hat{h}^{-1}(t-1) \qquad (4.2)$$

where

$$h(t-1) = \hat{h}^{-1}\, e_1 .$$

In other words, $\hat{h}(t-1)$ is the diagonal matrix derived from h, and $\hat{h}^{-1}(t-1)$ is its inverse--which is assumed to exist.[74]

Direct substitution into (4.1) then produces

$$h(t) = h_n(t) + \Omega(t)\, h(t-1) \qquad (4.3)$$

Given the data on housing at time t−1, we may regard the expression (4.3) as providing us with predictions of the housing stock at time t when $h_n(t)$ is the vector of new housing projected for t. The latter, i.e., $h_n(t)$, represents the requirements for new houses to be supplied directly or indirectly through government financing.[75]

Implicit in this model are the dynamic elements of change in characteristics of the housing stock. These changes can be physical--aging, for example--or influenced by government planning.

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[74] For such existence it is necessary and sufficient that h have no zero entries for any of its diagonal elements.

[75] Further expansion of equation (4.3) may be used to distinguish between those houses which are occupied from those which are not. Thus, as an initial formulation we may write

$h(t) = h_n(t) + \Omega(t)\, [\, h_o(t-1) + h_v(t-1)\,]$

$h_o(t-1)$ = mx1 vector of the occupied houses type i, i=1,....,m, from last year;

$h_v(t-1)$ = mx1 vector of the unoccupied (vacant) houses type i, i=1,....,m, from last year.

Now we can take this development one step further by allowing the transition proportions in each of h_o and h_v to be different. For example, due to lack of maintenance, each class of houses, occupied or unoccupied, may have different transition matrices. These relationships are written as:

$h(t) = h_n(t) + \Omega_o(t)\, h_o(t-1) + \Omega_v(t)\, h_v(t-1)$

where $\Omega_o(t)$ and $\Omega_v(t)$ which are of order mxm, are the respective transition matrices for h_o and h_v, respectively.

This model thus completes one part of our system of an accounting framework which will facilitate policy analysis with regard to housing. Later this part will be combined with another model for population and family analysis so that housing planning will be, appropriately, carried out in a demographic context.

4.3 POPULATION INPUT-OUTPUT AND FAMILY ASSOCIATION

First, for the purpose of analyzing population flow, we will adopt the cohort input-output model specified by Stone [275,276] and discuss the general principles of population input-output models. This model considers the population at time t to be the result of the sum of net birth and migration, b (t), and the survivors from the previous period. This is written as

$$p(t) = b(t) + Z(t)\, e_3 \tag{4.4}$$

where

$p(t)$ = sx1 vector of total population in cohort i, i= 1,....,s, at time t;

$b(t)$ = sx1 vector of birth and migration additions to cohort i, i= 1,....,s, at time t;

$Z(t)$ = sxs matrix of population transition, by age among those surviving from last year. That is z_{ij}, an element of $Z(t)$, is the portion of population of age j last year who will survive and be at age i this year.

e_3 = sx1 vector with unity for all of its elements.

Then, analogous to Ω in equation (4.2), we may divide elements in the columns of Z by the corresponding element in the opening stock of population to obtain:

$$\Psi(t) = Z(t)\, \hat{p}^{-1}(t-1) \tag{4.5}$$

assuming that the inverse of $\hat{p}(t-1)$ exists for every t

where

$\Psi(t)$ = sxs transition ratio matrix whose ψ_{ij} elements are the proportions of survivors from age j at time t-1 to age i at time t;

$\hat{p}(t-1)$ = sxs diagonal matrix whose $p_{ii} > 0$ entries are the population in age group i at time t-1.

Equation (4.4) can then be rewritten as

$$p(t) = b(t) + \Psi(t)\, p(t-1) \tag{4.6}$$

Notice that Z, and hence Ψ, are concerned only with survival numbers and ratios, respectively. Equations (4.5) and (4.6) can be adjusted to separate birth, b(t), from migration, b"(t). Then the newly born can be directly identified with the age cohort of their parents--i.e., they may be included in the matrices Z(t) and Ψ (t) as entries in the first row vector.

In this form, the entries in the Z matrix are as follows:

$$Z = \begin{bmatrix} z_{11} & b_{12} & b_{13} & \cdots & b_{1s} \\ z_{21} & z_{22} & 0 & \cdots & 0 \\ 0 & z_{32} & z_{33} & \cdots & 0 \\ \cdot & \cdot & \cdot & & \cdot \\ \cdot & \cdot & \cdot & & \cdot \\ 0 & 0 & 0 & & z_{ss} \end{bmatrix}$$

where each element z_{ij} indicates the number of people moving to or staying in each age group while b_{1j} is the number of newly born to parents of age group j. Consequently, via this form b"(t) is only the net migration. Thus

$$p(t) = b"(t) + \Psi\, p(t-1) \tag{4.7}$$

In equation (4.7), the total population is a function of the new entries, b"(t), and the transitions from the previous periods according to Ψ (t). For intermediate periods of time, and under the assumption that Ψ (t) is constant, we have.

$$p(1) = b"(1) + \Psi\, p(0)$$

$$p(2) = b"(2) + \Psi\, p(1)$$

$$= b"(2) + \Psi\, [b"(1) + \Psi\, p(0)] = b"(2) + \Psi\, b"(1) + \Psi^2\, p(0)$$

We then get

$$p(t) = b''(t) + \Psi\, b''(t-1) + \Psi^2\, b''(t-2) + \\ + \Psi^{t-1}\, b''(1) + \Psi^t\, p(0) \qquad (4.8)$$

by substituting recursively for p(t−1), p(t−2), etc.

Thus, knowing the forecasts for $b''(t)$-- the net migration, we can obtain the corresponding total population forecast at t. In cases where there is no variability so that $b''(t)$ is constant, the migration equation (4.5) can be rewritten as

$$p = (I + \Psi + \Psi^2 + \ldots + \Psi^{t-1})\, b'' + \Psi^t\, p(0)$$

$$= (I - \Psi)^{-1}(I - \Psi^t)\, b'' + \Psi^t\, p(0) \qquad (4.9)$$

since

$$(I - \Psi)^{-1}(I - \Psi)^t = I + \Psi + \Psi^2 + \ldots + \Psi^{t-1}$$

when t is of finite range and $(I - \Psi)^{-1}$ exists. In a sufficiently long period of time we may reasonably assume that p is in stationary equilibrium and equation (4.9) reduces to

$$p = (I - \Psi)^{-1} b'' \qquad (4.10)$$

These general input-output principles will be of help when the family input-output model, presented in a later section. In Table 4-1 we present data on base year (1976) domestic and expatriate population, and in Table 4-2 we present the multi-period projections (using 4.8) for the domestic population. These data will be used later to project families in Saudi Arabia.

4.3.1 Population-Family Association

The definitions of what constitutes a family-household vary from one country to the other; experience in many countries has shown that the estimates of future housing needs depend largely on that very definition. In some countries a concept is used which equates the household with the housing unit and defines the household as the aggregate number of persons who occupy one housing unit. A household, then, may be either a one-person household or a multi-person household. This is the definition of family-household used in this thesis. Family-household will be described along the dimensions of citizenship, age of head of

TABLE 4-2: BASE YEAR (1976) POPULATION DATA

		DOMESTIC	EXPATRIATE
MALE AGE-GROUP	1	1060000	129000
	2	722000	108300
	3	474000	237000
	4	343000	155500
	5	230000	70900
	6	147000	29100
	7	121000	19400
SUBTOTAL		3107000	749200
FEMALE AGE	1	100300	103600
	2	679000	52600
	3	470000	52700
	4	321000	39500
	5	217000	20500
	6	142000	11900
	7	127000	12800
SUBTOTAL		2959000	293600
TOTAL		6066000	1042800

*Data here are presented in number of population .

**The age groups are (0-10), (11-20), (21-30), (31-40), (41-50), (51-60), and (61-above).

TABLE 4-3: DOMESTIC POPULATION PROJECTIONS

		Year												
		76	77	78	79	80	81	82	83	84	85	86	87	88
Male	Age (1)	1060	1100	1139	1175	1210	1241	1278	1319	1361	1401	1438	1478	1528
	Age (2)	722	747	772	797	824	851	880	909	940	970	1003	1035	1069
	Age (3)	474	518	535	552	571	590	609	630	651	672	695	718	742
	Age (4)	343	354	367	468	391	403	418	431	445	460	475	491	507
	Age (5)	230	238	246	254	263	272	281	290	299	308	319	330	340
	Age (6)	147	152	157	162	167	173	179	185	191	197	203	210	217
	Age (7)	121	124	126	130	137	142	147	152	157	163	168	173	178
Female	Age (1)	1003	1042	1078	1112	1145	1175	1210	1248	1287	1326	1360	1400	1447
	Age (2)	679	701	725	749	773	800	826	853	882	911	942	972	1004
	Age (3)	470	486	501	519	536	554	572	591	610	631	651	673	695
	Age (4)	321	332	343	354	367	378	391	403	416	431	445	460	475
	Age (5)	217	224	233	240	247	256	264	273	282	291	302	311	322
	Age (6)	142	148	153	158	163	168	174	179	185	191	198	203	210
	Age (7)	127	129	133	136	142	149	153	158	164	169	174	180	186

* Data here are presented in thousands of people.

**Source: The Ministry of Planning, Saudi Arabia.

household, size of family, and relative income category.[76]

To map individuals to families we assume proportional ratios of families in each age group, with reference to the age of the head of the household; then the number of families in each cohort can be directly estimated from the corresponding population vector p. This relationship can be written as:

$$f(t-1) = \Gamma\, p(t-1) \qquad (4.11)$$

where $f(t-1)$ is the vector of families distinguished along the above mentioned dimensions. $p(t-1)$ is the population at $t-1$ appropriately described. Λ is, then, the "family association" matrix, assumed to be constant, whose entries indicate the proportion of individuals with characteristic j who are in families with characteristics i. When we distinguish among domestic and expatriate population groups

$$f(t-1) = [\, I \quad I \,] \begin{bmatrix} f_d \\ f_x \end{bmatrix} ;$$

$$p(t-1) = [\, I \quad I \,] \begin{bmatrix} p_d \\ p_x \end{bmatrix} ;$$

and

$$= [\, \Gamma_d \qquad \Gamma_x \,]$$

where

Γ = kx2s matrix whose entries Γ_{ij} are the proportions of domestic and expatriate population[ij] in cohort group j, (j= 1,....,s) associated with family type i, (i=1,.. ..,k),respectively;

---

[76] We rationalize the use of these dimensions in this thesis as follows. The determination of housing needs from one year to the other requires knowledge of the basic demographic and economic flows such as characteristics, family formation, size, and income. This is true for any country--developed, underdeveloped, or otherwise. Moreover, of special interest for us is the fact that some countries import expatriate labor for national development. Expatriate populations living temporarily in that country, or any subgroups with distinct social differences, may have completely different family formation behavior because of different cultural backgrounds. Thus, in addition to the customary needs of the domestic population mentioned above, further distinction between "expatriate" and "domestic" groups is required. Size of family is still another variable to determine "adequate" housing space--e.g., 1, 2, 3, 4 or more bedrooms--and so our families will be described according to their size, number, and income. Information about income groups may influence housing subsidies. For low income groups the government may provide housing stocks directly through mass housing projects (for rent or ownership) while loans for middle income groups may be an adequate mechanism to increase their home ownerships. For high income groups the government may consider itself less responsible for making similar housing provisions.

$f(t-1)$ = kx1 vector of the number of total families in cohort group i, i= 1,....,k;

f_d = kx1 vector of the number of domestic families in cohort group i, i= 1,....,k;

f_x = kx1 vector of the number of expatriate families in cohort group i, i= 1,....,k.

and $p(t-1)$ is as defined in (4.6).[77]

4.3.1.1 Prototype Data

Two basic sources provided the prototype data needed to derive population and family characteristics: the Population Census Data and the Household Survey.[78] The first provided the base year and projecting domestic and expatriate population data in each age-sex category (shown in tables 4-1 and 4-2 respectively). The Household Survey gave the prototype data with which we established Λ to associate dependents in a certain age-sex-nationality group with their family-household types. The estimated Λ is presented in Table 4-4.[79] We assume here that Λ is stationary.[80] Hence, to obtain projections of families, we substitute equation (4.6) into (4.11) to obtain

$$f(t) = \Gamma [\, b(t) + \Psi\, p(t-1)] \qquad (4.12)$$

Equation 4.12 can then be used with the data in Tables 4-2 and 4-4 to obtain

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[77] Similarly, within the domestic population we may further distinguish among various income groups of interest to policy development and, therefore, may rewrite equation (4.11) as

$$f(t) = [\, I \;\; I \,] \begin{bmatrix} f_d \\ f_x \end{bmatrix} = [\, I \;\; I \,] \begin{bmatrix} \Gamma_{d,1} & \Gamma_{d,2} & 0 \\ 0 & 0 & \Gamma_x \end{bmatrix} \begin{bmatrix} p_{d,1} \\ p_{d,2} \\ p_x \end{bmatrix}$$

where $\Gamma_{d,1}$ is the proportion of families associated with income group 1 and $\Gamma_{d,2}$ the proportion associated with income group 2.

[78] Sources: The Population Census, Department of census at the Ministry of Finance; and The Household survey in [219].

[79] The data in Table 4-4 shows the base year proportional distribution of dependents to families. The dependent entries in this table are grouped into 7 age categories, (0-10, 11-20, 21-30, 31-40, 41-50, 51-60, 61--above), two sex categories, (male-female), and two nationality groups, (Saudi-Expatriate). The Family characteristics used here are nationality (Saudi-Expatriate), income---cumulative for all income earning members-- (low-middle-high), and size of family (1-2, 3-4, 4-5, 5-6, 6-7, 7-8, 8-9, 9-above).

[80] We have no information to either support or deny this assumption.

TABLE 4-4: DEPENDENT-FAMILY ASSOCIATION RATIOS

TABLE 4-4: DEPENDENT-FAMILY ASSOCIATION RATIOS

Table 4-5 and for the expected family projections (shown in Table 4-6) for 4 aggregated family sizes, (1-4), (5-9), (9-12), and (13-above). These projections constitute the basis for the estimation of family transition probabilities used in the input-output structure for family changes described next.

TABLE 4-5: BASE YEAR FAMILY DATA

		DOMESTIC	EXPATRIATE
L INCOME, SIZE	1	25884	21336
	2	83570	29152
	3	109365	25804
	4	120643	20452
	5	74877	7700
	6	45019	1234
	7	17790	0
	8	13581	490
SUBTOTAL		490729	105662
M INCOME, SIZE	1	9028	19419
	2	30253	30835
	3	52581	25899
	4	61661	15928
	5	61659	6578
	6	31336	2123
	7	15351	810
	8	24054	453
SUBTOTAL		285925	102045
H INCOME, SIZE	1	0	0
	2	611	1234
	3	1756	545
	4	1098	728
	5	879	0
	6	254	0
	7	674	0
	8	958	0
SUBTOTAL		6230	2507
TOTAL		782884	210214

TABLE 4-6: PROJECTED DOMESTIC FAMILIES

YEAR	FAMILY GROUP (1)	(2)	(3)	(4)	TOTAL	NEW
(75)	149346	347104	214027	72408	782885	
(76)	155737	360749	222494	75328	814308	31423
(77)	160926	373187	230143	77908	842164	27856
(78)	170143	392475	239566	81177	883361	41197
(79)	171833	398218	245490	83073	913867	15253
(80)	177510	410823	253268	85673	942727	28660
(81)	183393	424368	261514	88441	973169	30442
(82)	189454	438395	270135	91342	1004779	31610
(83)	195765	452985	279112	94359	1037674	32895
(84)	202230	467717	288116	97387	1070903	33229
(85)	208785	482401	297165	100409	1104213	33310
(86)	215507	497459	306456	103528	1138403	34190

4.4 FAMILY INPUTS AND OUTPUTS

Accounting for families and their changing characteristics, as explained earlier, is necessary for adequate estimation of the changing needs for housing. One could consider family changes as a social process to be observed and analyzed in the same manner as demographic sequences [271, 272, 275, 276], population physical movements, migration, [247, 248], as well as other social processes, including educational [277] and organizational [12, 41, 188].[81]

To examine the inherent dynamics of family transitions, we utilize a finite input-output model that shows the flow of families from one period to the other, defined as

$$f(t) = f_n(t) + F(t)\, e_2 \tag{4.13}$$

where

$$F(t)\ e_2 = \Phi(t)\ f(t-1)$$

hence,

$$f(t) = f_n(t) + \Phi(t)\ f(t-1) \tag{4.14}$$

The total families at time t are those transiting from previous periods in addition to those families formed this period.[82] Here we define

$f(t)$ = kx1 vector of families in cohort group i, i= 1,.....,k at time t;

$f_n(t)$ = kx1 vector of new families "formed" in cohort group i,i=1,.....,k at time t;

$F(t)$ = kxk matrix of the number of families in group j who will be in group i at (t)

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[81] Although we thus far consider the entire country as one system, demographic accounting can also be extended to issues of movement of people from one region to the other. See Rogers [243, 245, 246]. Economic development may then be used as a tool to maintain or to change the demographic and social composition of a region in order, for example, to avoid extensive urbanization.

[82] Equation (4.14) can be further expanded to distinguish the portion of the population transiting from last year and also to distinguish those who were housed from those who were not. Thus

$$f(t) = f_n(t) + \Phi(t)\ [f_h(t-1) + f_u(t-1)]$$

where $f_h(t-1)$ and $f_u(t-1)$ are the housed and unhoused families from last year. A remark should be made here that families which are unhoused could be those in temporary settings--e.g. tents, wood huts, or else those families who are crowded in with others, etc.--but for planning purposes they are classified as being "unhoused" while awaiting the planned construction of more satisfactory housing at a future time. The additionally unhoused families could result from the attrition of houses as will be shown in the presentation of the recursive relationships.

$\Phi(t)$ = kxk matrix of the proportion of families in group j who will be in group I at (t)

$f(t-1)$ = kx1 vector of families in cohort group i, i=1,....,k at (t-1)

e_2 = kx1 vector of unity for all of its entries for the above expressions.

Of significant interest in $f_n(t)$ are the new expatriate families (due to the inter-relationships between families, housing, and other socio-economic goals discussed in chapter 3). Note that $f_n(t)$ includes the new expatriate families formed from the remaining expatriate population in addition to new immigrant families as seen in equation (4.15).

$$f_{x,n}(t) = \Gamma_x p_x(t) + \Gamma''_x /_{x+}(t) \qquad (4.15)$$

where

$f_{x,n}(t)$ = wx1 vector of expatriate families at time t;

Γ_x = kxw matrix whose entries are the proportion of expatriate families of characteristics cohort i, i= 1,....,k, who are associates with new labor in cohort j, j= 1,....,k;

$/_x(t)$ = kx1 vector of the new expatriate labor needed for national development.

4.4.1 Estimation of Family Transitions

Other elements of significance in our family input-output formulation (equation 4.14) are the transitions and changes in family characteristics over time. Several social activities-- birth-death, migration-immigration, and family formation-- cause family transitions and changes. Some points of relevance are as follows. (1) Birth-death are considered to be related to sex and age of the individual family members; (2) For migration-immigration, we consider the whole country as a system that allows expatriate entries and exits for economic development; (3) The size of a family varies from one year to the other; (4) The newly formed families

are usually generated from the existing families.[83] For example, a marriage will generate a new family and at the same time will reduce the size of existing families. Hence, family transitions are dependent on the formation of new families; or, equivalently, new families (barring migration) are the result of the internal changes in family structures. One may consider these processes as separate but interdependent activities.

Our problem, then, is to find the set of input-output coefficient matrices for a sequence of time periods such that they could be used to project the changes in family characteristics at period t given the information at the previous period t-1. Since explicit data on changing states are not available for the Saudi Arabian situation, we have to rely on the projected aggregate time series data, presented earlier in section 4.3 of this chapter, to establish a prototype of the necessary transition information. Two approaches to ex post estimation of input output coefficients from time series aggregate data are available. The first is the result of an investigation of the changes in economic input output coefficients, known as the biproportional approach. The second is directed toward the estimation Markov transition probabilities from aggregate time series data as applied to social process.[84]

If one is willing to accept their assumptions we could use either the biproportional or the Markov estimates for the steady state projections. The first, biproportional estimates, accounts for past changes in the coefficients but requires more detailed information than is generally available. The second, Markov estimates, attempts to estimate a stable Markov matrix for the steady state of the past transitional behavior using aggregate time series data. We share with these two approaches the desire to estimate transition probabilities from aggregate data. However, in the processes we wish to study, the transitions may not be stationary and are not independent of new family inputs.

Thus, given the aggregate family time series data, we present a two step

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[83] This contrasts with the increase in the size of organizations which is usually related to the exogenously given new entrants, which may follow a "recruitment distribution" function for their assignment across categories (hence the research of expanding and declining organizations as well as the policy issues of attainability and control through recruitment). See Bartholomew [12]. On the other hand, that new input to the system may be considered to follow certain stochastic properties and assumed to take the form of certain statistical functions. See Duncan and Lin [93] for an ex post analysis for the estimation of transitions with stochastic inputs and outputs.

[84] See Appendix 4-A for a summary presentation of the approaches and their estimation methodology. For details, see Bacharach [7] and Lee, Judge, and Zelner [177].

model to estimate the annual (periodic) movements and transitions of families. First recall from equations (4.13) and (4.14) the basic input- output model:

$$f(t) = F(t)\, e_2 + f_n(t)$$
$$= \Phi\, f(t-1) + f_n(t)$$

We also recall the assumptions that families may move from their initial staying state, the diagonal, one step in either direction indicating an increase or decrease in the family size. Also assume that newly formed families will always enter at the beginning state. We can then obtain the annual movements of families across categories by minimizing the sum of absolute deviations from the initial state in F(t-1), for each period, subject to the above conditions. The problem is then:

Minimize $\sum_i \zeta_i^T (\delta_i^- + \delta_i^+)$

Subject To:

$$\sum_j F_{ij}(t) + I\, f_n(t) = f_i(t) \quad (4.16)$$

$$\sum_i F_{ij}(t) = f_j(t-1) \quad (4.17)$$

$$F_{ii}(t) + I\, \delta_i^- - I\, \delta_i^+ = f_i(t-1) \quad (4.18)$$

$$\sum_{j=i+2}^{k} F_{ij}(t) = 0 \quad (4.19)$$

$$\sum_{i=j+2}^{k} F_{ij}(t) = 0 \quad (4.20)$$

$$I\, f_n(t) = \bar{f}_n(t) \quad (4.21)$$

$$F_{ij},\ \delta_i^-,\ \delta_i^+ \geq 0\ , \quad (i=1, \ldots, k, \text{ and } j=1, \ldots, k)$$

In this form the sum of the rows in the matrix F are the previous period's totals, f(t-1), and the sum of the columns are this period's totals, f(t); $\bar{f}_n(t)$ is the vector of the projected new families; δ^+ and δ^- are the deviations from the initial state; and ζ^T is the transpose of the unity vector.

The above formulation is applied using yearly aggregate family data (see Table 4-5) to obtain F, the matrix of family movements. As a result, the yearly

coefficients can be computed using[85]

$$\Phi(t) = F(t)\ \hat{f}^{-1}(t-1) \qquad (4.22)$$

This yearly data permits us to examine the stationary properties of the transitions and their use in projections. Both graphic and numeric tests of stability (stationary properties) of the transition probabilities were conducted.[86] In all instances, the hypothesis of stationary probabilities was rejected. Two problems associated with these tests need to be discussed. In the first place, a precise interpretation of the results is not possible due to the confounding of two distinct sources of non-stationary transition probabilities, viz. non-homogeneity of the cell population and "state dependence".[87] Unless we are able to a priori specify the mechanisms governing non-stationarity, heterogeneity and state dependence have to be considered as equally valid alternative explanations for the observed lack of stability of the transition probabilities. In the context of the present research, however, the two confounding sources, while relevant to an understanding of the process of family transformation and formation, need not be disentangled since we are interested in the predicted outcome rather than the process leading to the outcomes. In the second place, the extremely large numbers of observations (the column marginals) virtually ensures the rejection of any hypothesis that might be tested. However, the a priori arguments leading us to expect non-stationary transition probabilities appear, in this instance, to justify our acceptance of what might be a statistical artifact as indicative of an underlying non-stationary process. In summary, changes over time are accounted for, and incorporated into, the predictive model, but the "black box" leading to those changes is not, and need not be, analyzed in detail for our purposes.

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85 The assumptions here are that the birth and death process is stationary and that it is equally likely, across periods, that a person of certain cohort j will be associated with family type i, for all periods t, t= 1,.....,T. It follows, then, that any non-stationary characteristics will be embodied in the transition probabilities derived from the aggregate projected data.

86 To test for the stationarity of the transition probabilities, we use the procedure recommended by Forbes (1971). Briefly, the procedure involves the computing of the transition probabilities for each time period and an overall transition probability along with their associated standard errors. The formula for the standard error of the estimates is derived from the assumption that the transitions are multi-nominally distributed. The null hypothesis tested is that the probabilities for each period are not significantly different from the overall transition probability at some chosen level of statistical significance (taken to be 5% here). See Forbes [112] for a concise summary of both graphic and numeric techniques as applied to Markovian transition probabilities.

87 Social scientists have been aware of this problem for a while. See, for example, Blumen, Kogan, and McCarthy [18], Spilerman [264], Stewman [271], or Heckman [136].

Based on these tests, we reject the use of a fixed transition matrix for the entire interval of interest.[88] Hence annual transition matrices, obtained using equation (4.22), are used as the input parameters in equations (4.23) to (4.26) to predict the changes in the stocks of transiting families.

$$f(1) = \Phi(1)\ f(0) + f_n(1) \tag{4.23}$$

$$f(2) = \Phi(2)\ f(1) + f_n(2)$$

$$= \Phi(1)\ \Phi(2)\ f(0) + \Phi(2)\ f_n(1) + f_n(2) \tag{4.24}$$

and so on for the final year T

$$\begin{aligned} f(T) = {} & \Phi(1)\ \Phi(2)\ \ldots\ldots\ \Phi(T)\ f(0) \\ & + \Phi(2)\ \ldots\ldots\ \Phi(T)\ f_n(1) \\ & + \ldots\ldots\ldots + \Phi(T-1)\ \Phi(T)\ f_n(T-2) \\ & + \Phi(T)\ f_n(T-1) + f_n(T) \end{aligned} \tag{4.25}$$

Examples of the family movment used to obtain the prototype data for the transitionsare shown in table 4-6 for the several periods. The transition matrices for the years 1976-1985 will be used in section 4.6 where we link the models of Chapter 3 with the models developed here.

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[88] We should also be aware that replication of past yearly transition matrices (as an indication of what may happen for a similar future interval of time) may not be adequate. This is due to the dependence of the projected change in family characteristics on the predicted inputs of new families.

TABLE 4-7: DOMESTIC FAMILY MOVMENTS

FAMILY MOVMENT MATRIX 1976-1977

TO \ FROM	(1)	(2)	(3)	(4)	NEW FAMILIES t+1	TOTAL FAMILIES t+1
FAMILY SIZE (1)	124314	0	0	0	31424	155737
(2)	25032	335717	0	0	0	360749
(3)	0	11387	211107	0	0	222494
(4)	0	0	2920	72408	0	75328
FAMILIES AT t	149346	347104	214027	72408		

FAMILY MOVMENT MATRIX 1977-1978

TO \ FROM	(1)	(2)	(3)	(4)	NEW FAMILIES t+1	TOTAL FAMILIES t+1
FAMILY SIZE (1)	133070	0	0	0	27850	160926
(2)	22667	350520	0	0	0	373187
(3)	0	10229	219914	0	0	230143
(4)	0	0	2580	75328	0	77908
FAMILIES AT t	155737	360749	222494	75328		

FAMILY MOVMENT MATRIX 1978-1979

TO \ FROM	(1)	(2)	(3)	(4)	NEW FAMILIES t+1	TOTAL FAMILIES t+1
FAMILY SIZE (1)	128946	0	0	0	47197	170143
(2)	31980	360495	0	0	0	392475
(3)	0	12692	226874	0	0	239566
(4)	0	0	3269	77908	0	81177
FAMILIES AT t	160926	373187	230143	77908		

FAMILY MOVMENT MATRIX 1979-1980

TO \ FROM	(1)	(2)	(3)	(4)	NEW FAMILIES t+1	TOTAL FAMILIES t+1
FAMILY SIZE (1)	156580	0	0	0	15253	171833
(2)	13563	384655	0	0	0	398218
(3)	0	7820	237670	0	0	245490
(4)	0	0	1896	81177	0	83073
FAMILIES AT t	170143	392475	239566	81177		

4.5 A JOINT FAMILY-HOUSING INPUT-OUTPUT MODEL

Equations (4.1), (4.3), (4.13), and (4.14) define the finite difference relations to characterize the flow of housing stocks and families from one period to the other. Now we need to relate them to each other.

For the joint families-to-housing distribution, we define a matrix R whose entries r_{ik} are the number of families of type k (expatriate - 30 year old - 4 members - middle income) in house type (3 bedrooms - house - prefabricated - rent - 5 years old).

The overall relationships between families and houses can be more clearly seen in Table 4-8. This table shows that at any time the total of all families (columns) is equal to the sum of those who are already housed (in R), those assigned houses (in D), and those as yet considered unhoused (f_u). Total housing stock is equal to the houses that are occupied (in R), houses to be occupied (in D), and the houses that are vacant (h_v).

TABLE 4-8: FAMILY-HOUSE DISTRIBUTION INPUT OUTPUT

	Families to be housed		unoccupied houses	total houses
housing to be assigned		D(t)		
	D(t)	R(t)	$h_v(t)$	h(t)
unhoused families		$f_u(t)$		
total families		f(t)		

D(t) = mxk matrix of families, in category j, j= 1,.....,k, which are being housed in houses type i, i= 1,.....,m;

R(t) = mxk matrix of families, in category j, j= 1,.....,k, who are remaining in houses type i, i= 1,.....,m;

$f_u(t)$ = 1xk row vector of families, in category j, j=1,.....,k, remaining without houses;

$h_v(t)$ = mx1 vector of houses, type i, i=1,.....,m, remaining unoccupied;

$h(t)$ = mx1 vector of total housing type i, i= 1,.....,m;

$f(t)$ = 1xw vector of total families j, j= 1,.....,k.

The relationships between h, f, h_v, f_u, D, and R can then be written as

$$h(t) = D(t)\, e_2 + R(t)\, e_2 + h_v(t) \tag{4.26}$$

$$f(t) = e_1\, D(t) + e_1\, R(t) + f_u(t) \tag{4.27}$$

where

e_2 = kx1 vector of unity for all of its entries,

e_1 = 1xm vector of unity for all of its entries.

We use these two equations in specifying the recursive relationships of families and houses.

4.5.1 Recursive Relationships

We assume that both processes, family and housing transitions, are independent since, inter alia, no relationship is known to exist between the two at this time. Considering that, for example, houses will age whether or not a family increases in size or that the change in family size is, at least in a society like Saudi Arabia, independent of housing characteristics, this assumption may not be outrageous.

We now define the distribution of families to houses at time t as the sum of both the transiting distribution from last year and the additional distribution this year--viz.,

$$R(t) = \bar{R}(t) + D(t) \tag{4.28}$$

$$= \Omega(t)\ R(t-1)\ \Phi'(t) + D(t) \tag{4.29}$$

where $\Phi'(t)$ is the transpose of the matrix $\Phi(t)$. The total stocks of houses and families can also be written as

$$h_t = [\ \Omega(t)\ R(t-1)\ \Phi'(t)\ e_1\ ] + D(t)e_1 + h_v(t) \tag{4.30}$$

and

$$f(t) = e_2\ [\ \Omega(t)\ R(t-1)\ \Phi'(t)\ ] + e_2 D(t) + f_u(t) \tag{4.31}$$

where $h_v(t)$ and $f_u(t)$ represent houses that become vacant and families that become unhoused.

As can be seen from (4.30) and (4.31) the total houses h(t) are simply the sum of distributed houses from last year, subject to the transitions in both family and house characteristics, the new distributed houses this year, and the houses that remained vacant. Similarly, the total families f(t) are the sum of the families distributed from last year, the new distributed families this year, and the families that will remain to be considered unhoused.

Under an assumption that the transitions in Ω and Φ are constant over a period of time, 0−, then, we may rewrite (4.32) and (4.33) as follows:

$$h(t) = D(\tau)\ e_1 + [\ \Omega(\tau)\ R(0)\ \Phi'(\tau) + \Sigma_{i=1}^{\tau}\ \Omega(\tau-i+1)\ D(i)\ \Phi'(\tau-i+1)\ ]\ e_1 + h_v(\tau) \tag{4.32}$$

and

$$f(t) = e_2\ D(\tau) + e_2\ [\ \Omega(\tau)\ R(0)\ \Phi'(\tau) + \Sigma_{i=1}^{\tau}\ \Omega(\tau-i+1)\ D(i)\ \Phi'(\tau-i+1)\ ] + f_u(\tau) \tag{4.33}$$

Thus we identify the multi-period changes in the original distribution R(0), and in the yearly added distributions $D(\tau-i+1)$ for all $i=1,\ldots\tau$.

Our framework, including its transition characteristics, now enables us to deal with dynamics in variables that are important for the planning of housing. Specifically, it enables us to consider $D(\tau)$, the families that will be housed at time τ, $h_v(\tau)$, the houses that will remain unoccupied, $f_u(\tau)$, the families that will remain unhoused, and $h_n(\tau)$, the new houses to be built. In addition, as discussed earlier, this framework enables us to consider the new family inputs, $f_n(\tau)$, which includes the influx of expatriate families.

Of course, an application of the transition probabilities to the distribution matrix will result in the attrition of some families. The number of housed families will then decrease and some houses will become vacant. We could thus add these houses recursively to $h_v(t)$. Similarly, there will be some attrition of houses which will add to the stock of unhoused families, $f_u(t)$. Such recursive relationships can be shown explicitly. For instance, occupied houses $h_o(t)$, can be represented as:

$$h_o(t) = \{ \Omega [R(t-1) + D(t-1)] \Phi'(t) \} e_1 \quad (4.34)$$

In other words, the occupied houses at time t consist of those which resulted from application of the joint transition on the distributions of those which were already occupied, $R(t-1)$, and the newly occupied, $D(t-1)$, last year. It follows that the housed families are those originally and additionally housed from last year. The housed families can then be written as[89]

$$f_h(t) = e_2 \{ \Omega [R(t-1) + D(t-1)] \Phi' \} \quad (4.35)$$

Similarly, the total vacant houses are:

$$h_v(t) = \Omega \tilde{h}(t-1) + \{ \Omega R(t-1) [I - \Phi' e_2] \} e_1 \quad (4.36)$$

I.e.,

Total Vacant Houses	=	Houses remaining vacant as a result of previous period's planning	+	Houses becoming vacant due to family attrition as represented in the transition matrix.

And so the unhoused families can be defined as:

$$f_u(t) = \Phi f_u(t-1) + e_2 \{ [I - \Omega e_1] R(t-1) \Phi' \} \quad (4.37)$$

We can thus move from single to multiple-period planning using these recursive and transition probability relations. In the following section, we show the effects of transitions and recursions by solving a series of one-period problems with relevant outputs of the problem being treated as inputs for another, in effect creating a multi-period application.

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[89] Notice that if there were no policy regarding the redistribution of presently housed families, then $[\Omega(t) R(t-1) \Phi(t)] e_1 = h_o(t)$ and $e_2 [\Omega(t) R(t-1) \Phi(t)] = f_h(t)$. If redistribution is planned, then the discrepancy between $h_o(t)$ and the planned $R^* e_1$ needs to be considered in a treatment similar to the one accorded the one period model explained in Chapter Three of this thesis.

4.6 MULTI-PERIOD APPLICATION AND NUMERICAL ILLUSTRATION

The numerical illustrations are designed to show the interaction of the recursive relationships detailed above with the goals and policies of the models in Chapters 2 and 3. Consequently, we will use the illustrations from those chapters as our point of departure and discuss these interactions only in terms of changes in family-to-house distributions and in the number and characteristics of families. These specific illustrations are ECHSE1, ECHS11,ECHSS1, ECHS101, ECHS102, ECHS103, ECHS104, AND ECHS105 of Chapter 3.

Before discussing these illustrations, we must clarify our procedures and terminology. We denote by the term "expected" the results of the recursive relationships when values at t are derived using given parameters. On the other hand, we denote by the term "projected" the results of changing some parameters indirectly through policies and goals designed at least in part in light of "observed" "expected" values. Figure 4-1 attempts to graphically represent these denotations.

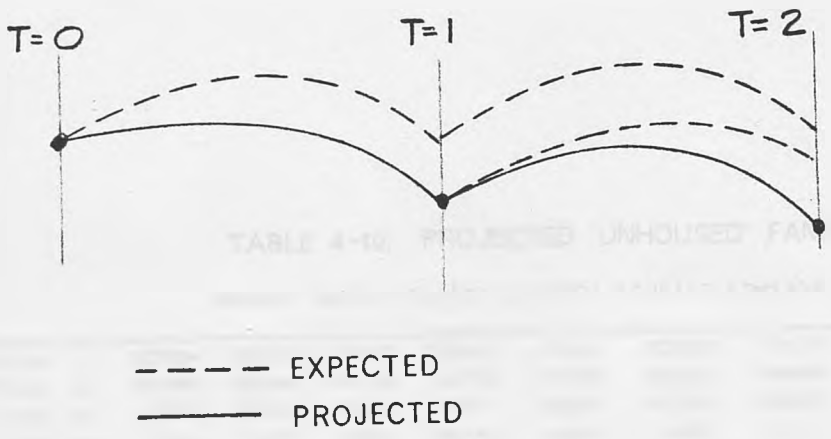


FIGURE 4-1: MULTI-PERIOD DENOTATIONS

Using the detailed output given in Appendix 4-B, we put together Tables 4-9 and 4-10 which contain the "projected" distribution of families in 1980 under various cases and the "expected" distribution in 1985. We reiterate that our "expected" 1985 distributions use parameter values in 1980 which are modified by policies implemented in 1976. Figure 4-2 is the graphic representation of these distributions of policies in the illustration coded by ECHSE1. The significant difference between the "expected" and the "projected" for family sizes (2) and (3),

TABLE 4-9: FAMILY DISTRIBUTIONS, "EXPECTED" AND "PROJECTED"

		ECHSE1		ECHS11		ECHSS1	
	"E"	"P"	"E"	"P"	"E"	"P"	"E"
	1976	1980	1980	1985	1980	1985	1980	1985
Family Size (1)	72979	36138	160614	71350	160621	72709	160619	72708
Family Size (2)	351386	362702	411520	409114	411522	415225	411522	415274
Family Size (3)	229070	244272	246066	270123	246061	274276	245794	274074
Family Size (4)	78606	85773	83072	92192	83075	93104	83075	93094

	ECHS101		ECHS102		ECHS103		ECHS104		ECHS105	
	"P"	"E"	"P"	"E"	"P"	"E"	"P"	"E"	"P"	"E"
	1980	1985	1980	1985	1980	1985	1980	1985	1980	1985
Family Size (1)	160620	72708	131898	59364	154092	69674	126118	56670	154091	69673
Family Size (2)	411521	415274	387424	373318	401462	403578	406700	395076	401463	403578
Family Size (3)	238888	267534	230432	255902	238154	265564	203862	233733	242193	269292
Family Size (4)	83074	92541	83072	90884	82689	92287	82944	90753	82690	92497

TABLE 4-10: PROJECTED "UNHOUSED" FAMILIES

	ECHSE1	ECHS11	ECHSS1	ECHS101	ECHS102	ECHS103	ECHS104	ECHS105
Family Size (1)	80584	08939	07582	07581	07581	20359	10616	07170	10616
Family Size (2)	55156	80338	74179	74179	74179	89542	85889	73195	85890
Family Size (3)	14945	20785	16628	16577	23372	31268	25345	15523	15523
Family Size (4)	4199	5272	4362	4325	4925	6495	5177	4426	4926

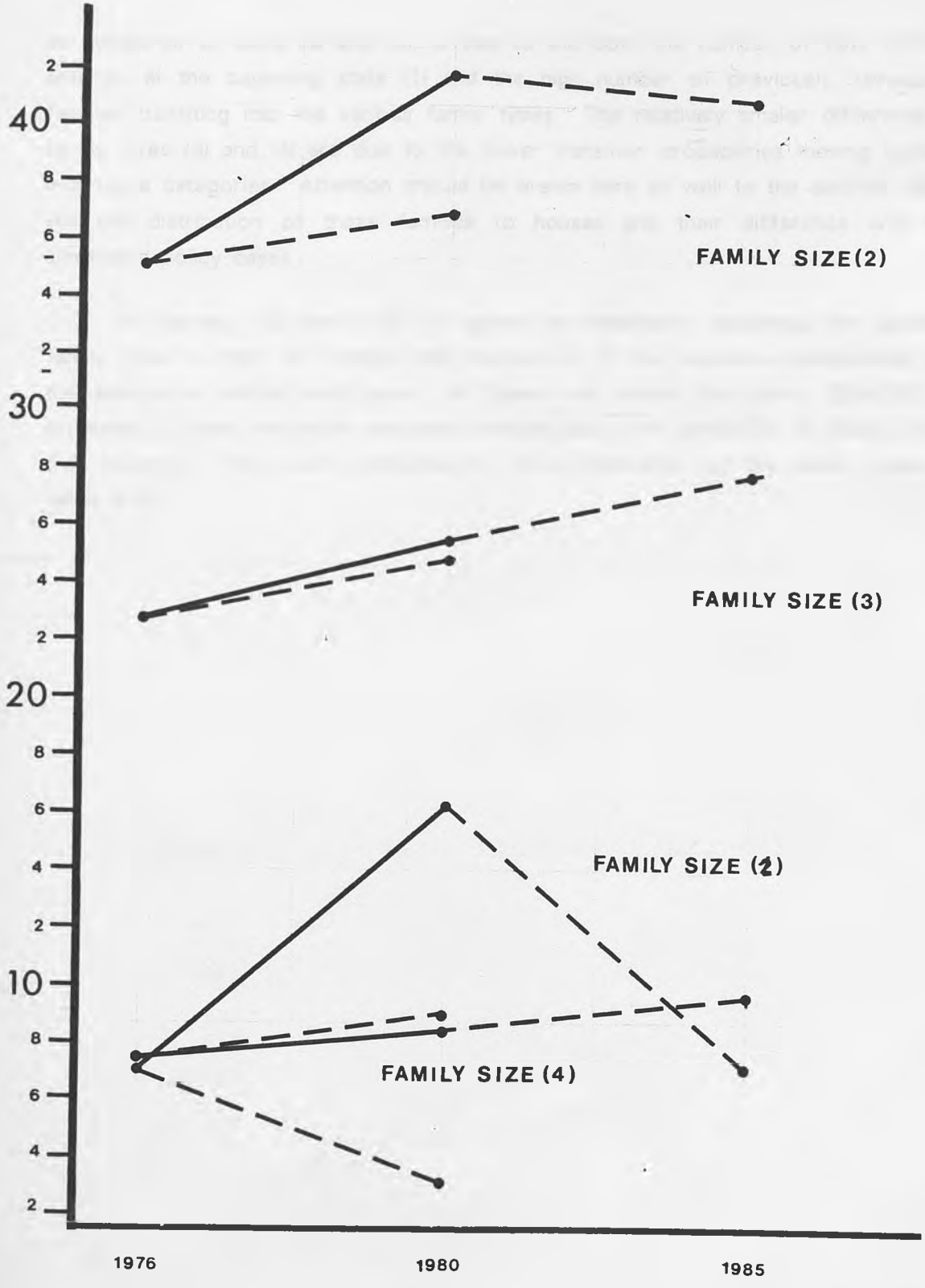


FIGURE 4-2: MULTI-PERIOD RELATIONSHIPS: ECHSE1 ILLUSTRATION

as compared to sizes (3) and (4), is due to the both the number of new families entering at the beginning state (1) and the high number of previously "unhoused" families transiting into the various family types. The relatively smaller difference in family sizes (3) and (4) are due to the lower transition probabilities moving families into these categories. Attention should be drawn here as well to the detailed tables for the distribution of these families to houses and their difference with the alternative policy cases.

In Figures 4-3 and 4-4 we graph the alternative outcomes for specific family type in order to highlight the interactions of the recursive relationships and the alternative policies and goals. In Figure 4-4, notice that policy ECHS102 is projected to have the most unhoused families due to the emphasis on issues other than housing. This is also indicated, by cross reference, by the lower values in Table 4-9.

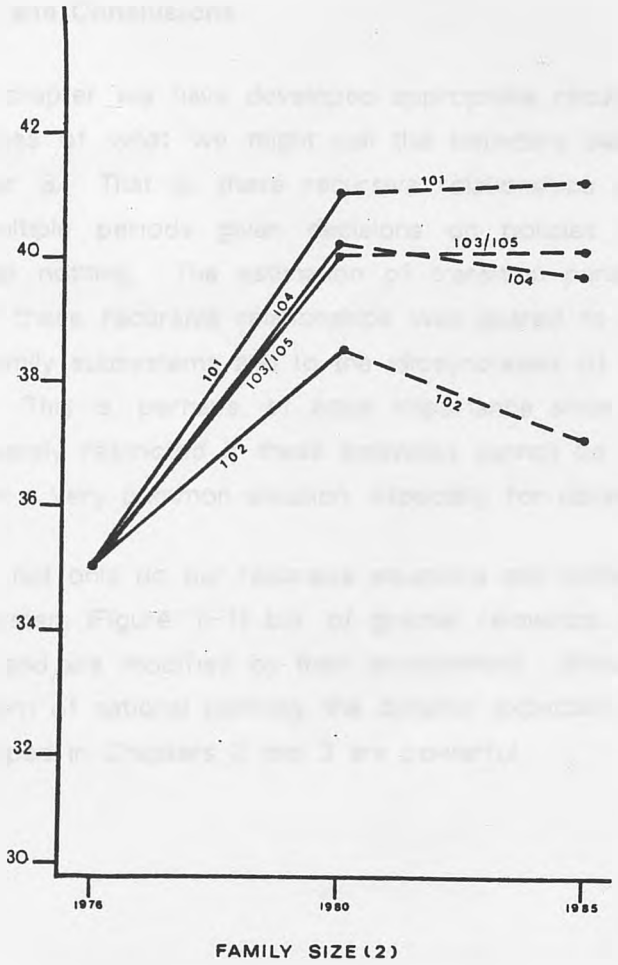


FIGURE 4-3: MULTI-PERIOD RELATIONSHIPS FOR FAMILY SIZE (2)

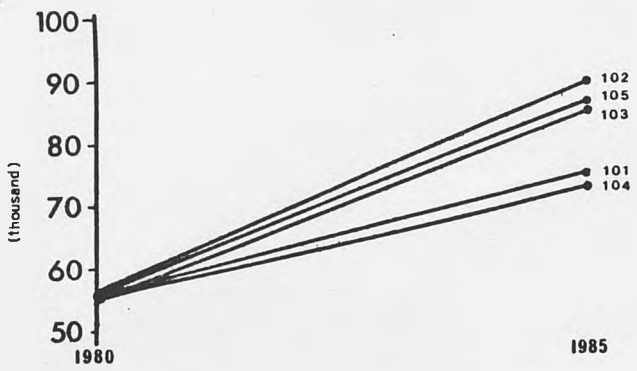


FIGURE 4-4: UNHOUSED FAMILIES SIZE (2)

4.7 Summary and Conclusions

In this chapter we have developed appropriate recursive equations to permit dynamic changes of what we might call the boundary conditions for the housing model, Chapter 3. That is, these recursive relationships allow us to model what happen in multiple periods given decisions on policies and goals including the decision to do nothing. The estimation of transition parameters required for the application of these recursive relationships was geared to both peculiarities of the houses and family subsystems and to the idiosyncrasies of the prototype data from Saudi Arabia. This is, perhaps, of equal importance since the use of our models would be severely restricted if these estimates cannot be obtained because of the lack of data-- a very common situation, especially for developing countries.

Clearly, not only do our recursive equations add considerably to our model of a social subsystem (Figure 1-1) but, of greater relevance, these recursive relationships modify and are modified by their environment. Since this environment is the specific concern of national planning, the dynamic expectations in this chapter of the models developed in Chapters 2 and 3 are powerful.

