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HEALTH FINANCE POLICY SIMULATION MODEL

Version 1.0
A User's Manual

By

LARRY FORGY
and
JAMES KNOWLES

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HEALTH FINANCING AND SUSTAINABILITY (HFS) PROJECT
ABT ASSOCIATES INC., Prime Contractor
4800 Montgomery Lane, Suite 600
Bethesda, Maryland, 20814 USA
Tel: (301) 913-0500 Fax: (301) 652-7791
Telex: 312636

Management Sciences for Health, Subcontractor
The Urban Institute, Subcontractor

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ABSTRACT

This computer program is a planning tool that provides a method for a quantitative approach to health finance policy analysis. It simulates policy interventions and predicts the effect the proposed policy change will have on different areas of the health sector. The model operates by presenting the viewer with menus providing the projections of per capita expenditure and services and the financial condition of both the public and private sector. An additional set of menus allows input of data on the current health care situation and the proposed policy changes for the health care sector. The model simultaneously considers several relationships and influences on the health sector, useful for generating informed policy dialogue.

TABLE OF CONTENTS

ABSTRACT.....i

FOREWORD.....iii

1. Introduction.....1
   1.1 Model Installation.....4
   1.2 A 10 Minute Tutorial.....6
   1.3 Background on Health Sector Modeling.....14

2. Model Operations.....19
   2.1 Basic Model Structure.....20
   2.2 The Menu Structure.....23
   2.3 Changing Parameters and Data.....33

3. Policy Simulations.....45
   3.1 Types of Policy Simulations. 45
   3.2 Methods of Policy Simulations.....45
   3.3 Specific Exercises.....45
      3.3.1 Budget Balancing.....46
      3.3.2 Cost Recovery.....46
      3.3.3 Efficiency Changes.....46
      3.3.4 Insurance Coverage.....47
      3.3.5 Investment Planning.....48
      3.3.6 Private Providers.....48
      3.3.7 Changes in Resource Costs.....49

4. Interpretation and Presentation.....50
   4.1 Interpreting Model Results.....50
   4.2 Using the Model for Presentations.....50

5. Model Setup.....51
   5.1 Types of Data Needed by the Model.....51
   5.2 Specific Data Requirements.....51
      5.2.1 Necessary Data.....51
      5.2.2. Optional Data.....51
   5.3 Likely Sources of Data.....51
   5.4 Making Changes in Model Form.....52

6. Technical Reference Section.....59
   6.1 Outline of Model Logic.....60
   6.2 Mathematical Description.....65
   6.3 Default Model Organization.....66

FOREWORD

This model for simulating policy interventions in health financing issues of developing countries is the result of interest and funding by AID's ANE Bureau. The model is an interactive computer program which simulates the volumes of financial and service flows within a developing country health sector. The conceptualization and design of the model is primarily the work of Larry Forgy at Abt Associates Inc. and Jim Knowles at the Futures Group Inc. Many others however, contributed to the development of the model. Among these are Holly Wong, John Stover, Marty Makinen, and Ricardo Bitran. Terri Lukas, Sue Gibson, and Mike Jordan at AID were instrumental in moving the project along.

The intended use of the model is to facilitate policy dialogue in developing countries on health care financing alternatives. It does so by allowing policy makers to experiment with various options, and predicts the net effects on sector solvency, service utilization, human resource requirements, access to care, and other important factors. Either one or several policy changes can be simulated simultaneously. As both expertise and information become more abundant in developing country health sectors, it is hoped that this model will provide impetus for a more critical, quantitative approach to health finance policy analysis.

The use of models such as this may be unfamiliar to health professionals or policy makers, but their use is policy analysis is quite common. Models are mathematical descriptions of reality, used to understand some particular process. They are abstractions which incorporate only the factors necessary to understand the issue at hand. Their major advantage is that consider several relationships and influences on the health system simultaneously. As all planners know, small changes in strategic places can have very big effects, both intended and unintended, when all the effects of the change ripple through the system. This model can help reduce the guesswork, and the surprises of policy change.

This manual will introduce the user to the use of this model and to policy simulation in general. The first section introduces the model with a short tutorial. The second section will provide a general reference to using the model. The third section provides an introduction to policy simulation and provides a cookbook style treatment of the more common policy alternatives. The fourth section provides guidance in understanding the results of the model. The fifth and sixth sections are intended for persons who will be implementing the model in a new country, or who wish to explore the technical details of the model. These sections will not generally able needed by most users.

It is worth mentioning here that there are a number of policies that this model will not analyze. This includes the efficacy of various treatment patterns, implementation issues, management problems, and even such issues as cost/benefit analysis. In addition, the political and managerial feasibility of proposed changes must be determined elsewhere, as it is quite possible to simulate completely irrelevant forecasts. Just as budgets are vital tools that nevertheless do not inform one how to run a Ministry, this model should be viewed as a sophisticated tool for policy planning that must be used with other tools, as well as a healthy dose of common sense.

1. Introduction

The health finance policy simulation model is a policy planning tool for developing country health planners, economists, donors, and others interested in forecasting the effects of potential finance policy changes. The computer programs containing the model are designed to be accessible to a wide range of persons working on health finance policy.

In its basic form, the model consists of a set of supply and demand curves and related equations. Its objective is simply to measure the volume of resource flows within the health sector, the cost of those flows, and to report the implications for the financial condition of health sector participants, both suppliers and consumers. Nevertheless, this simple model can have powerful uses. It can be useful for performing evaluations of a country's health sector, highlighting critical relationships with clear policy implications, pointing out important data needs for policy work, and offering a general overview of country policy options. It might point toward areas to be investigated for inefficiency or possible access problems, among other things.

In general, major uses of the model will include:

- POLICY ANALYSIS. Potential policies that affect the use of health resources are constantly being considered and adopted with little analysis. An important aspect of these policies is the financial implications. Many seemingly simple policies involve complex interactions and consequences that are not immediately apparent. Use of a model such as this can assist policy makers in a greater understanding of the intricacies and the consequences of policy change.

- POLICY DIALOGUE AND EDUCATION. Beyond the analysis of particular policies, use of simulation models can facilitate the development of a policy dialogue process. It does so by providing a format for the dialogue. Many more policy changes are available than can be implemented. To make reasoned choices among policies, there must be some common measures used for comparison. By simulating policies within a model such as this, a uniform set of criteria can be used and policy makers are able to gain a much better appreciation of the trade offs among alternatives.

- ORGANIZATIONAL TOOL. Using models always involves imposing some sort of organization on the data used. The process of building this model can point toward more efficient information systems and organizational structures. For example, instead of organizing the budget and accounting with all labor lumped together by doctors, nurses, etc., the MOH may want to think about labor used by facility and services delivered by facility.

In practice, the most important use of this model may be to sensitize users to the broad range of policy alternatives available, and to force them to deal explicitly with trade-offs of which they may not have been aware. The process of modeling will, in itself, have an effect on policy making.

The first step in using this model in any country is to divide all the health sector activity into a few classes of resource inputs and service outputs. The user in any country would be able to choose the most logical classification scheme for that country. The criterion would be the classification for which the data can most easily be gathered. In general, there is a need to independently identify the demand for health services and the supply of health sector inputs.

In general, these supply and demand relationships can be developed for the model by obtaining information from the following general categories.

- Volumes of health care services, in units such as bed days or consultations.

- Volumes of inputs into production of health care services. Typically, this will be various kinds of labor (doctors, nurses, other staff) and expendables, such as drugs.

- Prices for health care services and for the health care inputs (wages, drug costs, etc.).

- Consumer responses to the health care delivery system. In general this will include information on price elasticities, perhaps income elasticities, and any information available about how willing consumers are to substitute one type of health care for another (hospital and outpatient, public and private).

- The availability of health sector inputs, including information on training capacity, local production of expendables, and exchange rate issues.

Reliable data is a particular concern for this activity, and it is quite reasonable to expect that there are countries in which this model cannot currently be used. In other cases, the data will only be partially available. For this reason, the model is constructed in such a way that parts of the full model can be used without information for the entire model. In addition, as health financing information in general becomes more available, it is possible to begin using some reliable common values. This is probably most true for estimates of consumer responses (demand curves).

1.1. Model Installation

The diskette accompanying this manual contains the health sector financing policy simulation model developed for the ANE bureau of AID. The model may be run directly from the diskette, but the program operates much more quickly if installed on a hard disk. The following instructions explain how to install the model for use either with the floppy drive or a hard disk.

INSTALLATION ON A HARD DISK

The program is written to operate from a subdirectory labeled "HFM" and to use policy simulation data files from a subdirectory "\HFM\DATA." To create these subdirectories, issue the following commands, starting at the C:> prompt:

```
MKDIR HFM

CD HFM

MKDIR DATA
```

At this point, you can load the program and data into the subdirectories with the following commands:

```
COPY A:\HFM\*.* C:\HFM

COPY A:\HFM\DATA\*.* C:\HFM\DATA
```

If you wish to be able to invoke the model from any directory, also issue the following command:

```
COPY C:\HFM\HFM.BAT C:\HFM.BAT
```

FOR BOTH HARD DISK AND FLOPPY DISK INSTALLATION

Regardless of where you choose to install the program, you must tell the program where to find the needed files. There are two files on the diskette which give it the required information. Depending on where you choose to run the program, you must designate which file to use:

If your are using the floppy disk drive, issue the command:

COPY A:\HFM\DATADRV.A A:\HFM\DATADRV

If you are using the hard disk drive, issue the command:

COPY C:\HFM\DATADRV.C C:\HFM\DATADRV

The model is now installed and ready to be started and used. To invoke the model, issue the command:

HFM

at either the A:> or the C:> prompt, depending on where the model is intended to be operated. The tutorial in the next section is intended to give you a quick working knowledge of using the model.

1.2. A 10 Minute Tutorial

This tutorial introduces the user to the basic functions of the health finance policy simulation model. It is intended to help the user to get a feel for how policies can be simulated with the model. To do this the tutorial takes the user through the following steps:

- Setting up the model with an existing dataset.
- Examining a few displays of results.
- Changing a few variables to simulate alternative policies.
- Observing the difference in selected model results.

