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POLICY MODELING IN THE SMALL ISLAND ECONOMIES OF THE SOUTH PACIFIC: THE CASE OF VANUATU

by

Mark Sturton
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by
Mark Sturton

1989

Pacific Islands Development Program
East-West Center
1777 East-West Road
Honolulu, Hawaii 96848
MARK STURTON, PIDP research associate, has extensive experience with macroeconomic policy in the Pacific islands region. He has worked in Fiji’s Central Planning Office and the Reserve Bank of Fiji where he was research director. As a consultant to the United Nations, he has served as economic policy adviser in the Cook Islands, Papua New Guinea, and Vanuatu. Sturton has a special interest in policy modeling—analytical tools for designing economic policy appropriate to the small island economies of the region. He has a Ph.D. from Sussex University and is currently in charge of the financial intermediation and macroeconomic components of PIDP’s Private Sector Project.

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This paper is the first of several studies to develop an economic database and policy framework for an island economy. Although this particular study is based on one country of the Pacific islands region, the methodology can be applied to any small economy.

The specific purpose of this paper is to determine the feasibility of the policy modeling approach and methodology for Vanuatu. The next study in the modeling series will develop a financial policy framework for the Fiji economy; similar studies are planned for Western Samoa, Solomon Islands, and Papua New Guinea.

Based on this research, a set of economic policy tools can facilitate analysis in PIDP's major research projects on the role of the private sector, tourism, and gold.

Charles W. Lepani
Director
Pacific Islands Development Program
The research work on a macroeconomic policy modeling framework for Vanuatu began in 1986 under the auspices of the United Nations. During 1986 the Vanuatu Social Accounting Matrix was compiled, and a simple Semi-Input-Output model was constructed. In 1987 the model was further refined under the sponsorship of the Australian Development Assistance Bureau. Later the same year the work became the focus of a study at the Institute of Development Studies (IDS) at Sussex University for the development of suitable and user-friendly software to generate models based on the Social Accounting Matrix.

The availability of data and a basic operational modeling framework made the Vanuatu system the logical start of the PIDP studies on policy modeling. The model subsequently has been considerably refined and extended into the Computable General Equilibrium variant.

The author wishes to acknowledge and thank the many people and institutions involved in this study. Special thanks are extended to Augustine Garae, director of National Planning and Statistics Office, Prime Ministers Office, Vanuatu Government, who initiated the development of a macroeconomic planning framework. Recognition must also be given to David Woodward, U.N. adviser to the Vanuatu Government in 1985, who conceived a suitable set of policy tools to examine development issues for the Vanuatu economy. Similarly, the efforts of Henry Lucas, IDS fellow, made possible the development of the software program ASAP upon which the solution of the models is based. The availability of an easy-to-use program facilitated the development of the Vanuatu model in a short period of time. The cooperation of the Australian National University for seconding Lucas to the modeling project during 1986 is greatly appreciated. Acknowledgment is also given to David Evans, also an IDS fellow, for his many comments on earlier drafts of the work.

At PIDP thanks are extended to the many people who have worked on this monograph. Special thanks go to Barbara Yount who spent many long hours of hard work on editing the work and designing its layout for the laser printer. Thanks are also extended to Avis Berger for secretarial assistance, to Mary Yamashiro for proof reading, and to Chris Klutz-Simanu for his help in preparing this work.
Executive Summary

The purpose of this paper is to examine the feasibility, relevance, and practicability of policy modeling in the small economies of the South Pacific. Critics of policy modeling have argued that these nations are too small and their economic conditions too unstable to be conducive to economic analysis. The occurrence of natural disasters or volatile changes in commodity prices of certain key exports, which often represent the majority of these nations' production, makes economic planning precarious. In addition, these critics argue that the job of the economic planner is more effectively guided by experience and good judgment rather than through any modeling framework.

Granted, macroeconomic models used to make economic projections are often inaccurate and misleading. However, suitably constructed economic policy frameworks can reveal the underlying forces operating in these economies. The models, as detailed in this paper, can be used to examine the economic consequences of alternative economic policies. The models can provide useful information on the efficiency of fiscal policy, devaluation, wage and tariff policy, etc. Regardless of the uncertainty and variability of external conditions, these models can inform the policymaker about the likely impact of alterations in key macroeconomic policy tools.