CHAPTER FIVE

CONCLUSIONS AND FUTURE DIRECTIONS

CHAPTER 5
CONCLUSIONS AND FUTURE DIRECTIONS

5.1 INTRODUCTION

Throughout this effort, our guiding principle has been that the study of development is better served by explicitly including the multi-dimensional and the multi-objective properties of development plans into policy relevant models. In order to be of operational use in policy analysis and guidance, the models should closely fit the substantive context and, where required, include relevant subsystems and their interdependencies. The extent of the required flexibilities for a multi-objective planning for national development, which our models readly accommodates, are generally dependent on proper integration of system characteristics (and exhibited behaviors) with decision making (which includes consideration of policy makers attitudes and the extent of their ability to exercise influence over the system's behavior). In this thesis we represent mixed planning situations, observed in a large class of developing countries, by integrating models and information about system behaviors with planning activities affecting the inputs, the outputs and, in some cases, aspects of that behavior. Additionally, our framework and its analytical foundation accommodate the potential flexibilities required in modelling issues applicable to many development situations, particularly the simultaneous consideration of multiple objectives and their mixed impacts.

The models presented in this thesis utilize the principles of input-output modelling to represent relationships between and within economic and social-demographic systems for both internal activities and dynamic flows over time. However, straightforward applications of input-output models is not enough. Since planning is goal-setting and decision-making activity, we need to modify input-output models to permit the satisfaction (as closely as possible) of these goals which involve compromise and adjustments of goals and preferences during the planning process. To do this we join input output analysis with the ideas of goal programming as a more faithful representation of the characteristics of development planning and decision making. Hence, we are able to structure an integrated system for national development with multiple and possibly conflicting goals.

All of the work in this thesis is anchored in the substantive context of Saudi Arabia. Hence, we analyze in detail several social and economic characteristics unique to both the process of development in general and to the Saudi Arabian situation in particular. To portray all relevant aspects of the development situation characteristic of Saudi Arabia is a task beyond the scope of this thesis; and so we were rather selective. The features presently considered as well as future efforts in modelling, decision making, and data support will be briefly discussed below:

5.2 THE OVERALL MODELS

The overall socio-economic development model developed in Chapter 2 includes the following

1. Changes in production activities reflect multi-period changes in technology and in output levels due to industrial development. To portray these issues, we have used an input-output framework to accommodate flexible consideration of alternative mix of sectors, industries, and technologies (Usually attained through the proper sector or industry disagregation). As such we incorporate several issues involved in industrial planning including, in some cases, the development of non-existing base of technology. Generally, we have associated industrial projects (including those with different technology) with their sector of operation while the input requirements were referred to the respective sectors of demand. In any case, industrial plans are defined in terms of their operation and capital requirements as well as their expected outputs. Operation requirements are therefore allowed to influence the mix of intermediate inputs (changes in technology), and capital plans influence the output levels that could be achieved.

   Closely associated with industrial planning is the identification of public (government owened and operated industries) and private sector s activities and distinguish their respective treatment. Public sector industries (such as a utility) may be either operated by government or directly influenced through policy and management directions (such as those in the oil and gas sector). Indirectly, however, government through technical assistances and regulatory mechanisms may influence the private sector toward alternative paths of industrial development. For that purpose, several agencies of government (including the Industrial Research Center) provide the private sector with analyses and information necessary to realize plans from drawing board to implementation. As such these agencies evaluate the prerequisite feasibility and operating studies provided by the private sector (for their market potential and input requirements) and/or provide these studies directly to the private sector. In any case these activities provide the information base necessary for our model application as shown in Chapter 2 in the case of the utility and oil sectors. As such our model permits the observation of potential changes in the industrial structure and other impacts due to the various planning activities.

   Further analysis of the actual shaping of industrial structure in both the

private sector and government owned industries could help us adjust our model's input–output coefficients from those which are planned to those actually implemented (and in the meantime further identify future government roles in industrial planning). As an extension to our model, therefore, target outputs (for industrial planning) could be considered as additional goals and thereby enable us to identify the over or under–achievement of industrial goals in relation to other goals in national development. This information, combined with data on changes in the structure of technology, could provide insight into the decision making errors related to industrial planning in ways that are allowed for explicitly in the models we have considered.

2. Several aspects of labor utilization in government and production sectors along with their possible relationships are modeled. This required additional classifications, besides demographic–activity of both domestic and expatriate labor. Expected inputs and outputs of labor due to the flows from the education sector for domestic labor and the attrition of expatriate labor were explicitly considered. We have also examined government employment activities and their possible effects on labor supplies for production activities.

   In the case of expatriate labor, the decision to influence the participation levels in national development (and hence the population mix in Saudi Arabia) is modeled through goal programing to allow the examination of the trade offs between expatriate labor and other goals. This is an important problem that requires evaluation at the planning stage–– i.e., before plans are implemented.

   In our illustrative (prototype) applications, we focused on aggregate labor categories in the various activity–job system classifications. Further considerations could be accorded to nationality breakdowns to emphasize the mix of labor from different countries (and the associated differences in social–economic backgrounds). A significant extension to our model would then include a detailed model for manpower planning and related activities. A summary of several of the issues involved is in appendix 1–A.

3. Linkages between labor and households were explicitly developed in our models to delineate their relationships including the multiplier effects that some of them entail. We do this as follows. First we link labor income to household income and extend individual labor income to multiple family income. Second, we add to household income other transfers, public and private. Third, we determine the consumption proportions of household income. These relationships add information on the possible fluctuation of demands with various levels of employment and exits and entries of expatriate labor.

   Although we do not treat this topic here, an extension to our model would relate it to the study of inflation associated with changes in household income, government budget practices, and the supply of goods and services (including inflation rates associated with imported goods). These extensions are by no means straight forward. Inter alia, this would entail change in the fundamental focus of our models and bring in broad issues of monetary and fiscal policy.

4. Government involvement, in our model, was treated as distinct planning activities oriented toward the improvement of the quality of life. These are considered to be the goals which each agency of government tries to achieve. Since these goals may not be compatible between agencies or with other goals we examined both the impacts of these plans on other variables as well as the potential trade-offs among their achievement levels and relative preferences. This is done with both the aggregate government plans and the agency specific plans but only at fairly high levels of aggregation. To proceed further would require more elaboration of details and impose data requirements that might not be possible to satisfy at this time.

5. Imports and exports are modeled to indicate levels of imports needed to supplement domestic production or to trace the need for possible alternatives in the levels of exports planned. Further research may be required on the relationship between imports and industrial development and on trade balance issues. To do this in detail would require the development of detailed import substitution and foreign trade models.

Other issues pertinent to the further development of our models are related to the inclusion of spatial considerations. Although our models treat the country as one system, further extensions can be handled by "differentiating" the country into interrelated components, e.g. regions, districts, etc. Within each, we could represent and analyze region specific social and economic aspects as well as the interregional linkages. This would be achieved by modelling each region in a similar fashion to the national models (with particular attention to regional specific variables and parameters) and extend them to incorporate interregional interactions (such as the movements of goods and services, transportation systems, and the flow of people) particularly those which are influenced by both development programs and the availability of the supporting factor inputs (including labor) and services (for example health, education, and housing). In this fashion, we could link regional specific planning activities with the overall national development and examine the potential cross impact on other regions. These suggested extensions may also identify impacts of the different regional emphasis and, in turn, help balance regional development and to avoid negative impacts such as, for example, over urbanization and cumulative shortages in public services or the supply of goods.

The national system may therefore be presented as a lateraly interrelated hierarchy of smaller components. Hierarchical decomposition as such allows us to incorporate not only variables, parameters and decision making activities specific to the individual subsystem but also allows us to incorporate their proper association to their corresponding dimensions in the overall national model. Lateral linkages, on the other hand, allow us to identify and define the cross impacts of respective development programs. Furthermore, our use of goal programming methodology

and linear programming tools facilitates the examination of regional aspirations in relation to national goals as well as the conflicts and trade-offs associated with their planning activities.

5.3 HOUSING MODELS

In terms of component models, we modeled housing development as a separate, but interdependent, activity to examine specific housing issues and the cross impacts of housing development on other issues pertinent to national development. In particular, we specifically

1. Address the heterogeneous distribution of families to houses and their dynamic changes. As such, our model allows for distinguishing policy relevant areas related to household income, size, and nationality. The family-to-house distributions are arranged to deal with both distribution of new families to houses and the redistribution of existing families.

   In both distribution and redistribution cases, it has been assumed that a family will attempt to locate in a house that fits its needs and will remain only if neither vacancies nor new houses are available for its location or relocation. As such we explicitly assume, in our models, that a presently housed family is likely to move if its present house is considered 'not-suitable" and if the requisite house is available. This, as a result, will generate a vacancy that could be occupied by another family whose needs matches the generated vacancy (otherwise the house will remain vacant for future use). Vacancies as well as the demands for new houses are also related to the entry and exits of expatriate families which further link housing conditions to the employment of expatriate labor and national economic development. In this fashion, our models simultaneously considers the desired distributions of families to houses, the potential vacancies and their uses, along with the expected demands for new houses of various types.

   Other behavioral issues including family formation and the expected changes in family characteristics were explicitly considered in our models. It is of particular interest here that from our analysis of family formation and transition we observe a characteristic non-stationarity in family transitions from one category to another. This should not be unexpected due to the fast pace of development and should be taken as additional evidence of the dynamic changes which Saudi Arabian society is presently undergoing. For our models purposes, the existence of such non-stationarity has moved us to explicitly include the different transition probabilities in our multi-period application in lieu of forecasting future states (with simple markov matrix) to arrive at better estimate of future changes in family characteristics and hence their expected housing requirements. In application, our model shows that these dynamic changes (in family characteristics and the estimated multi-period family activities) significantly affect housing development needs and opportunities that have high relevance for public policy.

2. Identify linkages, and cross impacts, between housing and other activities. This includes the demand for new houses, and its multiplier effects, as well as inputs and outputs of expatriate families. Specifically, expatriate labor (recruited in both government and production sectors) and their associated families are linked to the overall socio-economic model discussed above. This identifies several multiplier effects including housing vacancies and other "reverse" multiplier relationships which bear on issues such as domestic to expatriate populations and labor mixes. They also indicate how importation of expatriate labor gives rise to housing needs that in turn give rise to demand for expatriate labor, and so on.

   Lately, several government agencies in Saudi Arabia have developed housing programs for their employees, domestic and expatriate. These programs take the form of subsidies for rentals as well as the provision of temporary housing. These activities point to a potential extension to our models which would require the identification of family and housing characteristics of each agency's employees (as related to their employment-income status). Housing development for government employees could then be treated as specific goals affecting both housing development programs as well as other socio-economic aspects. These planning activities are part of government planning and hence trade-offs between them may have to be resolved at the agency level.

3. Address policy making not only as an activity to meet given goals for housing development but also as an activity that requires an examination of the criteria that go into the formation of goals and objectives related to the improvements of the quality of housing conditions.

4. Examine the impacts of housing policies and their trade-offs with other areas of national development as well as the consequences of changes in goals and policy directions within, and between, these joint planning activities.

Other issues of importance to the extension of our housing model, left to the future, are:

1. The modelling of regional housing development. This would require extension of the input-output framework to accommodate both intra-regional characteristics and inter-regional flows. These extensions include regional specific family-household activities, economic-industrial development programs to improve the regional use of local inputs to meet both regional and national goals, the potential trade-offs with other regions in government resource allocation, as well as the potential flows of people, goods, and services.

2. The consideration of detailed physical design parameters (such as construction requirements, spatial configurations and, layout design of housing prototypes) developed by urban planners, designers, and architects. Such activities can be studied not only in isolation but also in an interdependent fashion by means of our models. This could be evaluated in terms not only of space and factor input requirements but also in terms of emphasis on construction methods with their demands,

of expatriate and expatriate labor. These design activities also involve further analysis of issues related to urbanization, neighborhoods, transportation, and infrastructures which our models can accommodate by rather straightforward extensions. Other extensions to physical design (and possibly the use of computer aided design approaches) may, however, bring change in the focus of these models.

5.4 COMPUTATION AND APPLICATION

Throughout this thesis, we have consistently used input output and goal programming as the methodological basis for both the analysis of economic and social subsystems and the planning of alternative courses of action. We would thus rely on ordinary linear programming algorithms to provide the necessary solution. This, too, can have important consequences for implementation. The use of linear programming allows the use of existing computer codes and hence sensitivity checks available in the software generally provided with intermediate and large scale computers. This permits flexibility of application to accommodate changes in goals, preferences and, at several points, changes in components of the linear programming matrix.

For purposes of use in actual decision making, several issues need to be considered. They include the representation of decision making activities (which simultaneously considers several decision-making activities at different levels), the treatment of variables (integer or mixed integer applications), and the consideration of problem size including the possibility of subsystem decomposition. Each of these affects the practicality of the methods for use where effective generation of many solutions for evaluation is required.

Information feedback about the achievement of goals and their possible effects on others plays an important role, in our context, for the successive adjustments of preferences and reconciliation of conflicting goals. In our context, the Ministry of Planning is seen to be the primary user of our models. Their interest is in the analysis of alternative solutions and the consequences of various subsystem requirements along with the trade-offs among the various planning activities. The Ministry of Planning's role extends from coordination (among subsystem planning and government agency's activities) to arbitration (reflecting policy directions from higher authority--the council of Ministers) among the alternative preferences and planning goals. As such, several preferences within and between subsystems (initially defined by planners in the various areas) could be indicated and thereafter adjusted in an iterative process. We have, therefore, shown in various

prototypes how effects of selected changes in goals and preferences including trade-offs among goals can be traced and evaluated.

Throughout this thesis, actual data were used but only in the manner of a prototype model to represent the development characteristics of Saudi Arabia as well as to guide those data needed to support our models. We had several objectives for our use of these prototype data: 1) to illustrate our model's capabilities', 2) to point to areas for data collection, and 3) in some cases, to examine tools and methods that could be used to provide necessary estimates. In some cases prototype data were drawn directly from Saudi Arabian sources such as economic transactions and government projects. In other cases, data were developed only to indicate the potential of additional information that were not directly obtainable (such as family-to-house distribution). In yet other cases, estimation procedures were developed as part of the research underlying this thesis to provide our models with several parameter inputs (e.g. family transitions).

We may recall that one set of purposes of the chosen models are directed toward their use when the requisite data are available. An equally important set of purposes, however, involve the use of these models to systematize the collection of data. This can help guide the needs for data assembly and treatment in terms of the uses to which they are to be put.

5.5 A PROLOGUE TO FIELD IMPLIMENTATION

Several issues underly the requisite field implementation of our models. Among these are the understanding of the open ended continuity of the planning process, coming to terms with an indeterminate environment (including mixture of scientifically reasoned ingredients and other judgments) within which they must operate, and the establishment of an effective *modus operandi*. In addition, continued implementation also requires continued commitment of time, finances, people, and organizations.

The importance of establishing a focal point for all pertinent information can hardly be exaggerated. Without it, separate conflicting channels develop, which reduce the effectiveness of advanced planning and impair the outcome of the analysis. One of the Ministry of Planning's objectives is to incorporate a base for coordinative planning and support it with the necessary technical and scientific know how. We support this objective by further suggesting a research and decision analysis center as the analytical focal point whose task is to analyze and maintain a

complete and coordinated picture of individual activities, models, their relationships, and their progress. These functions of research and analysis, are interdependent with many other activities and departments within the Ministry of Planning and with other government agencies and independent research organizations. The proposed center's activities (which are interdisciplinary in nature) should be interdependent only in the nesting of an information network but not in the bureaucratic hierarchy of control. In other words, while the responsibility for the continuity and adequacy of information flows could be shared, the management of these research activities must be independent due to the type of people and activities usually involved. Their organizational and environmental setting should be one that is conducive to creative research, interdisciplinary understanding, rigorous analysis and quantitative skills. Since one of their work attitudes may be oriented more toward inter-organizational cooperation they should encourage (and be encouraged) to exchange qualified people for specific tasks for effective coordination and training. In effect, the specific nature of their activities should allow them to operate as in a matrix organization across departments and tasks while maintaining internal integrity with checks and balances.

Experience suggest that effective satisfaction of the research tasks involves a general procedural approach of the following activities: gathering and dissemination of information, the analytical presentation and formulation of the various problems and their relationships, effective use of scientific tools, analytical methods and computer applications. Dissemination of information include providing decision makers with the special studies (future possibilities, impacts and, trends, as well as the evaluation of components and forces) needed for a variety of decisions so that meaningful use is made by those with responsibilities relating to the life of society.

Of particular importance to planning activities, and to the type of models we developed in this thesis, is the problem of facilitating operational reconciliation of competing or conflicting interests. In making decisions, responsible persons and agencies attempt to combine available information with their personal experience for critical appraisals and redirection. Very few people can accomplish this complex mental feat without special assistance. One purpose of analysis, which is a function of the proposed research and decision analysis center, is to assist in the synthesis of the quantifiable and unquantifiable data and judgments, scientific methods, and human insight. Hence, the proposed center is an information-communication center supplemented by analytical studies, mathematical-statistical analysis, graphic-visual display, and computer assistance. One may even think of a physical setting not very much different from strategic management and operation's "situation room" available in military and some corporate as well as national decision making environments.

The main emphasis in this thesis has been on improving the process of planning in countries like Saudi Arabia which have the means of development in many different quality of life dimensions even when this involves some economic cost. It must not be thought, however, that our emphasis on the machinery and the process of planning is not capable of generating other insights beyond those involved in merely implementing a plan.

As a case in point which we might note that our explicit inclusion of multiplier effects in our model made it quickly apparent that the proposed housing programs would have large and important consequences in the form of expatriate labor importation requirements (as well as the ensuing changes in the social structure). This has now been validated by experience, of course, but it could have formed an important ingredient in policy formulation and goal setting if it had been made apparent at an early data via the kind of planning model utilized. Knowledge of these possible multiplier effects at an early date could have entered importantly into deliberations about both the timing of housing programs and might have had other consequences as well.

Similar remarks could apply to the use of variable input–output coefficients, in our models, to reflect the development of previously non–existing industries. Note that here too there is a multiplier effect in the form of developing previously non–existing industries which depends infra–structure development that also depends on previously non–existing industries, and so on. This intern, lead to bottlenecks that imbalances other parts of planning process and probably also has inflationary effects on prices and related consequences (which are not yet included in the model). The point we are making is not one of model execution. On the contrary, the insights pointing towards such bottlenecks is already apparent from our models in terms of the variable coefficient input–output relations. Once again, availability of the kind of information at a sufficiently early date could have been utilized by the planning ministry, and possibly other agencies too, and it might then have resulted in a change of the pace or in altering of the direction of plans.

Finally, we note that our goal programming models are well suited for evaluating both pace and goal conflicts. The ways in which this can be dealt with in detail in earlier parts of this thesis and will not be repeated here.

To provide the necessary background for both scientific curiosity (related to the meaning and causes of events) and decision making needs, the planning process (as defined in this thesis) consist of few basic steps: gathering experience and

indicative data (including explanations of the various insights gained from both models and data), analysis of information, decision-making and evaluation, and implementation and follow-up. After experience, plans are not compared *de novo;* they are drawn from previous experiences and *post facto* comparison of performance. Information related activities, therefore, should be oriented toward the dynamic effects of changes in (and differences between) decision maker's emphasis to provide them with a historical evaluation of alternative paths of plans and to assist them in the development of learned judgments.

A specific consideration for actual field implementation of these models, and any other related to the proposed integrated approach for national development, requires us to consider data, modelling, and decision-making as a continuous interactive process. Several tactical considerations are related to the development of a computer aided decision-support system that incorporates data collection and empirical analysis, model development and calibration, as well as the interactive aspects with decision-making. Field implementation should also allow the integration of the models developed in this thesis with others under study such the macro-economic project, the manpower-education project, and the transportation study.

In many respects, this thesis constitutes a prototype involving the above issues in its attempt to provide a first step toward implementation. Further implementation efforts of this prototype should include 1) a focus on information management and decision support activities, 2) the calibration of models and their relationships and, 3) systematization of data collection and analysis. Research on these issues should continue while the necessary software is being designed, programmed, and tested. They may be directed in such a way as to further reinforce the already implemented portions.

The interrelationships of such an information system can be presented as a generalized network model linking data files, data analysis routines, mathematical models, solution generation routine, and finally, the user of these information. This may require internal management and synchronization of activities in an on-going operational environment. Software design, of such data management, must be modular to ensure that possible changes can be incorporated without disrupting the operation of the system. This is particularly important in the examination of historical trends in transitions or in the changes during the linear programming application.

APPENDICES

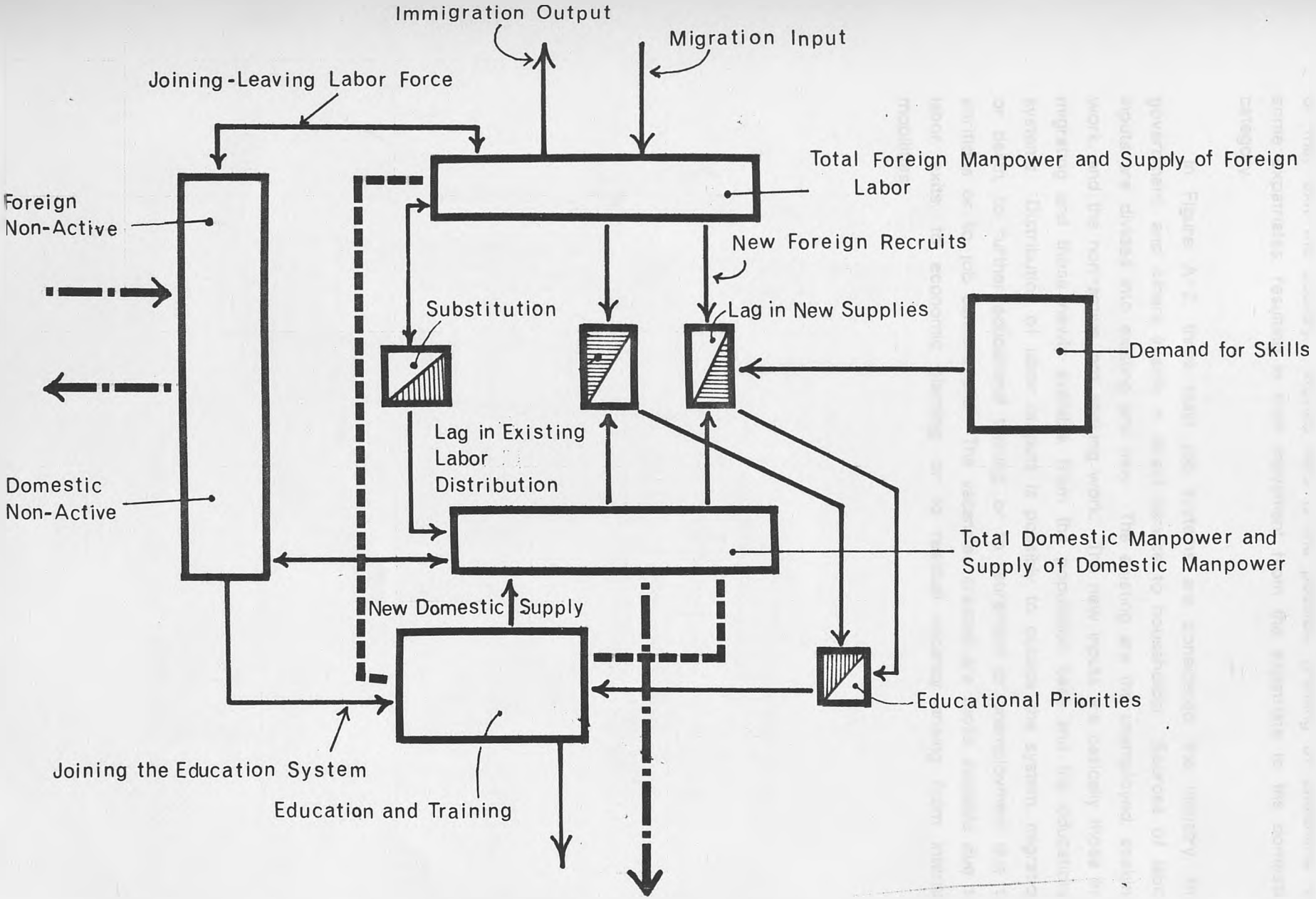


FIGURE 1-A-1: COMPONENTS IN MANPOWER SYSTEM DEVELOPMENT

or may exit the country. Implied here is the possible granting of citizenship to some expatriates, resulting in their movement from the expatriate to the domestic category.

In Figure A-2, three main job systems are considered the industry, the government, and others (mainly in direct service to households). Sources of labor inputs are divided into existing and new. The existing are the unemployed, seeking work, and the non-active, not seeking work. The new inputs are basically those in-migrating and those newly available from the population base and the educational systems. Distribution of labor outputs is possibly to outside the system, migration or death, to further educational training, or to retirement or unemployment due to attritions or to job cancellations. The vacancies created are those available due to labor exits, to economic planning, or to residual vacancy arising from internal mobilities.

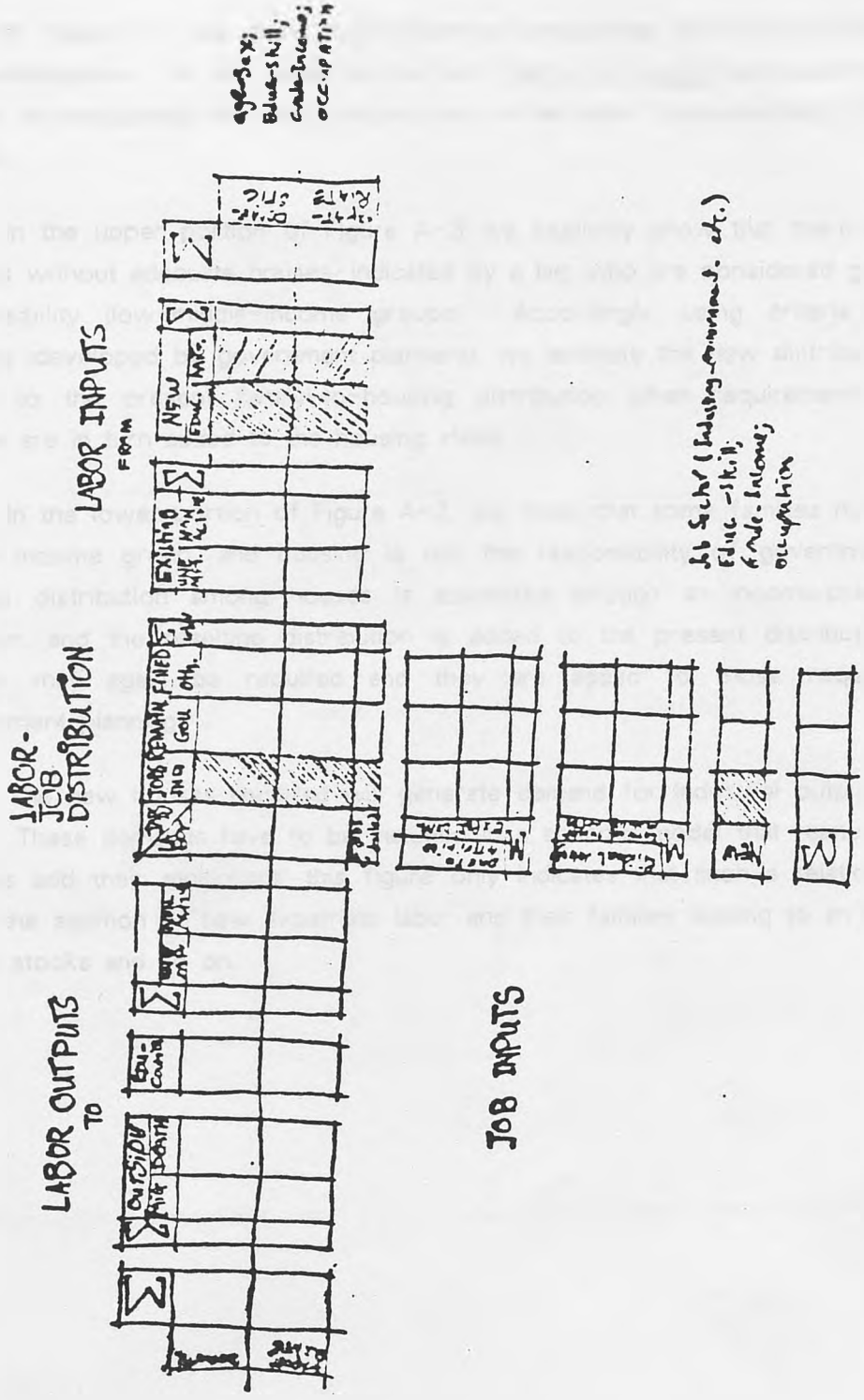


FIGURE 1-A-2: INPUT OUTPUT FRAMEWORK FOR LABOR AND JOB FLOWS

1-A.2 Housing

In Figure A-3, we show the accounting components for housing, families, and their distributions. At the center is the joint family to housing distributions. On one side is the accounting for family stocks and on the other the accounting for housing stocks.

In the upper portion of Figure A-3 we explicitly show that there may exist families without adequate houses, indicated by a lag, who are considered government responsibility (low-middle-income groups). Accordingly, using criteria for their housing (developed by government planners), we estimate the new distribution to be added to the present family-to-housing distribution when requirements of new houses are in turn added to the housing stock.

In the lower portion of Figure A-2, we show that some families may be of a higher income group, and housing is not the responsibility of government. This group's distribution among houses is estimated through an income/price related function, and the resulting distribution is added to the present distribution. New houses may again be required and they are added to those required from government planning.

The new houses required will generate demand for industrial outputs and for skills. These demands have to be included in a specific model that relates industrial sectors and their multipliers; this figure only indicates that such a relationship may mean the addition of new expatriate labor and their families leading to an increase in family stocks and so on.

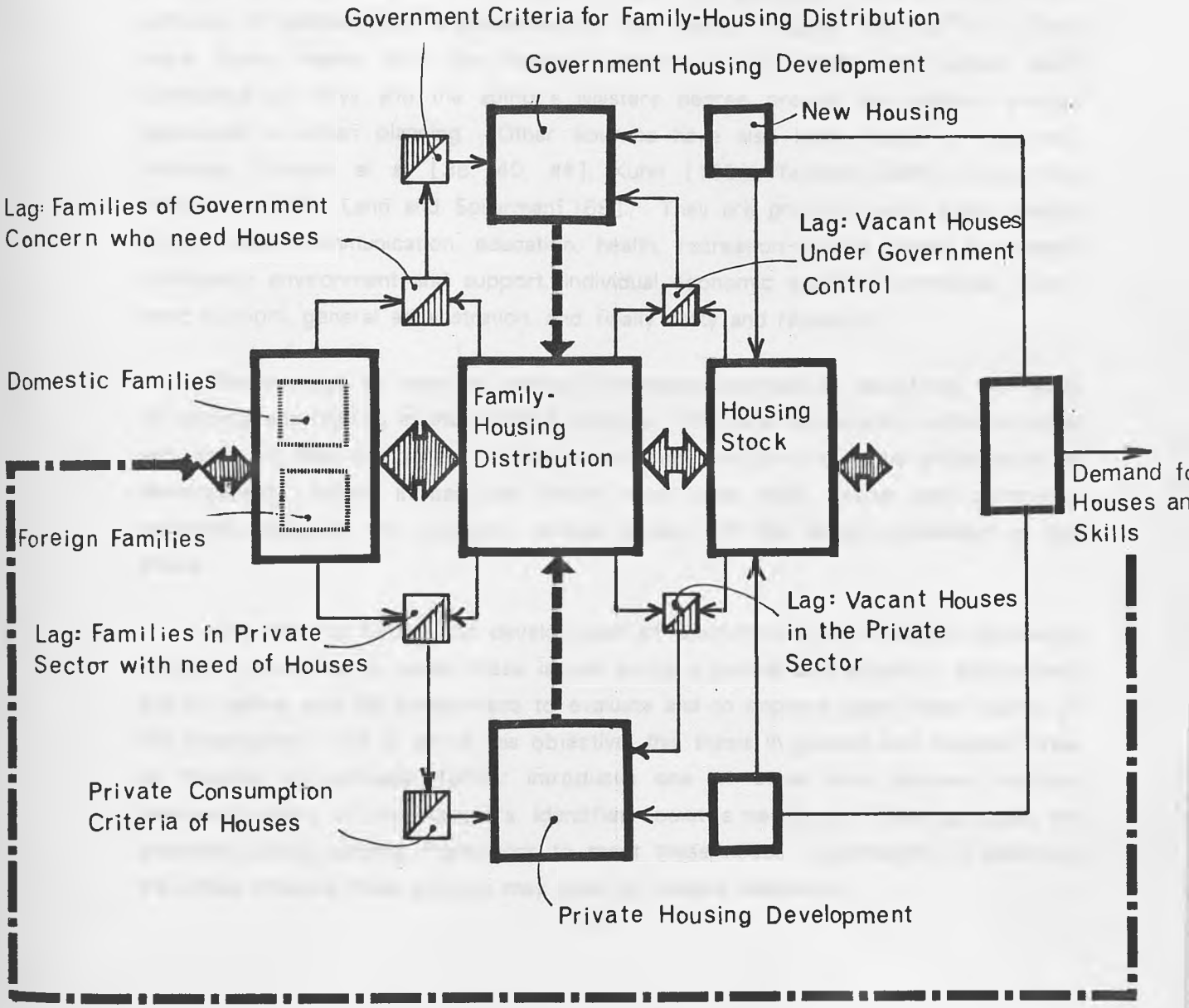


FIGURE 1-A-3: FAMILY-HOUSING ACTIVITIES AND CONSIDERATIONS

1-A.3 A Taxomony of Several Quality of Life Issues

In the following list of issues, we attempt to classify several qualitative and quatifiable dimensions that may be used as guide to government s direct and indirect activities in planning the improvement of the society's quality of life.[90] They were drawn mainly from the Fresno, California, Public information system study conducted by TRW and the author's Masters degree project on systems analysis approachs in urban planning. Other sources have also been helpful in this task, including Charnes el al [38, 40, ##], Kuhn [166], Terleckyj[288], Fox[115], deNeauvile[231], Land and Spilerman[169].) They are grouped under basic shelter, transportation/communication, education, health, recreation-culture, social involvment, community environment and support, individual economic support, community economic support, general adminstration, and finally safty and regulation.

These could be seen as guiding information oriented at identifying the needs of society and helping in the planning process. They are necessarily multidimensional and, as such, they could help provide a comprehensive picture in the progression of development. Notice in particular those listed under basic shelter and community economic support; this category include several of the issues presented in this thesis.

One way to further the development of Saudi Arabia is to employ alternative research resources to study these issues (using analytical and scientific approaches) and to define aids (to government) to evaluate and to improve upon these quality of life dimensions. And to serve this objective, this thesis in general and chapter three, on housing, in particular further introduces one of those links between multidimensional quality of life indicators, identifies society's needs, and finally provides the analytical policy planning framework to meet these needs. Additionally, it identifies the cross impacts these policies may have on related indicators.

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[90] These dimensions were compiled to focus attention on some indicators of the many issues representing aspects of life in society. (that may require both research and policy planning activities

BASIC SHELTER

QUANTITY

- HIGH DENSITY
- MEDIUM DENSITY
- LOW DENSITY
- TEMPORARY/TRANSIENT

QUALITY

- IMPROVEMENT
- MAINTENANCE
- STANDARDS
- ENFORCEMENT

TYPE

- SINGLE FAMILY
- MULTIPLE FAMILY
- SINGLE INDIVIDUALS
- SPECIAL PURPOSE

LOCATION/PROXIMITY

- RELOCATION
- DISTANCE
- SETTING
- AVAILABILITY
- OPPORTUNITY

LIVABILITY

- PRIVACY
- PROTECTION
- ARRANGEMENT
- SPACE
- ACCEPTABILITY
- SITE ORIENTATION

TRANSPORTATION/ COMMUNICATION

.VEHICLES

- PRIVATE MOTOR
- PUBLIC MOTOR
- RAIL
- AIR
- WATER
- TRUCKS
- PEDESTRIANS
- SPECIAL PURPOSE
- ANIMALS

FACILITIES

- SERVICE CENTERS
- OFF STREET PARKING
- AIRPORTS
- SEA PORTS
- RESERVOIRS
- WAREHOUSE
- OPEN STORAGE
- TANK FARMS

MEDIUM

- HIGHWAY
- STREET
- RIGHT OF WAY
- AIR CORRIDORS
- WALKWAYS
- PIPELINES
- RUNWAYS/HELIPADS
- POWER LINES
- STREET PARKING

COMMUNICATIONS

- WIRE
- WIRELESS
- PRINTED
- ASSEMBLY
- MAIL SYSTEM
- CONTROL SYSTEMS

EDUCATION

PRIMARY EDUCATION SERVICES

- PRE SCHOOL
- GENERAL
- HANDICAPPED
- EXEPTIONAL
- GIFTED

SECONDARY EDUCATION SERVICES

- GENERAL
- VOCATIONAL
- ADULT
- CONTINUATION
- COMPENSATORY

HIGHER EDUCATION SERVICES

- JUNIOR COLLEGES
- COLLEGES
- UNVERSITIES
- SPECIALIZED PROFESSIONAL
- TECHNICAL

FACILITIES

- RESEARCH
- PRIMARY
- SECONDARY
- HIGHER EDUCATION
- SUPPORT

HEALTH

SERVICES/PHYSICAL(INDIVIDUAL)

- COMMUNICABLE DISEASE
- CHRONIC ILLNESS
- ADDICTION
- GENERAL HEALTH
- INJURY

SERVICES/ MENTAL(INDIVIDUAL)

- ILLNESS
- ADDICTION
- RETARDATION

PREVENTION/CONTROL (COMMUNITY)

- STANDARDS
- ENFORCEMENT
- PUBLIC EDUCATION
- PREVENTIVE MEDICINE

FACILITIES

- REHABILITATION
- RESEARCH
- GENERAL TREATMENT
- LONG TERM CARE
- ISOLATION
- EMERGENCY
- INTENSIVE CARE
- PREVENTIVE

RECREATIONAL, CULTURE , OPEN SPACE

OUTDOOR

- PARKS
- OPEN SPACE
- ATHLETIC FIELDS
- PLAY GROUNDS
- ZOOS
- STADIUMS
- FAIR GROUNDS

INDOOR

- RECREATION CENTERS
- COMMERCIAL CENTERS
- ASSEMBLY HALLS
- ARTS & CRAFTS CENTERS

CULTURAL

- MUSEUMS,HISTORICAL SITES
- LIBRARIES
- THEATERS
- ARENAS
- GALLERIES
- GARDENS

PROGRAMS

- ATHLETICS
- MUSIC
- DRAMA
- ARTS & CRAFTS
- GROUPS
- INDIVIDUAL

SOCIAL INVOLVEMENT

CONFLICT RESOLUTION

- PARTISAN POLITICS
- LOBBYIST
- CIVIL RIGHTS
- COMMUNITY EXPRESSION

RELIGIOUS EXPRESSION

- ORGANIZED
- INDIVIDUAL
- COMMUNITY

SECURITY/ESTABLISHMENT

- CHARITY
- ACCEPTANCE
- PROTECTION
- POWER

IDENTITY STRENGTHENING

- CULTURAL
- STATUS
- INTEREST
- AGE GROUP
- ETHNIC
- COMMUNITY

COMMUNITY ENVIRONMENT AND SUPPORT

COMPREHENSIVE PLANNING

- LONG RANGE PLANS
- LAND USE REGULATION
- PROJECT PLANNING
- REGIONAL COORDINATION
- LOCAL BEAUTIFICATION

LIQUID WASTE

- ACCUMULATION
- TREATMENT
- SHORTAGE
- RECYCLE

SOLID WASTE

- COLLECTION
- DISPOSAL
- REGULATION
- CONVERSION

FLOOD/STORM WATER

- PREVENTION
- ACCUMULATION
- CONTROL RELEASE
- REGULATION

DOMESTIC WATER SUPPLY

- ACQUISITION
- DISTRIBUTION
- STORAGE
- TREATMENT
- REGULATION/CONTROL

BOUNDARY CONTROL

- SURVEYS
- RECORDS
- REGULATION

POLLUTION CONTROL

- WATER
- AIR
- NOISE
- VISUAL

PEST CONTROL

- RODENT CONTROL
- AGRICULTURAL PEST
- INSECT CONTROL

RESOURCE CONSERVATION

- ACCUMULATION
- STORAGE
- RELEASE CONTROL

AGRICULTURAL SERVICES

- INSPECTION
- MARKETING
- TECHNOLOGY

AGRICULTURAL WATER SUPPLY

- ACQUISITION
- DISTRIBUTION
- STORAGE
- REGULATION/CONTROL
- DRAINAGE

RENEWAL

- PUBLIC ACTION
- PRIVATE DEVELOPMENT
- COMMUNITY ACTION

INDIVIDUAL ECONOMIC SUPPORT

ASSISTANCE

- COUNSELING
- TRAINING
- SUPPORT FACILITIES
- ADMINISTRATION
- SERVICES
- FINANCIAL

EMPLOYMENT OPPORTUNITY

- CREATION
- IDENTIFICATION
- PLACEMENT
- PROXIMITY/ LOCATION

PROTECTION of INDIVIDUAL

- ASSOCIATIONS
- COMPENSATION
- REGULATION
- INFORMATION SERVICES

PRODUCTION

- TECHNOLOGY
- LABOR
- FINANCE
- MATERIALS

CONSUMPTION OPPORTUNITY

- FINANCE
- DEMAND
- MAINTENANCE
- INSURABILITY
- AFFORDABILITY

COMMUNITY ECONOMIC DEVELOPMENT

MARKET

- DEMAND
- SUPPLY
- EXCHANGE
- COMPETITION
- CONTROLS
- CONSUMER ACTIVITIES
- STABILITY

INCOME FLOW

- PRIMARY
- SECONDARY
- VOLUME
- INCENTIVE

LABOR

- SKILLS
- LOCATION
- AVAILABILITY
- MOBILITY
- MOTIVATION
- RATE

RESOURCE BASE

- INFRASTRUCTURE
- LAND & STRUCTURES NATURAL RESOURCES
- TECHNOLOGY & RERESEARCH
- SUPPORTIVE SERVICES
- POPULATION
- ENERGY SOURCES

ORGANIZATION

- PROGRAMS
- RESEARCH
- FINANCIAL INSTITUTIONS

FINANCE

- INCOME
- EXPENDITURE
- COST OF OPERATION
- CONTROL/FISCAL MONETARY
- INVESTMENT

GENERAL ADMINISTRATION

LAWMAKING

- LEGISLATIVE BODIES
- LAWS
- DIRECTIVES
- PROCLAMATIONS
- POLICY

JUSTICE

- JUDICIARY
- SPECIAL SYSTEMS

LEADERSHIP

- DEVELOPMENT
- RECOGNITION
- EXPRESSION
- CONTROL

INFORMATION

- ACQUISITION
- PROCESSING
- EXCHANGE
- REGULATION & CONTROL

RESOURCES MANAGEMENT

- PROGRAM ADMINISTRATION
- SUPPORT SERVICES
- RESOURCES ACQUISITION
- PUBLIC ACCOUNTABILITY

COOPERATIVE ACTION

- INTER GOVERNMENTAL
- INTRA GOVERNMENTAL
- INTER AGENCY
- CITIZEN PARTICIPATION
- PUBLIC/PRIVATE

POLITICAL EXPRESSION

- PUBLIC OPINION
- POLITICAL PHILOSOPHY

OPPORTUNITY EXPLORATION

- NATURAL ADVANTAGES
- PUBLIC INFORMATION
- INDUSTRIAL/COMMERCIAL ADVANTAGES
- COMMUNITY ATTITUDE

PROTECTION,SAFETY AND REGULATION

COMMUNITY ORDER

- CRIMINAL JUSTICE
- PROPERTY AND LAND USE CONTROL
- CIVIL JUSTICE
- TRAFFIC CONTROL
- COMMUNICATION CONTROL
- IMMIGRATION CONTROL
- FRANCHISES, LICENSES
- STANDARDS

PROTECTION of PERSONS

- ACCIDENT PREVENTION
- ISOLATION OF DEVIANTS
- CONSUMER PROTECTION
- ANIMAL CONTROL
- PEST CONTROL

PROPERTY PROTECTION

- FIRE
- FLOOD EMERGENCY
- CIVIL DISOBEDIENCE
- DISASTER RESPONSE
- WAR
- EARTHQUAKE
- WIND

DEFENSE

- CIVIL DEFENSE
- MILITARY DEFENSE
- EMERGENCY CITIZEN FORCE

APPENDIX 1-B

NOTES ON DATA ACTIVITIES

1-B NOTES ON DATA ACTIVITIES

In section 1.3 of this chapter, the emphasis was placed on treating data, model development, and decision making as an interacting , continuing activity, hence the need to underline several data requirments and activities supporting decision making. Data activities and decision support refer to the overall data base and computer activities involved in data inputs and evaluation as well to the dynamic planning activities, including those of the data base itself. In view of the proposed topic and activities, criteria for such a system are:

- To provide an integrated base for multidimensional data, indicative of the economic, demographic, and social aspects involved in the analysis of socio economic and housing development;
- To provide adequate decision support and interface at various decision making levels;
- To use standard data base design among model subsystems for compatible input and retrieval;
- To incorporate specific subfunctions for the necessary data analysis and for planning activities;
- To provide flexible structure for future evolution of the data base and the decision support systems involved.

The computer software satisfying these needs may be encompassed in an overall decision support system, (DSS). The structural framework of the DSS includes three main components: the data base, the system of models, and the decision support management. Essentially, the DSS is the framework within which the decision makers and planning analysts program the use of the data base and the system of models. In the following, we will delineate some of the activities implemented during this thesis development. First, we present in Figure 1-B-1 a diagram of the dynamic relations required to conduct the type of decision making models we develop in this thesis. To begin with, row data are checked and analyzed (using system routines) to examine their properties and statistics. Other data inputs in our case here will include the decision maker's direct participation in the form of goals, preferences and constraints. The resulting outputs are then

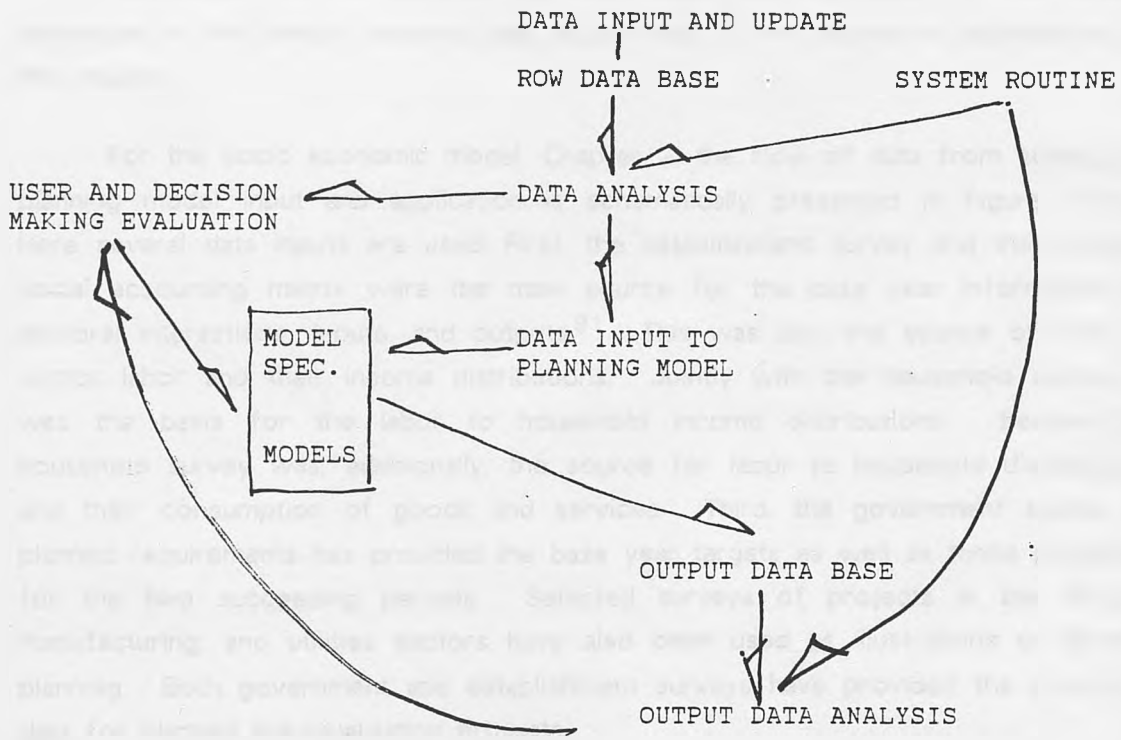


FIGURE 1-B-1: DECISION SUPPORT ACTIVITIES

analyzed and presented for decision making evaluation. The iterative stages to follow will then produce alternative model outputs. They are in turn analyzed and compared with the previous outputs, presenting a historical perspective of the changes in the data base due to decision making and evaluation. In this process, we underline two dynamic activities in data base design and structure the first resulting from follow up adjustment as implementation progress and the second resulting fromthe interactive adjustment of goals and preferences in response to solution outputs.