This exercise is not an exhaustive introduction to the model. It gives the user a simple understanding of how to use the model, rather than any real policy analysis. In fact, the results presented here are produced using an artificial dataset and are used for illustration purposes only. We will use them to introduce the menu structure, how to make changes, and the type of outputs that are available.

Assume that you are a health policy planner in a developing country. Over the next decade, you expect the country population to grow about 25%. Real per capita income is predicted to grow at about 2% per year, as well as the budget of the Ministry of Health. Because the MOH cannot keep up with demands now, this situation only promises to get worse. Therefore, you the planner want to use this model to experiment with cost recovery programs. The exercise included in this tutorial is for a policy of generating a cost recovery rate of 25% by the end of the decade. As a planner, you will want to know what this policy does to the financial solvency of the MOH and to access to health services.

SETTING UP THE MODEL

If the model has been installed according to the instructions in the previous section, it can be invoked with the following command:

HFM

After a moment, the user will be presented with a list of possible data files and asked to select one. Each file contains a set of data describing a country health sector. For this tutorial, move the cursor to the file named:

POLDEMO

and press return. The model will load the data and calculate projections. When complete, the screen will display the message **MAIN MENU**. Press enter for the model main menu, which will look like the following:

```
MAIN SECTOR MENU

Which sector do you wish to examine next:

        1 Demography

        2 Services

        3 Fees

        4 Inputs

        5 Input Prices

        6 Public Revenue & Costs

        7 Private Revenue & Costs

        8 Summary Service Measures

        9 Display more choices

                                F10  Quit
```

This menu is the primary point of access to the model results for the user. These menu items provide information on demographic characteristics, the amount of services that can be offered during the decade, the quantity of resources that will be used to provide those services, the financial condition of the MOH and other providers, and a set of summary measures of the services that are used during the decade.

An extension of this main menu provides the ability to change either the policies being simulated or the characteristics of the health sector. To move to that part of the menu, select **9 Display more choices** from the main menu either by typing 9 or by moving the cursor to the **Display more choices** line. The following menu will appear:

```
MAIN SECTOR MENU

Which sector do you wish to examine next:

    1 Change universal variables

    2 Change parameters

    3 Return to first page of menu

                                        F10  Quit
```

This menu allows changes in the structure of the health sector through the change parameters choice, and changes in policy variables through the change universal variables choice. To see how this is organized, select choice **1**, and then **9 Display more choices**. Select **1 Tax (Subsidy) on public outpatient visits**. You will then be presented with the following screen:

Tax (Subsidy) on public outpatient visits

Enter:

	1990	1991	1992	1993	1994	1995
Total - A	-18	-18	-18	-18	-18	-18
Total - B	-18	-17.5	-17	-16.5	-16	-15.5

F1Help F2Intrpl F3Copy F9Print F10Quit

The government is providing a subsidy for public outpatient visits of 18 local currency units per visit. Under scenario B, the government is slowly reducing its commitment by 25% by the year 2000, which can be seen by moving the cursor to the right. To look at private outpatient visits, press F10, then 9, and then select choice **2 Tax (Subsidy) on private outpatient visits**. This screen shows a charge of two local currency units per private outpatient service. This can be interpreted either as a direct tax or the cost of regulations on the private sector, or both.

EXAMINING A FEW RESULTS

We will actually change some of these variables later, but for the moment, we want to examine the results of the current simulations. You can move back to the main menu by successively pressing **F10** until the main menu appears on the screen. To see what will happen to services under current conditions, choose option **2 services**, either by typing **2** or by moving the cursor to the **services** alternative. After a moment of calculations, the services menu will appear:

```
MAIN SECTOR MENU
SERVICE QUANTITIES DISPLAY MENU

Which display do you wish to examine next:

 1 Bed Days in Public Hospitals

 2 Bed Days in Private Hospitals

 3 Visits to Public Outpatient Facilities

 4 Visits to Private Outpatient Facilities

 5 Preventive Care Visits

 6 Return to the MAIN SECTOR MENU

                                        F10  Quit
```

To examine one type of service, choose the alternative: **3 Visits to Public Outpatient Facilities**. You will be given a choice of four types of display. Choose **1 Line Graph**. The resulting graph shows that the quantity of MOH outpatient services will remain roughly constant over the decade. Now to observe what happens when cost recovery begins, press **B** for scenario B. We see that public outpatient visits fall over the decade from 81 million per year to 68 million per year.

Now examine what happens to private outpatient visits by pressing **F10** and **4 Visits to Private Outpatient Facilities**. Choose display **1 Line Graph**. Again we see that private services are roughly constant under current policies. Press **B** for the second scenario. Here we see that cost recovery in the MOH has increased the demand for private services, so that demand rises over the decade from 18 million visits to 28 million visits.

As a planner, you probably are interested in how these changes will affect the quantity of services delivered and access to those

services. Go back to the main menu and select **8 Summary Service Measures**. Here we want to examine both visits and expenditures per capita. First choose **4 Outpatient Visits per capita**. What we see is that visits per capita is falling over the decade from an average of 0.9 per year to 0.7 per year. Looking at scenario B reveals a slightly exaggerated trend. In scenario B, the increase in private visits was less than the decrease in public visits.

Now look at **2 Household Expenditures per capita** by pressing **F10** and choice **2**. Under current conditions, household expenditures are falling over the decade, but under scenario B, expenditures are shown to be rising.

CHANGING VARIABLES FOR ALTERNATIVE POLICIES

If you were to take a quick glance at the **Public Revenue and Costs** menu, you would see that the MOH has no choice but to initiate cost recovery. However, you are worried about the forecast of decreasing use of outpatient services. Therefore, you want to try additional policies to counteract this effect of cost recovery. One possible alternative is to try to boost the role of the private sector. You decide to do this by lowering the cost of producing private outpatient services. To simulate this policy, we go back to the portion of the main menu where policies can be changed.

Return to the **main menu** screen and then shift to the **Tax (Subsidy) on private outpatient visits** data entry screen seen earlier. To do this, make the following choices: **9, 1, 9, 2,**

These choices will give you the data entry screen you saw earlier. Data entry on this screen is similar to data entry in Lotus 123 and other spreadsheets. You decide in scenario B to remove the tax cost to private outpatient providers by the end of the decade. Move the shaded data entry block to row B and right until reaching the column for the year 2000. Type **0**. Then to interpolate between 1990 and the year 2000, press **F2 Interp**. The screen will appear as

below. You want to interpolate between columns, C, and for a single row, S. Move to the 1990 entry in row B and press enter. Then move to the year 2000 entry and press enter.

Tax (Subsidy) on private outpatient visits

Do you want to interpolate between columns (c) or rows (r) ?

	1990	1991	1992	1993	1994	1995
Total - A	2.0	2.0	2.0	2.0	2.0	2.0
Total - B	2.0	2.0	2.0	2.0	2.0	2.0

F1Help F2Intrpl F3Copy F9Print F10Quit

You should now see a steady decrease in the tax on private outpatient services in scenario B. Now press **F10** until back to the main menu.

OBSERVING NEW RESULTS

By now you are an old hand at using the model. Go back to the **2 Services** menu to examine what your new policy means for service utilization. When you attempt to go to the Services menu, the program recognizes that some variables have been changed and takes a moment to recalculate new projections. The message **Redoing Projections** appears on the screen while the calculations are being done. Then the program presents the services menu.

Examine **3 Visits to Public Outpatient Facilities** to see that the new policy affects public utilization very little. Instead of falling to 68 million visits, utilization falls to 67.8 million by the year 2000.

Next, examine **4 Visits to Private Outpatient Facilities**. Here, there is a dramatic increase of visits from 13 million to 78 million.

To see what this new policy means for utilization and access, go back to the main menu and select **8 Summary Service Measures**. Under the choice of **4 Outpatient Visits per Capita**, we see that the combination of cost recovery and lowering cost for the private sector has allowed utilization to reverse its decline. Instead of falling to 0.7 annual visits under current policies, average annual visits climbs to 1.0 visits under the new policies.

Of course, increases in utilization must also be paid for. An examination of **2 Household Expenditures per capita** also shows a rise in scenario B. Expenditures fell under the current policies from 15.6 to 13.4 local currency units. Under the combination of the two policies considered here, expenditures rise to 19.6 units. Under cost recovery alone, these expenditures rose to 18.1 units. Thus, it appears that the decrease in private costs has resulted in greater access and utilization of services.

AFTER THE TUTORIAL

This is the end of the formal tutorial on the model. You should feel comfortable enough now to browse through the various menus of results and to try other experiments at policy changes. There are several areas in the model that you may wish to examine, including capital investment, insurance coverage, and others. Probably the best way to learn how to use the model is to use it. Section 2 will provide you with a general reference to using the model, and Section 3 will detail methods to simulate some of the more common policy alternatives.

1.3. Background on Health Sector Modeling

Why the need for a model approach to health sector.

This is a highly focused modeling effort, constructed for the specific purpose of forecasting financial solvency and services delivered in the health sector. Nevertheless, it is constructed to be a powerful tool for addressing a range of policy and planning questions for health sector interventions.

It can address such ambitious goals by providing a comprehensive framework of resource allocation activities and financial flows. Within this framework, the user has great flexibility in ways to simulate proposed changes. Possible exercises that can be modeled fall into several categories.

- Resource allocation within the Health Sector. Efficiency is a major objective in the health sector of many developing countries. Health resources are so severely strained that it is important to allocate them in the most efficient manner possible. This model can help by illustrating the relative costs of alternative resource allocations within the Ministry, including resources to hospitals versus primary care activities, and questions of the level of staffing. The model can also point to long term investment consequences of decisions about operating costs.

- New sources of revenue through cost recovery and other means. In addition to efficiency, many health sectors are in need of new sources of revenue. The model can assist in understanding the tradeoffs implied by a range of possible new sources, including users fees or other forms of cost recovery.