Using a conventional approach, this paper adopts the Social Accounting Matrix (SAM) as the basic database. Two policy models are developed from the SAM, the Semi-Input-Output (SIO) model and the Computable General Equilibrium (CGE) model. The SIO model is less demanding on statistical resources and provides a suitable approach for analyzing many problems faced by small economies. However, the model is short term in nature and does not allow the economy to respond to many situations likely to occur. The CGE model does incorporate these features, but it is much more demanding of the parameters to drive it. This paper describes simultaneously and in detail the impact of various policy "experiments" on these two models.

Data from Vanuatu are used as the basis for analysis. Due to data limitations, the models are prototypes and could equally well represent any other island in the Pacific. The careful specification of the models, and the sensitivity test conducted on certain key parameters, details a list of statistical requirements. The paper also sets an agenda for statistical endeavors.
Chapter 1
Introduction

This paper has two main purposes; the first is methodological and the second prescriptive. The first purpose relates to the feasibility, relevance, and practicability of policy modeling in the island nations of the South Pacific. Based on this perspective, an approach will be outlined that has general applicability. The second purpose regards the framework that is used to discuss the appropriate use of some major tools of economic management in the small open economies of the region.

1.1 Criticisms of Modeling

Policy modeling in the small open economies of the South Pacific has attracted criticism and controversy. Critics have said that these economies are too small and unsophisticated to lend themselves to the normal tools of economic analysis and that data are often lacking and dubious in quality. Consequently, critics argue that a "judgmental" approach is warranted.

Such a viewpoint may have two rationals. First, this group of nations does not function economically like the rest of the world due to its special characteristics. No evidence exists to suggest that the Pacific islands are in any way unique. If anything, economic characteristics fit more closely with the simplified assumptions of theory than with a sophisticated economy. The second and more substantive criticism is that due to their small size, economic forecasts or projections are likely to be inaccurate. A substantial change in an important export commodity price, a significant mineral discovery, an investment by a large multinational corporation, or a tropical cyclone can make the economist's projection evaporate.

1.2 Objectives of Modeling

Although this viewpoint has merit, it fails to grasp the main point of economic policy modeling. The objectives are (1) to make long-term projections of the likely economic performance (ignoring ad hoc disturbances) and (2) to understand how the economy may react to different economic policies. Our interest is in how an economy with the structural characteristics of the Pacific
island nations is likely to perform and react to standard economic policies. In other words, which economic policies are effective and which are not?

An interactive framework for policy analysis is needed to answer practical policy questions relevant to the economic analyst. The analyst, for example, may want to explore the consequences of greater or lesser public sector involvement in the economy, the impact of this on growth, the balance of payments, and so on. In most cases, the analyst is aware of the limitations of data, but a tool is needed to help in understanding the complicated forces at work in real world economies.

This paper attempts to answer the major question of whether useful models can be built for the economies of the region. Vanuatu has been selected as a prototype for the region. In its development, clearly defined data requirements will emerge, which can generate guidelines for statistical policy.

The lack of suitable data often inhibits the development of policy tools. However, the official statistical office, which is usually the agency responsible for data collection, remains unaware of the type of information required. Indeed even the country economist may be ignorant about the actual requirements. Only through the careful specification of the policy framework can the real requirements be known. Accordingly, the building of the Vanuatu prototype can itself serve a useful purpose.

1.3 SAM-based Modeling

The approach used in the paper is not new and follows a well-traveled route. The Social Accounting Matrix (SAM) is adopted as the main database around which to build the map of the economy and to provide some flexibility in the type of models that can be developed. Tinbergen's (1966) Semi-Input-Output (SIO) method is used as the basic analytical framework because its main assumptions are compatible with the "stylized" economic characteristics of the island economies. The method is also well suited to a planning environment in which government officials (the "planners") set sectoral targets and attempt to achieve the best allocation of resources. In addition, the model is simple to construct and not unduly demanding on statistical resources.

This SIO model is extended into a more sophisticated Computable General Equilibrium (CGE) model, and the results of both are discussed simultaneously. The CGE model, unlike its SIO counterpart, allows private sector en-
entrepreneurs to make the major productive decisions in the economy. The movement of relative prices affects these decisions and guides production. The CGE model also approaches the labor market and the rural economy more satisfactorily than the simpler SIO variant. However, greater realism does not come without cost, and the CGE model places a much greater demand on statistics. But because most of these statistics are unavailable in Vanuatu, the model is clearly a prototype.