Specifically we no address the data needs and activities for the models developed in this thesis (including the output data of the alternative applications of this model).

For the socio economic model, Chapter 2, the flow of data from surveys to planning model input and application is schematically presented in Figure 1-B-3. Here several data inputs are used. First, the establishment survey and the resulting social accounting matrix were the main source for the base year information on sectoral interactions, inputs, and outputs.[91] This was also the source of data on sector labor and their income distributions. Jointly with the household survey, it was the basis for the labor to household income distributions. Second the household survey was, additionally, the source for labor to household distributions and their consumption of goods and services. Third, the government survey of planned requirements has provided the base year targets as well as those projected for the two succeeding periods. Selected surveys of projects in the oil-gas, manufacturing, and utilities sectors have also been used as illustrations of project planning. Both government and establishment surveys have provided the prototype data for planned industrialization projects.

Finally, labor forecasts and inputs were the result of another study.[92] This study was based on the development of a simulation model for the educational process in Saudi Arabia and the associated assignment to manpower pools.

Similarly for the housing development model (Chapters 3 and 4), in Figure 1-B-4 we delineate a process by which the prototype data was prepared for the model's application. At the center of this figure is the planning model whose

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91 In refence to the Macro Economic Modelling project, Ministry of Planning, Kingdom of Saudi Arabia [218].

92 In refence to the Labor Market and Manpower Studies, Ministry of Planning, Kingdom of Saudi Arabia [219].

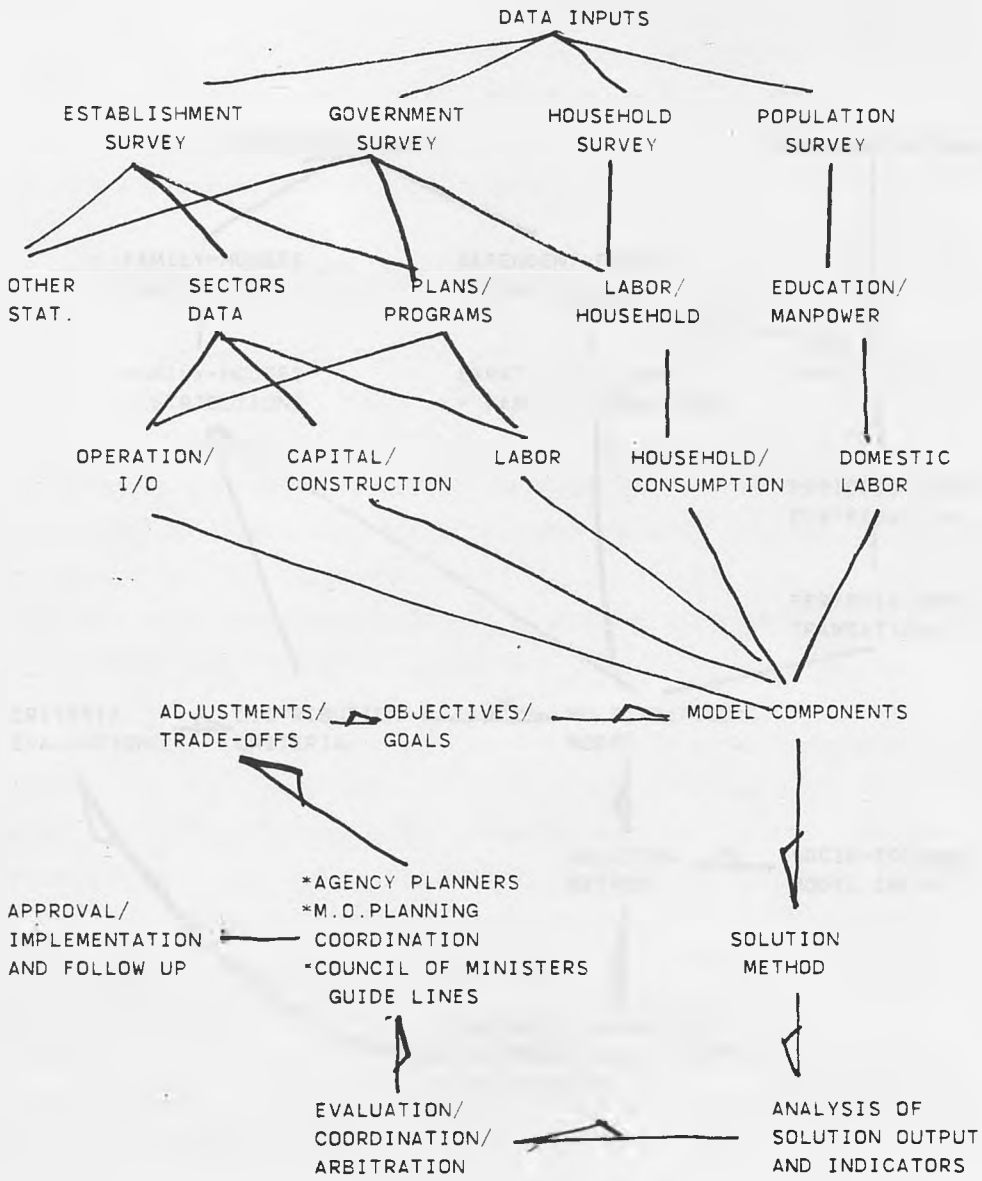


FIGURE 1-B-2: FLOW OF DATA AND SOLUTION PROCESS

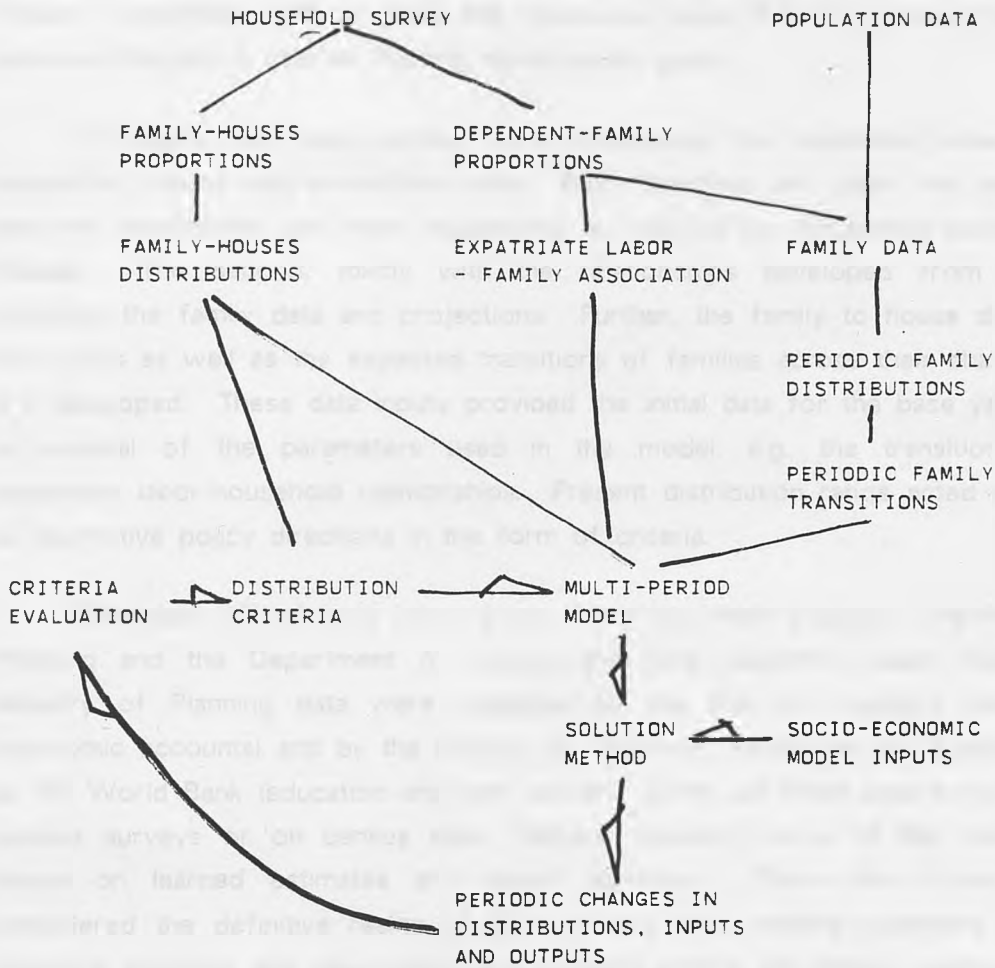


FIGURE 1-B-3: FLOW OF DATA AND PLANNING ACTIVITIES

components are discussed in the previous sections. This model accepts data and parameters of initial family/house distributions, transition probabilities, criteria of housing development, and other data inputs and constraints. As an output, it produces a report on the resulting distributions, inputs, and outputs of families and houses. Iteratively, criteria goals and objectives could then be adjusted to indicate possible changes in desired housing development goals.

To begin, two basic surveys were considered: the household survey and the population census and projections data. From the first we obtain the relationships between dependents and their households as well as the household distribution to houses. The second, jointly with the relationships developed from the first, provides the family data and projections. Further, the family to house distributions and ratios as well as the expected transitions of families across their characteristics are developed. These data inputs provided the initial data for the base year as well as several of the parameters used in the model, e.g., the transition and the expatriate labor/household relationships. Present distribution ratios acted as a guide to alternative policy directions in the form of criteria.

The data utilized here were drawn from two main sources: the Ministry of Planning and the Department of Census and Vital Statistics, Saudi Arabia. The Ministry of Planning data were collected by the firm of Coopers and Lybrand (economic accounts) and by the Division of Technical Assistance and Special Studies at the World Bank (education and man power). Some of these data were based on sample surveys or on census data. Others, including some of the trends, were based on learned estimates and expert opinions. These data should not be considered the definitive reality of Saudi Arabia since several questions about the sampling activities and observation and mapping errors still remain unanswered. In fact, some of these data may be already obsolete.

Our exercise here is to present representative data to support model's formulation and decision making. Hence we use these data as prototype representing the Saudi Arabian development situation. With this in mind, these data were organized in accordance with the above model formulation into the selected categories for illustrative purposes. Data are presented in both physical and in value terms. The unit of measurement for economic accounts and transactions is in thousands or in millions of Saudi Riyals as a surrogate to physical units, while labor is measured by number of laborers in each category.

APPENDIX 1-C

Notes on Some Aspects of Decision Making

1-C NOTES ON SOME ASPECTS OF DECISION MAKING

Centralization, decentralization, and multilevel planning have been the subjects of discussion and application for some time.[93] The multi-level situation was defined to be made of real and control organizations and decision making as one of super and sub-ordination (for example, operating unit, managerial units and central units in organization planning [248], sub-sector, sector, and multi-sector, in an economic system [159] or district, region, and country in a geographic system [36].

From the beginning the claim was made that multi-level planning and methods of decomposition are synonymous since one would want to optimize for the overall system by optimizing for the parts with some flow of information among them.[94]

The flow of information in such a methodology is based on a more restricted form. Usually one type of information flows downward and another upward. In reality, planning and the practical use of mathematical planning models is less rigid. One cannot expect to transform the planning system into a proper of decomposition method.[95] Further examination of the process of planning and the use of the method led Kornai [162] to conclude that the original work of 1960's to the abstract theory (and the following applications [126, 156,157]) have shown real confrontations with the practice of planning. Multi-level and other interdependencies (among the systems of models and the systems of decision making) should, therefore, be clearly delineated. The principles of multi-level planning, however, remain to be interpreted in a more general way.

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93 See Kornai [159-163].

94 These studies have dealt with perfect hierarchies and quasi hierarchies where the information flows only vertically. In reality, the flow of information could be horizontal as well as undetermined to allow for indirect super-sub relationships, where the two are not on the same level. That was also the conceptual conclusion of the Mexican study [126], where the need is recognized for the design and redesign of the models developed to form a more closely knit "system".

95 See Lasdon [170] for system decomposition methods and Kornai [162] for evaluation of decomposition methods as related to multi level planning. Worth noting also in [162] is that as of 1971, computationally, the direct method was preferable for problems of 2000 - 4000 rows. Experimental results of comparisons were published by T. M. Hogan, "A Comparison of Information Structures and Convergence Properties of Several Multi-Sector Economic Planning Procedures, Technical Paper No. 10, Berkeley, California, Center for Research in Management Science, Berkeley California.

Multi level planning usually refers to that class of problems characterized by vertical flow of information in a hierarchy, or quasi hierarchy, of super and sub ordination among the various system components. When reinterpreted, the principles of multi-level planning could mean the existence of interrelated systems of decision making and interdependent systems of models. One could then visualize a complex decision environment affecting systems represented by their interrelated parameters and variables. For example, government services planning and industrial planning share the demographic and other characteristics of labor with the manpower planning activities. Each may, however, have goals and objectives different from the other.

From another perspective, we may not assume here the existence of a perfect hierarchy in decision making. In this framework, we characterize the planning system to be both multi level and multi objective with a variety of decision chains, semi hierarchical subordination, and horizontal linkages. The flow of information to and from decision makers should be properly evaluated, according to the context of planning, i.e. the interdependent system of models. The identification of the proper indicators and the cross impacts, resulting from their conflicting goals and objectives, could begin to establish the horizontal links among the decision makers. Vertically however, these objectives could be preempted during the attempt to coordinate among their aspirations. This is done to balance among them, to emphasize one over the other, to arbiter their goals, to indicate the relative importance of either reaching their goals before the others. Again by identification of the interdependent dimensions among the respective system of models, the horizontal links are established.

The decision environment necessarily includes certain subjectivity, vagueness, and may be partly ill structured, There are a variety of operations and goals facing the decision maker(s); decision analysis therefore becomes a useful and supportive tool to help in reaching decisions. Additionally analytical approaches could be oriented at systematic approaches to the subjective decision making process -- to enable, not to substitute for the decision maker in his goal attainment. In turn the assignment of priorities to competing and conflicting goals is of added importance to indicate the directions for decisions.

The goal programming approach is a flexible tool for decision analysis that

allows a simultaneous solution to a system of complex multiple objectives.[96] It is capable of handling decision problems of single goals, multiple goals and subgoals and draws upon the highly developed and tested technique of linear programming. Generally in goal programming one encounters a set of conditions as goals to be met as closely as possible. Objective function(s) are then developed to penalize the deviations, over or under achievements, from the desired goal. Such a preference function could be one sided, to emphasize either over or under achievement or it could penalize one differently from the other. In general, goal programming can be applied where 1) objectives can be expressed as desired values for goal variables; 2) the decision makers makes and reviews relationships concerning the importance of the goals; and 3) policy variables are constrained by some functional relationships.

Goal programming does provide the decision maker with the ability to search for alternatives and explore their impacts. This can be done by iterative changes in the goals and constraints, and the choice of weights.[97] This process in itself is a learning process to educate the decision maker(s) and make them aware of areas of conflict and cooperation with others, particularly when the goals are the focus of coordination, and arbitration as exist in many decision making environments, including Saudi Arabia. At each stage in this process, the decision maker(s) adopt to new information, in contrast to a predetermined optimal strategy. Knowledge about these adoptive decision strategies may further provide the model developer with the most likely path to the decision maker's goal focusing process. The iterative process of

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[96] The original method was first developed by Charnes and Cooper [37, 45, 162, 177] and has received impetus from many contributors. Some of those contributions have centered on investigations of non-linear [222], integer [175], stochastic properties [62]; and to provide flexibile definitions of goals, goal interval programming [148]. Other approaches have addressed themselves to the interactive properties [98, 122, 176, 222, 238] to help the decision maker in iterative reach for solution(s). Several other contributions have examined the decision environment and/or the context of application and attempted to present the appropriate methodology for it. These efforts have taken a variety of directions, for example, joint eco-democratic planning [251-252], multi-level manpower planning [41], investment planning [254] and multi-level organization planning [248]. For a review of alternative multiple objective decision approaches see Cohon [59]; for the relationship to to multiple utility, Fishburn [109, 110] and Dyer [96]; for general classification of approaches, MacCrimmon [196]; for a review of the state of the art, Starr and Zeleny [266]; and for classification of optimization approaches, Wendell [302].

[97] Several iterative approaches have been developed [95, 97, 118, 174, 237, 298, 304, 309]. Basically they elicit information from the decision maker to form a series or a sequence of preference functions and limit the solution space simultaneously. Most notably mentioned for its mathematical elegance but practical difficulty is the Geffrion,Dyer,and Feinberg procedure [122]. The decision maker is specifically asked to determine the trade-off in one to compensate for another, i.e. derive his marginal rate of substitution, through pairwise comparison. See Wallinus [298] for discussion and comparison among several procedures. The complexity of the Geffrion et al procedure lies with the amount and the degree of substitutions decision makers can do and comprehend. See also Hopkins,M Massey, and Wehurng [xxx] for a modified version that restricts the changes and thus reduces information to be processed. To avoid many comparisons Zionts and Wallinus [310] depend upon the reduction of the feasible region through constraints, and Karwan [148] allows reductions through decision makers' threshold constraints, to better approximate the preference function.

evaluation and adjustment may as represented as a combinatorial decision process that distinguishs among the various levels of decision makers and their degree of involvement in the planning process. In this respect we may represent a problem of several levels; subsystems, components in each of these subsystems, and finally the smaller disaggrgate in these components. The evaluation and feedback in response to the model's solution and indicators, can happen at any of these levels.

The planning process, as delineated above, is supported by application of search methods to provide the solution outputs at each of the iterations. This type of problem could be solved either by direct or by partitioning procedures, e.g. across subsystem or periods, taking into account coupling rows and columns.[98] Whenever the computational time and or problem subdivision becomes at issue, we could resort to the appropriate partitioning procedure utilizing the dual of the problem's subset to guide the search for optimal solutions.[99] In addition to the possibilities of partitioning due to problem size, another is related to the use of mixed approaches for project evaluation, hence mixed integer procedures.[100] Further these projects could be connected through a sequencing network, hence the possibility of extending the focus of the analysis to effects of project developments paths on the rest of the model's components.

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[98] It has been reported in Kornai [162], that for problems of size 2000-4000 rows it is preferable to use the direct method. Therefore, no computational advantage is seen at this stage for the use of partitioning vs direct procedures. See Hogan [137] for the evaluation of advantages and disadvantages of alternative algorithmic procedures.

[99] See Lasdon [170] for definition of large scale optimization and for presentation of alternative methods and alternative decomposition procedures--including Dantzig-Wolfe principle, Column generation procedure, and Rozen's procedure.

[100] See Garfinkel and Nemhauser [122] for detailed presentation of integer and mixed integer programming problems and procedures. See also Manne [203] for his formulation of project evaluation as a mixed integer programming problem-- a specialized version of Bender's [14] partitioning procedure.

APPENDIX 2-A

SIMULATION OF ALTERNATIVE SCENARIOS

2-A SIMULATION OF ALTERNATIVE SCENARIOS

Under the hypothesis of 1 (complete cut-off of inter industrial imports) and 2 (sudden departure of expatriate labor in sectors), domestic outputs could drastically change, indicating decline in the growth rate as compared to the expected. These outputs could be estimated using

$$q_d = A_d^{-1}(q - X_m e - y)$$

where q_d is the domestic output using only intermediate inputs, X_m is the intermediate imports, and q and y are the total domestic output and the total final demand respectively. The output related to the use of domestic labor can alternatively be defined as

$$q_d = L_d^{-1} / _d$$

where L_d is the domestic labor input per unit output ratios.

These two hypotheses represent a rather extreme view of potential "pessimistic" effects. However, due to many other reasons, for example ports congestion and delays or decline in expatriate recruitment, the domestic output is bound to be affected. In a more optimistic view, an indicative application of project planning is accorded to oil-gas, manufacturing, and utility sectors since they, as shown from project data, were the sectors which had most of the industrialization programs. Data for the present outputs and the expected project outputs are shown in Table A-1. In Table A-2 we further show the alternative effects of the extreme views, no intermediate and no expatriate labor. Figure A-1 shows the results of these two pessimistic considerations and compares them to the present and expected conditions. We have not included in the above simulation other considerations such as those related to the diversification of sources of employment and other resources. See footnote 38, in Chapter 2, for a brief dicusstion of the political flexibility vs economic effeciency issues involved in the recruitment of expatriate labor.

TABLE 2-A-1: BASE YEAR AND PROJECTS EXPECTED OUTPUTS

	OUTPUT BASE YEAR	EXPECTED PROJECTS OUTPUT T= 1	EXPECTED PROJECTS OUTPUT T= 2
Agriculture	9085.700	0.0	0.0
Oil-Gas	23043.200	495.2	7423.4
Manufacturing	8780.000	0.0	3410.76
Utilities	951.700	33.29	2046.65
Const. Bldg.	15573.000	0.0	0.0
Const. Other	19706.200	0.0	0.0
Wholesale/Ret.	20490.100	0.0	0.0
Transp./Comm.	7740.500	0.0	0.0
Services	14462.700	0.0	0.0
TOTAL	119833.100	528.49	12890.81

TABLE 2-A-2: OUTPUTS UNDER ALTERNATIVE SCENARIOS

	OUTPUT- NO INTERMEDIATE IMPORTS	OUTPUT- NO EXPATRIATE LABOR
Agriculture	2508.46	9085.00
Oil-Gas	11840.58	15152.29
Manufacturing	4586.09	2474.02
Utilities	631.10	571.82
Const. Bldg.	7682.97	4730.91
Const. other	10298.45	4390.38
Wholesale/ret.	18296.13	12815.47
Trans./Comm.	5626.50	5848.27
Services	7933.09	5179.37
TOTAL	69403.37	60284.69

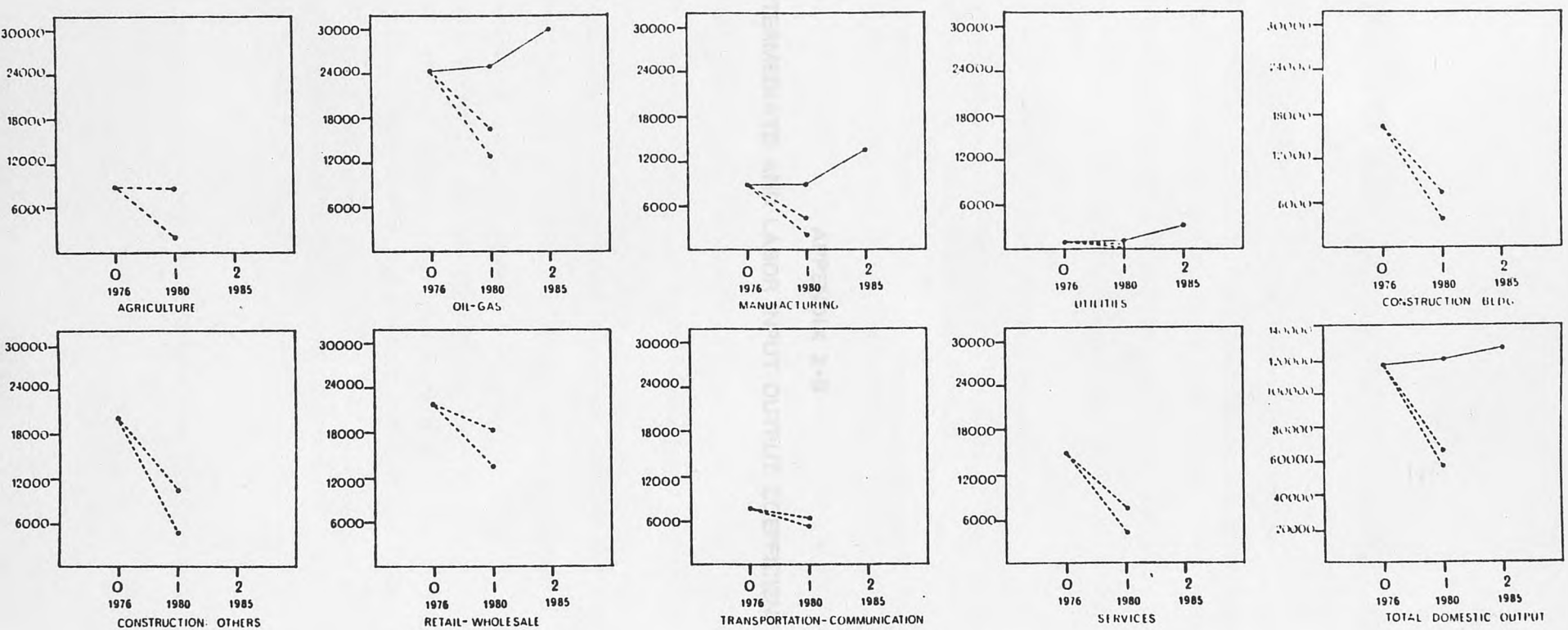


FIGURE 2-A-1: ALTERNATIVE SCENARIOS FOR DOMESTIC OUTPUTS

APPENDIX 2-B

INTERMEDIATE AND LABOR INPUT OUTPUT COEFFICIENTS

2-B INTERMEDIATE AND LABOR INPUT OUTPUT COEFFICIENTS

In the static leontief model, for the production system to be indecomposable and productive, several properties are observed [44, 51, 61, 108]; including:

1. at least one bill of final demand is producible;
2. any bill of final demand is producible, provided that there is sufficient labor available;
3. there is at least one set of measurements in which
   a. if a technology is to be viable at all, each of the "own" input coefficients, a_{ii}, must be less than unity, and
   b. no row sum (column sum) is greater that unity and at least one row sum (column sum) is less than unity;
4. the characteristic root, λ^*, of the matrix $[a_{ij}]$, which is invariant to any change in units, are all less than 1 in absolute value, so that the "multiplier series" $I + a + a^2 + \ldots$ converges to $(I - A)^{-1} = 1$;
5. all the elements in $(I - A)^{-1}$ are positive;
6. decreasing requirement coefficient a_{ij} decreases every element in $(I - A)^{-1}$;
7. $(I - A)$ is Hicksian, i.e. all its principle minors are positive; and
8. all the indecomposable subsystems of a have all the properties of A.

For the closed model if the characteristic root, property 3, is equal to unity the model has a unique equilibrium for the formulation $Aq = q$, $q \geq 0$. For the model to produce any bill of final demand $(I - A)q = c$, i.e. $q = (I - A)^{-1}c$, the inverse $(I - A)^{-1}$ must be positive. Also if s is the smallest and S is the largest of the row sums of A [that is $s = \min_i \sum_j |a_{ij}|$ $S = \max_i \sum_j |a_{ij}|$], then $s < \lambda^* < S$. The same kind of relationship holds for the column sums. We might also add that for matrices A and B, if $A \geq B$ then the characteristic roots will follow such that $\lambda^*_A \geq \lambda^*_B$.

From the previous information present and expected production coefficients could be constructed such that

$$A_{ij}(0) = X_{ij}(0) / q_j(0) ,$$

$$A_{ij}(1) = (X_{ij}(0) + X_{ij}(1)) / (q_j(0) + q_j(1)) ,$$

$$A_{ij}(2) = (X_{ij}(0) + X_{ij}(2)) / (q_j(0) + q_j(2)) ,$$

where $A_{ij}(0)$, $A_{ij}(1)$, and $A_{ij}(2)$ are the input-output coefficients for the base year as well as the expected at period 1 and the expected at period 2 if project implementation is completed at each respective period. Tables 2-B-1, 2-B-2, and 2-B-3 show the resulting intermediate input per unit output of base year as well as the expected at the succeeding two periods.

From the input-output properties , one can interpret an efficient production system as the one that could utilize less intermediate inputs to produce the same amount of output. Also, by the property of matrix comparison, if for two matrices A and B, $A \geq B$, then the characteristic root of A should be more than or equal to the characteristic root of B. Reviewing this and other properties of A(0), A(1), and A(2), the characteristic roots were .40996 (for A(0)) $\geq$ .40890 (for A(1)) $\geq$ .18347 (for A(2)). This could be indicative of the marginal change from the base year to the first period but a rather significant change in the second period.

Similar to the intermediate input per unit output shown in the previous subsection, the labor input per unit output coefficients can be stated as follows:

$$L_{ij}(0) = W_{ij}(0) / q_j(0) ,$$

$$L_{ij}(1) = (W_{ij}(0) + W_{ij}(1)) / q_j(0) + q_j(1) ,$$

$$L_{ij}(2) = (W_{ij}(0) + W_{ij}(2)) / q_j(0) + q_j(2).$$

The data for L(0), L(1), and L(2) are shown in Table 2-B-4, 2-B-5, and 2-B-6 for the base year and the expected labor inputs per unit outputs for the two succeeding periods. As an illustrative example the data indicates, as expected,

TABLE 2-B-1: BASE YEAR INPUT OUTPUT COEFFICIENTS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) AGR.	.03083	.00000	.00048	.00000	.00008	.00000	.00000	.01448	.00254
(2) OIL	.00664	.00906	.00517	.04697	.00315	.00513	.00173	.02874	.00609
(3) MANU.	.01542	.04798	.38852	.12556	.23029	.17007	.01034	.07076	.08068
(4) UTIL.	.00000	.00106	.00842	.00515	.00257	.00247	.00450	.00249	.00306
(5) CNS:B	.00000	.00025	.00055	.00651	.00286	.00053	.00117	.00040	.00468
(6) CNS:D	.00000	.00127	.01306	.00515	.02582	.06086	.00001	.09812	.00000
(7) RT/W.	.00768	.00054	.05964	.04035	.03748	.01823	.01363	.01642	.01415
(8) TRNS.	.00000	.01961	.02748	.11411	.01680	.02101	.04717	.08846	.01462
(9) SERV.	.00330	.03074	.04311	.10224	.10064	.02001	.03658	.07662	.04147
	.06837	.11051	.54641	.44604	.41969	.29831	.11513	.39650	.16730

TABLE 2-B-2: EXPECTED INPUT OUTPUT COEFFICIENTS PERIOD 1

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) AGR.	.03083	.00000	.00048	.00000	.00008	.00000	.00000	.01448	.00254
(2) OIL	.00664	.00906	.00517	.10032	.00315	.00513	.00173	.02874	.00609
(3) MANU.	.01542	.04797	.38852	.13427	.23029	.17007	.01034	.07076	.08068
(4) UTIL.	.00000	.00105	.00842	.01102	.00257	.00247	.00450	.00249	.00306
(5) CNS:B	.00000	.00025	.00055	.00639	.00286	.00053	.00117	.00040	.00468
(6) CNS:D	.00000	.00127	.01306	.00596	.02582	.06086	.00001	.09812	.00000
(7) RT/W.	.00768	.00053	.05964	.03917	.03748	.01823	.01363	.01642	.01415
(8) TRNS.	.00000	.01949	.02748	.11386	.01680	.02101	.04717	.08846	.01462
(9) SERV.	.00330	.03075	.04311	.10755	.10064	.02001	.03658	.07662	.04147
	.06837	.11037	.54641	.51854	.41969	.29831	.11513	.39650	.16730

TABLE 2-B-3: EXPECTED INPUT OUTPUT COEFFECIENTS PERIOD 2

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) AGR.	.03083	.00000	.00582	.00000	.00008	.00000	.00000	.01448	.00254
(2) OIL	.00664	.03087	.03592	.32735	.00315	.00513	.00173	.02874	.00609
(3) MANU.	.01542	.04652	.30431	.10446	.23029	.17007	.01034	.07076	.08068
(4) UTIL.	.00000	.00185	.01170	.03235	.00257	.00247	.00450	.00249	.00306
(5) CNS:B	.00000	.00024	.00044	.00252	.00286	.00053	.00117	.00040	.00468
(6) CNS:D	.00000	.00129	.00996	.00565	.02582	.06086	.00001	.09812	.00000
(7) RT/W.	.00768	.00047	.04304	.01394	.03748	.01823	.01363	.01642	.01415
(8) TRNS.	.00000	.01776	.02176	.05360	.01680	.02101	.04717	.08846	.01462
(9) SERV.	.00330	.03049	.03547	.07337	.10064	.02001	.03658	.07662	.04147
	.06837	.12949	.46842	.61324	.41969	.29831	.11513	.39650	.16730

TABLE 2-B-4: BASE YEAR LABOR INPUT PER UNIT OUTPUT

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
MANAGERS	0.00000	0.02417	0.23508	0.35726	0.04251	0.08601	0.10210	0.22389	0.17486
PROFESSIONAL	0.00000	0.15098	0.57506	2.29274	0.15142	0.29387	0.45934	0.44028	0.89886
CLERICAL	0.00000	0.19207	0.31173	0.84060	0.13067	0.20425	0.73089	1.02422	0.46513
SKILLED	0.00000	0.56529	2.75399	2.75087	1.45348	2.09041	0.78984	1.50003	1.41958
UNSKILLED	0.00000	0.16582	3.67335	2.80446	4.71309	3.01291	0.77667	1.15639	1.70072
AGRICULTURAL	78.36259	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
PROPRIETERS	0.00000	0.00000	2.43462	0.46864	0.47775	0.03471	3.41560	4.11046	1.96713
	1.08933	9.98383	9.51923	7.33170	5.68745	6.27444	8.45522	6.62628	

TABLE 2-B-5: EXPECTED LABOR INPUT PER UNIT OUTPUT PERIOD 1

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
MANAGERS	0.00000	0.02442	0.23508	0.36650	0.04251	0.08601	0.10210	0.22389	0.17486
PROFESSIONAL	0.00000	0.14948	0.57506	2.26550	0.15142	0.29387	0.45934	0.44028	0.89886
CLERICAL	0.00000	0.18955	0.31173	0.85711	0.13067	0.20425	0.73089	1.02422	0.46513
SKILLED	0.00000	0.55800	2.75399	2.79696	1.45348	2.09041	0.78984	1.50003	1.41958
UNSKILLED	0.00000	0.16449	3.67335	2.77464	4.71309	3.01291	0.77667	1.15639	1.70072
AGRICULTURAL	71.70770	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
PROPRIETERS	0.00000	0.00000	2.43462	0.46864	0.47775	0.03471	3.41560	4.11046	1.96713
	1.08594	9.98383	9.55971	7.33170	5.68745	6.27444	8.45522	6.62628	

TABLE 2-B-6: EXPECTED LABOR INPUT PER UNIT OUTPUT PERIOD 2

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
MANAGERS	0.00000	0.02686	0.18299	0.32668	0.04251	0.08601	0.10210	0.22389	0.17486
PROFESSIONAL	0.00000	0.13383	0.44567	1.44588	0.15142	0.29387	0.45934	0.44028	0.89886
CLERICAL	0.00000	0.16250	0.25204	0.73027	0.13067	0.20425	0.73089	1.02422	0.46513
SKILLED	0.00000	0.48023	2.06826	2.36963	1.45348	2.09041	0.78984	1.50003	1.41958
UNSKILLED	0.00000	0.14996	2.68492	1.83256	4.71309	3.01291	0.77667	1.15639	1.70072
AGRICULTURAL	65.61250	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
PROPRIETERS	0.00000	0.00000	2.43462	0.46864	0.47775	0.03471	3.41560	4.11046	1.96713
	0.95338	8.06851	7.17359	7.33170	5.68745	6.27444	8.45522	6.62628	

changes in the labor input per unit output ratios in the three sectors considered--oil-gas, manufacturing, and utilities. The data also indicates two other properties: 1) an expected improvement in the intensity of labor use in the three sectors considered, and 2) an estimated improvement in the productivity of agricultural labor associated with decrease in their numbers.[101] No attempts are made in this thesis to examine in detail the issue of sector labor productivity and the expatriate-domestic labor differences. One can expect, in further analysis, that on-the-job training of Saudi labor may increase their productivity[102], thus improving the achievement of expatriate labor substitution objectives.

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[101] The decrease in the agriculture labor input ratio was the result of a study of agricultural labor productivity conducted by the World Bank.

[102] compared with their expatriate counter persons

APPENDIX 2-C

LABOR INCOME AND HOUSEHOLD CONSUMPTION

2-C LABOR INCOME AND HOUSEHOLD CONSUMPTION

Several factors do affect the final household consumption: (1) the labor income differences among sector and government labor; (2) the labor share in household incomes; and (3) other incomes generated by the households, through government or private mechanisms. Using these factors we can relate labor to the household income. The generated household income is further related to consumption of goods. Finally, government subsidies are added to define the total consumption demands.

In the following we explain such income distribution relationships. First, we write the labor requirements as:

$$
\begin{aligned}
L\,q - I\;\; l_{ds} - I\;\; l_{xs} &= 0 \\
I\;\; l_{ds} + I\;\; l_{dg} &= l_d \\
I\;\; l_{xs} + I\;\; l_{xg} &= l_x
\end{aligned}
$$

Labor income could then be written as:

$$
\begin{aligned}
\hat{V}_{ds}\; l_{ds} + \hat{V}_{dg}\; l_{dg} &= Y_d \\
\hat{V}_{xs}\; l_{xs} + \hat{V}_{xg}\; l_{xg} &= Y_x
\end{aligned}
$$

The total labor share in household income could be written as:

$$
\begin{aligned}
D_d\, y_d &= y_{dh} \\
D_x\, y_x &= y_{xh}
\end{aligned}
$$

and the total household income as:

$$
\begin{aligned}
\beta\; y_{dh} &= y''_{dh} \\
\beta\; y_{xh} &= y''_{xh}
\end{aligned}
$$

Finally government subsidies and total consumption could be written as:

$$
\begin{aligned}
c_d\, y''_{dh} + c_x\, y''_{xh} &= c_h \\
\beta\;\; c_h &= gs
\end{aligned}
$$

Hence the resulting consumption of all households

$$l\ c_h + l\ gs = c$$

where

L = wxn matrix of labor, in activity k. k=1,....,w, input per unit output in sector i, i=1,....,n;

q = nx1 vector of sectors i, i=1,....,n, outputs;

l_{ds} = wx1 vector of domestic labor in sectors;

l_{xs} = wx1 vector of expatriate labor in sectors;

l_{dg} = wx1 vector of domestic labor in government;

l_{xg} = wx1 vector of expatriate labor in government;

$\hat{V}_{ds}$ = wxw diagonal matrix whose $\hat{V}_{ii}$ entries are the average incomes of domestic labor in sectors;

$\hat{V}_{xs}$ = wxw diagonal matrix whose $\hat{V}_{ii}$ entries are the average incomes of expatriate labor in sectors;

$\hat{V}_{dg}$ = wxw diagonal matrix whose $\hat{V}_{ii}$ entries are the average incomes of domestic labor in government;

$\hat{V}_{xg}$ = wxw diagonal matrix whose $\hat{V}_{ii}$ entries are the average incomes of expatriate labor in government;

Y_d = wx1 vector of domestic labor income;

Y_x = wx1 vector of expatriate labor income;

D_d = kxw matrix of the income proportions distributed by domestic labor to domestic households;

D_x = kxw matrix of the income proportions distributed by expatriate labor to expatriate households;

β = kxw diagonal matrix of the proportion of total household income to income generated by labor;

y''_{dh} = kx1 vector of domestic household income generated by labor;

y''_{xh} = kx1 vector of expatriate household income generate by labor;

y_{dh} = kx1 vector of total domestic household income;

y_{xh} = kx1 vector of total expatriate household income;

C_d = nxk matrix of consumption coefficients of domestic households;

C_x = nxk matrix of consumption coefficients of expatriate households;

C_h = nx1 vector of total household consumption without government subsidies;

βI_2 = nxn diagonal matrix proportion of government subsidies to household consumption;

gs = nx1 vector of government subsidies;

c = nx1 vector of total household consumption requirements from sectors i, i=1,.....,n.

By substitution of the above components we can then define c_i, i=1,...,4 for four combinations of the Saudi and expatriate labor in sectors and in government as

$$c_i = (I + \beta_2)c_i \beta D_i V_i I_i$$

such that

$$Z_i = (I + \beta_2)c_i \beta D_i V_i$$

where

Z_i = matrix of proportion of consumption for sectors of households related to labor in the private sector and government.

In tables 2-C-1 and 2-C-2, the average incomes of labor in government and in sectors are presented. Notice the differences across government agencies, in 2-C-1, an between sectors, in 2-C-2, as well as among occupations. From data, private sector total average income is higher than government's, and the expatriate labor's average is higher than that of domestic labor. Government employees' income could be the result of restrictions on increases in salaries to contain inflation. Expatriate labor income levels could be the result of the desire to provide more of an incentive for the expatriate to travel end change residence.

TABLE 2-C-1: AVERAGE INCOME OF LABOR IN GOVERNMENT

		(PA)	(HL)	(ED)	(OT)	TOTAL
DOMESTIC	MANAGERS	63.30	75.00	55.34	67.27	65.16
	PROFESSIONAL	34.99	34.20	27.85	42.02	33.40
	CLERICAL	21.86	21.00	18.82	27.17	22.93
	SKILLED	29.43	16.81	19.78	28.74	28.72
	UNSKILLED	17.50	12.27	13.63	21.23	17.07
EXPATRIATE	MANAGERS	85.43	76.00	64.71	0.00	79.89
	PROFESSIONAL	38.68	34.48	37.02	37.39	36.84
	CLERICAL	23.30	25.00	3.05	23.08	15.61
	SKILLED	31.51	20.00	34.48	25.00	31.64
	UNSKILLED	30.05	12.96	20.65	17.00	25.73

(PA) PUBLIC ADMINISTRATION (HL) HEALTH
(ED) EDUCATION (OT) OTHERS

TABLE 2-C-2: AVERAGE INCOME OF LABOR IN SECTORS

OCCUPATION \ SECTORS		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(T)
DOMESTIC MANAGERS	[A]	0.00	143.03	60.83	117.96	75.27	87.94	76.73	83.78	86.28	80.42
PROFESSIONAL	[B]	0.00	93.18	50.44	39.64	65.33	77.72	42.18	56.61	42.60	54.99
CLERICAL	[C]	0.00	61.53	30.06	23.33	48.34	40.75	30.09	33.27	26.63	35.85
SKILLED	[D]	0.00	52.01	24.84	22.99	44.75	39.29	25.31	37.71	25.38	37.77
UNSKILLED	[E]	0.00	38.92	29.19	14.28	19.92	20.52	21.66	19.30	19.27	21.82
AGRICULTURAL	[F]	11.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.96
PROPRIETERS	[G]	0.00	0.00	45.96	25.87	48.23	66.54	128.78	62.20	64.24	91.97
EXPATRIATE MANAGERS	[A]	0.00	327.30	294.59	128.42	111.74	106.56	84.45	94.86	93.14	148.70
PROFESSIONAL	[B]	0.00	180.42	50.22	47.01	62.95	64.31	25.32	57.79	51.24	57.31
CLERICAL	[C]	0.00	74.53	64.32	35.65	38.75	39.45	27.73	51.31	34.83	39.69
SKILLED	[D]	0.00	79.42	24.13	27.21	32.41	29.42	23.65	31.01	19.56	28.38
UNSKILLED	[E]	0.00	25.09	21.34	19.37	25.78	32.10	20.70	13.33	20.61	25.27
PROPRIETERS	[G]	0.00	0.00	37.16	25.49	48.20	66.47	136.15	115.14	92.55	75.91

data here are presented in thousands of S.R. per year

Labor income is the usual source of household income. Households may be composed of more than one wage earner. A Saudi wage earner may also be responsible for his extended family's income, hence the distribution of income to other households as well, including those headed by economically non-active members.

In Table 2-C-3, the data indicates those proportions of income generated by domestic and expatriate labor, in the various occupation categories, and distributed to households whose head is in a particular economic activity. Notice the higher share of the domestic labor's income distributed to other households as compared with the expatriate labor. This may indicate the social behavior of most wage domestic wage earners to continue to live within the same household as an extended family. Most expatriate wage earners are independent of their extended families.

Consumption requirements of those households are presented in table 2-C-4. Notice that two additional categories are added here, one for the foreign visitors,[103] and the second for the proportion of direct government subsidies to total household consumption from sectors. Finally, Tables 2-C-5 to 2-C-6 present those coefficients developed using the formulations described above. They show the consumption coefficients for households related to labor in sectors and in government.

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103 Primarily pilgrims to holly places in Saudi Arabia.

TABLE 2-C-3: LABOR INCOME DISTRIBUTION TO HOUSOLDS

TO DOMESTIC HOUSEHOLDS:	FROM: DOMESTIC LABOR A	B	C	D	E	F	H	EXPATRIATE LABOR A	B	C	D	E	H
A MANAGER	.810	.008	.009	.008	.006	.000	.001	.000	.000	.000	.000	.000	.000
B PROFESSIONAL	.022	.474	.097	.007	.021	.000	.006	.000	.000	.000	.000	.000	.000
C CLERICAL	.024	.105	.465	.026	.022	.000	.012	.000	.000	.000	.000	.000	.000
D SKILLED	.014	.049	.104	.738	.048	.000	.015	.000	.000	.000	.000	.000	.000
E UNSKILLED	.032	.092	.083	.032	.575	.000	.008	.000	.000	.000	.000	.000	.000
F AGGRICUL.	.027	.052	.056	.063	.131	1.000	.000	.000	.000	.000	.000	.000	.000
G INACTIVE	.028	.121	.096	.005	.115	.000	.949	.000	.000	.000	.000	.000	.000
H PROPRIOTER	.000	.047	.039	.027	.043	.000	.010	.000	.000	.000	.000	.000	.000
EXPATRIATE HOUSEHOLDS:													
A MANAGER	.000	.000	.000	.000	.000	.000	.000	.805	.003	.009	.000	.000	.000
B PROFESSIONAL	.000	.000	.000	.000	.000	.000	.000	.076	.914	.029	.011	.008	.003
C CLERICAL	.000	.000	.000	.000	.000	.000	.000	.000	.014	.845	.026	.068	.016
D SKILLED	.000	.000	.000	.000	.000	.000	.000	.000	.006	.038	.799	.028	.024
E UNSKILLED	.000	.000	.000	.000	.000	.000	.000	.000	.006	.020	.028	.809	.002
H PROPRIOTER	.000	.000	.000	.000	.000	.000	.000	.000	.010	.023	.107	.059	.954

TABLE 2-C-4: HOUSHOLD CONSUMPTION COEFFICIENTS

SECTORS:	HOUSEHOLDS: DOMESTIC A	B	C	D	E	F	G	H	EXPATRIATE A	B	C	D	E	H	(FU)
AGGRICULTURE	.03582	.10089	.12986	.16121	.18859	.22502	.08096	.14754	.04278	.08857	.10472	.15796	.15211	.03925	.07504
OIL-GAS	.01040	.00736	.01231	.01532	.01339	.01467	.00836	.01309	.00967	.01502	.01350	.01335	.01694	.00382	.00571
MANIFUCTURE	.07621	.18221	.24969	.26865	.27952	.37529	.14478	.27565	.09346	.18830	.17824	.23588	.23156	.07275	.18207
UTILITIES	.00114	.00205	.00341	.00418	.00433	.00121	.00264	.00573	.00372	.00416	.00549	.00844	.00959	.00175	.00000
CONST: BLDG.	.00062	.00189	.00153	.00451	.00230	.00494	.00180	.00240	.00011	.00038	.00057	.00133	.00047	.00035	.00000
CONST: OTHER	.00049	.00150	.00124	.00354	.00184	.00390	.00141	.00189	.00011	.00037	.00048	.00108	.00041	.00029	.00000
WHOLESALE/RET.	.06517	.14841	.19843	.22444	.24408	.32001	.11917	.22074	.07331	.14690	.14608	.19907	.20071	.05801	.14321
TRANSP./COMM.	.01552	.02192	.02865	.02861	.02284	.00805	.02206	.02641	.05493	.06539	.22293	.06380	.04822	.02858	.34063
SERVICES	.04969	.09165	.13963	.14681	.14288	.16716	.08257	.15585	.14032	.17426	.16936	.19190	.17501	.07069	.25311

TABLE 2-C-5: CONSUMPTION COEFFICIENTS FOR HOUSHOLDS RELATED TO DOMESTIC LABOR IN SECTORS

	(A)	(B)	(C)	(D)	(E)	(F)	(G)
(1)	.014610	.018286	.010929	.010084	.009722	.004348	.013228
(2)	.003421	.001452	.000956	.000917	.000726	.000284	.001333
(3)	.029307	.032249	.019608	.016994	.015243	.007252	.023619
(4)	.000421	.000436	.000280	.000255	.000224	.000023	.000427
(5)	.000251	.000319	.000171	.000249	.000141	.000096	.000283
(6)	.000201	.000253	.000137	.000196	.000112	.000075	.000222
(7)	.024963	.026488	.015993	.014171	.013062	.006184	.019421
(8)	.005228	.003460	.002044	.001660	.001243	.000156	.003405
(9)	.018206	.016802	.010608	.009153	.007841	.003230	.013390

TABLE 2-C-6: CONSUMPTION COEFFICIENTS FOR HOUSEHOLDS RELATED TO EXPATRIATE LABOR IN SECTORS

	(A)	(B)	(C)	(D)	(E)	(G)	(FV)
(1)	.009548	.006060	.005093	.005153	.004444	.004023	.000073
(2)	.002088	.001012	.000646	.000449	.000495	.000394	.000006
(3)	.020788	.012748	.008647	.007792	.006838	.007294	.000176
(4)	.000781	.000287	.000268	.000275	.000275	.000184	.000000
(5)	.000027	.000026	.000028	.000042	.000015	.000035	.000000
(6)	.000027	.000026	.000024	.000034	.000013	.000029	.000000
(7)	.016295	.009968	.007095	.006561	.005890	.005851	.000139
(8)	.011579	.004581	.009765	.002295	.001871	.003024	.000330
(9)	.029682	.011791	.008130	.006399	.005292	.006979	.000245

(1) AGRICULTURE (2) OIL-GAS (A) MANAGERS (B) PROFESSIONAL
(3) MANUFACTURING (4) UTILITIES (C) CLERICAL (D) SKILLED
(5) CONST:BLDG (6) CONST:OTHER (E) SKILLED (F) AGRICULTURE
(7) RET/WHOLESALE (8) TRANS/COMMUN (G) PROPRIETERS
(9) SERVICES (FV) FOREIGN VISITORS

TABLE 2-C-7: CONSUMPTION COEFFICIENTS FOR HOUSHOLDS RELATED TO DOMESTIC LABOR IN GOVERNMENT

	(A)	(B)	(C)	(D)	(E)
(1)	.004197	.002270	.002220	.010132	.001827
(2)	.000837	.000182	.000196	.000925	.000136
(3)	.008123	.003973	.003979	.016939	.002865
(4)	.000112	.000051	.000054	.000245	.000039
(5)	.000074	.000041	.000036	.000263	.000022
(6)	.000059	.000032	.000029	.000207	.000022
(7)	.006896	.003276	.003249	.014166	.002459
(8)	.001295	.000420	.000414	.001655	.000224
(9)	.004867	.002061	.002147	.009087	.001455

TABLE 2-C-8: CONSUMPTION COEFFICIENTS FOR HOUSHOLDS RELATED TO EXPATRIATE LABOR IN GOVERNMENT

	(A)	(B)	(C)	(D)	(E)
(1)	.009545	.003011	.004039	.006247	.003797
(2)	.002069	.000503	.000512	.000545	.000423
(3)	.020762	.006337	.006858	.009455	.005844
(4)	.000768	.000143	.000213	.000334	.000235
(5)	.000028	.000013	.000022	.000051	.000013
(6)	.000027	.000013	.000019	.000041	.000011
(7)	.016272	.004955	.005627	.007959	.005034
(8)	.001403	.002276	.007761	.002795	.001604
(9)	.029257	.005860	.006446	.007770	.004525

(1) AGRICULTURE (2) OIL-GAS (A) MANAGERS (B) PROFESSIONAL
(3) MANUFACTURING (4) UTILITIES (C) CLERICAL (D) SKILLED
(5) CONST:BLDG (6) CONST:OTHER (E) SKILLED
(7) RET/WHOLESALE (8) TRANS/COMMUN
(9) SERVICES

APPENDIX 2-D

OUTPUTS OF ALTERNATIVE APPLICATIONS

2-D OUTPUTS OF ALTERNATIVE APPLICATIONS

Data outputs for the various illustrations are presented in this appendix for the applications coded ECN11, section 2.3.2.1, ECN13, section 2.3.2.2, and ECN14, section 2.3.2.3. They are arranged in two tables: the first shows the economic variables of supply and demand, and the second shows variables related to labor inputs in sectors and in government, labor goals and deviations, and expatriate labor recruitment (which acounts for the expected attritions of exaptriate labor from the previous period).