- Investigate role of the private sector. Many planners suggest that the public sector concentrate of certain types of health care, such as preventive, EPI, MCH, etc. and promote the

private sector as a source of curative care. This would allow Ministry of Health resources to accomplish more in the selected areas. This model can show the financial benefits and consequences for utilization of proposed policies that place greater reliance on the private sector.

o Improved access, including insurance mechanisms. Access to health care, particularly as cost recovery becomes more effective, is a major concern. This model can point to possible access problems and help to determine ways to avoid them. Insurance systems and other methods of stimulating demand for care can be modeled here.

Using this model to develop a systematic approach to these policy issues will have numerous applications. Occasions when this model will be useful include:

- Facilitate understanding of health care financing process.
- Provide basis for policy dialogue in host country.
- Identify projects and policies with greatest potential impact.
- Provide information on the long term sustainabilty of health sector activities.

DESCRIPTION OF THE MODEL.

This model simulates as closely as possible the health sector activities of a developing country. Reliable data is often difficult to obtain, and institutional details vary widely across countries. As a result, this model concentrates on the basic features of a health sector: resources flow to suppliers of care and they, in turn, provide health services. To facilitate this modeling effort, there are a few important concepts around which this simulation is constructed:

Market Organization. This model is organized around the concept of a market for health services. Thus, it keeps track of

both the flow of services to users and the flow of payments to suppliers. To be realistic, it requires that adequate information be collected about both suppliers and users of services.

Basic Units. There are a number of basic units of health service defined within the model. These include hospital bed days, consultations, and preventive care. This is an important concept for a number of reasons. By measuring the myriad types of care in standard units, we can keep the number of markets simulated to a manageable few. In addition to making the model easier to calculate, it makes comparisons between primary and secondary care, or between public and private care, easier. Aggregations of these basic units serve as the building blocks of projections. Measures of cost, revenue and quantity of these blocks flow through the model.

Policy Objectives. The goal of this model is to simulate the effects of individual health policy interventions, as well as combinations of policies. As a result, the model is structured so that there are several ways to simulate multiple policy changes and predict the resulting outcomes. Chapter 2 discusses how this can be done.

There have been a number of earlier modeling efforts in LDC health sectors, including several simulation models. The majority of these simulations have involved sets of accounting relationships describing the cost of delivering services. Perhaps the most relevant of these models is work by Howard Barnum et al. (Health Finance Planning Model, World Bank, 1986) and a model by Marty Makinen, et al. for AID (Health Sector Financing Model for Microcomputers, REACH Project, Oct. 1988). A recent model by Manuel Zymelman of the World Bank (The Health Finance Simulation Model, World Bank, 1989) uses a similar approach.

In general, these models simulate the supply of public health care services. This is done through a set of equations that describe the costs of providing public health services. These services may be consultations and hospital episodes, or they may be hospital beds and clinics. They allow the user to exogenously set the expected amount of services to be provided and then predict the cost. If they also allow the user to exogenously set the Ministry budget, they can predict the size of any surplus or deficit. More elaborate models can allow changes in cost recovery and other policies in their predictions, but with no feedback on quantity or quality of services being provided.

Some recent work has taken health simulation modeling a step further by explicitly incorporating the demand for health services. Ongoing work by Ricardo Bitran on modeling health zones in Zaire uses a Lotus spreadsheet to analyze set consumer responses to prices, waiting time and distance away from the health center. A model by Chernichovsky, et al (A Simulation Model to Support the Planning and Budgeting of Health Services, World Bank, April, 1987) also attempts to account for demand changes. Documentation shows that the demand response, while not fully developed in the model, is based on demand elasticities.

The current model builds upon this earlier work. Much of the methodology for determining the cost of supplying public services is based on these models. Bitran's work has provided valuable guidance on important demand issues. However, this model provides a number of extensions over the current models.

- Simultaneity. Early models used a set of equations in which all the coefficients were fixed at the beginning of the exercise. It was then simply a matter of plugging in the planned outcome and the model would add up the costs. In reality, however, each change affects other factors, so that everything changes at once. In this model the equation coefficients are not fixed, but change with the policy exercise.

- Demand Side. This model allows for inclusion of a larger variety of demand side information. This allows, for example, a sensitivity analysis of the possibility that the population can substitute one form of care for another if prices are changed.

- Private Sector. A great deal of LDC health care takes place in the private sector. Private sector responses to changes in the public sector policy can have important changes on level of public demand, number of indigent patients, and other effects. Further, without some consideration of the private sector, it is impossible to know the real volume of care delivered, or its distribution among the population.

2. Model Operations

This section provides a general reference work for using the features of the model. This includes using the menus, changing data, and manipulating the model. After a quick overview of the model structure, the section is divided into to part. The first explains the menu structure of the model, and the second explains how to change data and conduct simulations. This information will be used in Section 3 to discuss specific policy simulations.

2.1. Basic Model Structure

The Health Finance Policy Simulation Model divides the health sector into a set of services and a set of resources needed to produce those services. It does so by defining a demand and supply curve for each service or resource. These two curves define a market for any given service or resource. Given information about the population, government budgets, and the organization of the health sector, the quantity of services expected to be produced, and the prices necessary to cover costs are calculated. Based on expected demographic and socio-economic changes, health care expenditures and utilization are projected over time.

Both the public and the private markets for health care are considered. The model simulates the conditions under which services will be produced and consumed, and predicts the behavior of both consumers and suppliers of the goods. That health care provision is analyzed in the context of market activities is an important aspect of the model. While many of the activities of Ministries of health may not appear to be market oriented, the use of markets for this analysis is more than merely a metaphor. There is a virtually inexhaustible demand for health services, but very limited, and sometimes declining, resources available. In such an atmosphere, users and suppliers of health services attempt to maximize the benefits they receive on any type of exchange. That is the essence of a market mechanism for the allocation of resources.

Like all market based models, this model uses supply and demand functions as the basic building blocks. Each individual market consists of a supply and demand curve. In general, the model considers four classes of relationships:

1. Demand for services, driven by economic conditions, health, etc.

2. Supply of services, driven by the cost of inputs and production technology.

3. Demand for inputs for production of services, which is derived from inputs needed to sustain the appropriate level of output.

4. Supply of inputs, determined elsewhere in the economy.

The model is driven by the exogenous factors affecting demand and supply, and by the underlying production functions for health services. Exogenous factor are assumed to affect demand and supply in an additive, or linear fashion, as are demand responses to prices.

Although the basic relationships are not complicated, in practice the model incorporates a number of feedbacks to assure realistic answers to policy questions. Cost, in both the public and private sectors, is a function of volume of services and competition for inputs. Demand is a function of income and the quality and price for services.

Moreover, many of these relationships can be modified by the user. For example, the amount of services in the public sector can be specified, so that the Ministry may run a deficit. Moreover, the user may specify that the size of the private health sector is fixed, or that it can grow over time.

POINTS FOR POLICY INSERTION

Policy exercises can be inserted in a number of places in the model. Generally, the user will be attempting one or two general goals: determine how much revenue can be generated for the system, or the quantity and mix of services can be supplied for a given amount of revenue. In general these exercises will include:

a. Revenues expected from user charges and effects on utilization.

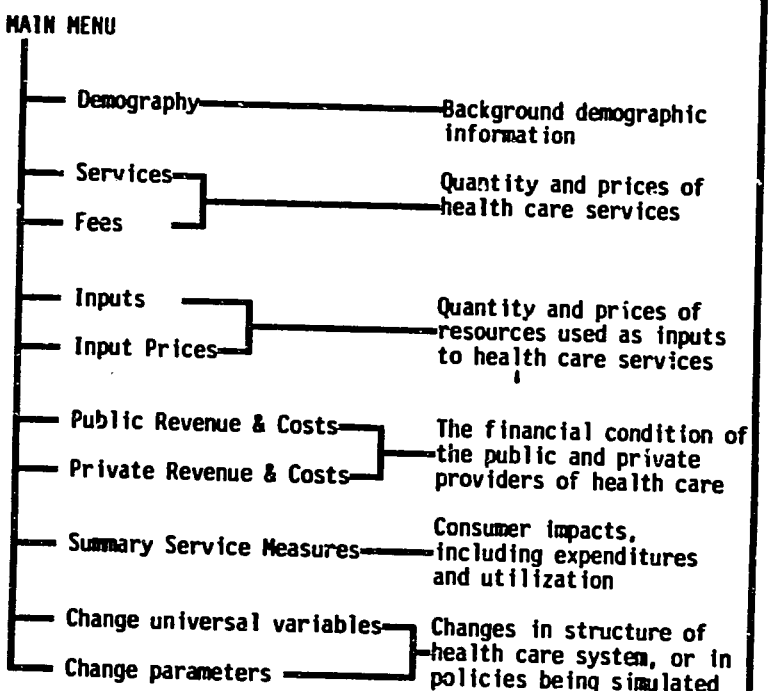
b. Effects of reallocation of resources on the mix of services delivered.
c. Effects of changes in private sector role on service use and financial condition of public health sector.
d. Evaluation of investment plan effects on recurrent budgets and services provided.

2.2. The Menu Structure

Access to this model is through a structure of menus that allow the user to display results and to change the data. Figure 2-1 provides a general guide to the alternatives shown in the main menu.

Figure 2-1

Guide to Main Menu Selections



As can be seen in Figure 2-1, main menu choices can be grouped into six types of displays. Demographic information is presented as a submenu. The next four types of displays include

projection results. These are organized into the base projections of quantity and prices for services and resources, and derived displays that illustrate the financial condition of the health sector and the utilization of services. Finally, the last type of display introduces the user to menus for changing data.

Section 2.2 will discuss the first five types of display. Section 2.3 will cover the menus for changing data.