1.4 Organization of the Paper

The organization of this paper relegates the technical aspects to the appendices, although a qualitative discussion is given in the text.

Chapter 2 provides an example of a simple SAM for those not familiar with the field. It also discusses the basic data requirements to construct the SAM. The chapter then gives a qualitative discussion of the major components of the models. The person not familiar with mathematics and the jargon of modeling is able to ascertain the main driving forces and their relevance to the small group of economies under consideration.

Chapter 3 discusses the results of the "base run" and compares the outcomes of the two models. The base run is our best guess at what the Vanuatu economy can be expected to look like over the next decade or so.

Chapter 4 examines the impact of various policies on the results, which is the most interesting aspect of the exercise. The major concern is the effectiveness of the standard tools of economic management on these projections. The chapter also examines the consequences of currency depreciation, fiscal restraint, wage indexation, and the like.

Chapter 5 conducts a sensitivity analysis of the results to changes in specification of the parameters of the CGE model. Given that most of the parameters used to drive the CGE model were derived from third country sources, it is important to know which parameters are particularly sensitive to the results. The answer will indicate areas where care must be exercised in using the model and, of more importance, will suggest areas where statistical resources should be concentrated.

Chapter 6, the concluding chapter, brings together the main results of the exercise.
Chapter 2
The Modeling Framework

This chapter describes in a qualitative fashion the Semi-Input-Output (SIO) and the Computable General Equilibrium (CGE) models developed in this paper. A formal mathematical treatment is given in Appendix 2. The two models use the Social Accounting Matrix (SAM) as the primary database. A simple SAM is explained in section 2.1 for those not familiar with the approach, and additional details are provided in Appendix 1. The models developed are multi-period models that make projections of the economy every year from 1985 to 1991 and for 1995 and 2000. For each projected year the models reproduce the SAM from which the most important results are obtained.

A description of the SIO model is given in section 2.2, which outlines the important ingredients. This model is easier to understand if it is first discussed before it is extended into the CGE counterpart in section 2.3. Much of the modeling approach is common to the two models, and these features are described along with the SIO model. The CGE model essentially uses more sophisticated functions to describe certain relationships than does the SIO version. It is helpful to develop the basic framework with the simplified model and then extend it, only when it is fully operational, into the CGE.

2.1 A Descriptive Social Accounting Matrix (SAM)

This section describes the basic structure of the SAM, which is intended as an introduction for those not familiar with the subject. Readers who wish a more complete detailed analysis should refer to the literature, in particular Pyatt, Roe et al. (1977). Because the models developed in the next two sections (2.2 and 2.3) are built around the SAM, an understanding of its structure is important. In essence, the models attempt to recreate a SAM for each period or year projected. All the normal results are derived in this process.

The SAM can be described as a set of accounts for the nation where the entries in any row are receipts and the columns payments. The sums of the corresponding rows and columns must equal. The accounts in a SAM may be divided into current and capital. The former deals with consumption, production, and income, while the latter describes savings, investment, and the flow
of funds. For most economies in the South Pacific, some information will exist to construct elements of the current accounts, but there will be less information for the capital. This illustrative SAM thus concentrates on the current transactions. The main ingredients of the SAM are shown in Figure 2.1.

Within the current accounts only the major categories of the economic system have been isolated, and no further information is provided. The illustrative SAM is concerned with form and functionality and not with detail. The major categories of the SAM can be discussed as follows. First are factors of production, which in Figure 2.1 are shown as capital and labor. These are the main components from which economic activity originates. In the detailed SAM for Vanuatu given in Appendix 1, labor is disaggregated into four skill categories.

The institutional accounts isolate households, private firms, and the government as the major actors. Households are usually subdivided in SAMs into various categories, e.g., urban, rural, small holder farmers, and landless labor. This disaggregation of the household set has attracted substantial interest because it provides a means to identify the impact of different policies on the distribution of income. The illustrative SAM identifies only private firms and the government as the remaining institutions, whereas in reality various other institutions will exist, for example, government enterprises, financial institutions, and non-profit organizations.