2-D.1 Numerical Illustration: Government Goals and Their Impacts(ECN11

ILLUSTRATION RESULTS FOR 1980

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Projects Projects
(1)	8287.32	5027.41	57.00	12579.57	0.00	13.10	161.00
(2)	23515.70	1382.59	22067.29	1134.85	0.00	285.80	75.00
(3)	8780.00	79130.29	146.00	21343.79	19614.60	3781.90	26908.00
(4)	6420.75	0.00	0.00	593.00	5004.90	393.70	0.00
(5)	28407.16	0.00	0.00	204.85	10944.00	1140.02	15846.30
(6)	6890.26	689.03	0.00	163.51	0.00	0.00	4822.60
(7)	22767.13	0.00	328.00	17861.30	343.80	575.54	777.70
(8)	12859.12	2443.23	552.94	4434.83	0.00	1020.20	641.00
(9)	21996.83	7038.98	1253.81	12700.69	2575.50	1748.40	3239.84
(T)	139924.27	95711.53	24405.04	71016.39	38482.80	8958.66	52471.44

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS, OUTPUTS, AND REQUIREMENTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	6958	300	8549	6658	9133	8849	2941	0	4017	4915
(B)	88859	77216	40877	59721	36339	29138	100598	0	10213	87430	32749
(C)	70435	34488	4855	42296	29633	26139	47151	434	0	34054	17168
(D)	104294	186916	47195	64808	139721	39486	112003	68010	0	118906	126398
(E)	193581	186924	1493	100305	185431	93276	101798	29542	0	157382	107790
(F)	598062	0	0	0	0	598062	0	0	0	0	0
(G)	154797	57274	0	0	57274	154797	0	35457	0	21817	46170
(T)	1227710	549776	94720	275679	455056	952031	370399	136384	10213	423606	335190

(A) MANAGERIAL (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURAL
(G) PROPRIETERS (T) TOTAL

ILLUSTRATION RESULTS FOR 1985

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Goverr. Dperation	Projects Projects
(1)	7375.71	7767.13	57.00	14385.41	0.00	15.60	161.00
(2)	32489.36	1503.43	28575.20	1329.49	0.00	340.10	75.00
(3)	12190.76	93720.87	3556.76	24416.79	22885.90	4499.70	30255.48
(4)	11240.20	0.00	0.00	725.45	9091.70	721.90	0.00
(5)	37651.79	0.00	0.00	228.01	13491.80	1388.40	22185.65
(6)	7401.32	740.13	0.00	181.69	0.00	0.00	4822.60
(7)	26430.70	0.00	328.00	20409.33	460.70	684.90	994.15
(8)	15151.77	2878.84	651.53	5270.15	0.00	1213.70	641.00
(9)	27484.80	8795.13	1566.63	14803.03	3818.40	2080.20	4199.28
(T)	177416.41	115405.53	34735.12	81749.35	49748.50	10944.50	63334.16

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS, OUTPUTS, AND REQUIREMENTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	21429	9643	362	10425	9281	11004	10787	5626	0	4017	6654
(B)	107689	99011	49165	71829	49846	35860	120994	11581	0	87430	65846
(C)	85361	44017	5896	51360	38121	34001	57256	9963	0	34054	29204
(D)	126395	234130	57035	78322	177095	48073	135357	115224	0	118906	153849
(E)	234603	240718	1805	121242	238913	113361	123047	83336	0	157382	148657
(F)	532275	0	0	0	0	532275	0	0	0	0	0
(G)	187600	63399	0	0	63399	187600	0	41582	0	21817	35191
(T)	1295352	690918	114263	333178	576655	962174	447441	267312	0	423606	439404

(A) MANAGERIAL (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURAL
(G) PROPRIETERS (T) TOTAL

2-D.2 Numerical Illustration: Total Government Plans and Labor Goals (ECN13

)

ILLUSTRATION RESULTS FOR W1G1T1 1980

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Projects Projects
(1)	8287.32	4400.00	57.00	11977.69	0.00	13.10	161.00
(2)	23515.70	1382.59	21624.50	1062.69	0.00	874.94	75.00
(3)	8780.00	76736.89	146.00	20304.10	19614.60	3781.90	26908.80
(4)	1310.20	0.00	0.00	538.03	0.00	393.70	0.00
(5)	27090.96	0.00	0.00	201.42	557.48	1140.02	15846.30
(6)	6721.83	672.18	0.00	160.52	0.00	0.00	4822.60
(7)	21220.77	0.00	328.00	17963.94	0.00	575.54	777.70
(8)	11720.54	2226.90	503.99	3962.77	0.00	1020.20	641.00
(9)	18479.83	5913.55	1053.35	11782.20	0.00	1748.40	32393.64
(T)	127127.15	91332.11	23712.84	67953.36	20172.08	9547.80	81626.04

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS, OUTPUTS, AND REQUIREMENTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	4034	300	8549	3734	9133	8849	17	0	4017	1991
(B)	88859	60877	40877	59721	20000	29138	100598	0	26552	87430	16410
(C)	70435	26053	4855	42296	21198	28139	47151	3658	0	34054	8733
(D)	104294	162671	47195	64808	115476	39486	112003	43764	0	118906	102153
(E)	193581	157381	1493	100305	155888	93276	101798	0	0	157382	78247
(F)	598062	0	0	0	0	598062	0	0	0	0	0
(G)	154797	37364	0	0	37364	154797	0	15547	0	21817	26260
(T)	1227710	448380	94720	275679	353660	952031	370399	62986	26552	423606	233794

(A) MANAGERIAL (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURAL
(G) PROPRIETERS (T) TOTAL

ILLUSTRATION RESULTS FOR W1G2T1 1980

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Projects Projects
(1)	8287.32	4764.69	57.00	12329.90	0.00	13.10	161.00
(2)	23515.70	1382.59	21624.50	1105.00	580.05	285.80	75.00
(3)	8780.00	78224.42	146.00	20909.43	19614.60	3781.19	26908.80
(4)	4780.99	0.00	0.00	570.44	3409.00	393.70	0.00
(5)	28361.53	0.00	0.00	203.39	10944.00	1140.02	15846.30
(6)	6838.61	683.86	0.00	162.25	0.00	0.00	4822.60
(7)	21943.82	0.00	328.00	17505.37	0.00	575.54	777.70
(8)	12417.85	2359.39	533.97	4233.46	0.00	1020.20	641.00
(9)	19378.99	6201.28	1104.60	12313.61	0.00	1748.40	3289.00
(T)	134304.81	93616.23	23794.07	69332.85	34547.65	8957.95	52521.40

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS, OUTPUTS, AND REQUIREMENTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	5726	300	8549	5426	9133	8849	1222	0	4504	3683
(B)	88859	70512	40877	59721	29635	29138	100598	0	27509	98021	26045
(C)	70435	30824	4855	42296	25969	28139	47151	0	7355	38179	13504
(D)	104294	177232	47195	64808	130037	39486	112003	43921	0	133310	116714
(E)	193581	176447	1493	100305	174954	93276	101798	0	0	176447	97313
(F)	598062	0	0	0	0	598062	0	0	0	0	0
(G)	154797	46716	0	0	46716	154797	0	2256	0	24460	35612
(T)	1227710	507457	94720	275679	412737	952031	370399	47399	34864	474921	292871

(A) MANAGERIAL (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURAL
(G) PROPRIETERS (T) TOTAL

ILLUSTRATION RESULTS FOR W2G1T1 1980

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Projects Projects
(1)	8287.32	5027.44	57.00	12579.57	0.00	13.10	161.00
(2)	23515.70	1382.59	21624.50	1134.85	0.00	390.42	75.00
(3)	8780.00	79130.29	146.00	21304.79	19614.60	3781.90	26908.80
(4)	6420.75	0.00	0.00	593.00	5004.90	393.70	0.00
(5)	28407.16	0.00	0.00	204.85	10944.00	1140.02	15846.30
(6)	6890.26	689.03	0.00	163.51	0.00	0.00	4822.60
(7)	22767.12	0.00	328.00	17861.30	343.80	575.54	777.70
(8)	12859.12	2443.23	552.94	4434.83	0.00	1020.20	644.00
(9)	21996.83	7038.99	1253.82	12700.69	2575.50	1746.40	32393.84
(T)	139924.26	95711.57	23962.26	70977.39	38482.80	9061.28	81629.24

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS, OUTPUTS, AND REQUIREMENTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	6958	300	8549	6658	9133	8849	2941	0	4017	4915
(B)	88859	77216	40877	59721	36339	29138	100598	0	10213	87430	32749
(C)	70435	34488	4855	42296	29633	28139	47151	434	0	34054	17168
(D)	104294	186916	47195	64808	139721	39486	112003	68010	0	118906	126398
(E)	193581	186924	1493	100305	185431	93276	101798	29542	0	157382	107790
(F)	598062	0	0	0	0	598062	0	0	0	0	0
(G)	154797	57234	0	0	57234	154797	0	35457	0	21817	46130
(T)	1227710	549736	94720	275679	455016	952031	370399	136384	10213	423606	335150

(A) MANAGERIAL (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURAL
(G) PROPRIETERS (T) TOTAL

ILLUSTRATION RESULTS FOR W2G2T1 1980

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Projects Projects
(1)	8287.40	5027.41	57.00	12575.00	0.00	13.10	161.00
(2)	23515.70	1382.59	21624.50	1135.00	442.79	390.42	75.00
(3)	8780.00	79130.29	146.00	21344.00	19614.60	3781.90	26908.80
(4)	6420.75	0.00	0.00	593.00	5004.90	393.70	0.00
(5)	28407.16	0.00	0.00	204.00	10944.00	1140.02	15846.30
(6)	6890.26	689.03	0.00	163.00	0.00	0.00	4822.60
(7)	22767.13	0.00	328.00	17861.00	343.80	575.54	777.70
(8)	12859.12	2443.23	552.94	4435.00	0.00	1020.20	641.00
(9)	21996.83	7038.98	1253.92	12701.00	2575.50	1746.40	3239.84
(T)	139924.35	95711.53	23962.36	71011.00	38925.59	9061.28	52472.24

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS, OUTPUTS, AND REQUIREMENTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	6959	300	8549	6659	9133	8849	2454	0	4504	4916
(B)	88859	77216	40877	59721	36339	29138	100598	0	20804	98021	32749
(C)	70435	34488	4855	42296	29633	28139	47151	0	3691	38179	17168
(D)	104294	186916	47195	64808	139721	39486	112003	53606	0	133310	126398
(E)	193581	186924	1493	100305	185431	93276	101798	10477	0	176447	107790
(F)	598062	0	0	0	0	598062	0	0	0	0	0
(G)	154797	57273	0	0	57273	154797	0	32814	0	24460	46169
(T)	1227710	549776	94720	275679	455056	952031	370399	99351	24495	474921	335190

(A) MANAGERIAL (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURAL
(G) PROPRIETERS (T) TOTAL

ILLUSTRATION RESULTS FOR W1G1T2 1985

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Projects Projects
(1)	7375.71	6377.75	57.00	13047.37	0.00	15.10	161.00
(2)	31812.17	1463.34	28575.20	1172.93	0.00	340.10	75.00
(3)	12190.76	87508.73	3556.76	29145.97	22885.90	4499.70	30255.48
(4)	2669.69	0.00	0.00	601.91	753.45	721.90	0.00
(5)	28843.64	0.00	0.00	220.49	4807.47	1388.40	22185.68
(6)	6909.32	690.93	0.00	175.12	0.00	0.00	4822.60
(7)	23233.80	0.00	328.55	18532.14	0.00	684.90	994.15
(8)	12785.05	2429.16	549.76	4277.33	0.00	1213.70	641.00
(9)	21032.34	6730.35	1198.84	12830.93	0.00	2080.20	4199.28
(T)	146852.48	105200.26	34266.11	80004.19	28446.82	10944.00	63334.19

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS, OUTPUTS, AND REQUIREMENTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	21429	4164	362	10325	3802	11104	10687	147	0	4017	2431
(B)	107689	69471	49165	71829	20306	35860	120994	0	17958	87430	43324
(C)	85361	27671	5896	51360	21775	34001	57256	0	6383	34054	16481
(D)	126395	181110	57035	78322	124075	48073	135357	62204	0	118906	111242
(E)	234603	157382	1805	121242	155577	113361	123047	0	0	157382	79871
(F)	532275	0	0	0	0	532275	0	0	0	0	0
(G)	187600	21817	0	0	21817	187600	0	0	0	21817	3415
(T)	1295352	461615	114263	333078	347352	962274	447341	62351	24341	423606	256766

(A) MANAGERIAL (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURAL
(G) PROPRIETERS (T) TOTAL

ILLUSTRATION RESULTS FOR W2G2T2 1985

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Projects Projects
(1)	7375.71	7767.13	75.00	14385.41	0.00	15.60	161.00
(2)	32480.36	1503.43	28575.20	1329.50	0.00	340.10	75.00
(3)	12190.76	93720.87	3556.76	24416.79	22885.90	4499.70	30255.48
(4)	11240.20	0.00	0.00	725.45	9091.70	721.90	0.00
(5)	37651.79	0.00	0.00	228.01	13491.80	1388.40	22185.68
(6)	7401.32	740.13	0.00	181.69	0.00	0.00	4822.60
(7)	26430.70	0.00	328.00	20409.98	460.70	684.90	994.15
(8)	15151.77	2878.84	651.53	5270.15	0.00	1213.70	641.00
(9)	27484.80	8795.14	1566.63	14803.03	3818.40	2080.20	4199.28
(T)	177407.41	115405.54	34753.12	81750.01	49748.50	10944.50	63334.19

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS, OUTPUTS, AND REQUIREMENTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	21429	9643	362	10325	9281	11104	10687	5626	0	4017	6654
(B)	107689	98011	49165	71829	48846	35860	120994	11581	0	87430	64846
(C)	85361	44017	5896	51360	38121	34001	57256	9963	0	34054	29204
(D)	126395	234130	57035	78322	177095	48073	135357	115224	0	118906	153849
(E)	234603	240718	1805	121242	238913	113361	123047	83336	0	157382	148657
(F)	532275	0	0	0	0	532275	0	0	0	0	0
(G)	187600	63399	0	0	63399	187600	0	41582	0	21817	35211
(T)	1295352	689918	114263	333078	575655	962274	447341	267312	0	423606	438424

(A) MANAGERIAL (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURAL
(G) PROPRIETERS (T) TOTAL

2-D.3 Numerical Illustration: Government Agencies Plans and Labor Goals (ECN14

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ILLUSTRATION RESULTS FOR W1 1980

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Projects Projects
(1)	8287.32	6471.89	57.00	12133.02	0.00	13.10	161.00
(2)	23515.70	1382.59	21624.50	1080.65	0.00	862.42	75.00
(3)	8780.00	80231.19	146.00	20584.22	19614.60	3781.90	26908.80
(4)	1425.24	0.00	0.00	551.14	0.00	393.70	0.00
(5)	25709.25	0.00	0.00	202.49	8256.63	1140.02	15846.30
(6)	6783.91	678.39	0.00	161.39	0.00	0.00	4822.60
(7)	24206.53	0.00	328.00	17232.92	0.00	575.54	777.70
(8)	12443.68	2358.60	533.70	4114.32	0.00	1020.20	641.00
(9)	20174.37	6455.79	1149.94	12043.64	0.00	1748.40	3239.84
(T)	131326.00	97578.45	23839.14	68103.79	27871.23	9535.28	52472.24

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS, OUTPUTS, AND REQUIREMENTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	4778	300	8549	4478	9133	8849	761	0	4017	2735
(B)	88859	64150	40877	59721	23273	29138	100598	0	23279	87430	19683
(C)	70435	29663	4855	42296	24808	28139	47151	0	4391	34054	12343
(D)	104294	166912	47195	64808	119717	39486	112003	48006	0	118906	106394
(E)	193581	157381	1493	100305	155888	93276	101798	0	0	157382	78247
(F)	598062	0	0	0	0	598062	0	0	0	0	0
(G)	154797	53140	0	0	53140	154797	0	31323	0	21817	42036
(T)	1227710	476024	94720	275679	381304	952031	370399	80090	27670	423606	261438

(A) MANAGERIAL (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURAL
(G) PROPRIETERS (T) TOTAL

ILLUSTRATION RESULTS FOR W2 1980

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Projects Projects
(1)	8287.32	6536.22	57.00	12186.30	0.00	13.10	161.00
(2)	23515.70	1362.59	21624.50	1087.75	0.00	862.42	75.00
(3)	8780.00	80333.70	140.00	20682.40	19614.60	3781.90	26908.80
(4)	2533.53	0.00	0.00	555.84	10997.80	393.70	0.00
(5)	24941.81	0.00	0.00	202.80	7483.00	1140.02	15846.30
(6)	6890.26	678.63	0.00	161.66	0.00	0.00	0.00
(7)	24320.26	0.00	328.00	17312.00	0.00	575.54	777.70
(8)	12580.29	2390.25	540.00	4164.60	0.00	1020.20	641.00
(9)	20303.96	6497.26	1157.33	12135.40	0.00	1748.40	3239.84
(T)	132153.13	97798.65	23846.83	68488.75	38095.40	9535.28	47649.64

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES .(5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS, OUTPUTS, AND REQUIREMENTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	5214	300	8549	4914	9133	8849	1196	0	4017	3171
(B)	88859	66818	40877	59721	25941	29138	100598	0	20612	87430	22351
(C)	70435	30809	4855	42296	25954	28139	47151	0	3245	34054	13489
(D)	104294	169374	47195	64808	122179	39486	112003	50468	0	118906	108856
(E)	193581	157381	1493	100305	155888	93276	101798	0	0	157382	78247
(F)	598062	0	0	0	0	598062	0	0	0	0	0
(G)	154797	54622	0	0	54622	154797	0	32805	0	21817	43518
(T)	1227710	484218	94720	275679	389498	952031	370399	84469	23857	423606	269632

(A) MANAGERIAL (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURAL
(G) PROPRIETERS (T) TOTAL

ILLUSTRATION RESULTS FOR W3 1980

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Projects Projects
(1)	8267.32	7044.80	57.00	12608.82	0.00	13.10	161.00
(2)	23515.70	1382.59	21624.50	1138.95	0.00	862.42	75.00
(3)	8813.29	81997.32	146.00	21418.28	19614.60	3781.90	0.00
(4)	6487.76	0.00	0.00	594.22	5004.90	393.70	0.00
(5)	24984.73	0.00	0.00	205.23	7483.00	1140.02	15846.30
(6)	6892.14	689.40	0.00	163.77	0.00	0.00	0.00
(7)	25453.57	0.00	328.00	17915.05	203.60	575.54	777.70
(8)	13454.07	2256.27	578.50	4504.81	0.00	1020.20	641.00
(9)	22911.81	7331.77	1305.97	12790.61	1911.40	1748.40	3239.84
(T)	140800.39	100702.15	24039.97	71339.74	34217.50	9535.28	20740.84

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS, OUTPUTS, AND REQUIREMENTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	7416	300	8549	7116	9133	8849	3399	0	4017	5373
(B)	88859	79247	40877	59721	38370	29138	100598	0	8182	87430	34780
(C)	70435	37124	4855	42296	32269	28139	47151	3070	0	34054	19804
(D)	104294	186534	47195	64808	139339	39486	112003	67628	0	118906	126016
(E)	193581	175411	1493	100305	173918	93276	101798	18029	0	157382	96277
(F)	598062	0	0	0	0	598062	0	0	0	0	0
(G)	154797	69107	0	0	69107	154797	0	47290	0	21817	58003
(T)	1227710	554839	94720	275679	460119	952031	370399	139416	8182	423606	340253

(A) MANAGERIAL (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURAL
(G) PROPRIETERS (T) TOTAL

ILLUSTRATION RESULTS FOR W4 1980

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Projects Projects
(1)	8287.32	6556.43	57.00	12202.15	0.00	13.10	161.00
(2)	23515.70	1382.59	21624.50	1089.53	0.00	862.42	75.00
(3)	8780.00	80359.69	164.00	20710.98	19614.60	3781.90	26908.80
(4)	2355.26	0.00	0.00	557.16	916.40	393.70	0.00
(5)	24770.34	0.00	0.00	202.92	7309.62	1140.02	15846.30
(6)	6782.42	678.24	0.00	161.76	0.00	0.00	4922.60
(7)	29510.57	0.00	328.00	17335.02	164.90	575.54	777.70
(8)	12521.74	2392.43	541.44	4179.55	0.00	1020.20	641.00
(9)	20985.47	6715.35	1196.17	12162.07	329.60	1748.40	3239.84
(T)	137508.82	98084.73	23911.11	68601.14	28335.12	9535.28	52572.24

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS, OUTPUTS, AND REQUIREMENTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	5283	300	8549	4983	9133	8849	1266	0	4017	3240
(B)	88859	77087	50877	49721	26210	39138	100598	0	2034	87430	32620
(C)	70435	31103	4855	42296	26248	28139	47151	0	2951	34054	13783
(D)	104294	169761	47195	64808	122566	39486	112003	50855	0	118906	109243
(E)	193581	157381	1493	100305	155888	93276	101798	0	0	157382	78247
(F)	598062	0	0	0	0	598062	0	0	0	0	0
(G)	154797	56494	0	0	56494	154797	0	34677	0	21817	45390
(T)	1227710	497109	104720	265679	392389	962031	370399	86798	4985	423606	282523

(A) MANAGERIAL (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURAL
(G) PROPRIETERS (T) TOTAL

3-A APPENDIX

NATIONALITY--INCOME GROUP							
.0833	.0233	.0000	.0000	.0000	.0000	.0000	.0000
.1042	.0814	.0588	.0127	.0000	.0000	.0000	.0000
.3958	.2907	.2353	.1519	.2121	.3333	.0000	.0000
.1875	.3488	.3235	.2671	.3939	.1667	.0000	.0000
.0625	.1279	.1863	.2025	.2727	.3333	.0000	.5000
.0000	.0116	.0784	.0633	.0303	.1667	.0000	.0000
.0000	.0000	.0196	.0127	.0303	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0625	.0000	.0196	.0253	.0000	.0000	.0000	.0000
.0417	.0116	.0294	.0253	.0000	.0000	.0000	.0000
.0000	.0465	.0196	.0380	.0000	.0000	.0000	.0000
.0000	.0116	.0000	.0127	.0303	.0000	.0000	.0000
.0000	.0116	.0000	.0127	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0253	.0000	.0000	.0000	.5000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0208	.0233	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0208	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0098	.0127	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0208	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0116	.0098	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0303	.0000	.0000	.0000
.0000	.0000	.0000	.0253	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0098	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0127	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

NATIONALITY--INCOME GROUP							
.0000	.0000	.0217	.0000	.0000	.0000	.0000	.0000
.0455	.0217	.0109	.0159	.0000	.0000	.0000	.0000
.1591	.2174	.2065	.1587	.2000	.2222	.0000	.0000
.3636	.2935	.3043	.2857	.2800	.5556	.3333	.5000
.1591	.2174	.2174	.2540	.0800	.1111	.3333	.0000
.0000	.0217	.0761	.1270	.1200	.0000	.0000	.5000
.0000	.0217	.0109	.0159	.0000	.0000	.0000	.0000
.0000	.0000	.0109	.0159	.0000	.0000	.0000	.0000
.0000	.0109	.0109	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0400	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0227	.0000	.0109	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0109	.0000	.0400	.0000	.0000	.0000
.0227	.0326	.0217	.0000	.0000	.0000	.0000	.0000
.0909	.0543	.0326	.0317	.0400	.0000	.0000	.0000
.0682	.0109	.0217	.0000	.0400	.0000	.0000	.0000
.0455	.0217	.0109	.0000	.0400	.0000	.0000	.0000
.0727	.0109	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0109	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.3333	.0000
.0000	.0109	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0159	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0159	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0217	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0109	.0109	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0109	.0159	.0000	.0000	.0000	.0000
.0000	.0109	.0000	.0159	.0800	.1111	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0400	.0000	.0000	.0000
.0000	.0000	.0000	.0159	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0159	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

NATIONALITY--INCOME GROUP							
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.2500	1.0000	.0000	.0000	.0000	.0000	.0000
.0000	.2500	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.2500	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.2500	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.5000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.5000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

Table A-A-1: PROPORTIONS OF DOMESTIC FAMILIES DISTRIBUTION TO HOUSES

NATIONALITY--INCOME GROUP							
.0000	.0000	.0030	.0026	.0000	.0000	.0000	.0000
.0263	.0202	.0182	.0053	.0042	.0000	.0000	.0000
.1316	.1298	.1061	.0422	.0293	.0476	.0345	.0227
.1184	.1377	.1152	.0818	.0628	.0544	.0172	.0000
.0789	.0891	.0848	.0607	.0418	.0204	.0345	.0000
.0132	.0283	.0121	.0369	.0418	.0136	.0000	.0455
.0132	.0162	.0182	.0079	.0251	.0136	.0172	.0227
.0000	.0000	.0061	.0106	.0042	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0068	.0000	.0227
.0000	.0000	.0030	.0000	.0042	.0000	.0000	.0000
.0000	.0040	.0000	.0000	.0042	.0000	.0000	.0000
.0395	.0202	.0182	.0079	.0084	.0068	.0000	.0000
.1053	.1215	.0818	.0501	.0502	.0340	.0345	.0227
.1447	.0931	.1576	.1478	.1381	.1156	.0690	.0227
.0921	.0850	.1091	.1135	.1172	.1156	.1034	.0909
.0132	.0364	.0424	.0897	.1213	.1224	.0862	.1136
.0000	.0081	.0394	.0528	.0669	.0884	.1034	.0682
.0263	.0121	.0182	.0317	.0837	.0884	.0517	.0455
.0132	.0081	.0091	.0132	.0251	.0408	.0690	.0455
.0000	.0081	.0182	.0607	.0502	.0748	.1552	.4091
.0132	.0162	.0030	.0026	.0042	.0000	.0000	.0000
.0000	.0040	.0000	.0053	.0000	.0204	.0000	.0000
.0000	.0081	.0000	.0000	.0000	.0000	.0172	.0000
.0000	.0000	.0000	.0053	.0000	.0000	.0000	.0227
.0395	.0081	.0242	.0150	.0126	.0136	.0172	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0030	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0068	.0000	.0000
.0000	.0000	.0000	.0026	.0000	.0000	.0000	.0000
.0000	.0040	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0053	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0068	.0172	.0000
.0000	.0000	.0030	.0000	.0000	.0068	.0000	.0000
.0000	.0000	.0000	.0000	.0042	.0000	.0000	.0000
.0263	.0121	.0030	.0000	.0000	.0000	.0000	.0000
.0132	.0202	.0091	.0106	.0042	.0000	.0345	.0000
.0000	.0040	.0091	.0000	.0000	.0136	.0000	.0000
.0000	.0040	.0061	.0026	.0042	.0000	.0000	.0000
.0000	.0081	.0030	.0026	.0042	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0042	.0000	.0000	.0000
.0000	.0000	.0000	.0053	.0000	.0068	.0000	.0000
.0000	.0000	.0030	.0053	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0132	.0121	.0061	.0132	.0209	.0000	.0000	.0000
.0395	.0445	.0091	.0132	.0084	.0000	.0000	.0000
.0000	.0202	.0212	.0132	.0167	.0204	.0517	.0000
.0132	.0081	.0061	.0317	.0084	.0204	.0000	.0000
.0132	.0000	.0061	.0132	.0042	.0000	.0345	.0000
.0132	.0000	.0091	.0106	.0042	.0136	.0172	.0000
.0000	.0000	.0030	.0079	.0042	.0136	.0000	.0227
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0227
.0000	.0081	.0121	.0185	.0167	.0136	.0345	.0000

NATIONALITY--INCOME GROUP							
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0400	.0341	.0061	.0000	.0000	.0099	.0000	.0000
.1200	.0909	.0427	.0300	.0197	.0198	.0000	.0000
.0800	.1250	.0915	.0600	.0298	.0495	.0204	.0000
.1600	.1705	.0915	.0700	.0345	.0396	.0204	.0128
.0000	.0341	.0548	.0300	.0197	.0297	.0000	.0000
.0000	.0114	.0122	.0150	.0049	.0198	.0000	.0000
.0000	.0000	.0183	.0100	.0148	.0000	.0204	.0128
.0000	.0000	.0000	.0000	.0000	.0099	.0000	.0000
.0000	.0000	.0061	.0050	.0000	.0099	.0204	.0128
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0122	.0000	.0000	.0000	.0204	.0000
.0800	.0795	.0244	.0300	.0197	.0000	.0000	.0000
.1200	.0568	.1159	.0900	.0887	.0396	.0612	.0385
.0800	.0909	.0978	.1200	.1232	.1386	.0204	.0641
.0800	.0682	.0978	.1600	.1232	.0990	.1224	.0897
.0400	.0341	.0488	.0550	.0936	.0792	.0816	.1028
.0400	.0114	.0427	.0500	.0690	.0594	.0816	.1282
.0000	.0000	.0061	.0250	.0296	.0495	.1020	.0769
.0400	.0727	.0305	.0750	.1330	.1584	.3469	.3846
.0000	.0227	.0368	.0350	.0197	.0099	.0000	.0000
.0000	.0227	.0122	.0150	.0197	.0198	.0000	.0128
.0000	.0000	.0000	.0100	.0000	.0297	.0000	.0128
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0114	.0000	.0000	.0197	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0400	.0000	.0061	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0061	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0061	.0050	.0049	.0000	.0000	.0000
.0000	.0000	.0061	.0050	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0128
.0000	.0000	.0061	.0000	.0049	.0000	.0000	.0000
.0000	.0227	.0122	.0050	.0000	.0000	.0000	.0000
.0000	.0000	.0122	.0000	.0049	.0000	.0000	.0000
.0000	.0000	.0000	.0050	.0000	.0000	.0000	.0000
.0000	.0114	.0000	.0050	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0400	.0114	.0000	.0050	.0000	.0000	.0000	.0128
.0000	.0000	.0000	.0050	.0000	.0000	.0000	.0000
.0000	.0000	.0061	.0250	.0148	.0099	.0000	.0000
.0000	.0455	.0244	.0100	.0197	.0198	.0000	.0000
.0000	.0114	.0122	.0100	.0148	.0198	.0000	.0000
.0000	.0000	.0061	.0050	.0049	.0099	.0204	.0000
.0400	.0000	.0122	.0000	.0197	.0000	.0204	.0000
.0000	.0114	.0183	.0050	.0049	.0000	.0204	.0128
.0000	.0000	.0061	.0050	.0099	.0099	.0000	.0000
.0000	.0000	.0000	.0050	.0099	.0099	.0000	.0000
.0000	.0000	.0122	.0150	.0246	.0495	.0204	.0128

NATIONALITY--INCOME GROUP							
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.2500	.0000	.0000	.0000	.3333
.0000	.0000	.2000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.2000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.3333
.0000	.0000	.2000	.2500	.3333	.0000	.0000	.0000
.0000	.0000	.0000	.2500	.2333	.0000	.0000	.0000
.0000	1.0000	.0000	.0000	.0000	1.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.4000	.2500	.3333	.0000	.5000	.3333
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.5000	.0000
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

Table 3-A-2: PROPORTIONS OF EXPATRIATE FAMILIES DISTRIBUTION TO HOUSES

3-B HOUSING DEVELOPMENT AND EXPATRIATE LABOR MULTIPLIER

As indicted before, the new expatriate labor and their families are necessary parts to the accounting of the total family stocks. We have also alluded to the existence of a multiplier affect between the expatriate labor, needed in the housing industry and their requirement for housing units. While this argument is limited here to construction labor inputs, it can evidently also be expanded to include similar interdependencies between construction activity and the rest of the industrial structure in a country. In this way we can account for the import of labor needed for other industries as a result of the increase in the production of housing construction. This can be done via an economic input-output model and its labor input ratios per unit of output. This argument here is important when we see that the total amount of labor imported for other industries may depend on the output of the construction industry. Vice versa, the labor imported will have to be housed--and so on--to produce a further multiplier effect via the overall industrial development activities.

To accommodate the later extension and for purposes of clarifying the linkages to the economic model we here first assume a stable economic structure and known production technology and use the basic Leontief input-output model [185, 214, 280] to establish the relationships with the overall industrial structure. This assumption will be relaxed in the next section to link housing development requirements model to the socio- economic model developed in chapter 2. However for purpose of illustrations, we first write

$$q = (I - A)^{-1}y \qquad (3\text{-}B.1)$$

$$I = Lq$$

$$I = L(I - A)^{-1}y \qquad (3\text{-}B.2)$$

where

q = nx1 vector array of sector outputs

y = nx1 vector array of final demand

l = wx1 vector array of labor input in various age-swill occupation categories

A = nxn matrix of inter-industrial input-output coefficients

I = nxn identity matrix

L = wxn matrix of labor input per unit output ratios where L_{ij} is the proportion of labor in citizenship-occupation category i, i= 1,....,w, in industrial sector j, j= 1,...,n.

Next we distinguish between local and expatriate labor is in

$$l = l_d + l_x \qquad (3\text{-B.3})$$

where

l_d = a vector of local labor arrayed by each age-skill occupation category

l_x = a vector of expatriate labor arrayed by each age-skill occupation category

with, of course, the same age-skill-occupation categories in L. If all of the construction labor needed is locally available then there will be no urgent need for importing expatriate labor in which case we may set l_x equal to the zero vector. However if there is a capacity limitation on local labor, including construction labor, then there will be a need to import labor and consequently a need to house them also. In any case from (3.11) and (3.12) we obtain

$$l_x = L(I - A)^{-1} y - l_d \qquad (3\text{-B.4})$$

The number of expatriate families is affected by the number of families entering the country for work purposes. Those families as well as all others will be housed if there is enough housing stock available to meet their need. Otherwise new houses have to be built and such lag will necessarily affect an increase in the final demand component in the industrial model. Again such demand will generate additional need for labor to service the housing and its supporting industries. This labor may have to be imported and the additionally imported labor will need housing.

And so on we realize the multiplier relationship between family model we have developed in this section and the industrialization model developed earlier.

Following the same principles presented in (3.12) and assuming that all elements in $/_x$, results from the desired increase in housing and its multipliers, we write

$$f_x = \Gamma''_x \; /_x(t)$$

$$= /_x \left[L(I - A)^{-1} \begin{bmatrix} 0 \\ h_n \end{bmatrix}\right] \qquad (3\text{-}B.5)$$

In this form we assume that expatriate labor in $/_{x(t)}$ will be used to build multiplied units of houses as well as the multiplied needs of the supporting industries. However since some of this labor may already exist domestically we define the net expatriate labor as

$$/_x = L\,(I - A)^{-1} \begin{bmatrix} 0 \\ h_n \end{bmatrix} - /_d] \qquad (3\text{-}B.6)$$

and rewrite (3.14 as)

$$f_x = /_x \left[L(I - A)^{-1} \begin{bmatrix} 0 \\ h_n \end{bmatrix} - /_d\right] \qquad (3\text{-}B.7)$$

and since the total new families to be housed is

$$f_n(t) = f_{d,n}(t) + f_{x,n}(t) + f_{x+}(t) \qquad (3\text{-}B.8)$$

and by substitution of equation (3-B.6)

$$f_n(t) = f_{d,n}(t) + f_{x,n}(t) + \Gamma''_x \left[\, L(I - A)^{-1} \begin{bmatrix} 0 \\ h_n \end{bmatrix} - /_d \,\right] \qquad (3\text{-}B.9)$$

In this form we relate f_n, the total new families and h_n, the new houses through a linear function that considers the multiplier effect of building new units of houses. In the following section we will relax the assumption of stable economic structure and subject the economic input output relationships to the kind of planning activities examined in the previous chapter of this thesis.

3-C SOLUTION OUTPUTS FOR ALTERNATIVE HOUSING DEVELOPMENT GOALS

3-C.1 Numerical Results For ECHSE1 Illustration

NEW FAMILIES DISTRIBUTION TO HOUSES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	2208.	624.	50.	0.	10909.	6031.	0.	0.	19822.
-2	21796.	8951.	1335.	95.	72627.	96795.	13697.	650.	215946.
-3	11639.	6375.	1066.	134.	20500.	54711.	6113.	980.	101518.
-4	1192.	1387.	371.	76.	1241.	3864.	316.	0.	8447.
-5	0.	228.	99.	57.	814.	603.	357.	0.	2158.
RG OW SZ-1	1788.	618.	99.	19.	2249.	2725.	0.	0.	7498.
-2	17800.	11214.	2300.	267.	5106.	7953.	357.	0.	44997.
-3	11227.	11976.	4118.	763.	7329.	5899.	1032.	0.	42344.
-4	2980.	4851.	2732.	762.	2947.	1677.	357.	324.	16630.
-5	1613.	3626.	2213.	1776.	427.	0.	0.	356.	10011.
TN OW SZ-1	1998.	1201.	368.	19.	1848.	0.	0.	0.	5434.
-2	394.	216.	74.	57.	0.	0.	0.	0.	741.
-3	1201.	786.	221.	19.	569.	0.	0.	0.	2796.
HT RT SZ-1	0.	0.	0.	0.	0.	1621.	0.	0.	1621.
-2	0.	61.	24.	0.	0.	0.	0.	0.	85.
-3	0.	54.	0.	0.	0.	0.	0.	0.	54.
HT OW SZ-1	412.	108.	0.	0.	0.	528.	0.	0.	1048.
-2	0.	216.	50.	19.	0.	0.	0.	0.	285.
-3	0.	168.	50.	19.	0.	0.	0.	0.	237.
TR RT SZ-1	999.	114.	24.	0.	14089.	0.	0.	0.	15226.
-2	1797.	840.	98.	38.	853.	2262.	0.	0.	5888.
-3	798.	391.	50.	0.	426.	1621.	1350.	0.	4636.
-4	0.	108.	50.	0.	0.	0.	0.	0.	158.
-5	412.	222.	0.	19.	0.	0.	0.	0.	653.
TR OW SZ-1	798.	762.	223.	0.	0.	0.	0.	0.	1783.
-2	4785.	1669.	493.	57.	0.	1074.	357.	0.	8435.
-3	1008.	1387.	294.	76.	0.	1074.	0.	0.	3839.
-4	403.	942.	246.	97.	0.	0.	0.	0.	1688.
-5	394.	936.	469.	95.	0.	0.	0.	0.	1894.
-T	87642.	60031.	17117.	4464.	141934.	188438.	23936.	2310.	525872.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

REDISTRIBUTION OF EXISTING FAMILIES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	1839.	3656.	664.	0.	4342.	3898.	0.	0.	14399.
-2	18149.	52407.	17858.	1674.	28906.	62556.	15726.	708.	197984.
-3	9691.	37328.	14264.	2358.	8159.	35359.	7018.	1058.	115235.
-4	993.	8119.	4968.	1344.	494.	2497.	363.	0.	18778.
-5	0.	1336.	1328.	1006.	324.	390.	409.	0.	4793.
RG OW SZ-1	1489.	3620.	1328.	338.	895.	1778.	0.	0.	9448.
-2	14822.	65659.	30771.	4693.	2032.	5139.	409.	0.	123525.
-3	9348.	70123.	55085.	13427.	2917.	3812.	1184.	0.	155896.
-4	2481.	28400.	36540.	13419.	1173.	1084.	409.	349.	83855.
-5	1343.	21230.	29603.	31279.	170.	0.	0.	385.	84010.
TN OW SZ-1	1664.	7030.	4922.	338.	736.	0.	0.	0.	14690.
-2	328.	1265.	984.	1006.	0.	0.	0.	0.	3583.
-3	1000.	4604.	2953.	330.	226.	0.	0.	0.	9113.
HT RT SZ-1	0.	0.	0.	0.	0.	1047.	0.	0.	1047.
-2	0.	351.	321.	0.	0.	0.	0.	0.	672.
-3	0.	316.	0.	0.	0.	0.	0.	0.	316.
HT OW SZ-1	343.	633.	0.	0.	0.	341.	0.	0.	1317.
-2	0.	1265.	664.	330.	0.	0.	0.	0.	2259.
-3	0.	984.	664.	338.	0.	0.	0.	0.	1986.
TR RT SZ-1	832.	668.	321.	0.	561.	0.	0.	0.	2382.
-2	1496.	4921.	1305.	668.	339.	1462.	0.	0.	10191.
-3	664.	2285.	664.	0.	170.	1047.	1549.	0.	6379.
-4	0.	633.	664.	0.	0.	0.	0.	0.	1297.
-5	343.	1301.	0.	338.	0.	0.	0.	0.	1982.
TR OW SZ-1	664.	4464.	2976.	0.	0.	0.	0.	0.	8104.
-2	3985.	9771.	6594.	998.	0.	694.	409.	0.	22451.
-3	839.	8119.	3938.	1344.	0.	694.	0.	0.	14934.
-4	336.	5518.	3297.	1706.	0.	0.	0.	0.	10857.
-5	328.	5483.	6273.	1674.	0.	0.	0.	0.	13758.
-T	72977.	351489.	228949.	78608.	51444.	121798.	27476.	2500.	935241.

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS (1) 1-4 Family Members
(HT) HUT (OW) OWN (-2) 3-4 ROOMS (2) 5-9 Family Members
(TN) TENT (-3) 5-6 ROOMS (3) 9-13 Family Members
(TR) TRADITIONAL (-4) 7-8 ROOMS (4) 13-A Family Members
(-5) 9-A ROOMS

TOTAL FAMILY-TO-HOUSE DISTRIBUTION

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	4047.	4280.	714.	0.	15251.	9929.	0.	0.	34221.
-2	39945.	61358.	19193.	1769.	101533.	159351.	29423.	1358.	413930.
-3	21330.	43703.	15330.	2492.	28659.	90070.	13131.	2038.	216753.
-4	2185.	9506.	5339.	1420.	1735.	6361.	679.	0.	27225.
-5	0.	1564.	1427.	1063.	1138.	993.	766.	0.	6951.
RG OW SZ-1	3277.	4238.	1427.	357.	3144.	4503.	0.	0.	16946.
-2	32622.	76873.	33071.	4960.	7138.	13092.	766.	0.	168522.
-3	20575.	82099.	59203.	14190.	10246.	9711.	2216.	0.	198240.
-4	5461.	33251.	39272.	14181.	4120.	2761.	766.	673.	100485.
-5	2956.	24856.	31816.	33055.	597.	0.	0.	741.	94021.
TN OW SZ-1	3662.	8231.	5290.	357.	2584.	0.	0.	0.	20124.
-2	722.	1481.	1058.	1063.	0.	0.	0.	0.	4324.
-3	2201.	5390.	3174.	349.	795.	0.	0.	0.	11909.
HT RT SZ-1	0.	0.	0.	0.	0.	2668.	0.	0.	2668.
-2	0.	412.	345.	0.	0.	0.	0.	0.	757.
-3	0.	370.	0.	0.	0.	0.	0.	0.	370.
HT OW SZ-1	755.	741.	0.	0.	0.	869.	0.	0.	2365.
-2	0.	1481.	714.	349.	0.	0.	0.	0.	2544.
-3	0.	1152.	714.	357.	0.	0.	0.	0.	2223.
TR RT SZ-1	1831.	782.	345.	0.	14650.	0.	0.	0.	17608.
-2	3293.	5761.	1403.	706.	1192.	3724.	0.	0.	16079.
-3	1462.	2676.	714.	0.	596.	2668.	2899.	0.	11015.
-4	0.	741.	714.	0.	0.	0.	0.	0.	1455.
-5	755.	1523.	0.	357.	0.	0.	0.	0.	2635.
TR OW SZ-1	1462.	5226.	3199.	0.	0.	0.	0.	0.	9887.
-2	8770.	11440.	7087.	1055.	0.	1768.	766.	0.	30886.
-3	1847.	9506.	4232.	1420.	0.	1768.	0.	0.	18773.
-4	739.	6460.	3543.	1803.	0.	0.	0.	0.	12545.
-5	722.	6419.	6742.	1769.	0.	0.	0.	0.	15652.
-T	160619.	411520.	246066.	83072.	193378.	310236.	51412.	4810.	1461113.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

FAMILY-TO-HOUSE DISTRIBUTION RATIOS

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	.0252	.0104	.0029	.0000	.0789	.0320	.0000	.0000	.0234
-2	.2487	.1491	.0780	.0213	.5250	.5136	.5723	.2823	.2833
-3	.1328	.1062	.0623	.0300	.1482	.2903	.2554	.4237	.1483
-4	.0136	.0231	.0217	.0171	.0090	.0205	.0132	.0000	.0186
-5	.0000	.0038	.0058	.0128	.0059	.0032	.0149	.0000	.0048
RG OW SZ-1	.0204	.0103	.0058	.0043	.0163	.0145	.0000	.0000	.0116
-2	.2031	.1868	.1344	.0597	.0369	.0422	.0149	.0000	.1153
-3	.1281	.1995	.2406	.1708	.0530	.0313	.0431	.0000	.1357
-4	.0340	.0808	.1596	.1707	.0213	.0089	.0149	.1399	.0688
-5	.0184	.0604	.1293	.3979	.0031	.0000	.0000	.1541	.0643
TN OW SZ-1	.0228	.0200	.0215	.0043	.0134	.0000	.0000	.0000	.0138
-2	.0045	.0036	.0043	.0128	.0000	.0000	.0000	.0000	.0030
-3	.0137	.0131	.0129	.0042	.0041	.0000	.0000	.0000	.0082
HT RT SZ-1	.0000	.0000	.0000	.0000	.0000	.0086	.0000	.0000	.0018
-2	.0000	.0010	.0014	.0000	.0000	.0000	.0000	.0000	.0005
-3	.0000	.0009	.0000	.0000	.0000	.0000	.0000	.0000	.0003
HT OW SZ-1	.0047	.0018	.0000	.0000	.0000	.0028	.0000	.0000	.0016
-2	.0000	.0036	.0029	.0042	.0000	.0000	.0000	.0000	.0017
-3	.0000	.0028	.0029	.0043	.0000	.0000	.0000	.0000	.0015
TR RT SZ-1	.0114	.0019	.0014	.0000	.0758	.0000	.0000	.0000	.0121
-2	.0205	.0140	.0057	.0085	.0062	.0120	.0000	.0000	.0110
-3	.0091	.0065	.0029	.0000	.0031	.0086	.0564	.0000	.0075
-4	.0000	.0018	.0029	.0000	.0000	.0000	.0000	.0000	.0010
-5	.0047	.0037	.0000	.0043	.0000	.0000	.0000	.0000	.0018
TR OW SZ-1	.0091	.0127	.0130	.0000	.0000	.0000	.0000	.0000	.0068
-2	.0546	.0278	.0288	.0127	.0000	.0057	.0149	.0000	.0211
-3	.0115	.0231	.0172	.0171	.0000	.0057	.0000	.0000	.0128
-4	.0046	.0157	.0144	.0217	.0000	.0000	.0000	.0000	.0086
-5	.0045	.0156	.0274	.0213	.0000	.0000	.0000	.0000	.0107

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

DOMESTIC FAMILY-TO-HOUSE DISTRIBUTIONS

VACANCIES AND NEW HOUSES REQUIREMENTS

	Vacancies	New
RG RT SZ-1	0.	15245.
-2	0.	198553.
-3	0.	100209.
-4	0.	9714.
-5	0.	2400.
RG OW SZ-1	0.	5980.
-2	0.	35627.
-3	0.	40717.
-4	0.	19294.
-5	0.	15243.
TN OW SZ-1	0.	11775.
-2	0.	2433.
-3	0.	6849.
HT RT SZ-1	0.	6706.
-2	0.	2708.
-3	0.	132.
HT OW SZ-1	0.	1169.
-2	0.	607.
-3	0.	807.
TR RT SZ-1	0.	1912.
-2	0.	6881.
-3	0.	5947.
-4	0.	449.
-5	0.	804.
TR OW SZ-1	0.	3031.
-2	0.	10356.
-3	0.	6642.
-4	0.	3919.
-5	0.	4852.