DEMOGRAPHIC DISPLAY

Demographic information for this model is generated elsewhere using the Demproj program. Most users will not be involved in demographic projections, but may find it useful to see these results displayed. This submenu provides the demographic choices shown in Figure 2.1.

```
MAIN SECTOR MENU
DEMOGRAPHIC DISPLAY MENU

Which display do you wish to examine next:

 1 Total fertility rate assumptions

 2 Total population

 3 Age distribution of the population

 4 Total births

 5 Women of reproductive age

 6 Crude birth rate

 7 Crude death rate

 8 Natural growth rate

 9 Display more choices

F1Help F2Make a new demographic projection                F10Quit
```

```
MAIN SECTOR MENU
DEMOGRAPHIC DISPLAY MENU

Which display do you wish to examine next:

 1 Population growth rate

 2 Dependency ratio

 3 Child dependency ratio

 4 Life expectancy assumptions

 5 International migration assumption

 6 Return to the MAIN SECTOR MENU

 7 Return to first page of menu

F1Help F2Make a new demographic projection                    F10Quit
```

SERVICES AND INPUTS

The exact composition of these submenus will depend on the set of services and inputs into which the sector is divided. The illustrations show how these submenus will appear if the sector is divided into five services and four inputs. These displays reveal the projections of the endogenous variables in their raw form.

figure 2.2

```
MAIN SECTOR MENU
SERVICE QUANTITIES DISPLAY MENU

Which display do you wish to examine next:

 1 Bed Days in Public Hospitals

 2 Bed Days in Private Hospitals

 3 Visits to Public Outpatient Facilities

 4 Visits to Private Outpatient Facilities

 5 Preventive Care Visits

 6 Return to the MAIN SECTOR MENU

                                  F10  Quit
```

figure 2.3

```
MAIN SECTOR MENU
SERVICE PRICES DISPLAY MENU

Which display do you wish to examine next:

 1 Fee per Public Hospital Bed Day

 2 Fee per Private Hospital Bed Day

 3 Fee per Public Outpatient Visit

 4 Fee per Private Outpatient Visit

 5 Fee per Preventive Care Visit

 6 Return to the MAIN SECTOR MENU

                                        F10  Quit
```

REVENUES AND COSTS

These displays take the raw output and develop measure of the financial condition of the health sector. The submenus are illustrated in Figures 2.4 and 2.5.

figure 2.4

```
MAIN SECTOR MENU
PUBLIC REVENUE AND COST DISPLAY MENU

Which display do you wish to examine next:

 1 Public Revenue

 2 Public Tax Receipts (Subsidies)

 3 Public Recurrent Costs

 4 Public Recurrent Budget

 5 Public Recurrent Deficit

 6 Public Capital Costs

 7 Public Investment

 8 Public Capital Budget

 9 Display more choices

                                F10  Quit
```

```
MAIN SECTOR MENU
PUBLIC REVENUE AND COST DISPLAY MENU

Which display do you wish to examine next:

 1 Public Capital Deficit

 2 Return to the MAIN SECTOR MENU

 3 Return to first page of menu
```

F10 Quit

figure 2.5

```
MAIN SECTOR MENU
PRIVATE REVENUE & COST DISPLAY MENU

Which display do you wish to examine next:

 1 Private Revenue

 2 Net Govt. Taxes (Subsidies)

 3 Private Recurrent Costs

 4 Private Capital Costs

 5 Private Profit

 6 Private Investment

 7 Return to the MAIN SECTOR MENU

F10 Quit
```

these are derived in the following manner.

SUMMARY SERVICES MEASURES

There are a number of aspects of the consumers of health care that the planner will want to know. The choices in this submenu will provide many of these measures. This submenu is illustrated in Figure 2.6.

Figure 2.6

```
MAIN SECTOR MENU
SUMMARY SERVICE MEASURES DISPLAY MENU

Which display do you wish to examine next:

 1 Total Household Expenditures

 2 Household Expenditures per capita

 3 Hospital Days per capita

 4 Outpatient Visits per capita

 5 Preventive Services per capita

 6 Ratio of Public to Private Hospital Services

 7 Ratio of Public to Private Outpatient Services

 8 Ratio of Outpatient to Hospital Services

 9 Display more choices

                                        F10  Quit
```

```
MAIN SECTOR MENU
SUMMARY SERVICE MEASURES DISPLAY MENU

Which display do you wish to examine next:

 1 Ratio of Preventive to Curative Services

 2 Private Insurance Premiums

 3 Return to the MAIN SECTOR MENU

 4 Return to the first page of menu

                                          F10  Quit
```

these results are produced in the following manner.

2.3. Changing Parameters And Data

The two menus disucssed in this section allow the user to make changes in the simulations.

The first menu, which is labled as the Universal Variables Menu, contains information about the policy envirnoment. Through it, the user can structure the existing policy decisions, and implement prospective future policies. This turns out to be a long list of options, including government budget policy, tax policy, insurance structure, and other issues. This menu is shown in Figure 2.7.

Figure 2.7

```
MAIN SECTOR MENU
SECTOR VARIABLE EDITOR MENU

Enter the variable to be edited:

1 Proportion of income spent on public hospital services
2 Proportion of income spent on private hospital services
3 Proportion of income spent on public outpatient services
4 Proportion of income spent on private outpatient services
5 Proportion of income spent on preventive services
6 Changes in aggregate income
7 Tax (Subsidy) on public hospital bed days
8 Tax (Subsidy) on private hospital bed days
9 Display more choices

F1 Help                                   F10 Quit
```

```
MAIN SECTOR MENU
SECTOR VARIABLE EDITOR MENU

Which display do you wish to examine next:

 1 Tax (Subsidy) on public outpatient visits
 2 Tax (Subsidy) on private outpatient visits
 3 Tax (Subsidy) on preventive services
 4 Growth rate of recurrent budget
 5 Growth rate of capital budget
 6 Proportion of population insured
 7 Coinsurance rate-public hospital services
 8 Coinsurance rate-private hospital services
 9 Display more choices

F1 Help                                        F10 Quit
```

```
MAIN SECTOR MENU
SECTOR VARIABLE EDITOR MENU

Which display do you wish to examine next:

 1 Coinsurance rate-public outpatient visits
 2 Coinsurance rate-private outpatient visits
 3 Coinsurance rate-preventive services
 4 Managed Care-public hospital services
 5 Managed Care-private hospital services
 6 Managed Care-public outpatient services
 7 Managed Care-private outpatient services
 8 Managed Care-preventive services
 9 Display more choices

F1 Help                                        F10 Quit
```

```
MAIN SECTOR MENU
SECTOR VARIABLE EDITOR MENU

Which display do you wish to examine next:

 1 Private insurance administrative markup

 2 Public hospital efficiency

 3 Private hospital efficiency

 4 Public outpatient efficiency

 5 Private outpatient efficiency

 6 Preventive service efficiency

 7 Physician supply

 8 Nurse supply

 9 Display more choices

F1 Help                                   F10  Quit
```

```
MAIN SECTOR MENU
SECTOR VARIABLE EDITOR MENU

Which display do you wish to examine next:

 1 Other staff supply

 2 Expendables supply

 3 Return to previous menu

 4 Return to first page of menu

F1 Help                                   F10  Quit
```

Menu items are discussed below.

Income Spent

For each of the categories shown, set the proportion of income spent in each year as a decimal amount (i.e. 2% would be 0.02).

Changes in Aggregate Income

Set annual changes in income for each year. Because this model uses real, rather than nominal, prices, set this equal to real growth rates. These are likely to be in the range of -0.02 to 0.02.

Taxes and Subsidies

Taxes are recorded as positive amounts and subsidies as negative amounts. Thus, if the government is covering a cost of 50 local currency units for a hospital bed day, this would be recorded as -50. If there is a tax on private hospital bed days of 3.5, this would be recorded as 3.5.

Budget Growth Rates

Record here your expectations about the growth of the public health budgets for recurrent and capital expenditures. Remember that this is in real terms. If the budgets merely keep up with inflation, then the real growth rate is 0.0.

Population Insured

Insured populations face different prices for health care than do uninsured populations. Record here the proportion of the population expected to be covered by health insurance.

Coinsurance Rates

These rates will determine the difference between the prices

that insured and uninsured consumers face. Sometimes called co-pay, record here the rate that insured consumers pay. If they pay 20%, for example, then record 0.20.

Managed Care

Under managed care types of insurance systems, there is usually some type of mechanism for restricting access to services. Record a number here between 0 and 1 that represents the effectiveness of this restriction. For example, if they reduce utilization by 50%, record 0.50.

Insurance Markup

Private insurance must include a markup to remain in business. This is the proportion that premiums represent over the amount paid for services. Typically, the markup will vary between 0.10 and 0.25.

Efficiency

These parameters indicate a change in the efficiency of production. They affect the service supply functions and the input demand functions.

Supply

These variables represent exogenous shifts in factor supplies that may occur in the future. For example, if a new nursing school begins providing nurses or new drug production begins.

THE CHANGE PARAMETERS MENU

The second menu contains the parameters of the health sector. This set of data defines the environment or context within which the health sector policies operate. As such, it is the main entry for the detailed data needed to run this model. Most of the research involved in setting up this model will go toward filling out this list of parameters. This menu is illustrated in Figure 2.8.

Figure 2.8

```
MAIN SECTOR MENU
PARAMETER EDITOR MENU

Enter the variable to be edited:

 1 Price elasticities

 2 Scale coefficients

 3 Services supply coefficients

 4 Input demand coefficients

 5 Input Supply elasticities

 6 Initial solution vector (X)

 7 Equation Intercepts

 8 Age-sex public hospital multipliers

 9 Display more choices

F1 Help                                  F10 Quit
```

```
MAIN SECTOR MENU
PARAMETER EDITOR MENU

Enter the variable to be edited:

 1 Age-sex private hospital multipliers
 2 Age-sex public outpatient multipliers
 3 Age-sex private outpatient multipliers
 4 Age-sex preventive multipliers
 5 Initial capital stock
 6 Capital-output ratios
 7 Initial capital costs
 8 Maintenance cost rates
 9 Display more choices

F1 Help                                  F10 Quit
```

```
MAIN SECTOR MENU
PARAMETER EDITOR MENU

Enter the variable to be edited:

 1 Depreciation rates
 2 Initial government budgets
 3 Return to the previous menu
 4 Return to first page of menu

F1 Help                                  F10 Quit
```

A fuller discussion of the items required for this menu can be found in the section on setting up the model. The discussion here is only for the purposes of altering existing simulations. The simulations contain a host of variables, which are discussed below.