Activities are the sectors of the economy that produce commodities (goods and services), which are agriculture, manufacturing, and services. In most SAMs this list will be expanded in greater detail to specifically include the major branches of industry, for example, copra growing, cattle ranching, sugar-cane farming, mining, and textile manufacturing.

Activities produce commodities, and the SAM includes a set of accounts for each. This division permits activities to produce commodities other than the principal commodity associated with that industry. The illustrative SAM classifies commodities into three basic groups: traded, non-traded, and non-competitive commodities. Traded items are commodities that compete with items produced elsewhere in the world, while non-traded items do not compete and are consumed only at home. Non-competitive commodities are imported items for which there is no domestic counterpart or competing good.

CoprA is an example of a traded good because it competes with copra produced in many other nations. Building and construction or government services are non-traded commodities because these services cannot be pur-
### Figure 2.1. An Illustrative Social Accounting Matrix (SAM)

| 1. Factors | Labor | Capital | Value Added |  
| 2. Indirect taxes |  |  | Indirect Taxes |  
| 3. Institutions | Households | Firms | Government | Factor Receipts | Govn Reven | Transfers |  
| 4. Activities | Agriculture | Manufacturing | Services |  |  | Make Matrix |  
| 5. Commodities | Traded Commodities | Non-Traded | Non-Competitive | Consumption | Intermediate Consumption | Exports | Investmnt |  
| 6. Rest of the World |  |  |  | Transfers |  | Imports |  
| 7. Capital Accounts |  |  |  | Savings |  | Cap Infl |  

Figure 2.1. An Illustrative Social Accounting Matrix (SAM)
chased from the rest of the world. An example of a non-competitive commodity is petroleum products, which at present are not produced in any South Pacific island country. This classification scheme for commodities has considerable significance for the models developed below.

The account for the rest of the world details all transactions that enter the balance of payments. Generally, it includes exports, imports, transfer payments, dividend remittances, and so on.

Finally, in the description of the major accounts of the SAM the capital accounts are consolidated into one account so that it includes only savings and investment. This procedure ignores the problem of how savings are channeled into investment, that is, the flow of funds. For most Pacific island nations the paucity of statistical information makes the flow of funds difficult to specify.

Given this overview, the SAM itself can now be discussed. In essence, the SAM describes the major transactions that occur in an economy during a given period of time, in this case, one year. While the SAM connects the various accounts of the nation together, there is also a causality or an interrelated direction of flow in the system. Our discussion of the SAM proceeds according to this flow.

A discussion of the modeling framework begins with the factor accounts. Factors receive their incomes from activities. It is through productive activity that labor receives wages and capital earns profits. This flow is shown in the SAM in the interaction of row 1 and column 4 as "value added." This submatrix of the SAM can be classified as transaction $T1.4$ for the purpose of the following description.

The SAM considers that "factors" are owned by institutions. In this case, factors pay their rewards to their owners; that is, wages are paid to households, profits are distributed to firms, and indirect taxes are paid to government. Institutions make outlays in various ways.

First, they can make payments to other institutions and the rest of the world, which include transfers, payments of taxes from firms and households to government, interest, rent, dividend payments, and so on. These items are included in $T3.3$. Institutions also make and receive payments from overseas, and these are included in $T6.3$ and $T3.6$. These categories include workers' remittances overseas, foreign company profit repatriation, foreign debt payments, and so on.
Second, institutions can either consume their incomes or save them. The consumption of commodities 75.3 is the major outlay for both government and households, although they also generate savings 76.3. Private firms do not consume but rather retain significant proportions of their revenues for reinvestment. Domestic savings, together with foreign capital inflow 77.6, are invested in capital assets, which create a demand for commodities 75.7.

Thus the flow of the system generates income from factors, which is paid to institutions. Institutions in turn either consume their receipts or invest in capital.

Activities produce commodities, which are shown in the so-called "make" matrix 74.5. The domestic supply of commodities is supplemented from the rest of the world through imports 76.5. The SAM is given in "producer" prices, which mean that the value of commodities must include indirect tax payments 72.5. Thus the total supply of commodities, the sum of column 5, includes both domestic and imported commodities and indirect taxes.