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS
(HT) HUT (OW) OWN (-2) 3-4 ROOMS
(TN) TENT (-3) 5-6 ROOMS
(TR) TRADITIONAL (-4) 7-8 ROOMS
(-5) 9-U ROOMS

TOTAL FAMILY ACCOUNTS

		Unhoused	New	Remaining	To be housed
DOM	(1)	0.	82294.	72976.	87642.
	(2)	0.	34956.	351492.	60031.
	(3)	0.	1156.	228949.	17116.
	(4)	0.	7.	78611.	4465.
EXP	(1)	0.	127249.	51444.	129253.
	(2)	0.	184078.	121800.	188464.
	(3)	0.	22906.	27478.	23934.
	(4)	0.	2242.	2500.	2316.

(1) 1-4 MEMBERS (2) 5-9 MEMBERS
(2) 10-13 MEMBERS (4) 13-U MEMBERS

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Sector Projects	Neg.Dev.	Pos.Dev.
(1)	8287.32	7170.44	57.00	14672.26	0.00	13.10	161.00	0.00	0.00
(2)	23555.24	1384.96	21624.50	1362.32	0.00	285.80	75.00	0.00	0.00
(3)	8780.00	92676.80	146.00	24716.51	19614.60	3781.90	26908.80	0.00	0.00
(4)	6772.20	0.00	0.00	729.08	5004.90	393.70	0.00	0.00	0.00
(5)	60528.15	0.00	0.00	216.16	10944.00	1140.02	15846.30	0.00	0.00
(6)	8108.13	810.81	0.00	173.49	0.00	0.00	4822.60	0.00	0.00
(7)	27390.63	0.00	328.00	20699.22	343.80	575.54	777.70	0.00	0.00
(8)	15078.11	2864.84	6484.36	5731.82	0.00	1020.20	641.00	0.00	0.00
(9)	27902.29	8928.72	1590.43	15475.96	2575.50	17148.40	3239.84	0.00	0.00
(T)	186402.07	113836.57	30230.29	83776.82	38482.80	24358.66	52472.24	0.00	0.00

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS AND OUTPUTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	10896	299	8549	10597	9133	8849	6879	0	4017	8853
(B)	88859	92871	40877	59721	51993	29138	100598	5441	0	87430	48404
(C)	70435	48631	4855	42296	43826	28139	47151	14627	0	34054	31361
(D)	104294	264129	47195	64808	216935	39486	112003	145224	0	118906	203611
(E)	193581	396880	1494	100304	390387	93277	101798	239498	0	157382	317746
(F)	598062	0	0	0	0	59862	0	0	0	0	0
(G)	154797	113179	0	0	1131379	154797	0	91362	0	21817	102075
(T)	1227710	926636	94720	275678	1845117	413832	370399	503031	0	423606	712050

(A) MANAGER (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURE
(G) PROPRIETERS (T) TOTAL

3-C.2 Numerical Results For ECHS11 Illustration

NEW FAMILIES DISTRIBUTION TO HOUSES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	13057.	0.	0.	0.	12995.	0.	0.	0.	26052.
-2	6528.	6717.	0.	0.	86573.	122543.	0.	0.	222361.
-3	0.	3359.	1132.	0.	24428.	67641.	15820.	19.	112399.
-4	0.	0.	566.	257.	1418.	3810.	7771.	1555.	15377.
-5	0.	0.	0.	126.	1003.	996.	431.	463.	3019.
RG OW SZ-1	19165.	0.	0.	0.	2681.	3605.	172.	2.	25625.
-2	38342.	13575.	0.	0.	6087.	9501.	724.	17.	68246.
-3	0.	27845.	4134.	0.	8727.	9363.	1132.	36.	51237.
-4	0.	0.	8798.	2467.	3518.	3239.	384.	349.	18755.
-5	0.	0.	0.	1184.	506.	278.	8.	201.	2177.
TN OW SZ-1	517.	1055.	0.	0.	573.	600.	7.	0.	2752.
-2	789.	2110.	302.	19.	0.	910.	57.	0.	4187.
-3	0.	0.	624.	38.	175.	96.	21.	0.	954.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1082.	0.	0.	0.	1280.	703.	0.	0.	3065.
-2	542.	1009.	0.	0.	774.	1752.	18.	0.	4095.
-3	0.	504.	73.	0.	385.	1169.	95.	0.	2226.
-4	0.	0.	36.	15.	0.	0.	784.	28.	863.
-5	0.	0.	0.	8.	0.	0.	0.	4.	12.
TR OW SZ-1	2540.	0.	0.	0.	0.	0.	0.	0.	2540.
-2	5080.	1286.	0.	0.	0.	628.	229.	9.	7232.
-3	0.	2571.	972.	0.	0.	637.	40.	0.	4220.
-4	0.	0.	478.	234.	0.	0.	0.	0.	712.
-5	0.	0.	0.	117.	0.	0.	0.	0.	117.
-T	87642.	60031.	17115.	4465.	151123.	227471.	27693.	2683.	578223.

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS (1) 1-4 Family Members
(HT) HUT (OW) OWN (-2) 3-4 ROOMS (2) 5-9 Family Members
(TN) TENT (-3) 5-6 ROOMS (3) 9-13 Family Members
(TR) TRADITIONAL (-4) 7-8 ROOMS (4) 13-A Family Members
(-5) 9-A ROOMS

REDISTRIBUTION OF EXISTING FAMILIES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	1963.	0.	0.	0.	4424.	6338.	476.	6.	13207.
-2	19365.	64956.	0.	0.	29470.	65616.	290.	10.	179707.
-3	10337.	43943.	39134.	1449.	8315.	29880.	15407.	12.	148477.
-4	1063.	8007.	6356.	4592.	483.	2040.	7235.	937.	30713.
-5	0.	1160.	1328.	1647.	342.	533.	428.	931.	6369.
RG OW SZ-1	1591.	0.	0.	0.	913.	1931.	171.	2.	4608.
-2	15816.	74326.	0.	0.	2072.	5086.	708.	16.	98024.
-3	9975.	70917.	58231.	14281.	2971.	5013.	1124.	33.	162545.
-4	2649.	27065.	75409.	36053.	1198.	1734.	381.	250.	144739.
-5	1430.	19757.	23394.	14021.	172.	149.	8.	263.	59194.
TN OW SZ-1	463.	1385.	1014.	145.	195.	322.	7.	0.	3531.
-2	354.	2622.	1406.	499.	0.	487.	56.	0.	5424.
-3	277.	2063.	1346.	356.	60.	51.	21.	1.	4175.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	672.	0.	0.	12.	436.	376.	0.	0.	1496.
-2	1212.	4309.	300.	0.	263.	939.	18.	0.	7041.
-3	539.	2995.	1332.	0.	131.	626.	94.	0.	5717.
-4	0.	1097.	1156.	558.	0.	0.	778.	1.	3590.
-5	280.	429.	117.	233.	0.	0.	0.	29.	1088.
TR OW SZ-1	682.	0.	0.	0.	0.	0.	0.	0.	682.
-2	538.	9279.	0.	0.	0.	336.	228.	8.	10389.
-3	3233.	9406.	5357.	1071.	0.	341.	40.	1.	19449.
-4	344.	7413.	8297.	2218.	0.	0.	0.	0.	18272.
-5	196.	362.	4769.	1475.	0.	0.	0.	0.	6802.
-T	72979.	351491.	228946.	78610.	51445.	121798.	27470.	2500.	935239.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

TOTAL FAMILY-TO-HOUSE DISTRIBUTION

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	15020.	0.	0.	0.	17419.	6338.	476.	6.	39259.
-2	25893.	71673.	0.	0.	116043.	188159.	290.	10.	402068.
-3	10337.	47302.	40266.	1449.	32743.	97521.	31227.	31.	260876.
-4	1063.	8007.	6922.	4849.	1901.	5850.	15006.	2492.	46090.
-5	0.	1160.	1328.	1773.	1345.	1529.	859.	1394.	9388.
RG OW SZ-1	20756.	0.	0.	0.	3594.	5536.	343.	4.	30233.
-2	54158.	87901.	0.	0.	8159.	14567.	1432.	33.	166270.
-3	9975.	98762.	62365.	14281.	11698.	14376.	2256.	69.	213782.
-4	2649.	27065.	84207.	38520.	4716.	4973.	765.	599.	163494.
-5	1430.	19757.	23394.	15205.	678.	427.	16.	464.	61371.
TN OW SZ-1	980.	2440.	1014.	145.	768.	922.	14.	0.	6283.
-2	1143.	4732.	1708.	518.	0.	1397.	113.	0.	9611.
-3	277.	2063.	1970.	394.	235.	147.	42.	1.	5129.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1754.	0.	0.	12.	1716.	1079.	0.	0.	4561.
-2	1754.	5318.	300.	0.	1037.	2691.	36.	0.	11136.
-3	539.	3499.	1405.	0.	516.	1795.	189.	0.	7943.
-4	0.	1097.	1192.	573.	0.	0.	1562.	29.	4453.
-5	280.	429.	117.	241.	0.	0.	0.	33.	1100.
TR OW SZ-1	3222.	0.	0.	0.	0.	0.	0.	0.	3222.
-2	5618.	10565.	0.	0.	0.	964.	457.	17.	17621.
-3	3233.	11977.	6329.	1071.	0.	978.	80.	1.	23669.
-4	344.	7413.	8775.	2452.	0.	0.	0.	0.	18984.
-5	196.	362.	4769.	1592.	0.	0.	0.	0.	6919.
-T	160621.	411522.	246061.	83075.	202568.	349269.	55163.	5183.	1513462.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

FAMILY-TO-HOUSE DISTRIBUTION RATIOS

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	.0935	.0000	.0000	.0000	.0860	.0181	.0086	.0012	.0259
-2	.1612	.1742	.0000	.0000	.5729	.5387	.0053	.0019	.2657
-3	.0644	.1149	.1636	.0174	.1616	.2792	.5661	.0060	.1724
-4	.0066	.0195	.0281	.0584	.0094	.0167	.2720	.4808	.0305
-5	.0000	.0028	.0054	.0213	.0066	.0044	.0156	.2690	.0062
RG OW SZ-1	.1292	.0000	.0000	.0000	.0177	.0159	.0062	.0008	.0200
-2	.3372	.2136	.0000	.0000	.0403	.0418	.0260	.0064	.1099
-3	.0621	.2400	.2535	.1719	.0577	.0412	.0409	.0133	.1413
-4	.0165	.0658	.3422	.4637	.0233	.0142	.0139	.1156	.1080
-5	.0089	.0480	.0951	.1830	.0033	.0012	.0003	.0895	.0406
TN OW SZ-1	.0061	.0059	.0041	.0017	.0038	.0026	.0003	.0000	.0042
-2	.0071	.0115	.0069	.0062	.0000	.0040	.0020	.0000	.0064
-3	.0017	.0050	.0080	.0047	.0012	.0004	.0008	.0002	.0034
HT RT SZ-1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
HT OW SZ-1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
TR RT SZ-1	.0109	.0000	.0000	.0001	.0085	.0031	.0000	.0000	.0030
-2	.0109	.0129	.0012	.0000	.0051	.0077	.0007	.0000	.0074
-3	.0034	.0085	.0057	.0000	.0025	.0051	.0034	.0000	.0052
-4	.0000	.0027	.0048	.0069	.0000	.0000	.0283	.0056	.0029
-5	.0017	.0010	.0005	.0029	.0000	.0000	.0000	.0064	.0007
TR OW SZ-1	.0201	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0021
-2	.0350	.0257	.0000	.0000	.0000	.0028	.0083	.0033	.0116
-3	.0201	.0291	.0257	.0129	.0000	.0028	.0015	.0002	.0156
-4	.0021	.0180	.0357	.0295	.0000	.0000	.0000	.0000	.0125
-5	.0012	.0009	.0194	.0192	.0000	.0000	.0000	.0000	.0046

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS (1) 1-4 Family Members
(HT) HUT (OW) OWN (-2) 3-4 ROOMS (2) 5-9 Family Members
(TN) TENT (-3) 5-6 ROOMS (3) 9-13 Family Members
(TR) TRADITIONAL (-4) 7-8 ROOMS (4) 13-A Family Members
(-5) 9-A ROOMS

DOMESTIC FAMILY-TO-HOUSE DISTRIBUTIONS

VACANCIES AND NEW HOUSES REQUIREMENTS

	Vacancies	New
RG RT SZ-1	0.	20204.
-2	0.	186682.
-3	0.	144333.
-4	0.	27579.
-5	0.	4836.
RG OW SZ-1	0.	19239.
-2	0.	33388.
-3	0.	56260.
-4	0.	82302.
-5	17406.	0.
TN OW SZ-1	2066.	0.
-2	0.	7719.
-3	0.	70.
HT RT SZ-1	574.	0.
-2	478.	0.
-3	238.	0.
HT OW SZ-1	1579.	0.
-2	1637.	0.
-3	1416.	0.
TR RT SZ-1	0.	1546.
-2	0.	1938.
-3	0.	2876.
-4	0.	3448.
-5	731.	0.
TR OW SZ-1	3634.	0.
-2	2909.	0.
-3	0.	11540.
-4	0.	10357.
-5	3884.	0.

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS
(HT) HUT (OW) OWN (-2) 3-4 ROOMS
(TN) TENT (-3) 5-6 ROOMS
(TR) TRADITIONAL (-4) 7-8 ROOMS
(-5) 9-U ROOMS

TOTAL FAMILY ACCOUNTS

		Unhoused	New	Remaining	To be housed
DOM	(1)	0.	82294.	72978.	87642.
	(2)	0.	34956.	351429.	60031.
	(3)	0.	1156.	228949.	17116.
	(4)	0.	7.	78611.	4465.
EXP	(1)	0.	149120.	51444.	151124.
	(2)	0.	223086.	121800.	227471.
	(3)	0.	2664.	27478.	27692.
	(4)	0.	2612.	2500.	2686.

(1) 1-4 MEMBERS (2) 5-9 MEMBERS
(2) 10-13 MEMBERS (4) 13-U MEMBERS

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Sector Projects	Neg.Dev.	Pos.Dev.
(1)	8287.32	7552.39	57.00	15053.37	0.00	13.10	161.00	0.00	0.00
(2)	23639.29	1930.00	21624.50	1402.95	0.00	285.80	75.00	0.00	0.00
(3)	8780.00	96175.72	146.00	25189.87	19614.60	3781.90	26908.80	0.00	0.00
(4)	6866.65	0.00	0.00	846.07	5004.90	393.70	0.00	0.00	0.00
(5)	80992.05	0.00	0.00	219.10	10944.00	1140.02	15846.30	0.00	0.00
(6)	8400.29	840.03	0.00	176.11	0.00	0.00	4822.60	0.00	0.00
(7)	28288.75	0.00	328.00	21134.55	343.80	575.54	777.70	0.00	0.00
(8)	14859.49	2823.31	638.96	5197.88	0.00	1020.20	641.00	0.00	0.00
(9)	29090.45	9308.95	1658.16	15638.70	2575.50	17148.40	3239.84	0.00	0.00
(T)	209204.29	118630.40	24452.62	84858.60	38482.80	24358.66	52472.24	0.00	0.00

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS AND OUTPUTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	11738	299	8549	11438	9133	8849	7721	0	4017	9695
(B)	88859	96457	40877	59721	55579	29138	100598	9027	0	87430	51990
(C)	70435	51450	4855	42296	46595	28139	47151	17396	0	34054	34130
(D)	104294	285323	47195	64808	238037	39486	112003	166326	0	118906	224805
(E)	193581	459248	1494	100304	457755	93277	101798	301866	0	157382	380114
(F)	598062	0	0	0	0	59862	0	0	0	0	0
(G)	154797	123694	0	0	123694	154797	0	101977	0	21817	112590
(T)	1227710	1027910	94720	275678	933098	413832	370399	604313	0	423606	813324

(A) MANAGER (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURE
(G) PROPRIETERS (T) TOTAL

3-C.3 Numerical Results For ECHSS1 Illustration

NEW FAMILIES DISTRIBUTION TO HOUSES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	13057.	0.	0.	0.	13489.	0.	0.	0.	26546.
-2	6528.	6717.	0.	0.	89864.	125108.	0.	0.	228217.
-3	0.	3359.	1132.	0.	25356.	69057.	16097.	19.	115020.
-4	0.	0.	566.	257.	1417.	3890.	7907.	1583.	15620.
-5	0.	0.	0.	126.	1042.	1017.	438.	471.	3094.
RG OW SZ-1	19165.	0.	0.	0.	2783.	3681.	175.	3.	25807.
-2	38342.	13575.	0.	0.	6319.	9700.	736.	18.	68690.
-3	0.	27845.	4134.	0.	9059.	9559.	1152.	37.	51786.
-4	0.	0.	8798.	2467.	3652.	3307.	391.	355.	18970.
-5	0.	0.	0.	1184.	526.	283.	8.	25.	2026.
TN OW SZ-1	517.	1055.	0.	0.	595.	613.	7.	0.	2787.
-2	789.	2110.	302.	19.	0.	929.	58.	0.	4207.
-3	0.	0.	624.	38.	182.	98.	22.	1.	965.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1082.	0.	0.	0.	1329.	718.	0.	0.	3129.
-2	542.	1009.	0.	0.	803.	1788.	18.	0.	4160.
-3	0.	504.	73.	0.	400.	1194.	96.	0.	2267.
-4	0.	0.	36.	15.	0.	0.	797.	29.	877.
-5	0.	0.	0.	8.	0.	0.	0.	4.	12.
TR OW SZ-1	2540.	0.	0.	0.	0.	0.	0.	0.	2540.
-2	5080.	1286.	0.	0.	0.	614.	233.	9.	7222.
-3	0.	2571.	972.	0.	650.	41.	1.	0.	4235.
-4	0.	0.	478.	234.	0.	0.	0.	0.	712.
-5	0.	0.	0.	117.	0.	0.	0.	0.	117.
-T	87642.	60031.	17115.	4465.	157466.	231597.	28136.	2554.	589006.

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS (1) 1-4 Family Members
(HT) HUT (OW) OWN (-2) 3-4 ROOMS (2) 5-9 Family Members
(TN) TENT (-3) 5-6 ROOMS (3) 9-13 Family Members
(TR) TRADITIONAL (-4) 7-8 ROOMS (4) 13-A Family Members
(-5) 9-A ROOMS

REDISTRIBUTION OF EXISTING FAMILIES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	982.	0.	0.	0.	4424.	6339.	476.	6.	12227.
-2	9683.	32478.	0.	0.	29470.	65616.	290.	10.	137547.
-3	5168.	21972.	19568.	725.	8315.	29880.	15407.	12.	101047.
-4	531.	4004.	3177.	1903.	483.	2040.	7235.	937.	20310.
-5	0.	580.	664.	1217.	342.	533.	428.	931.	4695.
RG OW SZ-1	2572.	0.	0.	0.	913.	1931.	171.	2.	5589.
-2	25499.	106804.	0.	0.	2072.	5088.	718.	16.	140197.
-3	15144.	92889.	77797.	15005.	2971.	5013.	1124.	33.	209976.
-4	3180.	31068.	69429.	37955.	1198.	1734.	381.	250.	145195.
-5	1430.	20337.	33216.	15238.	172.	149.	8.	263.	70813.
TN OW SZ-1	463.	1385.	1014.	145.	195.	322.	7.	0.	3531.
-2	354.	2974.	1635.	578.	0.	487.	56.	0.	6084.
-3	277.	1712.	1117.	277.	60.	51.	21.	1.	3516.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	336.	0.	0.	6.	436.	376.	0.	0.	1154.
-2	606.	2155.	151.	0.	263.	939.	18.	0.	4132.
-3	269.	1497.	666.	0.	131.	626.	94.	0.	3283.
-4	0.	548.	579.	279.	0.	0.	778.	1.	2185.
-5	140.	214.	57.	117.	0.	0.	0.	29.	557.
TR OW SZ-1	1018.	0.	0.	6.	0.	0.	0.	0.	1024.
-2	1144.	11434.	151.	0.	0.	336.	228.	8.	13301.
-3	3502.	10903.	5753.	1071.	0.	341.	40.	1.	21611.
-4	417.	7961.	6587.	3283.	0.	0.	0.	0.	18248.
-5	262.	576.	7118.	806.	0.	0.	0.	0.	8762.
-T	72977.	351491.	228679.	78611.	51445.	121801.	27480.	2500.	934984.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

TOTAL FAMILY-TO-HOUSE DISTRIBUTION

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	14039.	0.	0.	0.	17913.	6339.	476.	6.	38773.
-2	16211.	39195.	0.	0.	119334.	190724.	290.	10.	365764.
-3	5168.	25331.	20700.	725.	33671.	98937.	31504.	31.	216067.
-4	531.	4004.	3743.	2160.	1900.	5930.	15142.	2520.	35930.
-5	0.	580.	664.	1343.	1384.	1550.	866.	1402.	7789.
RG OW SZ-1	21737.	0.	0.	0.	3696.	5612.	346.	5.	31396.
-2	63841.	120379.	0.	0.	8391.	14788.	1454.	34.	208887.
-3	15144.	120734.	81931.	15005.	12030.	14572.	2276.	70.	261762.
-4	3180.	31068.	78227.	40422.	4850.	5041.	772.	605.	164165.
-5	1430.	20337.	33216.	16422.	698.	432.	16.	288.	72839.
TN OW SZ-1	980.	2440.	1014.	145.	790.	935.	14.	0.	6318.
-2	1143.	5084.	1937.	597.	0.	1416.	114.	0.	10291.
-3	277.	1712.	1741.	315.	242.	149.	43.	2.	4481.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1418.	0.	0.	6.	1765.	1094.	0.	0.	4283.
-2	1148.	3164.	151.	0.	1066.	2727.	36.	0.	8292.
-3	269.	2001.	739.	0.	531.	1820.	190.	0.	5550.
-4	0.	548.	615.	294.	0.	0.	1575.	30.	3062.
-5	140.	214.	57.	125.	0.	0.	0.	33.	569.
TR OW SZ-1	3558.	0.	0.	6.	0.	0.	0.	0.	3564.
-2	6224.	12720.	151.	0.	0.	950.	461.	17.	20523.
-3	3502.	13474.	6725.	1071.	650.	382.	41.	1.	25846.
-4	417.	7961.	7065.	3517.	0.	0.	0.	0.	18960.
-5	262.	576.	7118.	923.	0.	0.	0.	0.	8879.
-T	160619.	411522.	245794.	83076.	208911.	353398.	55616.	5054.	1523990.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

FAMILY-TO-HOUSE DISTRIBUTION RATIOS

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	.0874	.0000	.0000	.0000	.0857	.0179	.0086	.0012	.0254
-2	.1009	.0952	.0000	.0000	.5712	.5397	.0052	.0020	.2400
-3	.0322	.0616	.0842	.0087	.1612	.2800	.5665	.0061	.1418
-4	.0033	.0097	.0152	.0260	.0091	.0168	.2723	.4986	.0236
-5	.0000	.0014	.0027	.0162	.0066	.0044	.0156	.2774	.0051
RG OW SZ-1	.1353	.0000	.0000	.0000	.0177	.0159	.0062	.0010	.0206
-2	.3975	.2925	.0000	.0000	.0402	.0418	.0261	.0067	.1371
-3	.0943	.2934	.3333	.1806	.0576	.0412	.0409	.0139	.1718
-4	.0198	.0755	.3183	.4866	.0232	.0143	.0139	.1197	.1077
-5	.0089	.0494	.1351	.1977	.0033	.0012	.0003	.0570	.0478
TN OW SZ-1	.0061	.0059	.0041	.0017	.0038	.0026	.0003	.0000	.0041
-2	.0071	.0124	.0079	.0072	.0000	.0040	.0020	.0000	.0068
-3	.0017	.0042	.0071	.0038	.0012	.0004	.0008	.0004	.0029
HT RT SZ-1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
HT OW SZ-1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
TR RT SZ-1	.0088	.0000	.0000	.0001	.0084	.0031	.0000	.0000	.0028
-2	.0071	.0077	.0006	.0000	.0051	.0077	.0006	.0000	.0054
-3	.0017	.0049	.0030	.0000	.0025	.0052	.0034	.0000	.0036
-4	.0000	.0013	.0025	.0035	.0000	.0000	.0283	.0059	.0020
-5	.0009	.0005	.0002	.0015	.0000	.0000	.0000	.0065	.0004
TR OW SZ-1	.0222	.0000	.0000	.0001	.0000	.0000	.0000	.0000	.0023
-2	.0388	.0309	.0006	.0000	.0000	.0027	.0083	.0034	.0135
-3	.0218	.0327	.0274	.0129	.0031	.0011	.0007	.0002	.0170
-4	.0026	.0193	.0287	.0423	.0000	.0000	.0000	.0000	.0124
-5	.0016	.0014	.0290	.0111	.0000	.0000	.0000	.0000	.0058

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS (1) 1-4 Family Members
(HT) HUT (OW) OWN (-2) 3-4 ROOMS (2) 5-9 Family Members
(TN) TENT (-3) 5-6 ROOMS (3) 9-13 Family Members
(TR) TRADITIONAL (-4) 7-8 ROOMS (4) 13-A Family Members
(-5) 9-A ROOMS

DOMESTIC FAMILY-TO-HOUSE DISTRIBUTIONS

VACANCIES AND NEW HOUSES REQUIREMENTS

	Vacancies	New
RG RT SZ-1	0.	8553.
-2	0.	66235.
-3	0.	141297.
-4	0.	60393.
-5	0.	11698.
RG OW SZ-1	0.	19698.
-2	0.	71114.
-3	0.	102991.
-4	0.	96414.
-5	2787.	0.
TN OW SZ-1	1963.	0.
-2	0.	8377.
-3	169.	0.
HT RT SZ-1	574.	0.
-2	478.	0.
-3	10105.	0.
HT OW SZ-1	1579.	0.
-2	1637.	0.
-3	1416.	0.
TR RT SZ-1	0.	456.
-2	1313.	0.
-3	0.	853.
-4	0.	2131.
-5	511.	0.
TR OW SZ-1	3264.	0.
-2	552.	0.
-3	0.	18756.
-4	0.	10715.
-5	1923.	0.

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS
(HT) HUT (OW) OWN (-2) 3-4 ROOMS
(TN) TENT (-3) 5-6 ROOMS
(TR) TRADITIONAL (-4) 7-8 ROOMS
(-5) 9-U ROOMS

TOTAL FAMILY ACCOUNTS

	Unhoused	New	Remaining	To be housed
DOM (1)	0.	82294.	72978.	87642.
(2)	0.	34956.	351492.	60031.
(3)	0.	1156.	228949.	17116.
(4)	0.	7.	78611.	4465.
EXP (1)	0.	154866.	51444.	156869.
(2)	0.	227847.	121800.	232232.
(3)	0.	27150.	27478.	28178.
(4)	0.	2659.	2500.	2733.

(1) 1-4 MEMBERS (2) 5-9 MEMBERS
(2) 10-13 MEMBERS (4) 13-U MEMBERS

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Sector Projects	Neg.Dev.	Pos.Dev.
(1)	8287.32	7844.74	57.00	15330.40	0.00	13.10	161.00	0.00	0.00
(2)	23700.71	1393.69	2164.25	1433.87	0.00	285.80	75.00	0.00	0.00
(3)	8780.00	96944.05	146.00	25777.13	19614.60	3781.90	26908.80	0.00	0.00
(4)	6882.67	0.00	0.00	854.69	5004.90	393.70	0.00	0.00	0.00
(5)	81142.11	0.00	0.00	217.71	10944.00	1140.02	15846.30	0.00	0.00
(6)	8493.29	849.33	0.00	176.63	0.00	0.00	4822.60	0.00	0.00
(7)	28787.30	0.00	328.00	21591.69	343.80	575.54	777.70	0.00	0.00
(8)	15798.03	3001.62	679.32	6139.66	0.00	1020.20	641.00	0.00	0.00
(9)	29762.15	9523.89	1696.44	16348.64	2575.50	17148.40	3239.84	0.00	0.00
(T)	211633.58	119557.32	5071.01	87870.42	38482.80	24358.66	52472.24	0.00	0.00

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS AND OUTPUTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	12138	299	8549	11838	9133	8849	8121	0	4017	10095
(B)	88859	97799	40877	59721	56922	29138	100598	10369	0	87430	53332
(C)	70435	53152	4855	42296	48297	28139	47151	19098	0	34054	35832
(D)	104294	288478	47195	64808	241284	39486	112003	169572	0	118906	227960
(E)	193581	462906	1494	100304	461412	93277	101798	305524	0	157382	383772
(F)	598062	0	0	0	0	59862	0	0	0	0	0
(G)	154797	130658	0	0	130658	154797	0	1088421	0	21817	119554
(T)	1227710	1045131	94720	275678	950411	413832	370399	1601105	0	423606	830545

(A) MANAGER (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURE
(G) PROPRIETERS (T) TOTAL

3-D SOLUTIONS FOR INITIAL HOUSING GOALS AND LABOR-GOVERNMENT TRADE-OFFS

3-D.4 Numerical Results For ECHS101 Illustration

NEW FAMILIES DISTRIBUTION TO HOUSES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	13057.	0.	0.	0.	4534.	0.	0.	0.	17591.
-2	0.	0.	0.	0.	30203.	38820.	0.	0.	69023.
-3	0.	0.	0.	0.	8522.	21428.	6688.	8.	36646.
-4	0.	0.	0.	0.	495.	1207.	3285.	646.	5633.
-5	0.	0.	0.	0.	350.	316.	182.	192.	1040.
RG OW SZ-1	19165.	0.	0.	0.	935.	1142.	73.	1.	21316.
-2	38342.	13574.	0.	0.	2124.	3010.	306.	7.	57363.
-3	0.	27845.	4134.	0.	3045.	2966.	479.	15.	38484.
-4	0.	0.	2587.	2467.	1227.	1026.	162.	145.	7614.
-5	6528.	10076.	0.	1184.	177.	88.	3.	84.	18140.
TN OW SZ-1	517.	1055.	0.	383.	200.	190.	3.	0.	2348.
-2	789.	2110.	302.	19.	0.	288.	24.	0.	3532.
-3	0.	0.	624.	38.	61.	30.	9.	0.	762.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1082.	0.	0.	0.	467.	223.	0.	0.	1772.
-2	542.	1008.	0.	0.	270.	555.	8.	0.	2383.
-3	0.	505.	73.	0.	134.	370.	40.	0.	1122.
-4	0.	0.	36.	15.	0.	0.	331.	12.	394.
-5	0.	0.	734.	8.	0.	0.	0.	2.	744.
TR OW SZ-1	2539.	0.	0.	0.	0.	0.	0.	0.	2539.
-2	5081.	1286.	0.	0.	0.	199.	97.	4.	6667.
-3	0.	2572.	972.	0.	0.	202.	17.	0.	3763.
-4	0.	0.	478.	234.	0.	0.	0.	0.	712.
-5	0.	0.	0.	117.	0.	0.	0.	0.	117.
-T	87642.	60031.	9940.	4465.	52744.	72060.	11707.	1116.	299705.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

REDISTRIBUTION OF EXISTING FAMILIES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	1963.	0.	0.	0.	3325.	6290.	476.	6.	12060.
-2	19365.	60031.	0.	0.	22148.	65117.	290.	10.	166961.
-3	10337.	43944.	11707.	1116.	6249.	29653.	15407.	12.	118425.
-4	1063.	8007.	6356.	1116.	363.	2025.	7235.	937.	27102.
-5	0.	1160.	1328.	1109.	257.	529.	428.	931.	5742.
RG OW SZ-1	1591.	0.	0.	0.	686.	1916.	171.	2.	4366.
-2	15816.	71744.	0.	0.	1557.	5049.	718.	16.	94900.
-3	9975.	70917.	11635.	1115.	2233.	4975.	1124.	33.	102007.
-4	2649.	27065.	11402.	1109.	900.	1721.	381.	249.	45476.
-5	1430.	19757.	11229.	1101.	129.	147.	8.	263.	34064.
TN OW SZ-1	463.	1385.	1014.	145.	147.	319.	7.	0.	3480.
-2	354.	2622.	1406.	499.	0.	483.	56.	0.	5420.
-3	277.	2063.	1346.	356.	45.	51.	21.	0.	4159.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	672.	0.	0.	12.	327.	374.	0.	0.	1385.
-2	1212.	4309.	300.	0.	198.	932.	18.	0.	6969.
-3	539.	2995.	1332.	0.	99.	621.	94.	0.	5680.
-4	0.	1097.	1156.	558.	0.	0.	778.	1.	3590.
-5	279.	429.	117.	233.	0.	0.	0.	29.	1087.
TR OW SZ-1	682.	0.	0.	0.	0.	0.	0.	0.	682.
-2	538.	9279.	0.	0.	0.	334.	228.	8.	10387.
-3	3233.	9406.	5359.	1071.	0.	336.	40.	0.	19447.
-4	344.	7410.	8297.	2218.	0.	0.	0.	0.	18269.
-5	196.	362.	4769.	1475.	0.	0.	0.	0.	6802.
-T	72978.	343982.	78753.	13233.	38663.	120874.	27480.	2497.	698460.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

TOTAL FAMILY-TO-HOUSE DISTRIBUTION

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	15020.	0.	0.	0.	7859.	6290.	476.	6.	29651.
-2	19365.	64956.	0.	0.	52351.	103937.	290.	10.	240909.
-3	10337.	43944.	39134.	1449.	14771.	51081.	22095.	20.	182831.
-4	1063.	8007.	6356.	4592.	858.	3232.	10520.	1583.	36211.
-5	0.	1160.	1328.	1647.	607.	845.	610.	1123.	7320.
RG OW SZ-1	20756.	0.	0.	0.	1621.	3058.	244.	3.	25682.
-2	54158.	87901.	0.	0.	3681.	8059.	1024.	23.	154846.
-3	9975.	98762.	62365.	14280.	5278.	7941.	1603.	48.	200252.
-4	2649.	27065.	77996.	38520.	2127.	2747.	543.	394.	152041.
-5	7958.	29833.	23394.	15205.	306.	235.	11.	347.	77289.
TN OW SZ-1	980.	2440.	1014.	528.	347.	509.	10.	0.	5828.
-2	1143.	4732.	1708.	518.	0.	771.	80.	0.	8952.
-3	277.	2063.	1970.	394.	106.	81.	30.	0.	4921.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1754.	0.	0.	12.	794.	597.	0.	0.	3157.
-2	1754.	5317.	300.	0.	468.	1487.	26.	0.	9352.
-3	539.	3500.	1405.	0.	233.	991.	134.	0.	6802.
-4	0.	1097.	1192.	573.	0.	0.	1109.	13.	3984.
-5	279.	429.	851.	241.	0.	0.	0.	31.	1831.
TR OW SZ-1	3221.	0.	0.	0.	0.	0.	0.	0.	3221.
-2	5619.	10565.	0.	0.	0.	533.	325.	12.	17054.
-3	3233.	11978.	6331.	1071.	0.	540.	57.	0.	23210.
-4	344.	7410.	8775.	2452.	0.	0.	0.	0.	18981.
-5	196.	362.	4769.	1592.	0.	0.	0.	0.	6919.
-T	160620.	411521.	238888.	83074.	91407.	192934.	39187.	3613.	1221244.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

FAMILY-TO-HOUSE DISTRIBUTION RATIOS

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	.0935	.0000	.0000	.0000	.0860	.0326	.0121	.0017	.0243
-2	.1206	.1578	.0000	.0000	.5727	.5387	.0074	.0028	.1973
-3	.0644	.1068	.1638	.0174	.1616	.2648	.5638	.0055	.1497
-4	.0066	.0195	.0266	.0553	.0094	.0168	.2685	.4381	.0297
-5	.0000	.0028	.0056	.0198	.0066	.0044	.0156	.3108	.0060
RG OW SZ-1	.1292	.0000	.0000	.0000	.0177	.0158	.0062	.0008	.0210
-2	.3372	.2136	.0000	.0000	.0403	.0418	.0261	.0064	.1268
-3	.0621	.2400	.2611	.1719	.0577	.0412	.0409	.0133	.1640
-4	.0165	.0658	.3265	.4637	.0233	.0142	.0139	.1091	.1245
-5	.0495	.0725	.0979	.1830	.0033	.0012	.0003	.0960	.0633
TN OW SZ-1	.0061	.0059	.0042	.0064	.0038	.0026	.0003	.0000	.0048
-2	.0071	.0115	.0071	.0062	.0000	.0040	.0020	.0000	.0073
-3	.0017	.0050	.0082	.0047	.0012	.0004	.0008	.0000	.0040
HT RT SZ-1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
HT OW SZ-1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
TR RT SZ-1	.0109	.0000	.0000	.0001	.0087	.0031	.0000	.0000	.0026
-2	.0109	.0129	.0013	.0000	.0051	.0077	.0007	.0000	.0077
-3	.0034	.0085	.0059	.0000	.0025	.0051	.0034	.0000	.0056
-4	.0000	.0027	.0050	.0069	.0000	.0000	.0283	.0036	.0033
-5	.0017	.0010	.0036	.0029	.0000	.0000	.0000	.0086	.0015
TR OW SZ-1	.0201	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0026
-2	.0350	.0257	.0000	.0000	.0000	.0028	.0083	.0033	.0140
-3	.0201	.0291	.0265	.0129	.0000	.0028	.0015	.0000	.0190
-4	.0021	.0180	.0367	.0295	.0000	.0000	.0000	.0000	.0155
-5	.0012	.0009	.0200	.0192	.0000	.0000	.0000	.0000	.0057

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS (1) 1-4 Family Members
(HT) HUT (OW) OWN (-2) 3-4 ROOMS (2) 5-9 Family Members
(TN) TENT (-3) 5-6 ROOMS (3) 9-13 Family Members
(TR) TRADITIONAL (-4) 7-8 ROOMS (4) 13-A Family Members
(-5) 9-A ROOMS

DOMESTIC FAMILY-TO-HOUSE DISTRIBUTIONS

DEVIATIONS FROM NEW FAMILY DISTRIBUTION GOALS

	Negative Deviations				Positive Deviations			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
RG RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	6528.	6717.	0.	0.	0.	0.	0.	0.
-3	0.	3359.	1132.	0.	0.	0.	0.	0.
-4	0.	0.	566.	257.	0.	0.	0.	0.
-5	0.	0.	0.	126.	0.	0.	0.	0.
RG OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	6211.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	6528.	10076.	0.	0.
TN OW SZ-1	0.	0.	0.	0.	0.	0.	0.	383.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	734.	0.
TR OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

DEVIATIONS FROM EXISTING FAMILY REDISTRIBUTION GOALS

	Negative Deviations				Positive Deviations			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
RG RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	4925.	0.	0.	0.	0.	0.	0.
-3	0.	0.	27427.	333.	0.	0.	0.	0.
-4	0.	0.	0.	3476.	0.	0.	0.	0.
-5	0.	0.	0.	538.	0.	0.	0.	0.
RG OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	2583.	0.	0.	0.	0.	0.	0.
-3	0.	0.	46596.	13165.	0.	0.	0.	0.
-4	0.	0.	64007.	34944.	0.	0.	0.	0.
-5	0.	0.	12165.	12920.	0.	0.	0.	0.
TN OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.
TR OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

VACANCIES AND NEW HOUSES REQUIREMENTS

	Vacancies	New
RG RT SZ-1	0.	10675.
-2	0.	25522.
-3	0.	66287.
-4	0.	17699.
-5	0.	2768.
RG OW SZ-1	0.	14688.
-2	0.	21952.
-3	0.	42729.
-4	0.	70851.
-5	1488.	0.
TN OW SZ-1	2521.	0.
-2	0.	7061.
-3	137.	0.
HT RT SZ-1	0.	0.
-2	10478.	10000.
-3	238.	0.
HT OW SZ-1	1579.	0.
-2	1637.	0.
-3	1416.	0.
TR RT SZ-1	0.	121.
-2	0.	155.
-3	0.	1735.
-4	0.	2979.
-5	0.	0.
TR OW SZ-1	3635.	0.
-2	3479.	0.
-3	0.	1057.
-4	0.	10357.
-5	3884.	0.

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS
(HT) HUT (OW) OWN (-2) 3-4 ROOMS
(TN) TENT (-3) 5-6 ROOMS
(TR) TRADITIONAL (-4) 7-8 ROOMS
(-5) 9-U ROOMS

TOTAL FAMILY ACCOUNTS

		Unhoused	New	Remaining	To be housed
DOM	(1)	0.	82294.	72798.	87642.
	(2)	0.	34956.	351429.	60031.
	(3)	7176.	1136.	228949.	17116.
	(4)	0.	7.	78611.	4465.
EXP	(1)	0.	50719.	38611.	52723.
	(2)	0.	6764.	120874.	72059.
	(3)	0.	10679.	27478.	11707.
	(4)	0.	1042.	2500.	1116.

(1) 1-4 MEMBERS (2) 5-9 MEMBERS
(2) 10-13 MEMBERS (4) 13-U MEMBERS

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Sector Projects	Neg.Dev.	Pos.Dev.
(1)	8287.32	5180.08	57.00	12739.49	0.00	13.10	161.00	0.00	0.00
(2)	23515.70	1382.59	21624.50	1149.49	640.57	285.80	75.00	0.00	640.57
(3)	8780.00	81668.90	146.00	21531.83	19614.60	3781.90	26908.80	0.00	0.00
(4)	1438.13	0.00	0.00	610.51	0.00	393.70	0.00	5044.90	0.00
(5)	41703.31	0.00	0.00	205.54	0.00	1140.02	15846.30	10144.00	0.00
(6)	7165.07	716.50	0.00	164.16	0.00	0.00	4822.60	0.00	0.00
(7)	22902.49	0.00	328.00	18039.96	0.00	575.54	777.70	343.80	0.00
(8)	12525.60	2379.86	538.60	4434.82	0.00	1020.20	641.00	0.00	0.00
(9)	20629.54	6601.45	1175.88	12792.41	0.00	17148.40	3239.84	2575.50	0.00
(T)	146947.16	97929.38	23869.98	71668.21	20255.17	24358.66	52472.24	18108.20	640.57

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS AND OUTPUTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	4567	299	8549	5167	9133	8849	1450	0	4017	2524
(B)	88859	66573	40877	59721	25696	29138	100598	0	20857	87430	22106
(C)	70435	321215	4855	42296	26359	28139	47151	0	2839	34054	303895
(D)	104294	190075	47195	64808	143581	39486	112003	71869	0	118906	129557
(E)	193581	233839	1494	100304	232345	93277	101798	76457	0	157382	154705
(F)	598062	0	0	0	0	59862	0	0	0	0	0
(G)	154797	57703	0	0	57703	154797	0	35886	0	21817	46599
(T)	1227710	873972	94720	275678	490851	413832	370399	185662	23696	423606	659386

(A) MANAGER (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURE
(G) PROPRIETERS (T) TOTAL

3-D.5 Numerical Results For ECHS102 Illustration

NEW FAMILIES DISTRIBUTION TO HOUSES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	4378.	0.	0.	0.	2877.	0.	0.	0.	7255.
-2	6928.	72.	0.	0.	19165.	20224.	0.	0.	46389.
-3	0.	0.	0.	0.	5408.	11163.	4714.	5.	21290.
-4	0.	0.	0.	0.	314.	620.	2316.	450.	3700.
-5	0.	0.	0.	0.	222.	164.	128.	134.	648.
RG OW SZ-1	5464.	0.	0.	0.	593.	595.	51.	1.	6704.
-2	32456.	0.	0.	0.	1348.	1568.	216.	5.	35593.
-3	0.	0.	0.	0.	1932.	1545.	337.	10.	3824.
-4	0.	0.	0.	0.	779.	534.	114.	101.	1528.
-5	0.	18237.	0.	1184.	112.	46.	2.	58.	19639.
TN OW SZ-1	517.	1055.	0.	2849.	127.	99.	2.	0.	4649.
-2	489.	2111.	302.	19.	0.	150.	17.	0.	3088.
-3	0.	0.	624.	38.	39.	16.	6.	0.	723.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1082.	179.	0.	0.	283.	116.	0.	0.	1660.
-2	542.	1009.	0.	0.	171.	289.	5.	0.	2016.
-3	0.	504.	73.	0.	85.	193.	28.	0.	883.
-4	0.	0.	36.	15.	0.	0.	233.	8.	292.
-5	734.	0.	0.	8.	0.	0.	0.	1.	743.
TR OW SZ-1	2540.	0.	0.	0.	0.	0.	0.	0.	2540.
-2	5080.	1286.	0.	0.	0.	104.	68.	2.	6540.
-3	0.	2571.	972.	0.	0.	105.	12.	0.	3660.
-4	0.	0.	478.	234.	0.	0.	0.	0.	712.
-5	0.	0.	0.	117.	0.	0.	0.	0.	117.
-T	60210.	27024.	2485.	4464.	33455.	37531.	8249.	775.	174193.