Price Elasticities

This set of entries includes the price elasticities for each service and the cross price elasticities for other services. In particular, there is likely to be a substantial cross price elasticity for the same service provided in both public and private settings.

Scale Coefficients

These entries allow for possible economies of scale in the production of services. They can be 0 or a positive or negative amount.

Supply Coefficients

This matrix of numbers defines the relationship between the output of services and the amount of inputs used. This information defines the cost of supplying the service, and thus the supply curve.

Input Demands

This is the same information included in the supply coefficients matrix reorganized in a form useful for determining the amount of inputs needed for any given level of services provided.

Input Supplies

This set of entries defines the slope of the supply curves for

Initial Solution Vector

This list of numbers are the initial quantities and prices for all

the services and inputs used in the health sector. It is not likely that the user will want to change these.

Intercepts

This is a list of the equation intercepts used for the supply and demand curves in the model. It is not likely that the user will want to change these.

Age and Sex Multipliers

These columns of numbers allow the user to adjust the total demand by the age and sex of the population. The higher the number entered, the greater the weight on that portion of the population. The model automatically scales the total set of weights to sum to one.

Capital Stock

The total capital stock in the system can be defined by this matrix. Several types of capital stock are listed, and the user is asked to allocate the existing stock to the types of services provided.

Capital Output Ratios

This set of numbers indicate the amount of capital required to produce each type of service. These, in turn, are used to predict the amount of capital needed in the future when the amount of services provided has changed.

Initial Capital Costs

These numbers show the cost of each type of capital, and are used to predict investment costs in the future.

Maintenance Costs

These quantities are used to calculate the cost of maintaining the capital stock.

Depreciation Rates

These rates are used to determine the rate at which investment should be increased to maintain the capital stock.

Government Budgets

This sets the amount that the government is planning to use for health services. This quantity has no effect on the supply or demand curves, but is used to determine whether the government is running a deficit or a surplus in the health sector.

HOW TO CHANGE SIMULATION DATA

Changing data in these menus is a simple process. Basically, you can select any data item from the menus, and an editing screen will appear. Changes can be made throughout the screens, and the results will automatically be saved when you exit the editing screens via the F10 function key.

Most of the editing screen will appear in the form illustrated in Figure 2.9.

Figure 2.9

Tax (Subsidy) on private outpatient visits

Enter :

	1990	1991	1992	1993	1994	1995
Total - A	2.0	2.0	2.0	2.0	2.0	2.0
Total - B	2.0	2.0	2.0	2.0	2.0	2.0

F1Help F2Intrpl F3Copy F9Print F10Quit

Notice that the screen contains data on both scenarios. A and B. Changes can be made in either scenario, or in both. The simplest method is to move the blinking entry cell with the cursor movement keys to the entry you wish to change. Then merely type the desired change and press enter.

For entering trends in the data, it is possible to use an interpolation method available with the F2 function key. First move the cursor to the beginning and end of the series you wish to change

and enter the desired beginning and ending quantities. Next, press the F2 key. If you wish to interpolate a row, type interpolate between columns (C). To interpolate a column, type interpolate between rows (R). You can interpolate multiple rows or columns if desired. The program will then prompt you to identify the beginning and end points for interpolation, by pressing enter at the beginning and end.

Other variables do not have trends over time. Their editing screens will merely identify the type of variable and the current quantity, as illustrated in Figure 2.10. For these variables, simply move the blinking cell to the proper variable and type in the new quantity.

Figure 2.10

Services supply coefficients

Entry :

	Doctors	Nurses	Other	Expendable
Pub. Hospi	0.2500	0.60[illegible]	0.1000	4.0000
Pri. Hospi	0.2500	0.60[illegible]	0.1000	6.0000
Pub. Outpa	0.0300	0.0500	0.0160	0.2000
Pri. Outpa	0.0150	0.0400	0.0100	0.2000
Preventive	0.0133	0.0667	0.0067	0.1333

F1Help F2Intrpl F3Copy F9Print F10Quit

3. Policy Simulations

This section provides general guidance on how to implement some of the more common policy alternatives being discussed in Ministries of Health throughout the developing world. The first two sections discuss the type of simulations that can be done with this model and the general approach to doing so. This discussion is followed by a cookbook style commentary on specific policies. These are meant as both a guide for these exercises and as examples of policy simulation.

3.1. Types of Policy Simulations

This model is for financing and resource allocation issues. It can deal only generally with management problems.

3.2. Methods of Policy Simulation

Discussion of points where policy variables may be changed. The significance of each policy variable.

3.3. Specific Exercises

This section discusses particular exercises as examples. Each exercise follows the same pattern.

An issue is discussed in a hypothetical country.
A possible policy option is discussed.
How to alter the model to simulate this option is explained.

3.3.1. Budget Balancing

ISSUE:

POLICY OPTIONS:

SIMULATION METHODS: Both the recurrent and the investment government health budget can be set in the menu options. In addition to the current levels of these budgets, the annual growth rates of these budgets can be set annually.

3.3.2. Cost Recovery

ISSUE: Inadequate resource generation, overutilization of services.

POLICY OPTIONS: Setting fees for services, either uniformly or by different types of service.

SIMULATION METHODS: Changes in the prices of services can be adjusted by using the **Tax (Subsidy)** on services menu options. These options allow annual adjustments to the prices of services.

3.3.3. Efficiency Changes

ISSUE:

POLICY OPTIONS:

SIMULATION METHODS: Efficiency changes can be represented in several places in the model. In most cases, the change represents greater productivity of inputs. Other efficiency changes may take place if there is a more optimal combination of inputs.

To increase the productivity of inputs, the two main changes would be to provide for economies of scale in the **Scale Coefficients** options. These would allow higher rates of production to be done at

a lower unit cost. A higher unit cost could be specified if it is believed that there are diseconomies of scale operating. Secondly, the modeler can change the **Capital-Output Ratios** if it is believed that the amount of capital per service is changing.

If it is believed that the current mix of inputs is not optimal, then these could be altered by changing the **Input Demand Coefficients** to reflect a different mix of inputs. Note that to change these assumes a change in the underlying production function relationships upon which this model is based. See Section 6 for a discussion of the model production functions.

3.3.4. Insurance Coverage

ISSUE:

POLICY OPTIONS:

SIMULATION METHODS: This model has several opportunities for simulating the effects of insurance. One of the most important aspects is the **Proportion of Population Insured**. This can be adjusted on an annual basis.

The model allows for two types of insurance coverage: standard indemnity coverage where the patient chooses the services wanted and pays a co-insurance rate, and a managed care option where services are free but access is controlled.

Under the standard service option, the model allows for the selection of a different co-insurance rate for each type of service for for each year. Note that if desired, this allows the user to model a national insurance plan that covers only public services. One would merely set the coinsurance rate for private services at 100%.

If the user wishes to simulate the effect of a managed care plan as well, the **Managed Care** options are available. These options

allow the user to shift the demand curve for any particular service downward by some percentage to account for the rationing effect of managed care. For example, to shift the demand curve down by 10%, enter a -.10

3.3.5. Investment Planning

ISSUE:

POLICY OPTIONS:

SIMULATION METHODS: Investment planning can be examined by using several variables in the model. These include the size of the capital stock, capital output ratios, and the maintenance and depreciation costs assumed in the model.

3.3.6. Private Providers

ISSUE:

POLICY OPTIONS:

SIMULATION METHODS: Policies affecting the private sector can be simulated in a number of ways. These include the size of the sector and the cost of operations.

The cost of providing public services can be affected by the levels of taxes or subsidies that providers face, and these can be simulated in this model through the **Tax (Subsidy)** menu choices for private services. A tax is represented as a positive number and a subsidy as a negative number.

The size of the private sector can be adjusted by changes in the capital stock.

In addition, although not strictly a private sector option, the costs to the private sector can be changed by adjusting the input supply curves.

3.3.7. Changes in Resource Costs

ISSUE:

POLICY OPTIONS:

SIMULATION METHODS: Changes in resource costs can come from a number of sources. In this model, it is possible to set the initial amount of resources available by adjusting the **Initial Solution Vector** and to change future resource availability by adjusting the **Input Supply Elasticities.**

4. Interpretation and Presentation

4.1. Interpreting Model Results

This section is a guide for how to understand the results of a policy simulation. It suggests the most appropriate menu displays and how to understand changes in some key variables. It will also suggest how to use some less used outputs to help understand changes caused by the policies.

4.2. Using the Model for Presentations

This section suggests effective ways to present the results of policy simulations to individuals and groups. This includes how to put together a sequence of displays from the model.

5. Model Setup

This section is not intended for the general user, but for persons who will be setting up the model for a particular country. It discusses the data that will be needed and where they are likely to find it. It also discusses how to alter the model to conform to the basic structure of the health sector in that country.

5.1. Types of Data Needed by the Model

This is a general discussion of the supply and demand organization of the model, and how that determines the general types of data needed to operate this model.

5.2. Specific Data Requirements

This section provides specific lists of the types of data that are needed by the model. In addition, it also discusses types of data transformations that will probably be needed to make available data usable by the model.

5.2.1. Necessary Data: The core set of variables that are necessary for the model to run. Includes quantities and costs for the major components of the model, information about the MOH budget.

5.2.2. Optional Data: Other data that would improve the performance of the model. This includes information on demand elasticities, supply elasticities, additional demographic and economic data.

5.3. Likely Sources of Data

Suggests likely data sources, and the type of data that each

would have. Possible alternative data sources are suggested. For some key variables, several quantities known from other countries are discussed and suggested as guides.

5.4. Making Changes in Model Form

This section discusses how to determine what form of the model (the number of supply and demand curves) is most compatible with the form of the health sector in the country. Provides details on how to configure the model to this form.