So far the supply of commodities has been specified; this amount must equal the total demand, which is given in row 5. The demand for commodities is derived from the sum of consumption, investment, exports, and intermediate consumption (the last item completes the activity accounts).

Next comes the rest of the world or balance of payments. The discussion above has already specified all the items in this account. Exports, transfer receipts, plus capital inflow (current account deficit) all equal the sum of transfer payments and imports. In any system such as a SAM, when all but one of the accounts has been specified, the remaining account must balance. This rule is known as Walras's Law. The accounts of the SAM are not independent, and mathematically there exists one fewer degree of freedom than there are equations or variables.

Before the statistical requirements to construct a SAM are considered, one additional point about SAMs needs to be made. The items in the SAM are expressed in transactions values; that is, they give the value in dollars, say, of the payments from one account to another. This point is important because in some accounts these transactions values may be considered as the product of quantities and prices.

In the commodity accounts this categorization is immediately obvious. The elements in the SAM represent quantity transactions but have been ex-
pressed in values through multiplication of the appropriate price. For example, copra exports are given in values or the product of the quantity exported times the world price. The factor accounts can also be divided into quantities and "factor" prices. In the case of labor the number employed times the going wage gives the remuneration of labor. However, this decomposition of the SAM into transactions values is not possible in the other accounts. There is no corresponding price and quantity, for example, in the institution accounts.

The fact that certain SAM accounts may be divided into quantities and prices has important repercussions for the models. For those accounts that have decomposition, both the price and quantity relationships need to be modeled. For those accounts that have only a transactions value, this is not required and the modeler's work is reduced.

We now consider the statistical requirements to build a SAM. Again the reader can find more thorough references elsewhere in the literature (see, for example, Sturton 1986 and Appendix 1 for the specific example of Vanuatu). A list of the major survey material is provided so that the reader has some idea of the information requirements. The following list is not exhaustive, but in general if the surveys itemized below do exist, it should be possible to construct a SAM. In essence, the SAM is no more difficult than a full enumeration of national accounts. The data include

1. Government accounting data,
2. Trade statistics and balance of payments,
3. Employment survey,
4. Household income and expenditure survey,
5. Agricultural census, and
6. National accounts' establishment survey covering main industrial sectors, detailing firms' costs and revenues with information on intermediate consumption.

Preferably, all the data should exist for a common year. In practice, the period chosen for construction is usually determined by the year for which the majority of the data are available. Surveys such as household income and expenditure are not usually conducted annually, and the basis for the SAM is sometimes determined from the date that the survey was conducted. In any case, survey material often has to be adapted from an inconsistent set of years to construct the framework.
2.2 The Semi-Input-Output (SIO) Model

The SIO model described in this section attempts to reproduce a SAM for different time periods. It adopts different rules for modeling different elements and accounts of the SAM. In the productive accounts (activities and commodities), the model is a descendant of Tinbergen's (1966) Semi-Input-Output method. The approach also provides a mechanism for price determination, which is frequently used in the literature to portray the standard open economy (Dornbusch 1980). These features, together with a simple set of rules for modeling the remaining set of accounts of the SAM, are the basis of this approach.

The SIO model is based on the "small country" assumption; that is, the prices of commodities entering international trade are determined in international markets over which the small country has no influence, and the demand curves are perfectly elastic. Thus the terms of trade are given in this model. For small developing countries producing primary commodities for export, this assumption matches reality. The major exports of the South Pacific islands include copra, sugar, coffee, cocoa, fish, timber, gold, and copper—precisely those types of commodities that the small country assumption reflects well.

The small country assumption is frequently used in economic analyses of developing countries and is also frequently criticized. While this assumption may be realistic for imports, many developing countries do influence the price of their exports. However, this group of economies is particularly small, even by developing country standards; they produce almost exclusively bulk-type commodities for export, and they usually have no influence over price. The development of differentiated, specialized, high value primary commodities for export is as yet insignificant to the region. The small country assumption perhaps more realistically represents the conditions of the South Pacific than anywhere else in the world.