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS (1) 1-4 Family Members
(HT) HUT (OW) OWN (-2) 3-4 ROOMS (2) 5-9 Family Members
(TN) TENT (-3) 5-6 ROOMS (3) 9-13 Family Members
(TR) TRADITIONAL (-4) 7-8 ROOMS (4) 13-A Family Members
(-5) 9-A ROOMS

REDISTRIBUTION OF EXISTING FAMILIES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	1963.	0.	0.	0.	3046.	6229.	476.	5.	11719.
-2	19365.	60031.	0.	0.	20295.	64480.	290.	10.	164471.
-3	10337.	37541.	8252.	776.	5726.	29363.	15407.	12.	107414.
-4	1062.	8007.	6356.	776.	332.	2005.	7235.	937.	26710.
-5	0.	1160.	1328.	771.	235.	524.	427.	931.	5376.
RG OW SZ-1	1591.	0.	0.	0.	628.	1897.	171.	2.	4289.
-2	15816.	37377.	0.	0.	1427.	4999.	718.	16.	60353.
-3	9975.	36946.	8201.	776.	2046.	4926.	1123.	33.	64026.
-4	2649.	27065.	8037.	771.	824.	1704.	380.	249.	41679.
-5	143.	19757.	7915.	766.	119.	146.	8.	262.	29116.
TN OW SZ-1	463.	1385.	1014.	145.	134.	316.	7.	0.	3464.
-2	354.	2622.	1406.	499.	0.	479.	56.	0.	5416.
-3	277.	2063.	1346.	356.	41.	50.	21.	0.	4154.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	672.	0.	0.	12.	300.	369.	0.	0.	1353.
-2	1212.	4309.	300.	0.	181.	923.	18.	0.	6943.
-3	538.	2905.	1332.	0.	90.	615.	94.	0.	5574.
-4	0.	1096.	1156.	558.	0.	0.	778.	1.	3589.
-5	279.	429.	117.	233.	0.	0.	0.	29.	1087.
TR OW SZ-1	682.	0.	0.	0.	0.	0.	0.	0.	682.
-2	538.	9279.	0.	0.	0.	330.	227.	8.	10382.
-3	3233.	9406.	5359.	1071.	0.	335.	39.	0.	19443.
-4	344.	7413.	8297.	2217.	0.	0.	0.	0.	18271.
-5	195.	362.	4769.	1475.	0.	0.	0.	0.	6801.
-T	71688.	269153.	65185.	11202.	35424.	119690.	27475.	2495.	602312.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

TOTAL FAMILY-TO-HOUSE DISTRIBUTION

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	6341.	0.	0.	0.	5923.	6229.	476.	5.	18974.
-2	26293.	65028.	0.	0.	39460.	84704.	290.	10.	215785.
-3	10337.	43943.	39134.	1449.	11134.	40526.	20121.	17.	166661.
-4	1062.	8007.	6356.	4592.	646.	2625.	9551.	1387.	34226.
-5	0.	1160.	1328.	1647.	457.	688.	555.	1065.	6900.
RG OW SZ-1	7055.	0.	0.	0.	1221.	2492.	222.	3.	10993.
-2	48272.	74326.	0.	0.	2775.	6567.	934.	21.	132895.
-3	9975.	70917.	58230.	14281.	3978.	6471.	1460.	43.	165355.
-4	2649.	27065.	75409.	36052.	1603.	2238.	494.	350.	145860.
-5	143.	37994.	23394.	15205.	231.	192.	10.	320.	77489.
TN OW SZ-1	980.	2440.	1014.	2994.	261.	415.	9.	0.	8113.
-2	843.	4733.	1708.	518.	0.	629.	73.	0.	8504.
-3	277.	2063.	1970.	394.	80.	66.	27.	0.	4877.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1754.	179.	0.	12.	583.	485.	0.	0.	3013.
-2	1754.	5318.	300.	0.	352.	1212.	23.	0.	8959.
-3	538.	3409.	1405.	0.	175.	808.	122.	0.	6457.
-4	0.	1096.	1192.	573.	0.	0.	1011.	9.	3881.
-5	1013.	429.	117.	241.	0.	0.	0.	30.	1830.
TR OW SZ-1	3222.	0.	0.	0.	0.	0.	0.	0.	3222.
-2	5618.	10565.	0.	0.	0.	434.	295.	10.	16922.
-3	3233.	11977.	6331.	1071.	0.	440.	51.	0.	23103.
-4	344.	7413.	8775.	2451.	0.	0.	0.	0.	18983.
-5	195.	362.	4769.	1592.	0.	0.	0.	0.	6918.
-T	131898.	378424.	231432.	83072.	68879.	157221.	35724.	3270.	1089920.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

FAMILY-TO-HOUSE DISTRIBUTION RATIOS

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	.0481	.0000	.0000	.0000	.0860	.0396	.0133	.0015	.0174
-2	.1993	.1716	.0000	.0000	.5729	.5388	.0081	.0031	.1980
-3	.0784	.1161	.1691	.0174	.1616	.2578	.5632	.0052	.1529
-4	.0081	.0212	.0275	.0553	.0094	.0167	.2674	.4242	.0314
-5	.0000	.0031	.0057	.0198	.0066	.0044	.0155	.3257	.0063
RG OW SZ-1	.0535	.0000	.0000	.0000	.0177	.0159	.0062	.0009	.0101
-2	.3660	.1964	.0000	.0000	.0403	.0418	.0261	.0064	.1219
-3	.0756	.1874	.2516	.1719	.0578	.0412	.0409	.0131	.1517
-4	.0201	.0715	.3258	.4340	.0233	.0142	.0138	.1070	.1338
-5	.0011	.1004	.1011	.1830	.0034	.0012	.0003	.0979	.0711
TN OW SZ-1	.0074	.0064	.0044	.0360	.0038	.0026	.0003	.0000	.0074
-2	.0064	.0125	.0074	.0062	.0000	.0040	.0020	.0000	.0078
-3	.0021	.0055	.0085	.0047	.0012	.0004	.0008	.0000	.0045
HT RT SZ-1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
HT OW SZ-1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
TR RT SZ-1	.0133	.0005	.0000	.0001	.0085	.0031	.0000	.0000	.0028
-2	.0133	.0141	.0013	.0000	.0051	.0077	.0006	.0000	.0082
-3	.0041	.0090	.0061	.0000	.0025	.0051	.0034	.0000	.0059
-4	.0000	.0029	.0052	.0069	.0000	.0000	.0283	.0028	.0036
-5	.0077	.0011	.0005	.0029	.0000	.0000	.0000	.0092	.0017
TR OW SZ-1	.0244	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0030
-2	.0426	.0279	.0000	.0000	.0000	.0028	.0083	.0031	.0155
-3	.0245	.0316	.0274	.0129	.0000	.0028	.0014	.0000	.0212
-4	.0026	.0196	.0379	.0295	.0000	.0000	.0000	.0000	.0174
-5	.0015	.0010	.0206	.0192	.0000	.0000	.0000	.0000	.0063

(RG) REGULAR
(HT) HUT
(TN) TENT
(TR) TRADITIONAL

(RT) RENT
(OW) OWN

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

DOMESTIC FAMILY-TO-HOUSE DISTRIBUTIONS

DEVIATIONS FROM NEW FAMILY DISTRIBUTION GOALS

	Negative Deviations				Positive Deviations			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
RG RT SZ-1	8678.	0.	0.	0.	0.	0.	0.	0.
-2	0.	6645.	0.	0.	0.	0.	0.	0.
-3	0.	3359.	1132.	0.	0.	0.	0.	0.
-4	0.	0.	566.	257.	0.	0.	0.	0.
-5	0.	0.	0.	126.	0.	0.	0.	0.
RG OW SZ-1	13701.	0.	0.	0.	0.	0.	0.	0.
-2	5887.	13575.	0.	0.	0.	0.	0.	0.
-3	0.	27845.	4134.	0.	0.	0.	0.	0.
-4	0.	0.	8798.	2466.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	18237.	0.	0.
TN OW SZ-1	0.	0.	0.	0.	0.	0.	0.	2850.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	0.	0.	0.	0.	0.	179.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	734.	0.	0.	0.
TR OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

DEVIATIONS FROM EXISTING FAMILY REDISTRIBUTION GOALS

	Negative Deviations				Positive Deviations			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
RG RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	4925.	0.	0.	0.	0.	0.	0.
-3	0.	6402.	30882.	673.	0.	0.	0.	0.
-4	0.	0.	0.	3816.	0.	0.	0.	0.
-5	0.	0.	0.	876.	0.	0.	0.	0.
RG OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	36949.	0.	0.	0.	0.	0.	0.
-3	0.	33971.	50029.	13505.	0.	0.	0.	0.
-4	0.	0.	67372.	35281.	0.	0.	0.	0.
-5	0.	0.	15479.	13255.	0.	0.	0.	0.
TN OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.
TR OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

VACANCIES AND NEW HOUSES REQUIREMENTS

	Vacancies	New
RG RT SZ-1	0.	0.
-2	0.	0.
-3	0.	50120.
-4	0.	15724.
-5	0.	2349.
RG OW SZ-1	0.	0.
-2	0.	0.
-3	0.	7835.
-4	0.	64673.
-5	0.	0.
TN OW SZ-1	235.	0.
-2	0.	6911.
-3	181.	0.
HT RT SZ-1	0.	0.
-2	478.	0.
-3	238.	0.
HT OW SZ-1	11579.	10000.
-2	1637.	0.
-3	1416.	0.
TR RT SZ-1	0.	0.
-2	236.	0.
-3	0.	1482.
-4	0.	2878.
-5	0.	0.
TR OW SZ-1	2684.	0.
-2	3607.	0.
-3	0.	10973.
-4	0.	10357.
-5	3884.	0.

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS
(HT) HUT (OW) OWN (-2) 3-4 ROOMS
(TN) TENT (-3) 5-6 ROOMS
(TR) TRADITIONAL (-4) 7-8 ROOMS
(-5) 9-U ROOMS

TOTAL FAMILY ACCOUNTS

		Unhoused	New	Remaining	To be housed
DOM	(1)	27532.	82294.	72978.	87642.
	(2)	3307.	34956.	351492.	60031.
	(3)	14631.	1156.	228349.	17116.
	(4)	0.	7.	78611.	4465.
EXP	(1)	0.	31451.	35428.	33455.
	(2)	0.	33156.	119692.	37541.
	(3)	0.	7224.	27478.	8252.
	(4)	0.	702.	2500.	776.

(1) 1-4 MEMBERS (2) 5-9 MEMBERS
(2) 10-13 MEMBERS (4) 13-U MEMBERS

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Sector Projects	Neg.Dev.	Pos.Dev.
(1)	8287.32	4638.63	57.00	12202.90	0.00	13.10	161.00	0.00	0.00
(2)	23515.70	1382.59	2164.50	1807.17	765.00	285.80	75.00	0.00	764.71
(3)	8780.00	78192.27	146.00	20667.16	19615.00	3781.90	26908.80	0.00	0.00
(4)	1348.05	0.00	0.00	559.45	0.00	393.70	0.00	5004.90	0.00
(5)	31398.63	0.00	0.00	202.40	0.00	1140.02	15846.30	10944.00	0.00
(6)	6852.60	685.26	0.00	161.59	0.00	0.00	4822.60	0.00	0.00
(7)	21732.19	0.00	328.00	17312.36	0.00	575.54	777.70	343.80	0.00
(8)	11959.15	2272.24	814.24	4102.51	0.00	1020.20	641.00	0.00	0.00
(9)	19114.93	6116.78	1089.55	12081.05	0.00	17148.40	3239.84	2975.50	0.00
(T)	132988.57	93287.77	4599.29	69096.59	20380.00	24358.66	52472.24	19268.20	764.71

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS AND OUTPUTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	4495	299	8549	4159	9133	8849	442	0	4017	2452
(B)	88859	62566	40877	59721	21689	29138	100598	0	24864	87430	18099
(C)	70435	27588	4855	42296	22733	28139	47151	0	6465	34054	10268
(D)	104294	170972	47195	64808	123727	39486	112003	52066	0	118906	110454
(E)	193581	179936	1494	100304	178442	93277	101798	22554	0	157382	100802
(F)	598062	0	0	0	0	59862	0	0	0	0	0
(G)	154797	43421	0	0	43421	154797	0	21604	0	21817	32317
(T)	1227710	488978	94720	275678	394171	413832	370399	96666	31329	423606	274392

(A) MANAGER (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURE
(G) PROPRIETERS (T) TOTAL

3-D.6 Numerical Results For ECHS103 Illustration

NEW FAMILIES DISTRIBUTION TO HOUSES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	13057.	0.	0.	0.	4534.	0.	0.	0.	17591.
-2	0.	0.	0.	0.	30203.	38820.	0.	0.	69023.
-3	0.	0.	0.	0.	8522.	21428.	6688.	8.	36646.
-4	0.	0.	0.	0.	495.	1207.	3285.	646.	5633.
-5	0.	0.	0.	0.	350.	316.	182.	192.	1040.
RG OW SZ-1	19165.	0.	0.	0.	935.	1142.	73.	1.	21316.
-2	38342.	13575.	0.	0.	2124.	3010.	306.	7.	57364.
-3	0.	27845.	4134.	0.	3045.	2966.	479.	15.	38484.
-4	0.	0.	2587.	2467.	1227.	1026.	162.	145.	7614.
-5	0.	0.	0.	1184.	177.	88.	3.	84.	1536.
TN OW SZ-1	517.	1055.	0.	0.	200.	190.	3.	0	1965.
-2	789.	2110.	302.	19.	0.	288.	24.	0.	3532.
-3	0.	0.	624.	36.	61.	30.	9.	0.	760.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1082.	0.	0.	0.	447.	223.	0.	0.	1752.
-2	542.	1008.	0.	0.	270.	555.	8.	0.	2383.
-3	0.	504.	73.	0.	134.	370.	40.	0.	1121.
-4	0.	0.	36.	15.	0.	0.	331.	12.	394.
-5	0.	0.	0.	8.	0.	0.	0.	2.	10.
TR OW SZ-1	2540.	0.	0.	0.	0.	0.	0.	0.	2540.
-2	5080.	1286.	0.	0.	0.	199.	97.	4.	6666.
-3	0.	2571.	972.	0.	0.	202.	17.	0.	3762.
-4	0.	0.	478.	234.	0.	0.	0.	0.	712.
-5	0.	0.	0.	117.	0.	0.	0.	0.	117.
-T	81114.	49954.	9206.	4080.	52724.	72060.	11707.	1116.	281961.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

REDISTRIBUTION OF EXISTING FAMILIES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	1963.	0.	0.	0.	3325.	6290.	476.	6.	12060.
-2	19365.	60031.	0.	0.	22148.	65117.	290.	10.	166961.
-3	10337.	43944.	11707.	1116.	6249.	29653.	15407.	12.	118425.
-4	1063.	8007.	6356.	1116.	363.	2025.	7235.	937.	27102.
-5	0.	1160.	1328.	1109.	257.	529.	428.	931.	5742.
RG OW SZ-1	1591.	0.	0.	0.	686.	1916.	171.	2.	4366.
-2	15816.	71744.	0.	0.	1557.	5049.	718.	16.	94900.
-3	9975.	70917.	11635.	1115.	2233.	4975.	1124.	33.	102007.
-4	2649.	27065.	11402.	1109.	900.	1721.	381.	249.	45476.
-5	1430.	19757.	11229.	1101.	129.	147.	8.	263.	34064.
TN OW SZ-1	463.	1385.	1014.	145.	147.	319.	7.	0.	3480.
-2	354.	2622.	1406.	499.	0.	483.	56.	0.	5420.
-3	277.	2063.	1346.	356.	45.	51.	21.	0.	4159.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	672.	0.	0.	12.	327.	374.	0.	0.	1385.
-2	1212.	4309.	300.	0.	198.	932.	18.	0.	6969.
-3	539.	2995.	1332.	0.	99.	621.	94.	0.	5680.
-4	0.	1097.	1156.	558.	0.	0.	778.	1.	3590.
-5	279.	429.	117.	233.	0.	0.	0.	29.	1087.
TR OW SZ-1	682.	0.	0.	0.	0.	0.	0.	0.	682.
-2	538.	9297.	0.	0.	0.	334.	228.	8.	10405.
-3	3233.	9406.	5359.	1071.	0.	338.	40.	0.	19447.
-4	344.	7410.	8297.	2218.	0.	0.	0.	0.	18269.
-5	196.	362.	4769.	1475.	0.	0.	0.	0.	6802.
-T	72978.	344000.	78753.	13233.	38663.	120874.	27480.	2497.	698478.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

TOTAL FAMILY-TO-HOUSE DISTRIBUTION

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	15020.	0.	0.	0.	7859.	6290.	476.	6.	29651.
-2	19365.	64956.	0.	0.	52351.	103937.	290.	10.	240909.
-3	10337.	43944.	39134.	1449.	14771.	51081.	22095.	20.	182831.
-4	1063.	8007.	6356.	4592.	858.	3232.	10520.	1583.	36211.
-5	0.	1160.	1328.	1647.	607.	845.	610.	1123.	7320.
RG OW SZ-1	20756.	0.	0.	0.	1621.	3058.	244.	3.	25682.
-2	54158.	87902.	0.	0.	3681.	8059.	1024.	23.	154847.
-3	9975.	98762.	62365.	14280.	5278.	7941.	1603.	48.	200252.
-4	2649.	27065.	77996.	38520.	2127.	2747.	543.	394.	152041.
-5	1430.	19757.	23394.	15205.	306.	235.	11.	347.	60685.
TN OW SZ-1	980.	2440.	1014.	145.	347.	509.	10.	0.	5445.
-2	1143.	4732.	1708.	518.	0.	771.	80.	0.	8952.
-3	277.	2063.	1970.	392.	106.	81.	30.	0.	4919.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1754.	0.	0.	12.	774.	597.	0.	0.	3137.
-2	1754.	5317.	300.	0.	468.	1487.	26.	0.	9352.
-3	539.	3499.	1405.	0.	233.	991.	134.	0.	6801.
-4	0.	1097.	1192.	573.	0.	0.	1109.	13.	3984.
-5	279.	429.	117.	241.	0.	0.	0.	31.	1097.
TR OW SZ-1	3222.	0.	0.	0.	0.	0.	0.	0.	3222.
-2	5618.	10583.	0.	0.	0.	533.	325.	12.	17071.
-3	3233.	11977.	6331.	1071.	0.	540.	57.	0.	23209.
-4	344.	7410.	8775.	2452.	0.	0.	0.	0.	18981.
-5	196.	362.	4769.	1592.	0.	0.	0.	0.	6919.
-T	154092.	401462.	238154.	82689.	91387.	192934.	39187.	3613.	1203518.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

FAMILY-TO-HOUSE DISTRIBUTION RATIOS

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	.0975	.0000	.0000	.0000	.0860	.0326	.0121	.0017	.0246
-2	.1257	.1618	.0000	.0000	.5728	.5387	.0074	.0028	.2602
-3	.0671	.1095	.1643	.0175	.1616	.2648	.5638	.0055	.1519
-4	.0069	.0199	.0267	.0555	.0094	.0168	.2685	.4381	.0301
-5	.0000	.0029	.0056	.0199	.0066	.0044	.0156	.3108	.0061
RG OW SZ-1	.1347	.0000	.0000	.0000	.0177	.0158	.0062	.0008	.0213
-2	.3515	.2190	.0000	.0000	.0403	.0418	.0261	.0064	.1287
-3	.0647	.2460	.2619	.1727	.0578	.0412	.0409	.0133	.1664
-4	.0172	.0674	.3275	.4658	.0233	.0142	.0139	.1091	.1263
-5	.0093	.0492	.0982	.1839	.0033	.0012	.0003	.0960	.0504
TN OW SZ-1	.0064	.0061	.0043	.0018	.0038	.0026	.0003	.0000	.0045
-2	.0074	.0118	.0072	.0063	.0000	.0040	.0020	.0000	.0074
-3	.0018	.0051	.0083	.0047	.0012	.0004	.0008	.0000	.0041
HT RT SZ-1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
HT OW SZ-1	.0000	.0000	.0000	.0000	.0000	0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
TR RT SZ-1	.0114	.0000	.0000	.0001	.0085	.0031	.0000	.0000	.0026
-2	.0114	.0132	.0013	.0000	.0051	.0077	.0007	.0000	.0078
-3	.0035	.0087	.0059	.0000	.0025	.0051	.0034	.0000	.0057
-4	.0000	.0027	.0050	.0069	.0000	.0000	.0283	.0036	.0033
-5	.0018	.0011	.0005	.0029	.0000	.0000	.0000	.0086	.0009
TR OW SZ-1	.0209	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0027
-2	.0365	.0264	.0000	.0000	.0000	.0028	.0083	.0033	.0142
-3	.0210	.0298	.0266	.0130	.0000	.0028	.0015	.0000	.0193
-4	.0022	.0185	.0368	.0297	.0000	.0000	.0000	.0000	.0158
-5	.0013	.0009	.0200	.0193	.0000	.0000	.0000	.0000	.0057

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

DOMESTIC FAMILY-TO-HOUSE DISTRIBUTIONS

DEVIATIONS FROM NEW FAMILY DISTRIBUTION GOALS

	Negative Deviations				Positive Deviations			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
RG RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	6528.	6717.	0.	0.	0.	0.	0.	0.
-3	0.	3359.	1132.	0.	0.	0.	0.	0.
-4	0.	0.	566.	257.	0.	0.	0.	0.
-5	0.	0.	0.	126.	0.	0.	0.	0.
RG OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	6211.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	6528.	10076.	0.	0.
TN OW SZ-1	0.	0.	0.	0.	0.	0.	0.	383.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	734.	0.
TR OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

DEVIATIONS FROM EXISTING FAMILY REDISTRIBUTION GOALS

	Negative Deviations				Positive Deviations			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
RG RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	4925.	0.	0.	0.	0.	0.	0.
-3	0.	0.	27427.	333.	0.	0.	0.	0.
-4	0.	0.	0.	3476.	0.	0.	0.	0.
-5	0.	0.	0.	538.	0.	0.	0.	0.
RG OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	2583.	0.	0.	0.	0.	0.	0.
-3	0.	0.	46596.	13165.	0.	0.	0.	0.
-4	0.	0.	64007.	34944.	0.	0.	0.	0.
-5	0.	0.	12165.	12920.	0.	0.	0.	0.
TN OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.
TR OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS (1) 1-4 Family Members
(HT) HUT (OW) OWN (-2) 3-4 ROOMS (2) 5-9 Family Members
(TN) TENT (-3) 5-6 ROOMS (3) 9-13 Family Members
(TR) TRADITIONAL (-4) 7-8 ROOMS (4) 13-A Family Members
(-5) 9-A ROOMS

VACANCIES AND NEW HOUSES REQUIREMENTS

	Vacancies	New
RG RT SZ-1	0.	10675.
-2	0.	25522.
-3	0.	66287.
-4	0.	17699.
-5	0.	2768.
RG OW SZ-1	0.	14688.
-2	0.	21952.
-3	0.	42729.
-4	0.	70851.
-5	18092.	0.
TN OW SZ-1	2904.	0.
-2	0.	7061.
-3	137.	0.
HT RT SZ-1	0.	0.
-2	10478.	10000.
-3	238.	0.
HT OW SZ-1	1579.	0.
-2	2637.	0.
-3	1416.	0.
TR RT SZ-1	0.	121.
-2	0.	155.
-3	0.	1735.
-4	0.	2979.
-5	734.	0.
TR OW SZ-1	3635.	0.
-2	3479.	0.
-3	0.	11078.
-4	0.	10375.
-5	3884.	0.

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS
(HT) HUT (OW) OWN (-2) 3-4 ROOMS
(TN) TENT (-3) 5-6 ROOMS
(TR) TRADITIONAL (-4) 7-8 ROOMS
(-5) 9-U ROOMS

TOTAL FAMILY ACCOUNTS

		Unhoused	New	Remaining	To be housed
DOM	(1)	6528.	82294.	72978.	87642.
	(2)	10076.	34956.	351492.	60031.
	(3)	7910.	1156.	228349.	17116.
	(4)	383.	7.	78611.	4465.
EXP	(1)	0.	31451.	38661.	52722.
	(2)	0.	33156.	120874.	72059.
	(3)	0.	7224.	27478.	11707.
	(4)	0.	702.	2500.	1116.

(1) 1-4 MEMBERS (2) 5-9 MEMBERS
(2) 10-13 MEMBERS (4) 13-U MEMBERS

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Sector Projects	Neg.Dev.	Pos.Dev
(1)	8287.32	5180.08	57.00	12739.49	0.00	13.10	161.00	0.00	0.00
(2)	23515.70	1382.59	21624.50	1145.49	640.50	285.80	75.00	0.00	640.50
(3)	8780.00	81668.90	146.00	21531.83	19615.00	3781.90	26908.80	0.00	0.00
(4)	1438.13	0.00	0.00	610.51	0.00	393.70	0.00	5004.90	0.00
(5)	41703.31	0.00	0.00	205.54	0.00	1140.02	15846.30	10944.00	0.00
(6)	7165.07	716.51	0.00	164.16	0.00	0.00	4822.60	0.00	0.00
(7)	22902.49	0.00	328.00	18039.96	0.00	575.54	777.70	343.80	0.00
(8)	12525.60	2379.87	538.60	4434.82	0.00	1020.20	641.00	0.00	0.00
(9)	20629.54	6601.45	1175.88	12792.41	0.00	17148.40	3239.84	2575.50	0.00
(T)	146947.16	97929.40	23869.98	71664.21	20255.50	24358.66	52472.24	18868.20	640.50

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS AND OUTPUTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	5467	299	8549	5167	9133	8849	1450	0	4017	3424
(B)	88859	66573	40877	59721	25696	29138	100598	0	20856	87430	22106
(C)	70435	31215	4855	42296	26359	28139	47151	0	2839	34054	13895
(D)	104294	190775	47195	64808	143580	39486	112003	71869	0	118906	130257
(E)	193581	233838	1494	100304	232345	93277	101798	76457	0	157382	154704
(F)	598062	0	0	0	0	59862	0	0	0	0	0
(G)	154797	57703	0	0	57703	154797	0	35886	0	21817	46599
(T)	1227710	585571	94720	275678	490850	413832	370399	185662	23695	423606	370985

(A) MANAGER (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURE
(G) PROPRIETERS (T) TOTAL

3-D.7 Numerical Results For ECHS104 Illustration

NEW FAMILIES DISTRIBUTION TO HOUSES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	13057.	0.	0.	0.	3621.	0.	0.	0.	16678.
-2	6528.	6717.	0.	0.	35714.	48104.	0.	0.	97063.
-3	0.	3359.	1132.	0.	10077.	26552.	7674.	9.	48803.
-4	0.	0.	566.	257.	585.	1496.	3770.	744.	7418.
-5	0.	0.	0.	0.	414.	391.	209.	222.	1236.
RG OW SZ-1	19165.	0.	0.	0.	1106.	1415.	83.	1.	21770.
-2	3842.	13575.	0.	0.	2511.	3730.	351.	9.	24018.
-3	0.	27845.	4134.	0.	3600.	3675.	549.	17.	39820.
-4	0.	0.	8798.	2466.	1451.	1271.	186.	167.	14339.
-5	0.	0.	0.	1184.	209.	109.	4.	96.	1602.
TN OW SZ-1	517.	1055.	0.	0.	236.	235.	3.	0.	2046.
-2	789.	2110.	302.	19.	0.	357.	27.	0.	3604.
-3	0.	0.	624.	38.	72.	37.	10.	0.	781.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1082.	0.	0.	0.	528.	276.	0.	0.	1886.
-2	541.	1008.	0.	0.	319.	687.	9.	0.	2564.
-3	0.	504.	73.	0.	159.	459.	46.	0.	1241.
-4	0.	0.	36.	15.	0.	0.	380.	13.	444.
-5	0.	0.	0.	8.	0.	0.	0.	2.	10.
TR OW SZ-1	2540.	0.	0.	0.	0.	0.	0.	0.	2540.
-2	5080.	1286.	0.	0.	0.	246.	111.	4.	6727.
-3	0.	2571.	972.	0.	0.	250.	19.	0.	3812.
-4	0.	0.	478.	234.	0.	0.	0.	0.	712.
-5	0.	0.	0.	117.	0.	0.	0.	0.	117.
-T	53141.	60030.	17115.	4338.	60602.	89290.	13431.	1284.	299231.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

REDISTRIBUTION OF EXISTING FAMILIES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	1963.	0.	0.	0.	3463.	6321.	476.	6.	12229.
-2	19365.	60031.	0.	0.	23072.	65435.	219.	10.	168132.
-3	10337.	43943.	13432.	1285.	6510.	29798.	15407.	12.	120724.
-4	1063.	8006.	6356.	1285.	378.	2034.	7235.	937.	27294.
-5	0.	1160.	1328.	1276.	267.	532.	428.	931.	5922.
RG OW SZ-1	1591.	0.	0.	0.	714.	1925.	171.	2.	4403.
-2	15816.	74326.	0.	0.	1622.	5074.	718.	16.	97572.
-3	9975.	70917.	11148.	1284.	2326.	4999.	1124.	33.	101806.
-4	2649.	27065.	13081.	1277.	938.	1730.	381.	250.	47371.
-5	1430.	19757.	12883.	1268.	135.	148.	8.	262.	35891.
TN OW SZ-1	463.	1395.	1014.	145.	153.	321.	7.	0.	3498.
-2	354.	2622.	1406.	499.	0.	486.	56.	0.	5423.
-3	277.	2763.	1346.	356.	47.	51.	21.	0.	4861.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	672.	0.	0.	12.	341.	375.	0.	0.	1400.
-2	1212.	4309.	300.	0.	206.	936.	18.	0.	6981.
-3	538.	2995.	1332.	0.	103.	624.	94.	0.	5686.
-4	0.	1097.	1156.	558.	0.	0.	778.	1.	3590.
-5	279.	429.	117.	233.	0.	0.	0.	29.	1087.
TR OW SZ-1	682.	0.	0.	0.	0.	0.	0.	0.	682.
-2	538.	9279.	0.	0.	0.	335.	228.	8.	10388.
-3	3233.	4506	5360.	1071.	0.	340.	40.	0.	14550.
-4	344.	7413.	8297.	2218.	0.	0.	0.	0.	18272.
-5	196.	362.	4769.	1475.	0.	0.	0.	0.	6802.
-T	72977.	342375.	83325.	14242.	40275.	121464.	27409.	2497.	704564.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

TOTAL FAMILY-TO-HOUSE DISTRIBUTION

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	15020.	0.	0.	0.	7084.	6321.	476.	6.	28907.
-2	25893.	71043.	0.	0.	58786.	113539.	219.	10.	269490.
-3	10337.	47302.	40266.	1449.	16587.	56350.	23081.	21.	195393.
-4	1063.	8006.	6922.	4849.	963.	3530.	11005.	1681.	38019.
-5	0.	1160.	1328.	1646.	681.	923.	637.	1153.	7528.
RG OW SZ-1	20756.	0.	0.	0.	1820.	3340.	254.	3.	26173.
-2	19658.	87901.	0.	0.	4133.	8804.	1069.	25.	121590.
-3	9975.	98762.	20164.	14280.	5926.	8674.	1673.	50.	159504.
-4	2649.	27065.	84206.	38518.	2389.	3001.	567.	417.	158812.
-5	1430.	19757.	23394.	15204.	344.	257.	12.	358.	60756.
TN OW SZ-1	980.	2450.	1014.	145.	389.	556.	10.	0.	5544.
-2	1143.	4732.	1708.	518.	0.	843.	83.	0.	9027.
-3	277.	2763.	1970.	394.	119.	88.	31.	0.	5642.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1754.	0.	0.	12.	869.	651.	0.	0.	3286.
-2	1753.	5317.	300.	0.	525.	1623.	27.	0.	9545.
-3	538.	3499.	1405.	0.	262.	1083.	140.	0.	6927.
-4	0.	1097.	1192.	573.	0.	0.	1158.	14.	4034.
-5	279.	429.	117.	241.	0.	0.	0.	31.	1097.
TR OW SZ-1	3222.	0.	0.	0.	0.	0.	0.	0.	3222.
-2	5618.	10565.	0.	0.	0.	581.	339.	12.	17115.
-3	3233.	7077.	6332.	1071.	0.	590.	59	0.	18362.
-4	344.	7413.	8775.	2452.	0.	0.	0.	0.	18984.
-5	196.	362.	4769.	1592.	0.	0.	0.	0.	6919.
-T	126118.	406700.	203862.	82944.	100877.	210754.	40840.	3781.	1175876.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

FAMILY-TO-HOUSE DISTRIBUTION RATIOS

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	.1191	.0000	.0000	.0000	.0702	.0300	.0117	.0016	.0246
-2	.2053	.1747	.0000	.0000	.5827	.5387	.0054	.0026	.2292
-3	.0820	.1163	.1975	.0175	.1644	.2674	.5652	.0056	.1662
-4	.0084	.0197	.0340	.0585	.0095	.0167	.2695	.4446	.0323
-5	.0000	.0029	.0065	.0198	.0068	.0044	.0156	.3049	.0064
RG OW SZ-1	.1646	.0000	.0000	.0000	.0180	.0156	.0062	.0008	.0223
-2	.1559	.2161	.0000	.0000	.0410	.0418	.0262	.0066	.1034
-3	.0791	.2428	.0989	.1722	.0587	.0412	.0410	.0132	.1356
-4	.0210	.0665	.4131	.4644	.0237	.0142	.0139	.1103	.1351
-5	.0113	.0486	.1148	.1833	.0034	.0012	.0003	.0947	.0517
TN OW SZ-1	.0078	.0060	.0050	.0017	.0039	.0026	.0002	.0000	.0047
-2	.0091	.0116	.0084	.0062	.0000	.0040	.0020	.0000	.0077
-3	.0022	.0068	.0097	.0048	.0012	.0004	.0008	.0000	.0048
HT RT SZ-1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
HT OW SZ-1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
TR RT SZ-1	.0139	.0000	.0000	.0001	.0086	.0031	.0000	.0000	.0028
-2	.0139	.0131	.0015	.0000	.0052	.0077	.0007	.0000	.0081
-3	.0043	.0086	.0069	.0000	.0026	.0051	.0034	.0000	.0059
-4	.0000	.0027	.0058	.0069	.0000	.0000	.0284	.0037	.0034
-5	.0022	.0011	.0006	.0029	.0000	.0000	.0000	.0082	.0009
TR OW SZ-1	.0255	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0027
-2	.0445	.0260	.0000	.0000	.0000	.0028	.0083	.0032	.0146
-3	.0256	.0174	.0311	.0129	.0000	.0028	.0014	.0000	.0156
-4	.0027	.0182	.0430	.0296	.0000	.0000	.0000	.0000	.0161
-5	.0016	.0009	.0234	.0192	.0000	.0000	.0000	.0000	.0059

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

DOMESTIC FAMILY-TO-HOUSE DISTRIBUTIONS

DEVIATIONS FROM NEW FAMILY DISTRIBUTION GOALS

	Negative Deviations				Positive Deviations			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
RG RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	126.	0.	0.	0.	0.
RG OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.
TN OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.
TR OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

DEVIATIONS FROM EXISTING FAMILY REDISTRIBUTION GOALS

	Negative Deviations				Positive Deviations			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
RG RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	4295.	0.	0.	0.	0.	0.	0.
-3	0.	0.	25702.	164.	0.	0.	0.	0.
-4	0.	0.	0.	3307.	0.	0.	0.	0.
-5	0.	0.	0.	370.	0.	0.	0.	0.
RG OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	4882.	12996.	0.	0.	0.	0.
-4	0.	0.	62327.	34775.	0.	0.	0.	0.
-5	0.	0.	10511.	12752.	0.	0.	0.	0.
TN OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.
TR OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.

(RG) REGULAR
(HT) HUT
(TN) TENT
(TR) TRADITIONAL

(RT) RENT
(OW) OWN

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

VACANCIES AND NEW HOUSES REQUIREMENTS

	Vacancies	New
RG RT SZ-1	0.	11672.
-2	0.	54806.
-3	0.	78850.
-4	0.	19509.
-5	0.	2976.
RG OW SZ-1	0.	15180.
-2	0.	23195.
-3	0.	44185.
-4	0.	77623.
-5	18019.	0.
TN OW SZ-1	2814.	0.
-2	0.	7135.
-3	115.	0.
HT RT SZ-1	0.	0.
-2	10478.	10000.
-3	238.	0.
HT OW SZ-1	1579.	0.
-2	1638.	0.
-3	1416.	0.
TR RT SZ-1	0.	272.
-2	0.	351.
-3	0.	1861.
-4	0.	3030.
-5	733.	0.
TR OW SZ-1	3635.	0.
-2	3414.	0.
-3	0.	11131.
-4	0.	10357.
-5	3884.	0.

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS
(HT) HUT (OW) OWN (-2) 3-4 ROOMS
(TN) TENT (-3) 5-6 ROOMS
(TR) TRADITIONAL (-4) 7-8 ROOMS
(-5) 9-U ROOMS

TOTAL FAMILY ACCOUNTS

		Unhoused	New	Remaining	To be housed
DOM	(1)	0.	82294.	72978.	87642.
	(2)	0.	34956.	351491.	60031.
	(3)	0.	1156.	228949.	17116.
	(4)	126.	7.	78611.	4465.
EXP	(1)	0.	60339.	40276.	62343.
	(2)	0.	84908.	121465.	89293.
	(3)	0.	12404.	27478.	13432.
	(4)	0.	1212.	2500.	1286.

(1) 1-4 MEMBERS (2) 5-9 MEMBERS
(2) 10-13 MEMBERS (4) 13-U MEMBERS

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Sector Projects	Neg.Dev.	Pos.Dev.
(1)	8287.32	5454.41	57.00	13007.38	0.00	13.10	161.00	0.00	0.00
(2)	23515.70	1382.59	21624.50	1174.61	579.00	285.80	75.00	0.00	578.58
(3)	8780.00	83404.68	146.00	21963.52	19614.00	3781.90	26908.80	0.00	0.00
(4)	1483.10	0.00	0.00	635.99	0.00	393.70	0.00	5004.90	0.00
(5)	46848.32	0.00	0.00	206.92	0.00	1140.02	15846.30	10944.00	0.00
(6)	7321.07	732.11	0.00	156.43	0.00	0.00	4822.60	0.00	0.00
(7)	23486.78	0.00	328.00	18403.22	0.00	575.54	777.70	343.80	0.00
(8)	12803.42	2433.60	550.76	4600.73	0.00	1020.20	641.00	0.00	0.00
(9)	21385.74	6843.43	1218.99	13147.57	0.00	17148.40	3239.84	0.00	0.00
(T)	153911.45	100250.82	23925.25	73296.37	20193.00	24358.66	52472.24	16292.70	578.58

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS AND OUTPUTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	5970	299	8549	5651	9133	8849	1953	0	4017	3927
(B)	88859	68574	40877	59721	27697	29138	100598	0	18856	87430	24107
(C)	70435	33025	4855	42296	28170	28139	47151	0	1029	34054	15705
(D)	104294	200662	47195	64808	153468	39486	112003	81756	0	118906	140144
(E)	193581	260751	1494	100304	259257	93277	101798	103369	0	157382	181617
(F)	598062	0	0	0	0	59862	0	0	0	0	0
(G)	154797	64833	0	0	64833	154797	0	43016	0	21817	53729
(T)	1227710	633815	94720	275678	539076	413832	370399	230094	19885	423606	419229

(A) MANAGER (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURE
(G) PROPRIETERS (T) TOTAL

3-D.8 Numerical Results For ECHS105 Illustration

NEW FAMILIES DISTRIBUTION TO HOUSES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	13057.	0.	0.	0.	4658.	0.	0.	0.	17715.
-2	0.	0.	0.	0.	31022.	40217.	0.	0.	71239.
-3	0.	0.	0.	0.	8756.	22199.	6836.	8.	37799.
-4	0.	0.	0.	0.	508.	1250.	3358.	661.	5777.
-5	0.	0.	0.	0.	360.	327.	186.	197.	1070.
RG OW SZ-1	19165.	0.	0.	0.	961.	1183.	74.	1.	21384.
-2	38342.	13574.	0.	0.	2182.	3118.	313.	7.	57536.
-3	0.	27845.	4134.	0.	3128.	3073.	489.	15.	38684.
-4	0.	0.	6626.	2467.	1261.	1063.	166.	148.	11731.
-5	0.	0.	0.	1184.	181.	91.	3.	86.	1545.
TN OW SZ-1	517.	1055.	0.	0.	205.	197.	3.	0.	1977.
-2	789.	2110.	302.	19.	0.	299.	24.	0.	3543.
-3	0.	0.	624.	38.	63.	31.	9.	0.	765.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1082.	0.	0.	0.	459.	231.	0.	0.	1772.
-2	542.	1008.	0.	0.	277.	575.	8.	0.	2410.
-3	0.	504.	73.	0.	138.	384.	41.	0.	1140.
-4	0.	0.	36.	15.	0.	0.	339.	12.	402.
-5	0.	0.	0.	8.	0.	0.	0.	2.	10.
TR OW SZ-1	2539.	0.	0.	0.	0.	0.	0.	0.	2539.
-2	5080.	1286.	0.	0.	0.	206.	99.	4.	6675.
-3	0.	2571.	972.	0.	0.	209.	17.	0.	3769.
-4	0.	0.	478.	234.	0.	0.	0.	0.	712.
-5	0.	0.	0.	117.	0.	0.	0.	0.	117.
-T	81113.	49953.	13245.	4082.	54159.	74653.	11965.	1141.	290311.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

REDISTRIBUTION OF EXISTING FAMILIES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	1963.	0.	0.	0.	3345.	6295.	476.	6.	12085.
-2	19365.	60031.	0.	0.	22287.	65165.	290.	10.	167148.
-3	10337.	43944.	11967.	1141.	6288.	29674.	15406.	12.	118769.
-4	1063.	8007.	6356.	1141.	365.	2026.	7235.	937.	27130.
-5	0.	1160.	1328.	1134.	258.	530.	428.	931.	5769.
RG OW SZ-1	1591.	0.	0.	0.	690.	1917.	171.	2.	4371.
-2	15816.	74326.	0.	0.	1567.	5053.	718.	16.	97496.
-3	9975.	70917.	11893.	1141.	2246.	4979.	1124.	33.	102308.
-4	2649.	27065.	11654.	1134.	905.	1723.	381.	250.	45761.
-5	1430.	19757.	11478.	1126.	130.	147.	8.	263.	34339.
TN OW SZ-1	463.	1385.	1014.	145.	147.	319.	7.	0.	3480.
-2	354.	2622.	1406.	499.	0.	484.	56.	0.	5421.
-3	277.	2063.	1346.	356.	45.	51.	21.	0.	4159.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	672.	0.	0.	12.	329.	374.	0.	0.	1387.
-2	1212.	4309.	300.	0.	199.	933.	18.	0.	6971.
-3	539.	2995.	1332.	0.	99.	622.	94.	0.	5681.
-4	0.	1097.	1156.	558.	0.	0.	778.	1.	3590.
-5	279.	429.	117.	233.	0.	0.	0.	29.	1087.
TR OW SZ-1	682.	0.	0.	0.	0.	0.	0.	0.	682.
-2	538.	9297.	0.	0.	0.	334.	228.	8.	10405.
-3	3233.	9406.	5359.	1071.	9.	339.	40.	0.	19457.
-4	344.	7413.	8297.	2218.	0.	0.	0.	0.	18272.
-5	196.	362.	4769.	1475.	0.	0.	0.	0.	6802.
-T	72978.	346585.	79772.	13384.	38909.	120965.	27479.	2498.	702570.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

TOTAL FAMILY-TO-HOUSE DISTRIBUTION

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	15020.	0.	0.	0.	8003.	6295.	476.	6.	29800.
-2	19365.	64956.	0.	0.	53309.	105382.	290.	10.	243312.
-3	10337.	43944.	39134.	1449.	15044.	51873.	22242.	20.	184043.
-4	1063.	8007.	6356.	4592.	873.	3276.	10593.	1598.	36358.
-5	0.	1160.	1328.	1647.	618.	857.	614.	1128.	7352.
RG OW SZ-1	20756.	0.	0.	0.	1651.	3100.	245.	3.	25755.
-2	54158.	87900.	0.	0.	3749.	8171.	1031.	23.	155032.
-3	9975.	98762.	62365.	14281.	5374.	8052.	1613.	48.	200470.
-4	2649.	27065.	82035.	38519.	2166.	2786.	547.	398.	156165.
-5	1430.	19757.	23394.	15204.	311.	238.	11.	349.	60694.
TN OW SZ-1	980.	2440.	1014.	145.	352.	516.	10.	0.	5457.
-2	1143.	4732.	1708.	518.	0.	783.	80.	0.	8964.
-3	277.	2063.	1970.	394.	108.	82.	30.	0.	4924.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1754.	0.	0.	12.	788.	605.	0.	0.	3159.
-2	1754.	5317.	300.	0.	476.	1508.	26.	0.	9381.
-3	539.	3499.	1405.	0.	237.	1006.	135.	0.	6821.
-4	0.	1097.	1192.	573.	0.	0.	1117.	13.	3992.
-5	279.	429.	117.	241.	0.	0.	0.	31.	1097.
TR OW SZ-1	3221.	0.	0.	0.	0.	0.	0.	0.	3221.
-2	5618.	10583.	0.	0.	0.	540.	327.	12.	17080.
-3	3233.	11977.	6331.	1071.	9.	548.	57.	0.	23226.
-4	344.	7413.	8775.	2452.	0.	0.	0.	0.	18984.
-5	196.	362.	4769.	1592.	0.	0.	0.	0.	6919.
-T	154091.	401463.	242193.	82690.	93068.	195618.	39444.	3639.	1212206.

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS (1) 1-4 Family Members
(HT) HUT (OW) OWN (-2) 3-4 ROOMS (2) 5-9 Family Members
(TN) TENT (-3) 5-6 ROOMS (3) 9-13 Family Members
(TR) TRADITIONAL (-4) 7-8 ROOMS (4) 13-A Family Members
(-5) 9-A ROOMS

FAMILY-TO-HOUSE DISTRIBUTION RATIOS

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	.0975	.0000	.0000	.0000	.0860	.0322	.0121	.0016	.0246
-2	.1257	.1618	.0000	.0000	.5728	.5387	.0074	.0027	.2007
-3	.0671	.1095	.1616	.0175	.1616	.2652	.5639	.0055	.1518
-4	.0069	.0199	.0262	.0555	.0094	.0167	.2686	.4391	.0300
-5	.0000	.0029	.0055	.0199	.0066	.0044	.0156	.3100	.0061
RG OW SZ-1	.1347	.0000	.0000	.0000	.0177	.0158	.0062	.0008	.0212
-2	.3515	.2189	.0000	.0000	.0403	.0418	.0261	.0063	.1279
-3	.0647	.2460	.2575	.1727	.0577	.0412	.0409	.0132	.1654
-4	.0172	.0674	.3387	.4658	.0233	.0142	.0139	.1094	.1288
-5	.0093	.0492	.0966	.1839	.0033	.0012	.0003	.0959	.0501
TN OW SZ-1	.0064	.0061	.0042	.0018	.0038	.0026	.0003	.0000	.0045
-2	.0074	.0118	.0071	.0063	.0000	.0040	.0020	.0000	.0074
-3	.0018	.0051	.0081	.0048	.0012	.0004	.0008	.0000	.0041
HT RT SZ-1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
HT OW SZ-1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
TR RT SZ-1	.0114	.0000	.0000	.0001	.0085	.0031	.0000	.0000	.0026
-2	.0114	.0132	.0012	.0000	.0051	.0077	.0007	.0000	.0077
-3	.0035	.0087	.0058	.0000	.0025	.0051	.0034	.0000	.0056
-4	.0000	.0027	.0049	.0069	.0000	.0000	.0283	.0036	.0033
-5	.0018	.0011	.0005	.0029	.0000	.0000	.0000	.0085	.0009
TR OW SZ-1	.0209	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0027
-2	.0365	.0264	.0000	.0000	.0000	.0028	.0083	.0033	.0141
-3	.0210	.0298	.0261	.0130	.0001	.0028	.0014	.0000	.0192
-4	.0022	.0185	.0362	.0297	.0000	.0000	.0000	.0000	.0157
-5	.0013	.0009	.0197	.0193	.0000	.0000	.0000	.0000	.0057

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

DOMESTIC FAMILY-TO-HOUSE DISTRIBUTIONS

DEVIATIONS FROM NEW FAMILY DISTRIBUTION GOALS

	Negative Deviations				Positive Deviations			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
RG RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	6528.	6717.	0.	0.	0.	0.	0.	0.
-3	0.	3359.	1132.	0.	0.	0.	0.	0.
-4	0.	0.	566.	257.	0.	0.	0.	0.
-5	0.	0.	0.	126.	0.	0.	0.	0.
RG OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	2172.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.
TN OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.
TR OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

DEVIATIONS FROM EXISTING FAMILY REDISTRIBUTION GOALS

	Negative Deviations				Positive Deviations			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
RG RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	4925.	0.	0.	0.	0.	0.	0.
-3	0.	0.	27167.	308.	0.	0.	0.	0.
-4	0.	0.	0.	3451.	0.	0.	0.	0.
-5	0.	0.	0.	513.	0.	0.	0.	0.
RG OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	46338.	13140.	0.	0.	0.	0.
-4	0.	0.	63755.	34918.	0.	0.	0.	0.
-5	0.	0.	11916.	12894.	0.	0.	0.	0.
TN OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.
TR OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

VACANCIES AND NEW HOUSES REQUIREMENTS

	Vacancies	New
RG RT SZ-1	0.	10825.
-2	0.	27937.
-3	0.	67503.
-4	0.	17848.
-5	0.	2799.
RG OW SZ-1	0.	14762.
-2	0.	22139.
-3	0.	42948.
-4	0.	74975.
-5	18081.	0.
TN OW SZ-1	2891.	0.
-2	0.	7072.
-3	134.	0.
HT RT SZ-1	0.	0.
-2	10678.	10000.
-3	238.	0.
HT OW SZ-1	1579.	0.
-2	1637.	0.
-3	1416.	0.
TR RT SZ-1	0.	144.
-2	0.	184.
-3	0.	1753.
-4	0.	2987.
-5	734.	0.
TR OW SZ-1	3635.	0.
-2	3469.	0.
-3	0.	11086.
-4	0.	10352.
-5	3884.	0.