DEVELOPMENT OF MODEL INPUTS

This section provides a summary of the information necessary to operation of the model, and explains how some variables are defined to allow for reasonable aggregation of data.

LIST OF INPUT VARIABLES USED BY MODEL.

Public health Care System

- Revenues
  - Central government
  - Regional and local governments
  - Social Security
  - Civil Service
  - Donors
  - User fees
  - Insurance collections
  - Dedicated or local taxes
- Costs
  - Drugs

Salaries
- Doctors
- Nurses
- Other

equipment and supplies
- Vehicles

maintenance
Capital expenditures, or costs
Any costs reported by program

Physical Plant
- # and type of facilities
  - Hospitals, beds
  - Clinics
  - Dispensaries
  - Pharmacies
  - Mobile Units
  - Administrative offices
  - Special programs (leprosaria, etc.)
- # of vehicles

Volume of services
- bed days per year
- consultations per year
- prescriptions filled
- Other

Use of resources
- # of Doctor days
- # of Nurse days
- # of other staff days

<u>Population/Household</u>

Size
Growth rate.
Income
Income distribution

Price elasticity of demand
Income elasticity of demand
% income spent on health care,
Geographic distribution of population
% of population within 5k of a clinic
% of population within 5k of a hospital

Macroeconomic Variables

GNP
GNP growth rate
Inflation rate
Unemployment
Exchange rates, free market and fixed

Private Health Care

# of doctors and average salary
# of nurses and average salary
dollar volume of drug spending
annual number of private consultations
# of hospital beds and/or patient days

Average price of a consultation
Average price of a hospital bed day

Training Facilities

Medical schools annual graduates
Nursing schools annual graduates
Paramedical training annual graduates

BASIC RELATIONSHIPS

Much of the information put into this model is aggregated into

units that are more usable. It is expected that the model is flexible enough to allow easy definition of health sector outputs. However, the vast array of inputs into the health sector must be placed into a reasonable number of categories. The following section provides guidance on how to form the basic units that are the building blocks of this model.

UNITS (DAYS) OF LABOR:

To determine the amount and price of labor inputs, first define a reasonable number of labor types. Then determine the following information. Find days of labor in:

	Doctors	Nurse I	Nurse II	Admin	Other
Hospitals	L11	L12	L13	L14	L15
Outpatient and clinics	L21	L22	L23	L24	L25
Other services	L31	L32	L33	L34	L35

Find total labor cost for the same categories:

	Doctors	Nurse I	Nurse II	Admin	Other
Hospitals	LC11	LC12	LC13	LC14	LC15
Outpatient and clinics	LC21	LC22	LC23	LC24	LC25
Other services	LC31	LC32	LC33	LC34	LC35

The quantity of labor used is shown in the first table. For the price of labor, define the daily wage in each category as:

$$Wij = LCij/Lij$$

A composite wage for hospitals, outpatient and clinics, and other services can be found by taking the average of wages weighted by the

number of days in each rc

UNITS OF EXPENDABLES:

Aggregating the non-labor inputs into the health sector into a single or a few categories is an extremely difficult task. The approach taken here is to define a standard unit of supplies, using a method suggested by work of Ricardo Bitran. Both the price and the number of standard units used are found using a weighted average of the amount of supplies used about 20 categories. The following table provides a suggested method of measuring the standard unit. Actual drugs and supplies used should be chosen at the time data is being collected.

Medications	size	cost	Amount used in: Hospitals	Clinics	Other
Chloroquine	1000 tab				
Aspirin	5000 tab				
Anti-allergics	1000 tab				
Penicillin	1M units				
Tetracycline	1000 tab				
Chloramphenicol	1000 tab				
Iron	5000 tab				
Metronidazole	1000 tab				
Antiacid	5000 tab				
OR Salts	125 sac.				
Vitamin B6	100 amp.				
Methergin	100 amp.				
Anti-paracitals	1000 tab				
Other products					
Bandages	100 band				
Cotton	100 unit				
Alcohol	1 liters				
TOTAL UNITS USED					

The following procedure is used for defining the standard unit of expendables:

- Define representative list of expendables.
- Find the price per unit of measure of each expendable: (UP).
- Find the sum of the prices of all units of measure: (TP).
- Determine number of units of each used in hospital and outpatient care.
- Define total number of units used as:

$$E = \text{Sum over all units of } (UP/TP) * \text{number of units used.}$$

- Define P_E as:

$$P_E = (\text{total expenditure on expendables})/E$$

NON-RECURRENT COSTS

For costs other than [illegible] and supplies, find the following information:

	Hospital Beds	Outpatient Departments	Clinics	Other
Number				
Costs				
Buildings				
Construction				
Maintenance				
Equipment				
Purchase				
Maintenance				
Vehicles				
Purchase				
Maintenance				
Usable life				
Buildings				
Equipment				

Vehicles				

From Ministry of Health records, determine the percentage of hospital, clinic or other activity that is curative and the percentage that is preventive, and allocate capital costs accordingly.

6. Technical Reference Section

This model is organized around a set of markets, or the exchange of a set of goods and services. The model simulates the conditions under which these exchanges take place, and predicts the behavior of both consumers and suppliers of the goods. That health care provision is analyzed in the context of market activities is a conscious decision. While many of the activities of Ministries of health may not appear to be market oriented, the use of markets for this analysis is more than merely a metaphor. There is a virtually inexhaustible demand for health services, but very limited, and sometimes declining, resources available. In such an atmosphere, users and suppliers of health services attempt to maximize the benefits they receive on any type of exchange. That is the essence of a market mechanism for the allocation of resources.

GENERAL APPROACH

Several types of exchanges are taking place at once in separate, but related markets. As such, we model a general equilibrium in which product and input markets are operating with some degree of substitutability and mobility. Supply and demand functions, as well as relationships among markets, are assumed rather than estimated as they would be in a computable general equilibrium model, because the data is not sufficient to allow the estimation of relationships.

The general form of this model is to assume some very simple linear demand and production relationships in the health sector, and to build a simultaneous equation system for finding future values. The logic of the model is to model several markets for both the health services being produced and the inputs going into that production. The next section provides a brief description of the underlying theoretical model of the health sector. A following

section provides an illustrative example of how a health sector can be modeled.

6.1. Outline of Model Logic

This is a description of the methodology of the model. Discusses the structure and matrix calculations. Provides a flow chart of the model.

A HEALTH SECTOR MARKET MODEL. Like all market models, this model uses supply and demand functions as the basic building blocks. Each individual market consists of a supply and demand curve. In large models of entire economies, every agent in the model is both a suppler in one or more markets and a demander in other markets, and the sets of exchanges are such that all flows of cash and goods are accounted for. In modeling only the health sector, we are not subject to these adding up constraints. Instead, we can assume that consumers receive income from elsewhere to purchase health services, and that they may not be the suppliers of health sector inputs. The markets that we do model are illustrated in Figure 1. In general, we model four classes of relationships:

1. Demand for services, driven by economic conditions, health, etc.
2. Supply of services, driven by the cost of inputs and production technology.
3. Demand for inputs for production of services, which is derived from inputs needed to sustain the appropriate level of output.
4. Supply of inputs, determined elsewhere in the economy.

The model is driven by the exogenous factors affecting demand and supply, and by the underlying production functions for health services. Exogenous factor are assumed to affect demand and supply

in an additive, or linear fashion, as are demand responses to prices. The production functions for health services are assumed to be of the fixed coefficient variety. Such production functions will yield health service cost functions which are additive in the inputs.

The model is constructed in the following manner. For a given set of health services and health sector inputs, the cost of supplying the service is derived from the production functions and the cost of inputs. The demand for services is estimated from elsewhere and added to the model. Demand for inputs is calculated on the basis of the amounts needed to produce the called for quantity of services, and the supply of inputs is obtained from outside the model.

This system of linear supply and demand functions can then be written as:

$$A\,x = d$$

and the solution can be found as:

$$x = A^{-1}\,d$$

This system of equations can provide quick solutions to the equilibrium values in each of these markets, as long as the changes in parameters used in forecasting do not exceed reasonable values. Data requirements for this model include the relationships among the endogenous variables, in the A matrix, and the effects of the exogenous variables, in the d vector.

AN EXAMPLE OF HEALTH SECTOR MODELING. The following example will explain how the model is put together. It is extremely simple, but will serve to illustrate all of the major details of the model. For purposes of illustration, suppose that we are simulating a health sector with two outputs: Hospital days (H), and consultations (C); and that these are produced with two inputs, Labor (L), and Expendables (E). We have information about the demand for outputs, the amount of inputs used in both, and the cost

of the inputs:

Demand for H: $H = 2{,}000 - .3\ P_H + .2\ Y$
Demand for C: $C = 8{,}000 - .1\ P_C + .3\ Y + .2\ P_H$
Price of H: $2
Price of C: free
Sector operations: 1,000 H produced using 200 L and 300 E
10,000 C produced using 500 L and 1,000 E
Price of L: $20
Price of E: $10
Total Ministry budget: $27,000; $25,000 from central government, $ 2,000 from fees

Thus, in this example, we have some information about demand for services, and about the operations of the Ministry. The demand information could have come from demand studies, the production and cost of inputs information from Ministry budgets and records and other sources. Note that in this example, a rise in the price of hospital days will increase the use of consultations.

We use the information about Ministry operations to infer production relationships. This is done by assuming simple fixed coefficient production functions for the two outputs, and using the observed production relationships to determine the coefficients. The production functions underlying the Ministry activities can be written as:

$$H = \text{Minimum of } [200/1000\ L,\ 300/1000\ E] = \text{Min } [.2\ L,\ .3\ E]$$
$$C = \text{Minimum of } [500/10000\ L,\ 1000/10000\ E] = \text{Min } [.05\ L,\ .1\ E]$$

From these, the following cost functions can be derived by multiplying the amount of inputs used by their cost:

$$\text{Cost (H)} = 200/1000\ W + 300/1000\ P_E = .2\ W + .3\ P_E$$
$$\text{Cost (C)} = 500/10000\ W + 1000/10000\ P_E = .05\ W + .1\ P_E$$

It should be noted that these are actually expenditure functions rather than cost functions. We do not know true unit costs or real

production relationships. However, what we are interested in here is the ability to forecast expenditures and service volumes rather than to identify any inefficiencies in the system. If independent information on possible Ministry improvements is known, that could be used to modify the assumed production relationships.

This production and cost information can be combined with the Ministry budget to derive the Ministry supply curves for H and C. A quick calculation shows that the MOH is spending:

$7,000 for H, including $5 from budget and $2 fee per H
$20,000 for C, including $2 from budget per C

Using the amount of inputs, cost of inputs and the amount from the budget for each output, we can write price functions of:

$$P_H = .2\,W + .3\,P_E - \$5$$
$$P_C = .05\,W + .1\,P_E - \$2$$

The demand for labor and expendables is the amount it takes the MOH to produce the desired quantity of H and C:

$$L = .2\,H + .05\,C$$
$$E = .3\,H + .1\,C$$

One final bit of information necessary is the supply curve for inputs. In cases where the supply of labor and transportation for expendables is abundant, these may be as simple as:

$$W = \$\,20$$
$$P_E = \$\,10$$

In this case, assume that there is some rising cost to using more labor or expendables:

Cost of labor: $W = 15 + .01\,L$
Cost of expendables: $P_E = 8 + .001\,E$

Greater use of labor or expendables will drive the price up,

causing rises in the cost of Ministry outputs.

The information developed above can be used to write down a set of demand and supply curves for H, C, L, and E. This produces a set of 8 equations in 8 unknowns: the two outputs, two inputs, and their prices. These equations can then be solved as a set of simultaneous equations:

$$
\begin{aligned}
H + .3\,P_H \qquad\qquad\qquad\qquad\qquad\qquad &= 2000 + .2\,Y \\
P_H \qquad\qquad -.2\,W \qquad\qquad -.3\,P_E &= -5 \\
-.2P_H + C + .1P_C \qquad\qquad\qquad\qquad &= 8000 + .3\,Y \\
+P_C \qquad -.05W \qquad\qquad -.1\,P_E &= -2 \\
-.2\,H \quad -.05\,C \qquad + L \qquad\qquad\qquad &= 0 \\
-.01\,L + W \qquad\qquad\qquad\qquad &= 15 \\
-.3\,H \quad -.1\,C \qquad\qquad\qquad + E \qquad\qquad &= 0 \\
-.001\,E \quad + P_E &= 8
\end{aligned}
$$

This system can be solved using linear algebra to solve for the eight unknowns. By changing various parameters in the system, alternative policies or assumptions can be tested. For example, changes in the MOH budget allocation could be simulated by changing the -5 or the -2 which the government contributes toward hospital care or consultation respectively. This would raise the price of the services, which would reduce the demand. If the MOH chose to respond to budget reductions be reducing quality or becoming more efficient, rather than raising prices, then the coefficients on the cost functions and input demand functions could be modified.

Using the derived values, results on government cost, service usage, prices, and access can be calculated and displayed. Iterations can include single policy changes or several changes occurring at the same time.

6.2. Mathematical Description

The health sector can be divided into a set of outputs, inputs and capital:

	Quantities	Prices
Outputs:	Q_i	P_i
Inputs:	X_j	W_j
Capital:	K_k	C_k

In this model, we will consider the recurrent and capital cost and expenditures separately. Recurrent expenditures are calculated first, and the necessary capital stock and expense is derived from the resulting quantity of services provided.

A fixed factor production function specifies the relationship between outputs and inputs:

$$Q_i = \underset{j=1}{\overset{J}{MIN}}(\alpha_{i,j} X_{i,j})$$

The demand for outputs is a function of the prices of all outputs and exogenous factors, d_i, with include income, health status and other variables:

*b10W

$$D_i(P_i, d_{i,1}) = \sum_i \eta_{i,i} \; P_i - d_{i,1}$$

Where P is the vector of prices P_i, and η is a matrix of coefficients derived from the own price and cross price elasticities of the vector of outputs.

The supply of outputs is based on breakeven pricing (here marginal

and average costs are the same). Thus, it is based on the cost of inputs and on any possible economies of scale, β :

$$S_i = S_i(Q_i, W_j, d_1) = \beta Q_i + \sum_j \frac{1}{\alpha_{ij}} W_j - d_{i1}$$

The demand for inputs is the standard derived demand based on the quantity of output desired and the production function:

$$D_j = D_j(Q_i, d_1) = \sum_i \frac{1}{\alpha_{ij}} Q_i + d_{j1}$$

Given this set of equations, we can specify the model in matrix notation by defining the following matricies:

A: an i+j by i+j matrix of terms with endogenous variables

X: an i+j by 1 vector of endogenous variables

d: an i+j by 1 vector of exogenous variables

6.3. Default Model Organization

CONSTRUCTION OF THE BASIC MODEL

In its simplest form this model consists of public and private sector health care providers, consumers of health services, and the

goods and labor used to create health services. These providers purchase inputs from the pool of health human resources, the government, and elsewhere, and in turn sell services to households. Households buy from both providers, and labor and expendables are sold to both providers. With this commonality in both inputs and outputs, the relationship of the two provi[illegible]s is complex. They sell related, but not identical, goods, allowing some substitution of services. Further, their products are a blend of heterogenous goods, consisting of hospital services, consultancies, drugs, preventive care and other types of specialized care. The labor market also deals in heterogenous goods. This includes doctors, nurses of various classes, paramedics and other staff.

To make any model tractable, it will be necessary to abstract out the salient characteristics of this complex interrelationship to produce a working model with sufficiently simple data demands. This model is based on a set of linear equations for each input and output. These equations represent demand and supply relationships and production functions. Because they are all linear, the entire system can be solved simultaneously using matrix algebra. To keep the information needs as simple as possible, health services are lumped into five categories:

- -Hospital days
  - -Public
  - -Private
- -Outpatient curative
  - -Public
  - -Private
- -Preventive and Promotive

Inputs into this system are grouped into four categories:

- -Doctors
- -Nurses
- -Other Staff
- -Expendables

These groups are quite crude, but represent the major types of health care delivered. A method of grouping data into these categories is described in a later section.

Both the demand and the production of all types of health care is affected by what occurs elsewhere in the sector, and as a result, we form an algorithm that solves for all these quantities simultaneously. We do this by specifying a demand function and supply function for each good, and for each input (factor of production) In addition we specify the relationships between inputs and outputs (production functions).

The principal equations for this model are the demand and supply functions for the five outputs and the 4 inputs. Thus, we solve for a set of 18 equations in 18 unknowns:

Hospital care:

H_1: Hospital days in the public sector.
P_{H1}: Price of public hospital days.
H_2: Hospital days in the private sector.
P_{H2}: Price of private hospital days.

Outpatient care:

O_1: Outpatient treatment, public sector.
P_{O1}: Price of outpatient treatment, public sector.
O_2: Outpatient treatment, private sector.
P_{O2}: Price of outpatient treatment, private sector.

Preventive and promotive care:

C: Preventive and promotive services.
P_C: Price of preventive and promotive services.

Health Sector inputs:

L_D: Doctor labor available for health services.
W_D: Doctor wages for health services labor
L_N: Nurse labor available for health services.
W_N: Nurse wages for health services labor
L_S: Other Staff labor available for health services.
W_S: Other Staff wages for health services labor.
E: Expendables used in health services.

P_e: Price of expendables

This should be regarded as the minimum disaggregation of the services and inputs into the health sector. In cases where information allows a more complex disaggregation, or in countries where idiosyncracies in the system call for a different structure, the model can be expanded or modified. Procedures for doing so are discussed below.

These sets of variables deal only with the operating costs of the sector. We use a separate set of equations relating the necessary capital investment to the level of services offered. In most cases, we use the ratio of physical plant to services provided to indicate the level of investment necessary for any new mix of services. Independent estimates of physical plant cost, maintenance and depreciation are then used to determine annual costs. Total financial liability includes an estimate of the annual amount of capital investment needed to sustain the target level of services.

The 18 equations listed above are used to form the vectors and matrices of the model. Filling in the entries of these matrices is relatively straightforward. The x vector is simply a list of the endogenous variables, the A matrix contains all the coefficients on any of the endogenous variables, and the d vector contains a column of numbers that represent the sum of all the exogenous influences on the model. That is:

x = a 18x1 vector of unknown, endogenous variables
A = an 18x18 matrix of coefficients on the x variables
d = a 18x1 vector of the sums of independent (known) variables.

THE x VECTOR

The order in which the equations of the model are placed has no effect on the calculation of results, but for purposes of simplified exposition, equations are arranged by: output demands, output supplies, input demands, and input supplies. Thus, x vector is:

H_1
H_2
O_1
O_2
C
P_{H1}
P_{H2}
P_{O1}
P_{O2}
P_C
L_D
L_N
L_S
E
W_D
W_N
W_S
P_E

THE A MATRIX

The A matrix is not as imposing as its size would indicate. As can be seen below, a large portion of the matrix is filled with 0s. Each of the four types of equations use only a small portion of the matrix entries in any row. The demand functions depict the demand for each good using price and cross price elasticities of demand. The supply curves in this model essentially are expenditure functions: the amount of input into each commodity is determined, and that amount is multiplied by the price of the input. The demand for inputs comes from multiplying the quantity of outputs by the amount of input needed per unit of output. These derived demands are paired with supply curves to develop the price of inputs.