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS
(HT) HUT (OW) OWN (-2) 3-4 ROOMS
(TN) TENT (-3) 5-6 ROOMS
(TR) TRADITIONAL (-4) 7-8 ROOMS
(-5) 9-U ROOMS

TOTAL FAMILY ACCOUNTS

		Unhoused	New	Remaining	To be housed
DOM	(1)	6528.	82294.	72978.	87642.
	(2)	10076.	34956.	351492	60031.
	(3)	3570.	1156.	228949.	17116.
	(4)	383.	7.	78611.	4465.
EXP	(1)	0.	52167.	38905.	54171.
	(2)	0.	70268.	120963.	74653.
	(3)	0.	10939.	27478.	11967.
	(4)	0.	1068.	2500.	1141.

(1) 1-4 MEMBERS (2) 5-9 MEMBERS
(2) 10-13 MEMBERS (4) 13-U MEMBERS

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Sector Projects	Neg.Dev.	Pos.Dev.
(1)	8287.32	5531.38	57.00	12779.82	0.00	13.10	161.00	0.00	0.00
(2)	23515.70	1382.59	21624.50	1149.88	631.24	285.80	75.00	0.00	631.24
(3)	8780.00	81930.20	146.00	21596.31	19614.60	3781.90	26908.80	0.00	0.00
(4)	1444.89	0.00	0.00	614.34	0.00	393.70	0.00	5004.90	0.00
(5)	42477.82	0.00	0.00	205.75	0.00	1140.02	15846.30	10944.00	0.00
(6)	7188.56	718.86	0.00	164.35	0.00	0.00	4822.60	0.00	0.00
(7)	22990.45	0.00	328.00	18094.64	0.00	575.54	777.70	343.80	0.00
(8)	12568.18	2387.95	504.43	4459.79	0.00	1020.20	641.00	0.00	0.00
(9)	20743.37	6637.89	1182.37	12845.88	0.00	17148.40	3239.84	2575.50	0.00
(T)	147996.29	98588.87	23842.30	71910.76	20245.84	24358.66	52472.24	18868.20	631.24

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS AND OUTPUTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	5543	299	8549	5243	9133	8849	1526	0	4017	3500
(B)	88859	66875	40877	59721	25997	29138	100598	0	20555	87430	22408
(C)	70435	31487	4855	42296	26632	28139	47151	0	2567	34054	14167
(D)	104294	192264	47195	64808	145068	39486	112003	73358	0	118906	131746
(E)	193581	237890	1494	100304	236396	93277	101798	80508	0	157382	158756
(F)	598062	0	0	0	0	59862	0	0	0	0	0
(G)	154797	58776	0	0	58776	154797	0	36959	0	21817	47672
(T)	1227710	592835	94720	275678	498112	413832	370399	192351	23122	423606	378249

(A) MANAGER (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURE
(G) PROPRIETERS (T) TOTAL

3-E SOLUTIONS FOR ALTERNATIVE HOUSING GOALS AND LABOR-GOVERNMENT TRADE-OFFS

3-E.9 Numerical Results For ECHS201 Illustration

NEW FAMILIES DISTRIBUTION TO HOUSES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	13057.	0.	0.	0.	6362.	0.	0.	0.	19419.
-2	6528.	10076.	0.	383.	42383.	59261.	0.	0.	118631.
-3	0.	0.	0.	0.	11959.	32711.	8837.	10.	53517.
-4	0.	0.	0.	0.	694.	1843.	4341.	860.	7738.
-5	0.	0.	0.	0.	491.	482.	241.	256.	1470.
RG OW SZ-1	19165.	0.	0.	0.	1312.	1744.	96.	1.	22318.
-2	35342.	13575.	0.	0.	2980.	4595.	404.	10.	56906.
-3	0.	27845.	4134.	0.	4273.	4528.	632.	20.	41432.
-4	0.	0.	8798.	2467.	1722.	1566.	214.	193.	14960.
-5	0.	0.	1074.	1184.	248.	134.	4.	112.	2756.
TN OW SZ-1	517.	1055.	0.	0.	280.	290.	4.	0.	2146.
-2	789.	2110.	302.	19.	0.	440.	32.	0.	3692.
-3	0.	0.	624.	38.	86.	46.	12.	0.	806.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1082.	0.	624.	0.	627.	340.	0.	0.	2673.
-2	542.	1008.	0.	0.	379.	847.	10.	0.	2786.
-3	0.	504.	73.	0.	189.	565.	53.	0.	1384.
-4	0.	0.	36.	15.	0.	0.	438.	16.	505.
-5	0.	0.	0.	7.	0.	0.	0.	2.	9.
TR OW SZ-1	2540.	0.	0.	0.	0.	0.	0.	0.	2540.
-2	5080.	1286.	0.	0.	0.	304.	128.	5.	6803.
-3	0.	2571.	972.	0.	0.	308.	22.	0.	3873.
-4	0.	0.	478.	234.	0.	0.	0.	0.	712.
-5	0.	0.	0.	117.	0.	0.	0.	0.	117.
-T	84642.	60030.	17115.	4464.	73985.	110004.	15468.	1485.	367193.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

REDISTRIBUTION OF EXISTING FAMILIES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	982.	0.	0.	0.	0.	0.	0.	0.	982.
-2	9683.	32478.	0.	0.	3603.	6338.	476.	6.	52584.
-3	5168.	21972.	15469.	725.	24005.	65616.	290.	10.	133255.
-4	531.	4003.	3178.	1486.	6773.	29880.	15407.	12.	61270.
-5	0.	580.	664.	1217.	393.	2040.	7235.	937.	13066.
RG OW SZ-1	2572.	0.	0.	0.	278.	533.	428.	931.	4742.
-2	25498.	106804.	0.	0.	743.	1930.	171.	2.	135148.
-3	15144.	92889.	15373.	1485.	1688.	5088.	718.	16.	132401.
-4	3188.	31068.	15065.	1477.	2420.	5013.	1124.	33.	59388.
-5	1430.	20337.	14837.	1466.	975.	1734.	381.	250.	41410.
TN OW SZ-1	463.	1385.	1014.	145.	189.	149.	19.	263.	3627.
-2	353.	2974.	1635.	578.	159.	373.	17.	0.	6089.
-3	277.	1712.	1117.	277.	0.	487.	56.	0.	3926.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	336.	0.	0.	5.	0.	0.	0.	0.	341.
-2	606.	2155.	151.	0.	355.	376.	0.	0.	3643.
-3	269.	1497.	666.	0.	214.	939.	18.	0.	3603.
-4	0.	548.	579.	279.	107.	626.	94.	0.	2233.
-5	140.	214.	57.	117.	0.	0.	778.	1.	1307.
TR OW SZ-1	1018.	0.	0.	5.	0.	0.	0.	29.	1052.
-2	1144.	11434.	151.	0.	0.	0.	0.	0.	12729.
-3	3502.	10903.	10605.	1071.	0.	336.	227.	8.	26652.
-4	417.	7961.	6587.	3283.	0.	341.	40.	0.	18629.
-5	262.	576.	7118.	806.	0.	0.	0.	0.	8762.
-T	72983.	351490.	94266.	14422.	41902.	121799.	27479.	2498.	726839.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

TOTAL FAMILY-TO-HOUSE DISTRIBUTION

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	14039.	0.	0.	0.	6362.	0.	0.	0.	20401.
-2	16211.	42554.	0.	383.	45986.	65599.	476.	6.	171215.
-3	5168.	21972.	19568.	725.	35964.	98327.	9127.	20.	190871.
-4	531.	4003.	3178.	1903.	7467.	31723.	19748.	872.	69425.
-5	0.	580.	664.	1217.	884.	2522.	7476.	1193.	14536.
RG OW SZ-1	21737.	0.	0.	0.	1590.	2277.	524.	932.	27060.
-2	60840.	120379.	0.	0.	3723.	6525.	575.	12.	192054.
-3	15144.	120734.	70631.	12905.	5961.	9616.	1350.	36.	236377.
-4	3188.	31068.	67097.	45044.	4142.	6579.	1338.	226.	158682.
-5	1430.	20337.	32047.	13920.	1223.	1868.	385.	362.	71572.
TN OW SZ-1	980.	2440.	1014.	145.	469.	439.	23.	263.	5773.
-2	1142.	5084.	1937.	597.	159.	813.	49.	0.	9781.
-3	277.	1712.	1741.	315.	86.	533.	68.	0.	4732.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1418.	0.	624.	5.	627.	340.	0.	0.	3014.
-2	1148.	3163.	151.	0.	734.	1223.	10.	0.	6429.
-3	269.	2001.	739.	0.	403.	1504.	71.	0.	4987.
-4	0.	548.	615.	294.	107.	626.	532.	16.	2738.
-5	140.	214.	57.	124.	0.	0.	778.	3.	1316.
TR OW SZ-1	3558.	0.	0.	5.	0.	0.	0.	29.	3592.
-2	6224.	12720.	151.	0.	0.	304.	128.	5.	19532.
-3	3502.	13474.	11577.	1071.	0.	644.	249.	8.	30525.
-4	417.	7961.	7065.	3517.	0.	341.	40.	0.	19341.
-5	262.	576.	7118.	923.	0.	0.	0.	0.	8879.
-T	157625.	411520.	225974.	83093.	115887.	231803.	42947.	3983.	1272832.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

FAMILY-TO-HOUSE DISTRIBUTION RATIOS

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	.0891	.0000	.0000	.0000	.0549	.0000	.0000	.0000	.0160
-2	.1028	.1034	.0000	.0046	.3968	.2830	.0111	.0015	.1345
-3	.0328	.0534	.0866	.0087	.3103	.4242	.2125	.0050	.1500
-4	.0034	.0097	.0141	.0229	.0644	.1369	.4598	.2189	.0545
-5	.0000	.0014	.0029	.0146	.0076	.0109	.1741	.2995	.0114
RG OW SZ-1	.1379	.0000	.0000	.0000	.0137	.0098	.0122	.2340	.0213
-2	.3860	.2925	.0000	.0000	.0321	.0281	.0134	.0030	.1509
-3	.0961	.2934	.3126	.1553	.0514	.0415	.0314	.0090	.1857
-4	.0202	.0755	.2969	.5421	.0357	.0284	.0312	.0567	.1247
-5	.0091	.0494	.1418	.1675	.0106	.0081	.0090	.0909	.0562
TN OW SZ-1	.0062	.0059	.0045	.0017	.0040	.0019	.0005	.0660	.0045
-2	.0072	.0124	.0086	.0072	.0014	.0035	.0011	.0000	.0077
-3	.0018	.0042	.0077	.0038	.0007	.0023	.0016	.0000	.0037
HT RT SZ-1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
HT OW SZ-1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
TR RT SZ-1	.0090	.0000	.0028	.0001	.0054	.0015	.0000	.0000	.0024
-2	.0073	.0077	.0007	.0000	.0063	.0053	.0002	.0000	.0051
-3	.0017	.0049	.0033	.0000	.0035	.0065	.0017	.0000	.0039
-4	.0000	.0013	.0027	.0035	.0009	.0027	.0124	.0040	.0022
-5	.0009	.0005	.0003	.0015	.0000	.0000	.0181	.0008	.0010
TR OW SZ-1	.0226	.0000	.0000	.0001	.0000	.0000	.0000	.0073	.0028
-2	.0395	.0309	.0007	.0000	.0000	.0013	.0030	.0013	.0153
-3	.0222	.0327	.0512	.0129	.0000	.0028	.0058	.0020	.0240
-4	.0026	.0193	.0313	.0423	.0000	.0015	.0009	.0000	.0152
-5	.0017	.0014	.0315	.0111	.0000	.0000	.0000	.0000	.0070

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

DOMESTIC FAMILY-TO-HOUSE DISTRIBUTIONS

DEVIATIONS FROM NEW FAMILY DISTRIBUTION GOALS

	Negative Deviations				Positive Deviations			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
RG RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	3359.	0.	383.
-3	0.	3359.	1132.	0.	0.	0.	0.	0.
-4	0.	0.	566.	257.	0.	0.	0.	0.
-5	0.	0.	0.	126.	0.	0.	0.	0.
RG OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	1074.	0.
TN OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	0.	0.	0.	0.	0.	0.	624.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.
TR OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

DEVIATIONS FROM EXISTING FAMILY REDISTRIBUTION GOALS

	Negative Deviations				Positive Deviations			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
RG RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	4099.	0.	0.	0.	0.	0.
-4	0.	0.	0.	417.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.
RG OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	51124.	11420.	0.	0.	0.	0.
-4	0.	0.	43234.	41100.	0.	0.	0.	0.
-5	0.	0.	16136.	11270.	0.	0.	0.	0.
TN OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.
TR OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

VACANCIES AND NEW HOUSES REQUIREMENTS

	Vacancies	New
RG RT SZ-1	0.	1425.
-2	44171.	0.
-3	0.	74328.
-4	0.	50915.
-5	0.	9984.
RG OW SZ-1	0.	16067.
-2	0.	62161.
-3	0.	92253.
-4	0.	91855.
-5	2459.	0.
TN OW SZ-1	2635.	0.
-2	0.	7826.
-3	326.	0.
HT RT SZ-1	0.	122.
-2	10356.	9878.
-3	238.	0.
HT OW SZ-1	1579.	0.
-2	1637.	0.
-3	1416.	0.
TR RT SZ-1	0.	0.
-2	2767.	0.
-3	79.	0.
-4	0.	1734.
-5	513.	0.
TR OW SZ-1	3264.	0.
-2	999.	0.
-3	0.	18395.
-4	0.	10715.
-5	1923.	0.

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS
(HT) HUT (OW) OWN (-2) 3-4 ROOMS
(TN) TENT (-3) 5-6 ROOMS
(TR) TRADITIONAL (-4) 7-8 ROOMS
(-5) 9-U ROOMS

TOTAL FAMILY ACCOUNTS

	Unhoused	New	Remaining	To be housed
DOM (1)	0.	82294.	72978.	87642.
(2)	0.	34956.	351492.	60031.
(3)	0.	1156.	228949.	17116.
(4)	0.	7.	78611.	4465.
EXP (1)	0.	71981.	41903.	73985.
(2)	0.	105619.	121800.	110004.
(3)	0.	14441.	27478.	15469.
(4)	0.	1412.	2500.	1486.

(1) 1-4 MEMBERS (2) 5-9 MEMBERS
(2) 10-13 MEMBERS (4) 13-U MEMBERS

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Sector Projects	Neg.Dev.	Pos.Dev.
(1)	8287.32	5778.36	57.00	13323.74	0.00	13.10	161.00	0.00	0.00
(2)	23515.70	1382.59	21624.50	128.99	0.00	285.80	75.00	0.00	505.00
(3)	8780.00	85454.92	146.00	22473.34	19614.60	3781.90	26908.80	0.00	0.00
(4)	1536.22	0.00	0.00	666.09	0.00	393.70	0.00	5004.90	0.00
(5)	52922.51	0.00	0.00	208.69	0.00	1140.02	15846.30	10944.00	0.00
(6)	7505.07	750.53	0.00	166.90	0.00	0.00	4822.60	0.00	0.00
(7)	24178.56	0.00	328.00	18832.22	0.00	575.54	777.70	343.80	0.00
(8)	13142.48	2497.07	565.13	4796.67	0.00	1020.20	641.00	0.00	0.00
(9)	22278.68	7129.17	1269.88	13567.00	0.00	17148.40	3239.84	2575.50	0.00
(T)	162146.54	102992.64	23990.51	74163.64	19614.60	24358.66	52472.24	18868.20	505.00

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS AND OUTPUTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	6565	299	8549	6265	9133	8849	2548	0	4017	4522
(B)	88859	70937	40877	59721	30060	29138	100598	0	16493	87430	26470
(C)	70435	35164	4855	42296	30309	28139	47151	1110	0	34054	17844
(D)	104294	212337	47195	64808	165143	39486	112003	93431	0	118906	151819
(E)	193581	292525	1494	100304	291031	93277	101798	135143	0	157382	213391
(F)	598062	0	0	0	0	59862	0	0	0	0	0
(G)	154797	73258	0	0	73258	154797	0	51441	0	21817	62154
(T)	1227710	690786	94720	275678	596066	413832	370399	283673	16493	423606	476200

(A) MANAGER (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURE
(G) PROPRIETERS (T) TOTAL

3-E.10 Numerical Results For ECHS202 Illustration

NEW FAMILIES DISTRIBUTION TO HOUSES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	13057.	0.	213.	0.	4723.	0.	0.	0.	17993.
-2	6528.	6717.	0.	0.	31467.	40947.	0.	0.	85659.
-3	0.	0.	0.	0.	8879.	22602.	6914.	8.	38403.
-4	0.	0.	0.	0.	515.	1273.	3396.	669.	5853.
-5	0.	0.	0.	0.	365.	333.	188.	199.	1085.
RG OW SZ-1	4016.	0.	0.	0.	974.	1205.	75.	1.	6271.
-2	0.	0.	0.	0.	2213.	3175.	316.	7.	5711.
-3	0.	0.	0.	0.	3172.	3128.	495.	15.	6810.
-4	0.	0.	0.	0.	1279.	1082.	168.	150.	2679.
-5	0.	3743.	0.	1184.	184.	93.	4.	87.	5295.
TN OW SZ-1	517.	1055.	0.	2809.	208.	201.	3.	0.	4793.
-2	789.	2110.	302.	19.	0.	304.	25.	0.	3549.
-3	0.	0.	624.	39.	64.	32.	9.	0.	768.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1082.	0.	891.	0.	465.	235.	0.	0.	2673.
-2	542.	1009.	0.	0.	281.	585.	8.	0.	2425.
-3	334.	504.	73.	0.	140.	391.	41.	0.	1483.
-4	0.	0.	36.	15.	0.	0.	343.	12.	406.
-5	0.	514.	0.	7.	0.	0.	0.	2.	523.
TR OW SZ-1	2540.	0.	3263.	0.	0.	0.	0.	0.	5803.
-2	5080.	1286.	0.	0.	0.	210.	100.	4.	6680.
-3	0.	2571.	972.	0.	0.	213.	17.	0.	3773.
-4	0.	0.	478.	234.	0.	0.	0.	0.	712.
-5	0.	0.	0.	117.	0.	0.	0.	0.	117.
-T	34485.	19509.	6852.	4424.	54929.	76009.	12102.	1154.	209464.

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS (1) 1-4 Family Members
(HT) HUT (OW) OWN (-2) 3-4 ROOMS (2) 5-9 Family Members
(TN) TENT (-3) 5-6 ROOMS (3) 9-13 Family Members
(TR) TRADITIONAL (-4) 7-8 ROOMS (4) 13-A Family Members
(-5) 9-A ROOMS

REDISTRIBUTION OF EXISTING FAMILIES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	982.	0.	0.	0.	0.	0.	0.	0.	982.
-2	9683.	32478.	0.	0.	3356.	6297.	476.	6.	52296.
-3	5168.	21972.	12103.	725.	22360.	65191.	290.	10.	127819.
-4	531.	4003.	3178.	1155.	6309.	29686.	15407.	12.	60281.
-5	0.	580.	664.	1147.	366.	2027.	7235.	937.	12956.
RG OW SZ-1	2572.	0.	0.	0.	259.	530.	428.	931.	4720.
-2	25499.	75674.	0.	0.	692.	1918.	171.	2.	103956.
-3	15144.	74802.	12027.	1154.	1572.	5055.	718.	16.	110488.
-4	3180.	31068.	17786.	1148.	2254.	4981.	1124.	33.	61574.
-5	1430.	20337.	11608.	1140.	909.	1723.	380.	249.	37776.
TN OW SZ-1	463.	1385.	1014.	145.	131.	148.	8.	263.	3557.
-2	354.	2974.	1635.	577.	148.	319.	6.	0.	6013.
-3	277.	1711.	1117.	277.	0.	484.	56.	0.	3922.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	45.	51.	21.	0.	117.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	336.	0.	0.	6.	0.	0.	0.	0.	342.
-2	606.	2155.	151.	0.	331.	374.	0.	0.	3617.
-3	269.	1497.	666.	0.	200.	933.	18.	0.	3583.
-4	0.	548.	579.	279.	100.	622.	94.	0.	2222.
-5	140.	214.	57.	117.	0.	0.	778.	1.	1307.
TR OW SZ-1	1018.	0.	0.	6.	0.	0.	0.	29.	1053.
-2	1144.	11434.	151.	0.	0.	0.	0.	0.	12729.
-3	3502.	10903.	10605.	1071.	0.	334.	228.	9.	26652.
-4	417.	7961.	6567.	3283.	0.	339.	40.	0.	18627.
-5	262.	576.	7118.	806.	0.	0.	0.	0.	8762.
-T	72977.	302272.	87046.	13036.	39032.	121012.	27478.	2498.	665351.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

TOTAL FAMILY-TO-HOUSE DISTRIBUTION

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	14039.	0.	213.	0.	4723.	0.	0.	0.	18975.
-2	16211.	39195.	0.	0.	34823.	47244.	476.	6.	137955.
-3	5168.	21972.	19569.	725.	31239.	87793.	7204.	18.	173688.
-4	531.	4003.	3178.	1903.	6824.	30959.	18803.	681.	66882.
-5	0.	580.	664.	1217.	731.	2360.	7423.	1136.	14111.
RG OW SZ-1	6586.	0.	0.	0.	1233.	1735.	503.	932.	10991.
-2	25499.	106804.	0.	0.	2905.	5093.	467.	9.	140797.
-3	15144.	92888.	67535.	12585.	4744.	8183.	1213.	31.	202323.
-4	3180.	31068.	75208.	43396.	3533.	6063.	1292.	183.	163923.
-5	1430.	24080.	33115.	13401.	1093.	1816.	384.	336.	75655.
TN OW SZ-1	980.	2440.	1014.	2954.	339.	349.	11.	263.	8350.
-2	1143.	5084.	1937.	596.	148.	623.	31.	0.	9562.
-3	277.	1711.	1741.	316.	64.	516.	65.	0.	4690.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	45.	51.	21.	0.	117.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1418.	0.	891.	6.	465.	235.	0.	0.	3015.
-2	1148.	3164.	151.	0.	612.	959.	8.	0.	6042.
-3	603.	2001.	739.	0.	340.	1324.	59.	0.	5066.
-4	0.	548.	615.	294.	100.	622.	437.	12.	2628.
-5	140.	728.	57.	124.	0.	0.	778.	3.	1830.
TR OW SZ-1	3558.	0.	3263.	6.	0.	0.	0.	29.	6856.
-2	6224.	12720.	151.	0.	0.	210.	100.	4.	19409.
-3	3502.	13474.	11577.	1071.	0.	547.	245.	9.	30425.
-4	417.	7961.	7065.	3517.	0.	339.	40.	0.	19339.
-5	262.	576.	7118.	923.	0.	0.	0.	0.	8879.
-T	107462.	370997.	235801.	83034.	93961.	197021.	39580.	3652.	1131508.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

FAMILY-TO-HOUSE DISTRIBUTION RATIOS

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	.1306	.0000	.0009	.0000	.0503	.0000	.0000	.0000	.0168
-2	.1509	.1056	.0000	.0000	.3706	.2398	.0120	.0016	.1219
-3	.0481	.0592	.0830	.0087	.3325	.4456	.1820	.0049	.1535
-4	.0049	.0108	.0135	.0229	.0726	.1571	.4751	.1865	.0591
-5	.0000	.0016	.0028	.0147	.0078	.0120	.1875	.3111	.0125
RG OW SZ-1	.0613	.0000	.0000	.0000	.0131	.0088	.0127	.2552	.0097
-2	.2373	.2879	.0000	.0000	.0309	.0259	.0123	.0025	.1244
-3	.1409	.2504	.2864	.1516	.0505	.0415	.0306	.0085	.1788
-4	.0296	.0837	.3189	.5226	.0376	.0308	.0326	.0501	.1449
-5	.0133	.0649	.1404	.1614	.0116	.0092	.0097	.0920	.0669
TN OW SZ-1	.0091	.0066	.0043	.0356	.0036	.0018	.0003	.0720	.0074
-2	.0106	.0137	.0082	.0072	.0016	.0032	.0008	.0000	.0085
-3	.0026	.0046	.0074	.0038	.0007	.0026	.0016	.0000	.0041
HT RT SZ-1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0005	.0003	.0005	.0000	.0001
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
HT OW SZ-1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
TR RT SZ-1	.0132	.0000	.0036	.0001	.0049	.0012	.0000	.0000	.0027
-2	.0107	.0085	.0006	.0000	.0065	.0049	.0002	.0000	.0053
-3	.0056	.0054	.0031	.0000	.0036	.0067	.0015	.0000	.0045
-4	.0000	.0015	.0026	.0035	.0011	.0032	.0110	.0033	.0023
-5	.0013	.0020	.0002	.0015	.0000	.0000	.0197	.0008	.0016
TR OW SZ-1	.0331	.0000	.0138	.0001	.0000	.0000	.0000	.0079	.0061
-2	.0579	.0343	.0006	.0000	.0000	.0011	.0025	.0011	.0172
-3	.0326	.0363	.0491	.0129	.0000	.0028	.0062	.0025	.0269
-4	.0039	.0215	.0300	.0424	.0000	.0017	.0010	.0000	.0171
-5	.0024	.0016	.0302	.0111	.0000	.0000	.0000	.0000	.0078

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

DOMESTIC FAMILY-TO-HOUSE DISTRIBUTIONS

DEVIATIONS FROM NEW FAMILY DISTRIBUTION GOALS

	Negative Deviations				Positive Deviations			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
RG RT SZ-1	0.	0.	0.	0.	0.	0.	213.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	3359.	1132.	0.	0.	0.	0.	0.
-4	0.	0.	566.	257.	0.	0.	0.	0.
-5	0.	0.	0.	126.	0.	0.	0.	0.
RG OW SZ-1	15146.	0.	0.	0.	0.	0.	0.	0.
-2	38342.	13575.	0.	0.	0.	0.	0.	0.
-3	0.	27845.	4134.	0.	0.	0.	0.	0.
-4	0.	0.	8798.	2467.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	3743.	0.
TN OW SZ-1	0.	0.	0.	0.	0.	0.	0.	2809.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	0.	0.	0.	0.	0.	0.	891.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	334.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	514.	0.	0.
TR OW SZ-1	0.	0.	0.	0.	0.	0.	3264.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

DEVIATIONS FROM EXISTING FAMILY REDISTRIBUTION GOALS

	Negative Deviations				Positive Deviations			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
RG RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	7466.	0.	0.	0.	0.	0.
-4	0.	0.	0.	748.	0.	0.	0.	0.
-5	0.	0.	0.	70.	0.	0.	0.	0.
RG OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	31130.	0.	0.	0.	0.	0.	0.
-3	0.	18086.	55508.	11431.	0.	0.	0.	0.
-4	0.	0.	57422.	42248.	0.	0.	0.	0.
-5	0.	0.	21507.	11077.	0.	0.	0.	0.
TN OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.
TR OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

VACANCIES AND NEW HOUSES REQUIREMENTS

	Vacancies	New
RG RT SZ-1	0.	0.
-2	77432.	0.
-3	0.	57143.
-4	0.	48372.
-5	0.	9559.
RG OW SZ-1	0.	0.
-2	0.	7903.
-3	0.	57483.
-4	0.	79374.
-5	0.	0.
TN OW SZ-1	0.	0.
-2	0.	7670.
-3	369.	0.
HT RT SZ-1	0.	118.
-2	478.	0.
-3	238.	0.
HT OW SZ-1	1579.	0.
-2	1637.	0.
-3	1416.	0.
TR RT SZ-1	0.	0.
-2	3156.	0.
-3	0.	0.
-4	0.	1623.
-5	0.	0.
TR OW SZ-1	0.	0.
-2	1121.	0.
-3	0.	18292.
-4	0.	10712.
-5	1923.	0.

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS
(HT) HUT (OW) OWN (-2) 3-4 ROOMS
(TN) TENT (-3) 5-6 ROOMS
(TR) TRADITIONAL (-4) 7-8 ROOMS
(-5) 9-U ROOMS

TOTAL FAMILY ACCOUNTS

		Unhoused	New	Remaining	To be housed
DOM	(1)	53154.	82294.	72978.	87642.
	(2)	40522.	34956.	351492.	60031.
	(3)	10264.	1156.	228949.	17116.
	(4)	41.	7.	78611.	4465.
EXP	(1)	0.	52925.	39032.	54929.
	(2)	0.	71622.	121010.	76007.
	(3)	0.	11074.	27478.	12103.
	(4)	0.	1081.	2500.	1155.

(1) 1-4 MEMBERS (2) 5-9 MEMBERS
(2) 10-13 MEMBERS (4) 13-U MEMBERS

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Sector Projects	Neg.Dev.	Pos.Dev
(1)	8287.32	5242.96	57.00	12800.96	0.00	13.10	161.00	0.00	0.00
(2)	23515.70	1382.59	21624.50	1152.17	0.00	285.80	75.00	0.00	628.36
(3)	8780.00	82066.42	146.00	21630.79	19614.60	3781.90	26908.80	0.00	0.00
(4)	1448.29	0.00	0.00	616.35	0.00	393.70	0.00	5004.90	0.00
(5)	42881.00	0.00	0.00	205.87	0.00	1140.02	15846.30	10944.00	0.00
(6)	7200.79	720.08	0.00	164.95	0.00	0.00	4822.60	343.80	0.00
(7)	23038.16	0.00	328.00	18123.23	0.00	575.54	777.70	0.00	0.00
(8)	12590.51	2392.19	541.39	4472.87	0.00	1020.20	641.00	257.50	0.00
(9)	20802.81	6656.89	1185.76	12673.84	0.00	17148.40	3239.84	0.00	0.00
(T)	148544.58	98461.13	23882.65	72041.05	19614.60	24358.66	52472.24	16550.20	628.36

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS AND OUTPUTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	5582	299	8549	5283	9133	8849	1565	20397	4017	3539
(B)	88859	67033	40677	59721	26155	29138	100598	0	2423	87430	22566
(C)	70435	31631	4855	42296	26776	28139	47151	0	0	34054	14311
(D)	104294	193041	47195	64808	145846	39486	112003	74134	0	118906	132523
(E)	193581	240001	1494	100304	238507	93277	101798	82619	0	157382	160867
(F)	598062	0	0	0	0	59862	0	0	0	0	0
(G)	154797	59342	0	0	59342	154797	0	37525	0	21817	48238
(T)	1227710	596630	94720	275678	501909	413832	370399	195843	22820	423606	382044

(A) MANAGER (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURE
(G) PROPRIETERS (T) TOTAL

3-E.11 Numerical Results For ECHS203 Illustration

NEW FAMILIES DISTRIBUTION TO HOUSES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	13057.	0.	0.	0.	6229.	0.	0.	0.	19286.
-2	6528.	6717.	0.	0.	41499.	57791.	0.	0.	112535.
-3	0.	0.	0.	0.	11709.	31899.	8686.	10.	52304.
-4	0.	0.	0.	0.	679.	1797.	4267.	845.	7588.
-5	0.	0.	0.	0.	481.	470.	237.	252.	1440.
RG OW SZ-1	19165.	0.	0.	0.	1285.	1700.	95.	1.	22246.
-2	38342.	13575.	0.	0.	2918.	4480.	397.	9.	59721.
-3	0.	27845.	4134.	0.	4183.	4415.	622.	20.	41219.
-4	0.	0.	4719.	0.	1686.	1528.	211.	190.	8334.
-5	0.	0.	0.	1184.	243.	131.	4.	109.	1671.
TN OW SZ-1	517.	1055.	0.	0.	275.	283.	4.	0.	2134.
-2	789.	2110.	302.	19.	0.	429.	31.	0.	3680.
-3	0.	0.	624.	38.	84.	45.	12.	0.	803.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1082.	0.	0.	0.	614.	331.	0.	0.	2027.
-2	542.	1008.	0.	0.	371.	826.	10.	0.	2757.
-3	0.	504.	73.	0.	185.	551.	52.	0.	1365.
-4	0.	0.	36.	15.	0.	0.	430.	15.	496.
-5	0.	0.	0.	8.	0.	0.	0.	0.	8.
TR OW SZ-1	2540.	0.	0.	0.	0.	0.	0.	5.	2545.
-2	5080.	1286.	0.	0.	0.	296.	126.	0.	6788.
-3	0.	2571.	972.	0.	0.	300.	22.	0.	3865.
-4	0.	0.	478.	234.	0.	0.	0.	0.	712.
-5	0.	0.	0.	117.	0.	0.	0.	0.	117.
-T	87642.	56671.	11338.	1615.	72441.	107272.	15206.	1456.	353641.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

REDISTRIBUTION OF EXISTING FAMILIES

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	982.	0.	0.	0.	0.	0.	0.	0.	982.
-2	9783.	32478.	0.	0.	3588.	6338.	476.	6.	52669.
-3	5276.	21974.	15209.	725.	23903.	65616.	250.	10.	132963.
-4	631.	4003.	3178.	1460.	6745.	29880.	15407.	12.	61316.
-5	0.	580.	664.	1217.	391.	2040.	7235.	937.	13064.
RG OW SZ-1	2682.	0.	0.	0.	27.	533.	478.	931.	4651.
-2	24699.	106804.	0.	0.	740.	1931.	171.	2.	134347.
-3	15244.	92889.	15110.	1459.	1681.	5088.	718.	16.	132205.
-4	3295.	31068.	14808.	1451.	2410.	5013.	1124.	33.	59202.
-5	1530.	20337.	14583.	1441.	971.	1734.	381.	249.	41226.
TN OW SZ-1	563.	1385.	1014.	145.	140.	149.	8.	263.	3667.
-2	354.	2974.	1635.	578.	158.	322.	7.	0.	6028.
-3	277.	1712.	1117.	277.	0.	487.	56.	0.	3926.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	48.	51.	21.	0.	120.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	386.	0.	0.	6.	0.	0.	0.	0.	392.
-2	606.	2155.	151.	0.	353.	376.	0.	0.	3641.
-3	369.	1497.	666.	0.	214.	939.	18.	0.	3703.
-4	0.	548.	579.	279.	106.	626.	94.	0.	2232.
-5	146.	214.	57.	117.	0.	0.	778.	1.	1313.
TR OW SZ-1	1018.	0.	0.	6.	0.	0.	0.	29.	1053.
-2	1144.	11434.	151.	0.	0.	0.	0.	0.	12729.
-3	3502.	10903.	10605.	1071.	0.	336.	228.	8.	26653.
-4	417.	7961.	6587.	3283.	0.	341.	39.	0.	18628.
-5	262.	576.	7118.	806	0.	0.	0.	0.	8762.
-T	73166.	351492.	93232.	14321.	41475.	121800.	27489.	2497.	725472.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

TOTAL FAMILY-TO-HOUSE DISTRIBUTION

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	14039.	0.	0.	0.	6229.	0.	0.	0.	20268.
-2	16311.	39195.	0.	0.	45087.	64129.	476.	6.	165204.
-3	5276.	21974.	15209.	725.	35612.	97515.	8936.	20.	185267.
-4	631.	4003.	7541.	1460.	7424.	31677.	19674.	857.	73267.
-5	0.	580.	664.	1660.	872.	2510.	7472.	1189.	14947.
RG OW SZ-1	21847.	0.	0.	0.	1312.	2233.	573.	932.	26897.
-2	63041.	120379.	0.	0.	3658.	6411.	568.	11.	194068.
-3	15244.	120734.	80688.	12684.	5864.	9503.	1340.	36.	246093.
-4	3295.	31068.	73028.	43597.	4096.	6541.	1335.	223.	163183.
-5	1530.	20337.	30993.	14001.	1214.	1865.	385.	358.	70683.
TN OW SZ-1	1080.	2440.	1014.	145.	415.	432.	12.	263.	5801.
-2	1143.	5084.	1937.	597.	158.	751.	38.	0.	9708.
-3	277.	1712.	1741.	315.	84.	532.	68.	0.	4729.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	48.	51.	21.	0.	120.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	1468.	0.	0.	6.	614.	331.	0.	0.	2419.
-2	1148.	3163.	151.	0.	724.	1202.	10.	0.	6398.
-3	369.	2001.	739.	0.	399.	1490.	70.	0.	5068.
-4	0.	548.	615.	294.	106.	626.	524.	15.	2728.
-5	146.	214.	57.	125.	0.	0.	778.	1.	1321.
TR OW SZ-1	3558.	0.	0.	6.	0.	0.	0.	34.	3598.
-2	6224.	12720.	151.	0.	0.	296.	126.	0.	19517.
-3	3502.	13474.	11577.	1071.	0.	636.	250.	8.	30518.
-4	417.	7961.	7065.	3517.	0.	341.	39.	0.	19340.
-5	262.	576.	7118.	923.	0.	0.	0.	0.	8879.
-T	160808.	408163.	240288.	81126.	113916.	229072.	42695.	3953.	1280021.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

FAMILY-TO-HOUSE DISTRIBUTION RATIOS

	Domestic Families				Expatriate Families				Total
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
RG RT SZ-1	.0873	.0000	.0000	.0000	.0547	.0000	.0000	.0000	.0158
-2	.1014	.0960	.0000	.0000	.3958	.2800	.0111	.0015	.1291
-3	.0328	.0538	.0633	.0089	.3126	.4257	.2093	.0051	.1447
-4	.0039	.0098	.0314	.0180	.0652	.1383	.4606	.2168	.0572
-5	.0000	.0014	.0028	.0205	.0077	.0110	.1750	.3008	.0117
RG OW SZ-1	.1359	.0000	.0000	.0000	.0115	.0097	.0134	.2358	.0210
-2	.3920	.2949	.0000	.0000	.0321	.0280	.0133	.0028	.1516
-3	.0948	.2958	.3358	.1563	.0515	.0415	.0314	.0091	.1923
-4	.0205	.0761	.3039	.5374	.0360	.0286	.0313	.0564	.1275
-5	.0095	.0498	.1290	.1726	.0107	.0081	.0090	.0906	.0552
TN OW SZ-1	.0067	.0060	.0042	.0018	.0036	.0019	.0003	.0665	.0045
-2	.0071	.0125	.0081	.0074	.0014	.0033	.0009	.0000	.0076
-3	.0017	.0042	.0072	.0039	.0007	.0023	.0016	.0000	.0037
HT RT SZ-1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0004	.0002	.0005	.0000	.0001
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
HT OW SZ-1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
TR RT SZ-1	.0091	.0000	.0000	.0001	.0054	.0014	.0000	.0000	.0019
-2	.0071	.0077	.0006	.0000	.0064	.0052	.0002	.0000	.0050
-3	.0023	.0049	.0031	.0000	.0035	.0065	.0016	.0000	.0040
-4	.0000	.0013	.0026	.0036	.0009	.0027	.0123	.0038	.0021
-5	.0009	.0005	.0002	.0015	.0000	.0000	.0182	.0003	.0010
TR OW SZ-1	.0221	.0000	.0000	.0001	.0000	.0000	.0000	.0086	.0028
-2	.0387	.0312	.0006	.0000	.0000	.0013	.0030	.0000	.0152
-3	.0218	.0330	.0482	.0132	.0000	.0028	.0059	.0020	.0238
-4	.0026	.0195	.0294	.0434	.0000	.0015	.0009	.0000	.0151
-5	.0016	.0014	.0296	.0114	.0000	.0000	.0000	.0000	.0069

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

DOMESTIC FAMILY-TO-HOUSE DISTRIBUTIONS

DEVIATIONS FROM NEW FAMILY DISTRIBUTION GOALS

	Negative Deviations				Positive Deviations			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
RG RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	3359.	1132.	0.	0.	0.	0.	0.
-4	0.	0.	566.	257.	0.	0.	0.	0.
-5	0.	0.	0.	126.	0.	0.	0.	0.
RG OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	4079.	2467.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.
TN OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.
TR OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS (1) 1-4 Family Members
(HT) HUT (OW) OWN (-2) 3-4 ROOMS (2) 5-9 Family Members
(TN) TENT (-3) 5-6 ROOMS (3) 9-13 Family Members
(TR) TRADITIONAL (-4) 7-8 ROOMS (4) 13-A Family Members
(-5) 9-A ROOMS

DEVIATIONS FROM EXISTING FAMILY REDISTRIBUTION GOALS

	Negative Deviations				Positive Deviations			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
RG RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	4363.	0.	0.	0.	0.	0.
-5	0.	0.	0.	443.	0.	0.	0.	0.
RG OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	61444.	11225.	0.	0.	0.	0.
-4	0.	0.	53501.	42146.	0.	0.	0.	0.
-5	0.	0.	16410.	11376.	0.	0.	0.	0.
TN OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
TR RT SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.
TR OW SZ-1	0.	0.	0.	0.	0.	0.	0.	0.
-2	0.	0.	0.	0.	0.	0.	0.	0.
-3	0.	0.	0.	0.	0.	0.	0.	0.
-4	0.	0.	0.	0.	0.	0.	0.	0.
-5	0.	0.	0.	0.	0.	0.	0.	0.

(RG) REGULAR (RT) RENT
(HT) HUT (OW) OWN
(TN) TENT
(TR) TRADITIONAL

(-1) 1-2 ROOMS
(-2) 3-4 ROOMS
(-3) 5-6 ROOMS
(-4) 7-8 ROOMS
(-5) 9-A ROOMS

(1) 1-4 Family Members
(2) 5-9 Family Members
(3) 9-13 Family Members
(4) 13-A Family Members

VACANCIES AND NEW HOUSES REQUIREMENTS

	Vacancies	New
RG RT SZ-1	0.	1293.
-2	50284.	0.
-3	0.	73014.
-4	0.	50737.
-5	0.	9952.
RG OW SZ-1	0.	15993.
-2	0.	61975.
-3	0.	92034.
-4	0.	85217.
-5	3548.	0.
TN OW SZ-1	2649.	0.
-2	0.	7814.
-3	329.	0.
HT RT SZ-1	0.	122.
-2	10356.	9878.
-3	238.	0.
HT OW SZ-1	1579.	0.
-2	1637.	0.
-3	1416.	0.
TR RT SZ-1	646.	0.
-2	2798.	0.
-3	99.	0.
-4	0.	1725.
-5	513.	0.
TR OW SZ-1	3264.	0.
-2	1008.	0.
-3	0.	18387.
-4	0.	10715.
-5	1923.	0.

(RG) REGULAR (RT) RENT (-1) 1-2 ROOMS
(HT) HUT (OW) OWN (-2) 3-4 ROOMS
(TN) TENT (-3) 5-6 ROOMS
(TR) TRADITIONAL (-4) 7-8 ROOMS
(-5) 9-U ROOMS

TOTAL FAMILY ACCOUNTS

		Unhoused	New	Remaining	To be housed
DOM	(1)	0.	82294.	72978.	87642.
	(2)	3359.	34956.	351492.	60031.
	(3)	5777.	1156.	228949.	17116.
	(4)	2849.	7.	78611.	4465.
EXP	(1)	0.	70437.	41726.	72441.
	(2)	0.	102889.	121800.	107274.
	(3)	0.	14177.	27478.	15205.
	(4)	0.	1386.	2500.	1460.

(1) 1-4 MEMBERS (2) 5-9 MEMBERS
(2) 10-13 MEMBERS (4) 13-U MEMBERS

ECONOMIC VARIABLES

	Domestic Output	Imports	Exports	H.Hold Consumpt.	Govern. Capital	Govern. Operation	Sector Projects	Neg.Dev.	Pos.Dev
(1)	8287.32	5736.34	57.00	13282.70	0.00	13.10	161.00	0.00	0.00
(2)	23515.70	1382.59	21624.50	1204.54	0.00	285.80	75.00	0.00	514.88
(3)	8780.00	85188.26	146.00	22407.22	19614.60	3781.90	26908.80	0.00	0.00
(4)	1529.33	0.00	0.00	662.19	0.00	393.70	0.00	5004.90	0.00
(5)	52134.07	0.00	0.00	208.47	0.00	1140.02	15846.30	10944.00	0.00
(6)	7481.37	748.13	0.00	166.74	0.00	0.00	4822.60	0.00	0.00
(7)	2489.06	0.00	328.00	18776.58	0.00	575.54	777.70	343.80	0.00
(8)	13099.16	2488.84	563.26	4771.26	0.00	1020.20	641.00	0.00	0.00
(9)	22162.86	7092.11	1263.28	13512.61	0.00	17148.40	3239.84	2575.50	0.00
(T)	139478.87	102636.27	23982.04	74992.31	19614.60	24358.66	52472.24	18868.20	514.88

(1) AGRICULTURE (2) OIL-GAS (3) MANUFACTURING
(4) UTILITIES (5)CONST:BLDG (6) CONST:oth
(7)RET/WHOLSALE (8) TRANS/COMM (9) SERVICES
(T) TOTAL

LABOR INPUTS AND OUTPUTS

	Domest. Labor	Expat. Labor	Govern. Expat.	Govern. Domestic	Sector Expat.	Sector Domestic	Govern. Required	Neg.Dev.	Pos.Dev	Goals	Recruit-ment
(A)	17682	6488	299	8549	6188	9133	8849	2471	0	4017	4445
(B)	88859	70631	40877	59721	29753	29138	100598	0	16799	87430	26164
(C)	70435	34887	4855	42296	30031	28139	47151	833	0	34054	17567
(D)	104294	210823	47195	64808	163628	39486	112003	91917	0	118906	150305
(E)	193581	288403	1494	100304	286909	93277	101798	131021	0	157382	209269
(F)	598062	0	0	0	0	59862	0	0	0	0	0
(G)	154797	72166	0	0	72166	154797	0	50349	0	21817	61062
(T)	1227710	683398	94720	275678	588675	413832	370399	276591	16799	423606	468812

(A) MANAGER (B) PROFESSIONAL (C) CLERICAL
(D) SKILLED (E) UNSKILLED (F) AGRICULTURE
(G) PROPRIETERS (T) TOTAL

APPENDIX 4-A

Estimation Approaches of Input Output Coefficients

4-A ESTIMATION APPROACHES OF INPUT OUTPUT COEFFICIENTS

Two approaches to ex post estimation of input output coefficients were introduced in two different processes. The first was the result of investigation about changes in economic transactions and input output coefficients. The second is the result of the desire to estimate Markov transition probabilities from aggregate time series data as applied to social processes.

In the first, detailed distribution data are assumed to exist for at least one period. Data are also assumed to exist for the aggregate inputs and outputs in the succeeding periods. In this case, the estimates of the temporal input-output relation through time is defined as a matrix having a prescribed row and column totals. The problem is to find the entries of a constrained matrix, in which the marginal constraints are non-negative and a solution matrix is required to be biproportional to a given non-negative matrix.

This type of problem was presented in the context of economic input-output analysis by Leontief [187]. Since then it was solved by Stone [281] by fitting the coefficient matrix to total observed inputs and outputs at time (1).[104] The problem was originally written as

$$A_{ij}(1) = \alpha_i \beta_j A_{ij}(0) \quad (i=1,\ldots m, j=1,\ldots n)$$

$$A_{ij}(1) \geq 0$$

Thus, knowing the initial input output coefficients in A(0), α_i and β_j could be determined such that

$$\sum_{j=1}^{n} \alpha_i \beta_j A_{ij}(0) q_j(1) = u_i(1) \quad (i=1,\ldots n)$$

$$\sum_{i=1}^{n} \alpha_i \beta_j A_{ij}(0) q_j(1) = v_j(1) \quad (j=1,\ldots n),$$

---

[104] The problem was known since by the code name RAS. See LeComber [170] for a solution to the RAS estimate given two period complete matrices.

where $u_i(1)$ and $v_j(1)$ are the observed intermediate outputs of commodity i and inputs of commodity j at time (1), and $q_j(1)$ is the gross domestic output at the succeeding period (1). The problem is then to solve for α_i and β_j by fitting the left hand side argument, in the above equations, to the marginal values in the right hand side.[105] the proof of convergence of the RAS method, and 2) relating the constrained matrix estimation to the minimization of a function "distance" approach, i.e. the approach to seek the minimization of a distance metric function subject to the constraints and matrices prespecified.)

Similar formulation could be accorded our problem here by writing the relationship between the two period coefficients as

$$\Phi_{ij}(1) = \alpha_i \beta_j \Phi_{ij}(0) \qquad (i,j=1,\ldots.n; \quad i,j \geq 0)$$

then knowing $\Phi_{ij}(0)$, α_i and β_j could be determined such that

$$\sum_{i=1}^{n} \alpha_i \beta_j \Phi_{ij}(0) f_j(1) = f_i(1)$$

$$\sum_{j=1}^{n} \alpha_i \beta_j \Phi_{ij}(0) f_j(1) = f_j(0)$$

where $f_i(1)$ and $f_j(1)$ are the observed total family stocks at time (1).

Data, however, may not be available for the initial distribution matrix; therefore, we may not be able to make use of the above formulation (hence the second approach).

Starting from another vantage point, Lee, Judge, and Zelner [179] consider a stochastic process with a finite number of possible outcomes which a discrete random variable takes at a finite number of equidistant time periods. The probability of that ordered set of sequences is reflected by the multiplication law of conditional probability and may be expressed as a Markov process. Such a stochastic mechanism is described by the initial probability distribution and the conditional probability. This is written as the probability that a variable, x, will be in state s_j at time t, given that it was in state s_i at time t-1, or

$$\Pr\left(x(t) = s_j \mid x(t-1) = s_i \right) = P_{ij}(t) = P_{ij}$$

where P_{ij}, the probability that a variable at state j in time t was in state i at time t-1, is constant for all time periods and

---

[105] See Bacharach [7] for a detailed examination of biproportional matrices and temporal analysis of input-output changes. Two aspects in Bacharachs study are of particular interest here 1

$$0 \leq P_{ij} \leq 1$$

$$\Sigma_j P_{ij} = 1 \quad \text{for } i,j = 1,\ldots,r$$

They further present the analysis and procedures to estimate the transition parameters using alternative estimators to guide their formulations. These estimators included the generalized least square, maximum likelihood, and the minimum absolute deviation estimators. We will summarize in the following the first and the third to shed light on some of the issues and the methodologies involved.

The problem is first written as

$$\begin{matrix} y_1 \\ y_2 \\ y_3 \\ \cdot \\ \cdot \\ y_r \end{matrix} = \begin{matrix} X & & & \\ & X & & \\ & & X & \\ & & & \cdot \\ & & & \cdot \\ & & & X \end{matrix} \begin{matrix} P_1 \\ P_2 \\ P_3 \\ \cdot \\ \cdot \\ P_r \end{matrix} + \begin{matrix} u_1 \\ u_2 \\ u_3 \\ \cdot \\ \cdot \\ u_r \end{matrix}$$

where $y_1, y_2,\ldots y_r$ are (Tx1) vectors of sample proportions, X is an Txr matrix such that

$$X = \begin{matrix} y_1(0) & y_2(0) & \ldots & y_r(0) \\ y_1(1) & y_2(1) & \ldots & y_r(1) \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ y_1(T-1) & y_2(T-1) & \ldots & y_r(T-1) \end{matrix}$$

$P_1, P_2,\ldots P_r$ are the transition parameters to be estimated, and $u_1,\ldots u_r$ are the Tx1 vectors of random disturbances.

Further, the problem is restricted to satisfy non-negativity of all row sums conditions such that

$$0 \leq P_{ij} \leq 1$$

and

$$\Sigma_j \quad P_{ij} = 1 \text{ for all } i$$

and since the conventional estimators, least square, may violate the non-negativity constraints, the suggestion is made to use an estimate on the boundary of the subset which minimize the quadratic form

$$u'u = (y - Xp)'(y - Xp)$$

subject to

$$Ep = \zeta_r$$

$$p \geq 0$$

where

E is an rxr^2 matrix in the form $[I_1, I_2, \ldots I_r]$ with each I_i an (rxr) identity matrix and ζ_r is an rx1 unity vector.[106]

By the duality theorem of quadratic programming and the duality property of linear programming, the problem is further introduced as a primed-dual programming problem. To maximize

$$- \quad \gamma'_1 \quad \alpha_1 - . \quad \gamma'_2 \quad \alpha_2 - \quad \beta P \leq \quad 0$$

subject to

$$E' \quad \gamma_1 - E' \quad \gamma_2 + (X'X) P - \quad = X'y$$

$$E P \quad = \quad \zeta r$$

$$P, \quad \gamma_1, \quad \gamma_2, \quad \alpha_1, \quad \alpha_2, \quad \zeta \quad \geq 0$$

where α_1, α_2, and β are the vectors of slack variables to primal and dual respectively.

The minimum absolute deviation estimator (MAD) was then presented in two different ways, first as the minimization of the unweighted sum and then of the weighted sum of the absolute deviations. In the unweighted sum, the problem is presented as

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[106] See Miller [215], Goodman [125], and Lee, Judge and Takayama [180].

Minimize $(u_1 + u_2)' \zeta r$

Subject To

$$XP + u_1 - u_2 = y$$

$$Ep = \zeta r,$$

$$p, u_1, u_2 \geq 0$$

Then a different weight for each observation may be defined if the sampling error is not uniform. Hence the problem of minimizing the function

Minimize $(u_1 + u_2)' W' \zeta r$

subject to the same constraints in the above formulation.[107] The problem could then be solved using the linear programming method.[108]

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[107] See Lee, Judge, and Zeiner [177], pp. 131-137.

[108] See Wagner [297], and Fisher [111].

APPENDIX 4-B

DATA FOR MULTI PERIOD ILLUSTRATIONS

4-B DATA FOR MULTI PERIOD ILLUSTRATIONS

Initial Family-to-House Distribution (1976)

4-B.1 Base Year (1976

Data)

Base Year Family-to-House Distribution 1976

	(1)	(2)	(3)	(4)
RG RT SZ-1	1925.	4781.	1042.	36.
-2	18991.	61296.	21803.	2366.
-3	10140.	40739.	16703.	2794.
-4	1042.	7860.	5207.	1432.
-5	0.	1137.	1291.	965.
RG OW SZ-1	1561.	4457.	1604.	369.
-2	15511.	69631.	34249.	5648.
-3	9783.	68504.	55612.	14527.
-4	2598.	26568.	34826.	13655.
-5	1403.	19395.	28007.	29384.
TN OW SZ-1	893.	3856.	2604.	268.
-2	178.	711.	519.	485.
-3	535.	2491.	1589.	223.
HT RT SZ-1	0.	0.	0.	0.
-2	0.	221.	246.	11.
-3	0.	212.	26.	0.
HT OW SZ-1	275.	665.	64.	1.
-2	0.	845.	539.	253.
-3	0.	641.	521.	254.
TR RT SZ-1	712.	1078.	319.	13.
-2	1283.	4562.	1414.	544.
-3	570.	2092.	697.	27.
-4	0.	453.	528.	24.
-5	296.	1164.	123.	248.
TR OW SZ-1	569.	3641.	2535.	111.
-2	3421.	9825.	5687.	982.
-3	721.	6322.	3538.	1142.
-4	287.	4129.	2829.	1382.
-5	284.	4109.	4948.	1462.
TOTAL -T	72979.	351386.	229070.	78606.

4-B.2 Expected Distrubutions at 1980

Expected at (1980)

Expected Family-to-House Distribution Prior to 1980 Plans (Ω R Φ)

	(1)	(2)	(3)	(4)
RG RT SZ-1	984.	4997.	1516.	92.
-2	9711.	61558.	27160.	3416.
-3	5185.	39817.	20053.	3561.
-4	533.	7278.	5694.	1648.
-5	0.	986.	1320.	1002
RG OW SZ-1	798.	4556	1996.	441.
-2	7932.	67252.	39534.	7196.
-3	5003.	63745.	59149.	16819.
-4	1329.	24194.	35238.	14945.
-5	717.	17444.	28115.	29957.
TN OW SZ-1	234.	1918.	1460.	198.
-2	47.	357.	288.	255.
-3	140.	1229.	898.	151.
HT RT SZ-1	0.	0.	0.	0.
-2	0.	147.	194.	17.
-3	0.	141.	36.	1.
HT OW SZ-1	108.	537.	104.	4.
-2	0.	564.	454.	210.
-3	0.	428.	425.	210.
TR RT SZ-1	299.	1025.	350.	24.
-2	538.	3712.	1497.	495.
-3	239.	1696.	723.	51.
-4	0.	322.	442.	40.
-5	124.	936.	200.	205.
TR OW SZ-1	239.	2798.	2259.	189.
-2	1435.	8233.	5251.	1013.
-3	303.	4761.	3260.	1055.
-4	120.	3043.	2521.	1217.
-5	119.	3028.	4135.	1360.
TOTAL -T	36138.	326702.	244272.	85773.

Expected Families to be Housed

	$\bar{f}$	f_n	h_u	Total
Size (1)	0.	78447.	2137.	80584.
Size (2)	0.	36175.	18980.	55156.
Size (3)	0.	1100.	13846.	14945.
Size (4)	0.	7.	4192.	4199.

4-B.3 Projected Output Data for Alternative Illustrations

Projected for 1980 and Expected at 1985 Illustration ECHSxx

Projected Family-to-House Distribution 1980

	(1)	(2)	(3)	(4)
RG RT SZ-1	4047.	4280.	714.	0.
-2	39945.	61358.	19193.	1769.
-3	21330.	43703.	15330.	2492.
-4	2185.	9506.	5339.	1420.
-5	0.	1564.	1427.	1063.
RG OW SZ-1	3277.	4238.	1427.	357.
-2	32622.	76873.	33071.	4960.
-3	20575.	82099.	59203.	14190.
-4	5461.	33251.	39272.	14181.
-5	2956.	24856.	31816.	33055.
TN OW SZ-1	3662.	8231.	5290.	357.
-2	722.	1481.	1058.	1063.
-3	2201.	5390.	3174.	349.
HT RT SZ-1	0.	0.	0.	0.
-2	0.	412.	345.	0.
-3	0.	370.	0.	0.
HT OW SZ-1	755.	741.	0.	0.
-2	0.	1481.	714.	349.
-3	0.	1152.	714.	357.
TR RT SZ-1	1831.	782.	345.	0.
-2	3293.	5761.	1403.	706.
-3	1462.	2676.	714.	0.
-4	0.	741.	714.	0.
-5	755.	1523.	0.	357.
TR OW SZ-1	1462.	5226.	3199.	0.
-2	8770.	11440.	7087.	1055.
-3	1847.	9506.	4232.	1420.
-4	739.	6460.	3543.	1803.
-5	722.	6419.	6742.	1769.
TOTAL -T	160619.	411520.	246066.	83072.

Expected Family-to-House Distribution Prior to 1985 ($\Omega R \Phi'$)

	(1)	(2)	(3)	(4)
RG RT SZ-1	1881.	5584.	1299.	50.
-2	18569.	71389.	26342.	2908.
-3	9915.	47432.	20080.	3357.
-4	1016.	9140.	6144.	1690.
-5	0.	1331.	1506.	1115.
RG OW SZ-1	1523.	5179.	1929.	435.
-2	15165.	81083.	40808.	6783.
-3	9564.	79753.	65194.	17154.
-4	2539.	30923.	40432.	15967.
-5	1374.	22576.	32460.	33956.
TN OW SZ-1	873.	4494.	3071.	332.
-2	172.	824.	604.	562.
-3	525.	2894.	1871.	267.
HT RT SZ-1	0.	0.	0.	0.
-2	0.	270.	283.	15.
-3	0.	242.	34.	1.
HT OW SZ-1	270.	764.	86.	2.
-2	0.	970.	645.	294.
-3	0.	754.	614.	299.
TR RT SZ-1	698.	1267.	384.	17.
-2	1256.	5320.	1716.	639.
-3	556.	2444.	843.	37.
-4	0.	518.	614.	32.
-5	288.	1361.	170.	289.
TR OW SZ-1	558.	4225.	2978.	149.
-2	3345.	11442.	6719.	1176.
-3	704.	7366.	4194.	1339.
-4	282.	4803.	3343.	1609.
-5	275.	4767.	5761.	1718.
TOTAL -T	71350.	409114.	270123.	92192.

Expected House Vacancies at 1985: Illustration ECHSxx

RG RT SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	0.
RG OW SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	0.
TN OW SZ-1	0.
-2	0.
-3	0.
HT RT SZ-1	0.
-2	0.
-3	0.
HT OW SZ-1	0.
-2	0.
-3	0.
TR RT SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	0.
TR OW SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	0.

Expected Families to be Housed

	$\bar{f}$	f_n	h_u	Total
Size (1)	0.	103710.	5229.	108939.
Size (2)	0.	51161.	29177.	80338.
Size (3)	0.	1949.	18837.	20785.
Size (4)	0.	17.	5255.	5272.

Projected for 1980 and Expected at 1985 Illustration ECHSxx

Projected Family-to-House Distribution 1980

	(1)	(2)	(3)	(4)
RG RT SZ-1	15020.	0.	0.	0.
-2	25893.	71673.	0.	0.
-3	10337.	47302.	40266.	1449.
-4	1063.	8007.	6922.	4849.
-5	0.	1160.	1328.	1773.
RG OW SZ-1	20756.	0.	0.	0.
-2	54158.	87901.	0.	0.
-3	9975.	98762.	62365.	14281.
-4	2649.	27065.	84207.	38520.
-5	1430.	19757.	23394.	15205
TN OW SZ-1	980.	2440.	1014.	145.
-2	1143.	4732.	1708.	518.
-3	277.	2063.	1970.	394.
HT RT SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
TR RT SZ-1	1754.	0.	0.	12.
-2	1754.	5318.	300.	0.
-3	539.	3499.	1405.	0.
-4	0.	1097.	1192.	573.
-5	280.	429.	117.	241.
TR OW SZ-1	3222.	0.	0.	0.
-2	5618.	10565.	0.	0.
-3	3233.	11977.	6329.	1071.
-4	344.	7413.	8775.	2452.
-5	196.	362.	4769.	1592.
TOTAL -T	160621.	411522.	246061.	83075.

Expected Family-to-House Distribution Prior to 1985 ($\Omega R \Phi'$)

	(1)	(2)	(3)	(4)
RG RT SZ-1	6982.	7205.	452.	5.
-2	12037.	73429.	9455.	206.
-3	4805.	45222.	43197.	3645.
-4	494.	7326.	7389.	5111.
-5	0.	987.	1366.	1801.
RG OW SZ-1	9649.	9956.	625.	7.
-2	25176.	100800.	12270.	261.
-3	4637.	88852.	69810.	17450.
-4	1231.	24309.	81068.	42021.
-5	665.	17503.	24024.	16099.
TN OW SZ-1	234.	1306.	646.	103.
-2	272.	2347.	1120.	312.
-3	66.	969.	1065.	253.
HT RT SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
TR RT SZ-1	669.	690.	43.	10.
-2	669.	4405.	799.	25.
-3	206.	2656.	1425.	68.
-4	0.	766.	1012.	512.
-5	107.	410.	138.	199.
TR OW SZ-1	1229.	1268.	80.	1.
-2	2143.	9590.	1188.	26.
-3	1233.	9638.	6062.	1155.
-4	131.	5313.	7389.	2354.
-5	75.	330.	3652.	1478.
TOTAL -T	72709.	415275.	274276.	93104.

Expected House Vacancies at 1985: Illustration ECHSxx

RG RT SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	0.
RG OW SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	16971.
TN OW SZ-1	1033.
-2	0.
-3	0.
HT RT SZ-1	431.
-2	359.
-3	179.
HT OW SZ-1	1184.
-2	1228.
-3	1062.
TR RT SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	585.
TR OW SZ-1	2907.
-2	2327.
-3	0.
-4	0.
-5	3107.

Expected Families to be Housed

	$\bar{f}$	f_n	h_u	Total
Size (1)	0.	103710.	3871.	107582.
Size (2)	0.	51161.	23018.	74179.
Size (3)	0.	1949.	14679.	16628.
Size (4)	0.	17.	4345.	4362.

Projected for 1980 and Expected at 1985: Illustration ECHSxx

Projected Family-to-House Distribution 1980

		(1)	(2)	(3)	(4)
RG RT	SZ-1	14039.	0.	0.	0.
	-2	16211.	39195.	0.	0.
	-3	5168.	25331.	20700.	725.
	-4	531.	4004.	3743	2160.
	-5	0.	580.	664.	1343.
RG OW	SZ-1	21737.	0.	0.	0.
	-2	63841.	120379.	0.	0.
	-3	15144.	120734.	81931.	15005.
	-4	3180.	31068.	78227.	40422.
	-5	1430.	20337.	33216.	16422.
TN OW	SZ-1	980.	2440.	1014.	145.
	-2	1143.	5084.	1937.	597.
	-3	277.	1712.	1741.	315.
HT RT	SZ-1	0.	0.	0.	0.
	-2	0.	0.	0.	0.
	-3	0.	0.	0.	0.
HT OW	SZ-1	0.	0.	0.	0.
	-2	0.	0.	0.	0.
	-3	0.	0.	0.	0.
TR RT	SZ-1	1418.	0.	0.	6.
	-2	1148.	3164.	151.	0.
	-3	269.	2001.	739.	0.
	-4	0.	548.	615.	294.
	-5	140.	214.	57.	125.
TR OW	SZ-1	3558.	0.	0.	6.
	-2	6224.	12720.	151.	0.
	-3	3502.	13474.	6725.	1071.
	-4	417.	7961.	7065.	3517.
	-5	262.	576.	7118.	923.
TOTAL	-T	160619.	411522.	245794.	83076.

Expected Family-to-House Distribution Prior to 1985 ($\Omega R \Phi'$)

	(1)	(2)	(3)	(4)
RG RT SZ-1	6526.	6734.	423.	5.
-2	7536.	41139.	5232.	114.
-3	2402.	24041.	22325.	1857.
-4	247.	3663.	3955.	2312.
-5	0.	494.	683.	1346.
RG OW SZ-1	10105.	10426.	655.	8.
-2	29677.	133090.	16493.	354.
-3	7040.	110034.	90682.	19238.
-4	1476.	27971.	76050.	43575.
-5	665.	17997.	33159.	17799.
TN OW SZ-1	234.	1306.	646.	103.
-2	272.	2500.	1250.	358.
-3	66.	815.	935.	207.
HT RT SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
TR RT SZ-1	541.	558.	35.	5.
-2	438.	2662.	457.	14.
-3	103.	1503.	765.	36.
-4	0.	383.	520.	263.
-5	53.	205.	68.	103.
TR OW SZ-1	1357.	1400.	88.	6.
-2	2374.	11334.	1531.	37.
-3	1336.	10789.	6517.	1176.
-4	159.	5724.	6151.	3134.
-5	100.	505.	5454.	1044.
TOTAL -T	72708.	415274.	274074.	93094.

Expected House Vacancies at 1985: Illustration ECHSxx

RG RT SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	0.
RG OW SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	2717.
TN OW SZ-1	982.
-2	0.
-3	85.
HT RT SZ-1	431.
-2	359.
-3	7579.
HT OW SZ-1	1184.
-2	1228.
-3	1062.
TR RT SZ-1	0.
-2	1050.
-3	0.
-4	0.
-5	409.
TR OW SZ-1	2611.
-2	442.
-3	0.
-4	0.
-5	1538.

Expected Families to be Housed

	$\bar{f}$	f_n	h_u	Total
Size (1)	0.	103710.	3871.	107581.
Size (2)	0.	51161.	23018.	74179.
Size (3)	0.	1949.	14629.	16577.
Size (4)	0.	17.	4343.	4359.

Projected for 1980 and Expected at 1985: Illustration ECHSxx

Projected Family-to-House Distribution 1980

	(1)	(2)	(3)	(4)
RG RT SZ-1	15020.	0.	0.	0.
-2	19365.	64956.	0.	0.
-3	10337.	43944.	39134.	1449.
-4	1063.	8007.	6356.	4592.
-5	0.	1160.	1328.	1647.
RG OW SZ-1	20756.	0.	0.	0.
-2	54158.	87901.	0.	0.
-3	9975.	98762.	62365.	14280.
-4	2649.	27065.	77996.	38520.
-5	7958.	29833.	23394.	15205.
TN OW SZ-1	980.	2440.	1014.	528.
-2	1143.	4732.	1708.	518.
-3	277.	2063.	1970.	394.
HT RT SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
TR RT SZ-1	1754.	0.	0.	12.
-2	1754.	5317.	300.	0.
-3	539.	3500.	1405.	0.
-4	0.	1097.	1192.	573.
-5	279.	429.	851.	241.
TR OW SZ-1	3221.	0.	0.	0.
-2	5619.	10565.	0.	0.
-3	3233.	11978.	6331.	1071.
-4	344.	7410.	8775.	2452.
-5	196.	362.	4769.	1592.
TOTAL -T	160620.	411521.	238888.	83074.

Expected Family-to-House Distribution Prior to 1985 ($\Omega R \Phi'$)

		(1)	(2)	(3)	(4)
RG RT	SZ-1	6982.	7205.	452.	5.
	-2	9002.	64580.	8445.	186.
	-3	4805.	42364.	41746.	3577.
	-4	494.	7326.	6867.	4831.
	-5	0.	987.	1366.	1678.
RG OW	SZ-1	9649.	9956.	625.	7.
	-2	25176.	100800.	12270.	261.
	-3	4637.	88852.	69810.	17449.
	-4	1231.	24309.	75336.	41698.
	-5	3699.	29211.	25440.	16129.
TN OW	SZ-1	234.	1306.	646.	295.
	-2	272.	2347.	1120.	312.
	-3	66.	969.	1065.	253.
HT RT	SZ-1	0.	0.	0.	0.
	-2	0.	0.	0.	0.
	-3	0.	0.	0.	0.
HT OW	SZ-1	0.	0.	0.	0.
	-2	0.	0.	0.	0.
	-3	0.	0.	0.	0.
TR RT	SZ-1	669.	690.	43.	10.
	-2	669.	4404.	799.	25.
	-3	206.	2657.	1425.	68.
	-4	0.	766.	1012.	512.
	-5	106.	409.	694.	230.
TR OW	SZ-1	1229.	1268.	80.	1.
	-2	2143.	9590.	1188.	26.
	-3	1233.	9638.	6064.	1156.
	-4	131.	5311.	7389.	2354.
	-5	75.	330.	3652.	1478.
TOTAL	-T	72708.	415274.	267534.	92541.

Expected House Vacancies at 1985: Illustration ECHSxx

RG RT SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	0
RG OW SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	1451.
TN OW SZ-1	1261.
-2	0.
-3	69.
HT RT SZ-1	0.
-2	7859.
-3	179.
HT OW SZ-1	1184.
-2	1228.
-3	1062.
TR RT SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	0.
TR OW SZ-1	2908.
-2	2783.
-3	0.
-4	0.
-5	3107.

Expected Families to be Housed

	$\bar{f}$	f_n	h_u	Total
Size (1)	0.	103710.	3871.	107581.
Size (2)	0.	51161.	23018.	74179.
Size (3)	6792.	1949.	14631.	23372.
Size (4)	384.	17.	4524.	4925.

Projected for 1980 and Expected at 1985. Illustration ECHSxx

Projected Family-to-House Distribution 1980

	(1)	(2)	(3)	(4)
RG RT SZ-1	6341.	0.	0.	0.
-2	26293.	65028.	0.	0.
-3	10337.	43943.	39134.	1449.
-4	1062.	8007.	6356.	4592
-5	0.	1160.	1328.	1647.
RG OW SZ-1	7055.	0.	0.	0.
-2	48272.	74326.	0	0.
-3	9975.	70917.	58230.	14281.
-4	2649.	27065.	75409.	36052.
-5	143.	37994.	23394.	15205.
TN OW SZ-1	980.	2440.	1014.	2994.
-2	843.	4733.	1708.	518.
-3	277.	2063.	1970.	394.
HT RT SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
TR RT SZ-1	1754.	179.	0.	12.
-2	1754.	5318.	300.	0.
-3	536.	3409.	1405.	0.
-4	0.	1096.	1192.	573.
-5	1013.	429.	117.	241.
TR OW SZ-1	3222.	0.	0.	0.
-2	5618.	10565.	0.	0.
-3	3233.	11977.	6331.	1071.
-4	344.	7413.	8775.	2451.
-5	195.	362.	4769.	1592.
TOTAL -T	131898.	378424.	231432.	83072.

Expected Family-to-House Distribution Prior to 1985 ($\Omega R\Phi'$)

	(1)	(2)	(3)	(4)
RG RT SZ-1	2948.	3042.	191.	2.
-2	12222.	67964.	8663.	188.
-3	4805.	42363.	41746.	3577.
-4	494.	7325.	6867.	4831.
-5	0.	987.	1366.	1678.
RG OW SZ-1	3280.	3384.	212.	3.
-2	22440.	86422.	10450.	222.
-3	4637.	65150.	62623.	17158.
-4	1231.	24309.	72949.	39157.
-5	66.	32410.	26193.	16149.
TN OW SZ-1	234.	1306.	646.	1528.
-2	201.	2273.	1115.	311.
-3	66.	969.	1065.	253.
HT RT SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
TR RT SZ-1	669.	815.	61.	11.
-2	669.	4405.	799.	25.
-3	205.	2593.	1416.	68.
-4	0.	765.	1011.	512.
-5	386.	698.	156.	199.
TR OW SZ-1	1229.	1268.	80.	1.
-2	2143.	9590.	1188.	26.
-3	1233.	9638.	6063.	1156.
-4	131.	5313.	7389.	2353.
-5	74.	330.	3652.	1478.
TOTAL -T	59364.	373318.	255902.	90884.

Expected House Vacancies at 1985: Illustration ECHSxx

RG RT SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	0.
RG OW SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	0.
TN OW SZ-1	118.
-2	0.
-3	91.
HT RT SZ-1	0.
-2	359.
-3	179.
HT OW SZ-1	8684.
-2	1228.
-3	1062.
TR RT SZ-1	0.
-2	190.
-3	0.
-4	0.
-5	0.
TR OW SZ-1	2147.
-2	2886.
-3	0.
-4	0.
-5	3107

Expected Families to be Housed

	$\tilde{f}$	f_n	h_u	Total
Size (1)	13127.	103710.	3522.	120359.
Size (2)	16432.	51161.	21949.	89542.
Size (3)	15110.	1949.	14210.	31268.
Size (4)	802.	17.	5676.	6495.

Projected for 1980 and Expected at 1985. Illustration ECHSxx

Projected Family-to-House Distribution 1980

		(1)	(2)	(3)	(4)
RG RT	SZ-1	15020.	0.	0.	0.
	-2	19365.	64956.	0.	0.
	-3	10337.	43944.	39134.	1449.
	-4	1063.	8007.	6356.	4592.
	-5	0.	1160.	1328.	1647.
RG OW	SZ-1	20756.	0.	0.	0.
	-2	54158.	87902.	0.	0.
	-3	9975.	98762.	62365.	14280.
	-4	2649.	27065.	77996.	38520.
	-5	1430.	19757.	23394.	15205.
TN OW	SZ-1	980.	2440.	1014.	145.
	-2	1143.	4732.	1708.	518.
	-3	277.	2063.	1970.	392.
HT RT	SZ-1	0.	0.	0.	0.
	-2	0.	0.	0.	0.
	-3	0.	0.	0.	0.
HT OW	SZ-1	0.	0.	0.	0.
	-2	0.	0.	0.	0.
	-3	0.	0.	0.	0.
TR RT	SZ-1	1754.	0.	0.	12.
	-2	1754.	5317.	300.	0.
	-3	539.	3499.	1405.	0.
	-4	0.	1097.	1192.	573.
	-5	279.	429.	117.	241.
TR OW	SZ-1	3222.	0.	0.	0.
	-2	5618.	10583.	0.	0.
	-3	3233.	11977.	6331.	1071.
	-4	344.	7410.	8775.	2452.
	-5	196.	362.	4769.	1592.
TOTAL	-T	154092.	401462.	238154.	82689.

Expected Family-to-House Distribution Prior to 1985 ($\Omega R\Phi'$)

	(1)	(2)	(3)	(4)
RG RT SZ-1	6982.	7205.	452.	5.
-2	9002.	64580.	8445.	186.
-3	4805.	42364.	41746.	3577.
-4	494.	7326.	6867.	4831.
-5	0.	987.	1366.	1678.
RG OW SZ-1	9649.	9956.	625.	7.
-2	25176.	100801.	12271.	261.
-3	4637.	88852.	69810.	17449.
-4	1231.	24309.	75336.	41698.
-5	665.	17503.	24024.	16099.
TN OW SZ-1	234.	1306.	646.	103.
-2	272.	2347.	1120.	312.
-3	66.	969.	1065.	252.
HT RT SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
TR RT SZ-1	669.	690.	43.	10.
-2	669.	4404.	799.	25.
-3	206.	2656.	1425.	68.
-4	0.	766.	1012.	512.
-5	106.	409.	138.	199.
TR OW SZ-1	1229.	1268.	80.	1.
-2	2143.	9603.	1190.	26.
-3	1233.	9638.	6063.	1156.
-4	131.	5311.	7389.	2354.
-5	75.	330.	3652.	1478.
TOTAL -T	69674.	403578.	265564.	92287.

Expected House Vacancies at 1985: Illustration ECHSxx

RG RT SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	0.
RG OW SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	17640.
TN OW SZ-1	1452.
-2	0.
-3	69.
HT RT SZ-1	0.
-2	7859.
-3	179.
HT OW SZ-1	1184.
-2	1978.
-3	1062.
TR RT SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	587.
TR OW SZ-1	2908.
-2	2783.
-3	0.
-4	0.
-5	3107.

Expected Families to be Housed

	$\bar{f}$	f_n	h_u	Total
Size (1)	3112.	103710.	3794.	110616.
Size (2)	12008.	51161.	22721.	85889.
Size (3)	8940.	1949.	14456.	25345.
Size (4)	837.	17.	4323.	5177.

Projected for 1980 and Expected at 1985: Illustration ECHSxx

Projected Family-to-House Distribution 1980

		(1)	(2)	(3)	(4)
RG RT	SZ-1	15020.	0.	0.	0.
	-2	25893.	71043.	0.	0.
	-3	10337.	47302.	40266.	1449.
	-4	1063.	8006.	6922.	4849.
	-5	0.	1160.	1328.	1646.
RG OW	SZ-1	20756.	0.	0.	0.
	-2	19658.	87901.	0.	0.
	-3	9975.	98762.	20164.	14280.
	-4	2649.	27065.	84206.	38518.
	-5	1430.	19757.	23394.	15204.
TN OW	SZ-1	980.	2450.	1014.	145.
	-2	1143.	4732.	1708.	518.
	-3	277.	2763.	1970.	394.
HT RT	SZ-1	0.	0.	0.	0.
	-2	0.	0.	0.	0.
	-3	0.	0.	0.	0.
HT OW	SZ-1	0.	0.	0.	0.
	-2	0.	0.	0.	0.
	-3	0.	0.	0.	0.
TR RT	SZ-1	1754.	0.	0.	12.
	-2	1753.	5317.	300.	0.
	-3	538.	3499.	1405.	0.
	-4	0.	1097.	1192.	573.
	-5	279.	429.	117.	241.
TR OW	SZ-1	3222.	0.	0.	0.
	-2	5618.	10565.	0.	0.
	-3	3233.	7077.	6332.	1071.
	-4	344.	7413.	8775.	2452.
	-5	196.	362.	4769.	1592.
TOTAL	-T	126118.	406700.	203862.	82944.

Expected Family-to-House Distribution Prior to 1985 ($\Omega R \Phi'$)

	(1)	(2)	(3)	(4)
RG RT SZ-1	6982.	7205.	452.	5.
-2	12037.	72893.	9379.	205.
-3	4805.	45222.	43197.	3645.
-4	494.	7325.	7389.	5111.
-5	0.	987.	1366.	1677.
RG OW SZ-1	9649.	9956.	625.	7
-2	9138.	84252.	11231.	249.
-3	4637.	88852.	30863.	15249.
-4	1231.	24309.	81066.	42019.
-5	665.	17503.	24024.	16098.
TN OW SZ-1	234.	1311.	647.	103.
-2	272.	2347.	1120.	312.
-3	66.	1274.	1108.	254.
HT RT SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
TR RT SZ-1	669.	690.	43.	10.
-2	669.	4403.	799.	25.
-3	205.	2656.	1425.	68.
-4	0.	766.	1012.	512.
-5	106.	409.	138.	199.
TR OW SZ-1	1229.	1268.	80.	1.
-2	2143.	9590.	1188.	26.
-3	1233.	6215.	5578.	1145.
-4	131.	5313.	7389.	2354.
-5	75.	330.	3652.	1478.
TOTAL -T	56670.	395076.	233773.	90753.

Expected House Vacancies at 1985: Illustration ECHSxx

RG RT SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	0.
RG OW SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	17569.
TN OW SZ-1	1407.
-2	0.
-3	58.
HT RT SZ-1	0.
-2	7859.
-3	179.
HT OW SZ-1	1184.
-2	1229.
-3	1062.
TR RT SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	586.
TR OW SZ-1	2908.
-2	2731.
-3	0.
-4	0.
-5	3107.

Expected Families to be Housed

	$\bar{f}$	f_n	h_u	Total
Size (1)	0.	103710.	3460.	107170.
Size (2)	0.	51161.	22034.	73195.
Size (3)	0.	1949.	13575.	15523.
Size (4)	126.	17.	4283.	4426.

Projected for 1980 and Expected at 1985 Illustration ECHSxx

Projected Family-to-House Distribution 1980

	(1)	(2)	(3)	(4)
RG RT SZ-1	15020.	0.	0.	0.
-2	19365.	64956.	0.	0.
-3	10337.	43944.	39134.	1449.
-4	1063.	8007.	6356.	4592.
-5	0.	1160.	1328	1647.
RG OW SZ-1	20756.	0.	0.	0.
-2	54158.	87900.	0.	0.
-3	9975.	98762.	62365.	14281.
-4	2649.	27065.	82035.	38519.
-5	1430.	19757.	23394.	15204.
TN OW SZ-1	980.	2440.	1014.	145.
-2	1143.	4732.	1708.	518.
-3	277.	2063.	1970.	394.
HT RT SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
TR RT SZ-1	1754.	0.	0.	12.
-2	1754.	5317.	300.	0.
-3	539.	3499.	1405.	0.
-4	0.	1097.	1192.	573.
-5	279.	429.	117.	241.
TR OW SZ-1	3221.	0.	0.	0.
-2	5618.	10583.	0.	0.
-3	3233.	11977.	6331.	1071.
-4	344.	7413.	8775.	2452.
-5	196.	362.	4769.	1592.
TOTAL -T	154091.	401463.	242193.	82690.

Expected Family-to-House Distribution Prior to 1985 ($\Omega R \Phi'$)

	(1)	(2)	(3)	(4)
RG RT SZ-1	6982.	7205.	452.	5.
-2	9002.	64580.	8445.	186.
-3	4805.	42364.	41746.	3577.
-4	494.	7326.	6867.	4831.
-5	0.	987.	1366.	1678.
RG OW SZ-1	9649.	9956.	625.	7.
-2	25176.	100799.	12270.	261.
-3	4637.	88852.	69810.	17450.
-4	1231.	24309.	79064.	41907.
-5	665.	17503.	24024.	16098.
TN OW SZ-1	234.	1306.	646.	103.
-2	272.	2347.	1120.	312.
-3	66.	969.	1065.	253.
HT RT SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
TR RT SZ-1	669.	690.	43.	10.
-2	669.	4404.	799.	25.
-3	206.	2656.	1425.	68.
-4	0	766.	1012.	512.
-5	106.	409.	138.	199.
TR OW SZ-1	1229.	1268.	80.	1.
-2	2143.	9603.	1190.	26.
-3	1233.	9638.	6063.	1156.
-4	131.	5313.	7389.	2354.
-5	75.	330.	3652.	1478.
TOTAL -T	69673.	403578.	269292.	92497.

Expected House Vacancies at 1985: Illustration ECHSxx

RG RT SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	0.
RG OW SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	17629.
TN OW SZ-1	1446.
-2	0.
-3	67.
HT RT SZ-1	0.
-2	8009.
-3	179.
HT OW SZ-1	1184.
-2	1228.
-3	1062.
TR RT SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	587.
TR OW SZ-1	2908.
-2	2775.
-3	0.
-4	0.
-5	3107.

Expected Families to be Housed

	$\bar{f}$	f_n	h_u	Total
Size (1)	3112.	103710.	3793.	110616.
Size (2)	12008.	51161.	22721.	85890.
Size (3)	4832.	1949.	14552.	21332.
Size (4)	605.	17.	4330.	4951.

Projected for 1980 and Expected at 1985: Illustration ECHSxx

Projected Family-to-House Distribution 1980

	(1)	(2)	(3)	(4)
RG RT SZ-1	14039.	0.	0.	0.
-2	16211.	42554.	0.	383.
-3	5168.	21972.	19568.	725.
-4	531.	4003.	3178.	1903.
-5	0.	580.	664.	1217.
RG OW SZ-1	21737.	0.	0.	0.
-2	60840.	120379.	0.	0.
-3	15144.	120734.	70631.	12905.
-4	3188.	31068.	67097.	45044.
-5	1430.	20337.	32047.	13920.
TN OW SZ-1	980.	2440.	1014.	145.
-2	1142.	5084.	1937.	597.
-3	277.	1712.	1741.	315.
HT RT SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
TR RT SZ-1	1418.	0.	624.	5.
-2	1148.	-3163.	151.	0.
-3	269.	2001.	739.	0.
-4	0.	548.	615.	294.
-5	140.	214.	57.	124.
TR OW SZ-1	3558.	0.	0.	5.
-2	6224.	12720.	151.	0.
-3	3502.	13474.	11577.	1071.
-4	417.	7961.	7065.	3517.
-5	262.	576.	7118.	923.
TOTAL -T	157625.	411520.	225974.	83093.

Expected Family-to-House Distribution Prior to 1985 (ΩRΦ')

		(1)	(2)	(3)	(4)
RG RT SZ-	1	6526.	6734.	423.	5.
	-2	7536.	43998.	5639.	496.
	-3	2402.	21182.	20874.	1789.
	-4	247.	3662.	3433.	2032.
	-5	0.	494.	683.	1223.
RG OW SZ-	1	10105.	10426.	655.	8.
	-2	28282.	131651.	16403.	353.
	-3	7040.	110034.	80253.	16601.
	-4	1482.	27975.	65779.	47502.
	-5	665.	17997.	32080.	15299.
TN OW SZ-	1	234.	1306.	646.	103.
	-2	272.	2500.	1250.	358.
	-3	66.	815.	935.	207.
HT RT SZ-	1	0.	0.	0.	0.
	-2	0.	0.	0.	0.
	-3	0.	0.	0.	0.
HT OW SZ-	1	0.	0.	0.	0.
	-2	0.	0.	0.	0.
	-3	0.	0.	0.	0.
TR RT SZ-	1	541.	558.	508.	31.
	-2	438.	2661.	457.	14.
	-3	103.	1503.	765.	36.
	-4	0.	383.	520.	263.
	-5	53.	205.	68.	102.
TR OW SZ-	1	1357.	1400.	88.	5.
	-2	2374.	11334.	1531.	37.
	-3	1336.	10789.	10191.	1383.
	-4	159.	5724.	6151.	3134.
	-5	100.	505.	5454.	1044.
TOTAL	-T	71316.	413837.	254785.	92025.

Expected House Vacancies at 1985: Illustration ECHSxx

RG RT SZ-1	0.
-2	43067.
-3	0.
-4	0.
-5	0.
RG OW SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	2398.
TN OW SZ-1	1318.
-2	0.
-3	163.
HT RT SZ-1	0.
-2	7767.
-3	179.
HT OW SZ-1	1184.
-2	1228.
-3	1062.
TR RT SZ-1	0.
-2	2214.
-3	63.
-4	0.
-5	410.
TR OW SZ-1	2611.
-2	799.
-3	0.
-4	0.
-5	1538.

Expected Families to be Housed

	$\bar{f}$	f_n	h_u	Total
Size (1)	0.	103710.	3835.	107545.
Size (2)	0.	51161.	22981.	74142.
Size (3)	0.	1949.	15065.	17013.
Size (4)	0.	17.	4367.	4384.

Projected for 1980 and Expected at 1985: Illustration ECHSxx

Projected Family-to-House Distribution 1980

		(1)	(2)	(3)	(4)
RG RT	SZ-1	14039.	0.	213.	0
	-2	16211.	39195.	0.	0.
	-3	5168.	21972.	19569.	725.
	-4	531.	4003.	3178.	1903.
	-5	0.	580.	664.	1217.
RG OW	SZ-1	6588.	0.	0.	0.
	-2	25499.	106804.	0.	0.
	-3	15144.	92888.	67535.	12585.
	-4	3180.	31068.	75208.	43396.
	-5	1430.	24080.	33115.	13401.
TN OW	SZ-1	980.	2440.	1014.	2954.
	-2	1143.	5084.	1937.	596.
	-3	277.	1711.	1741.	316.
HT RT	SZ-1	0.	0.	0.	0.
	-2	0.	0.	0.	0.
	-3	0.	0.	0.	0.
HT OW	SZ-1	0.	0.	0.	0.
	-2	0.	0.	0.	0.
	-3	0.	0.	0.	0.
TR RT	SZ-1	1418.	0.	891.	6.
	-2	1148.	3164.	151.	0.
	-3	603.	2001.	739.	0.
	-4	0.	548.	615.	294.
	-5	140.	728.	57.	124.
TR OW	SZ-1	3558.	0.	3263.	6.
	-2	6224.	12720.	151.	0.
	-3	3502.	13474.	11577.	1071.
	-4	417.	7961.	7065.	3517.
	-5	262.	576.	7118.	923.
TOTAL	-T	107462.	370997.	235801.	83034.

Expected Family-to-House Distribution Prior to 1985 ($\Omega R \Phi'$)

	(1)	(2)	(3)	(4)
RG RT SZ-1	6526.	6734.	619.	16.
-2	7536.	41139.	5232.	114.
-3	2402.	21182.	20875.	1789.
-4	247.	3662.	3433.	2032.
-5	0.	494.	683.	1223.
RG OW SZ-1	3062.	3160.	198.	2.
-2	11853.	103144.	13695.	303.
-3	7040.	86331.	74026.	16051.
-4	1478.	27971.	73264.	46318.
-5	665.	21183.	33519.	14859.
TN OW SZ-1	234.	1306.	646.	1508.
-2	272.	2500.	1250.	357.
-3	66.	815.	934.	207.
HT RT SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
TR RT SZ-1	541.	558.	710.	43.
-2	438.	2662.	457.	14.
-3	230.	1635.	773.	36.
-4	0.	383.	520.	263.
-5	53.	564.	119.	103.
TR OW SZ-1	1357.	1400.	2559.	145.
-2	2374.	11334.	1531.	37.
-3	1336.	10789.	10191.	1383.
-4	159.	5724.	6151.	3134.
-5	100.	505.	5454.	1044.
TOTAL -T	47970.	355175.	256841.	90983.

Expected House Vacancies at 1985: Illustration ECHSxx

RG RT	SZ-1	0.
	-2	75496.
	-3	0.
	-4	0.
	-5	0.
RG OW	SZ-1	0.
	-2	0.
	-3	0.
	-4	0.
	-5	0.
TN OW	SZ-1	0.
	-2	0.
	-3	185.
HT RT	SZ-1	0.
	-2	359.
	-3	179.
HT OW	SZ-1	1184.
	-2	1228.
	-3	1062.
TR RT	SZ-1	0.
	-2	2525.
	-3	0.
	-4	0.
	-5	0.
TR OW	SZ-1	0.
	-2	897.
	-3	0.
	-4	0.
	-5	1538.

Expected Families to be Housed

	$\tilde{f}$	f_n	h_u	Total
Size (1)	25343.	103710.	3266.	132318.
Size (2)	61527.	51161.	21587.	134275.
Size (3)	16388.	1949.	15730.	34066.
Size (4)	724.	17.	5743.	6484.

Projected for 1980 and Expected at 1985 Illustration ECHSxx

Projected Family-to-House Distribution 1980

		(1)	(2)	(3)	(4)
RG RT	SZ-1	14039.	0.	0.	0.
	-2	16311.	39195.	0.	0.
	-3	5276.	21974.	15209.	725.
	-4	631.	4003.	7541.	1460.
	-5	0.	580.	664.	1660.
RG OW	SZ-1	21847.	0.	0.	0.
	-2	63041.	120379.	0.	0.
	-3	15244.	120734.	80688.	12684.
	-4	3295.	31068.	73028.	43597.
	-5	1530.	20337.	30993.	14001.
TN OW	SZ-1	1080.	2440.	1014.	145.
	-2	1143.	5084.	1937.	597.
	-3	277.	1712.	1741.	315.
HT RT	SZ-1	0.	0.	0.	0.
	-2	0.	0.	0.	0.
	-3	0.	0.	0.	0.
HT OW	SZ-1	0.	0.	0.	0.
	-2	0.	0.	0.	0.
	-3	0.	0.	0.	0.
TR RT	SZ-1	1468.	0.	0.	6.
	-2	1148.	3163.	151.	0.
	-3	369.	2001.	739.	0.
	-4	0.	548.	615.	294.
	-5	146.	214.	57.	125.
TR OW	SZ-1	3558.	0.	0.	6.
	-2	6224.	12720.	151.	0.
	-3	3502.	13474.	11577.	1071.
	-4	417.	7961.	7065.	3517.
	-5	262.	576.	7118.	923.
TOTAL	-T	160808.	408163.	240285.	81126.

Expected Family-to-House Distribution Prior to 1985 ($\Omega R\Phi'$)

	(1)	(2)	(3)	(4)
RG RT SZ-1	6526.	6734.	423.	5.
-2	7582.	41187.	5235.	114.
-3	2453.	21235.	16855.	1562.
-4	293.	3710.	7463.	1828.
-5	0.	494.	683.	1655.
RG OW SZ-1	10156.	10479.	658.	8.
-2	29305.	132707.	16469.	354.
-3	7086.	110082.	89538.	16910.
-4	1532.	28026.	71256.	46400.
-5	711.	18045.	31110.	15323.
TN OW SZ-1	257.	1331.	648.	103.
-2	272.	2500.	1250.	358.
-3	66.	815.	935.	207.
HT RT SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
HT OW SZ-1	0.	0.	0.	0.
-2	0.	0.	0.	0.
-3	0.	0.	0.	0.
TR RT SZ-1	560.	578.	36.	5.
-2	438.	2661.	457.	14.
-3	141.	1543.	767.	36.
-4	0.	383.	520.	263.
-5	56.	207.	68.	103.
TR OW SZ-1	1357.	1400.	88.	6.
-2	2374.	11334.	1531.	37.
-3	1336.	10789.	10191.	1383.
-4	159.	5724.	6151.	3134.
-5	100.	505.	5454.	1044.
TOTAL -T	72760.	412469.	267786.	90851.

Expected House Vacancies at 1985: Illustration ECHSxx

RG RT SZ-1	0.
-2	49027.
-3	0.
-4	0.
-5	0.
RG OW SZ-1	0.
-2	0.
-3	0.
-4	0.
-5	3459.
TN OW SZ-1	1325.
-2	0.
-3	165.
HT RT SZ-1	0.
-2	7767.
-3	179.
HT OW SZ-1	1184.
-2	1228.
-3	1062.
TR RT SZ-1	517.
-2	2238.
-3	79.
-4	0.
-5	410.
TR OW SZ-1	2611.
-2	806.
-3	0.
-4	0.
-5	1538.

Expected Families to be Housed

	$\bar{f}$	f_n	h_u	Total
Size (1)	0.	103710.	3909.	107619.
Size (2)	2933.	51161.	22984.	77077.
Size (3)	5885.	1949.	15294.	23128.
Size (4)	3167.	17.	4332.	7516.

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