The specific entries in the A Matrix are shown below:

MATRIX A

	H_1	H_2	O_1	O_2	C	P_{H1}	P_{H2}	P_{O1}	P_{O2}	P_C	L_D	L_N	L_S	E	W_D	W_N	W_S	P_E
H_1	1	0	0	0	0	$A_{1,6}$	$A_{1,7}$	$A_{1,8}$	$A_{1,9}$	$A_{1,10}$	0	0	0	0	0	0	0	0
H_2	0	1	0	0	0	$A_{2,6}$	$A_{2,7}$	$A_{2,8}$	$A_{2,9}$	$A_{2,10}$	0	0	0	0	0	0	0	0
O_1	0	0	1	0	0	$A_{3,6}$	$A_{3,7}$	$A_{3,8}$	$A_{3,9}$	$A_{3,10}$	0	0	0	0	0	0	0	0
O_2	0	0	0	1	0	$A_{4,6}$	$A_{4,7}$	$A_{4,8}$	$A_{4,9}$	$A_{4,10}$	0	0	0	0	0	0	0	0
C	0	0	0	0	1	$A_{5,6}$	$A_{5,7}$	$A_{5,8}$	$A_{5,9}$	$A_{5,10}$	0	0	0	0	0	0	0	0
P_{H1}	$A_{6,1}$	0	0	0	0	1	0	0	0	0	0	0	0	0	$A_{6,15}$	$A_{6,16}$	$A_{6,17}$	$A_{6,18}$
P_{H2}	0	$A_{7,2}$	0	0	0	0	1	0	0	0	0	0	0	0	$A_{7,15}$	$A_{7,16}$	$A_{7,17}$	$A_{7,18}$
P_{O1}	0	0	$A_{8,3}$	0	0	0	0	1	0	0	0	0	0	0	$A_{8,15}$	$A_{8,16}$	$A_{8,17}$	$A_{8,18}$
P_{O2}	0	0	0	$A_{9,4}$	0	0	0	0	1	0	0	0	0	0	$A_{9,15}$	$A_{9,16}$	$A_{9,17}$	$A_{9,18}$
P_C	0	0	0	0	$A_{10,5}$	0	0	0	0	1	0	0	0	0	$A_{10,15}$	$A_{10,16}$	$A_{10,17}$	$A_{10,18}$
L_D	$A_{11,1}$	$A_{11,2}$	$A_{11,3}$	$A_{11,4}$	$A_{11,5}$	0	0	0	0	0	1	0	0	0	0	0	0	0
L_N	$A_{12,1}$	$A_{12,2}$	$A_{12,3}$	$A_{12,4}$	$A_{12,5}$	0	0	0	0	0	0	1	0	0	0	0	0	0
L_S	$A_{13,1}$	$A_{13,2}$	$A_{13,3}$	$A_{13,4}$	$A_{13,5}$	0	0	0	0	0	0	0	1	0	0	0	0	0
E	$A_{14,1}$	$A_{14,2}$	$A_{14,3}$	$A_{14,4}$	$A_{14,5}$	0	0	0	0	0	0	0	0	1	0	0	0	0
W_D	0	0	0	0	0	0	0	0	0	0	$A_{15,11}$	0	0	0	1	0	0	0
W_N	0	0	0	0	0	0	0	0	0	0	0	$A_{16,12}$	0	0	0	1	0	0
W_S	0	0	0	0	0	0	0	0	0	0	0	0	$A_{17,13}$	0	0	0	1	0
P_E	0	0	0	0	0	0	0	0	0	0	0	0	0	$A_{18,14}$	0	0	0	1

Each endogenous variable in the matrix is represented by an entry of one along the principal diagonal. The remainder of non-zero entries in the matrix fall into a pattern representing the four type of equations. Entries for each class of equations are discussed separately below.

Services Demand Functions. These functions are the first five rows of the matrix. Demand for health services is affected by the price of those services and the prices of any substitutes and complements. Entries $A_{1,8}$ to $A_{5,10}$ are based on the price and cross price elasticities for services. For the services listed in these rows, let:

Entries $A_{1,8}$, $A_{2,7}$, $A_{3,8}$, $A_{4,9}$, and $A_{5,10}$ = (PE)(Q/P)

where:

PE = Own price elasticity
Q = The original quantity of the service in row
P = The original price of the service in row

All other entries in this block are: (CE)(Q/PO)

where:

CE = Cross price elasticity of service in row with price in column
PO = Original price in column

Note that these entries use elasticities in the general usage, with the sign changed. That is, the expressions using own price elasticity will be positive, as will entries for complementary goods. Substitutes will have negative signs. See the earlier example for an illustration of this. The use of elasticities here is a departure from assumptions of linearity. We have used elasticities to develop linear approximations of local portions of demand curves because elasticities are the type of demand information most likely to be available. As the model iterates over time periods, constant updating

to the more recent values of price and quantity will produce a better fit to demand than a linear function would allow.

Service Supply Functions. Rows 6 through 10 are the supply functions for health care services. Entries in these rows are of two types. Entries $A_{6,1}$, $A_{7,2}$, $A_{8,3}$, $A_{9,4}$, and $A_{10,5}$ serve the purpose of allowing for changes in economies of scale (0 if no economies, > 0 if economies of scale exist.

The block of entries from $A_{6,15}$ to $A_{10,18}$ relate the quantity and cost of inputs to the cost of outputs. The general form for these entries is:

$$-\frac{\text{Total amount of Y used in production of Z}}{\text{Total amount of Z produced}}$$

where: Y = input for which price is in the column.
Z = output for which price is in row.

Note that this is always a negative number.

Input Demand Functions. Rows 11 through 14 are the input demand functions. The input demands are simply the sum of all the inputs needed to produce the services demanded, at the current rate of production. Entries $A_{11,1}$ to $A_{14,5}$ contain this information. The general form for these entries is:

$$-\frac{\text{Total amount of input in row used in output in column}}{\text{Total production of output in column}}$$

This will always be a negative number.

Input Supply Functions. The final four rows represent the supply functions for the inputs. The entries $A_{15,11}$, $A_{16,12}$, $A_{17,3}$, and

$A_{18,14}$ are derived from any independent estimates of the slope of the supply curve for that factor of production. If the supply of the input is perfectly elastic, these entries will be 0. If the supply curve is considered to be upward sloping, then these entries will by the negative of that slope.

THE d MATRIX: EXOGENOUS VARIABLES

The effects of the independent variables in this system are found in the d vector of the equation. A great amount of data is used to calculate these quantities, and they are very important to the proper calculations of results. Each entry in the d vector is a single number, representing all the various influences of exogenous factors. The calculation for each vector entry need not be linear, but may take any form desired. The elements of the d vector, d_1 to d_{18}, can be quite complex, and their composition is discussed below. The elements are:

Vector element	Exogenous factors affecting:
d_1	demand for public hospital days
d_2	demand for private hospital days
d_3	demand for public outpatient care
d_4	demand for private outpatient care
d_5	demand for preventive and promotive care
d_6	supply of public hospital days

d_7	supply of private hospital days
d_8	supply of public outpatient care
d_9	supply of private outpatient care
d_{10}	supply of preventive and promotive care
d_{11}	demand for days of doctor labor
d_{12}	demand for days of nurse labor
d_{13}	demand for days of other staff labor
d_{14}	demand for units of expendables
d_{15}	supply of days of doctor labor
d_{16}	supply of days of nurse labor
d_{17}	supply of days of other staff labor
d_{18}	supply of units of expendables

OUTPUT DEMAND FACTORS

The demand functions will have several exogenous factors which affect all five, but four factors stand out. (1.) Income is a strong determinant of demand for all types of health services, and if income elasticities are known, this will help to sharpen model predictions. (2.) Distance and waiting time to health services has been shown to have a significant effect also. Demand studies often estimate the elasticity of demand with respect to waiting time. (3.) The perceived level of quality of services has a very large effect on demand for the service. In the absence of other information, we allow for a subjective evaluation of the change in quality, and assume that the change in demand will be proportional. (4.) Finally, in the absence of any other changes, demand should grow at the rate of population growth. Entries d_1 to d_5 contain the following:

d_1 = constant derived from demand function
+ % of income spent on good i * predicted changes in income
+ quantity of good i in previous period * waiting time elasticity of demand * % change in waiting time
+ quantity of good i in previous period * % change in quality of services

+ quantity of good i in previous period * population growth rate.

OUTPUT SUPPLY FACTORS

In general, factors other than inputs that affect the supply curves of outputs are things which affect the overall funding of the supply. In the case of public sector services, this will include budget allocations from the central government. For private sector services, this includes any subsidies or taxes on the supply.

For d_6, d_8, and d_{10}:

d_i = (total government budget for service i)/quantity of service i in previous period

For d_7 and d_9:

d_i = any government price controls, subsidies, or taxes per unit of service.

INPUT DEMAND FACTORS

Input demands in this model are determined by the production functions assumed earlier, with very few exogenous influences. Nevertheless, we can allow for some fixed level of input use, independent of the variable rate of input use with the production of services.

For d_{11} to d_{14}:

d_i = # of units of input that are fixed overhead, rather than variable with production.

INPUT SUPPLY FACTORS

The supply of inputs can be affected by a large number of factors. In countries where there is not an excess supply of labor, the capacity of training can have an important effect. Where there are fixed exchange rates or exchange restrictions, this can have important effect on supply of expendables.

For d_{15}, d_{16}, and d_{17}:

d_i = constant determined from the supply function
+ any predicted macroeconomic wage changes
- any expected wage changes in this category due to increased supply of labor from training

d_{18} = unit price developed from formula (discussed below)
+ unit price * (change in ratio of fixed exchange rate to free market exchange rate)

THE INVESTMENT SIDE OF THE HEALTH SECTOR

The preceding model deals only with the operating cost portion of the health sector. The sector, however, also needs to construct and maintain a physical plant. To simulate that portion of the health sector, this model follows several steps.

- Allocate current physical plant among the sector outputs.
- Determine the plant costs for each output.
- Determine the annual maintenance and depreciation associated with each output.
- Use this information to determine capital cost per unit of output.
- After new levels of output are determined, calculate capital cost based on unit capital cost.

The user should be allowed to adjust the unit capital costs, based on the existence of excess capacity or efficiency changes. In

addition, users should be able to declare future investment plans and the model then calculate:

- Cost implications for the Ministry.
- Probable over or under utilization, based on predicted levels of services delivered.