The SIO model distinguishes between traded and non-traded commodities. Although the prices of traded goods are given in world markets, the prices of non-traded goods are determined at home endogenously. For the so-called home goods, it is necessary to choose some pricing rule for producers. The SIO model uses a simple cost-plus markup rule on prime cost. These types of assumptions are extremely useful for examining the effectiveness of nominal devaluations.
On the output side, the model also distinguishes between traded and non-traded activities. The output of traded activities is considered fixed in the short run, which is compatible with the price rule. Producers can find markets for any level of production given world prices, and demand is not a constraint. Outputs of traded activities are accordingly fixed by supply considerations, and in the planning environment the central planning organization is responsible for setting output targets and making projections.

The output of non-traded activities is, however, constrained by demand and is endogenous in the model. The non-traded goods market must "clear" and complement traded goods production. In the traded goods market, domestic production is supplemented through international trade, and the market for domestically supplied goods need not clear. Thus if output levels are given, international trade will supply any excess demand. Accordingly, it is net exports that equilibrate in this segment of the economy.

The following discussion departs from the standard SIO approach in two important respects. First, traded goods are classified into exportables and importables; this departure was necessary because of the different pricing formulations adopted (see Appendix 2). However, in the importable department, the small amounts of exports are projected exogenously, and the net exports described above become imports unambiguously. This procedure was considered an improvement over the standard SIO approach. Second, the SAM also details exports of commodities classified as non-traded. In the classification of commodities the important criterion is whether the commodity is traded at the margin. If the additional unit of demand originates from the domestic economy, the item should be classified as non-traded, although it may enter international trade. Only commodities whose origin of supply at the margin is from the rest of the world should be treated as traded. Under these circumstances, the exports of non-traded goods need to be projected exogenously.

Although this procedure is straightforward, the question arises about what is the relevant price of exports of non-traded goods. If we follow the small country assumption, the relevant price will be fixed in international markets. This exposition, however, departs from this rule and assumes that exports of non-traded goods (mainly tourism-related items) are sufficiently differentiated to diverge from international prices. The export price is accordingly the domestic price adjusted for exchange variations.

Given a solution of the price system and an estimate (but known level) of the productive side of the economy, that is, the activity accounts, the model fol-
allows the circular flow of the SAM in filling out the remaining parts of the system. Factor incomes are split into two parts in the model: wages and profits, with wages being differentiated by skills. The wage expenditure by skill level is determined through multiplying activity output levels by fixed labor output ratios and the corresponding wage rates. Wages are then distributed to households depending on the ownership of skills by the various household groups. A distinction is also made between rural and urban households so that agricultural wages end up as rural household incomes, while wages earned in other activities end up mainly as urban household incomes.

Expatriate labor is an important factor of production in many island economies, and it is distinguished in this SAM and models. In this case, wages earned in activities by expatriates are mapped to expatriate households.

Regarding the profit side of factor incomes, rural and urban activities again need to be distinguished. In the rural areas, production is considered as originating from either small holder or estate systems. Incomes earned from small holder activities accrue to rural households, while the profits of estates are considered as returns to the private sector and are not distributed directly to households. In the urban areas, profits are distributed according to fixed proportions between the various institutions identified in the SAM.

At this point we have identified the incomes of the various institutions derived from factors. However, to complete the story, institutions make payments to each other in the form of transfers, taxes, dividends, interest payments, etc., which must be taken into account. These are not discussed in detail because different and often ad hoc specifications were used (see Appendix 2). In general, however, some of these intra-institutional payments can be specified by functional relationships. For example, if government foreign debt service is related to the level of foreign debt, private sector dividend payments will be related to the level of profits and so on. However, for many transfers between institutions no functional relationship exists. Transfers between households, payments of fines and fees to the government, transfers from overseas migrants, etc., are ad hoc in nature and not easily specified.

Once all transfer payments have been specified in one form or another, it is possible to derive institutional savings residually, that is, by deducting all payments from receipts (including indirect taxes in the case of government). In the case of both households and government, however, this balance defines a level of funds that can be used for either savings or consumption. Government consumption is treated exogenously, and the public sector's cur-
rent account balance is a residual. In the case of households, consumption is determined by a simple linear consumption function, and again savings constitute the remainder.

Household consumption, however, is a collection of expenditures on different commodities, and a system is needed for allocating total consumption among them. Various and differing approaches have been adopted in the literature, but this report uses the Linear Expenditure System (LES) (see Stone 1954). In principle, households have a subsistence level of consumption by commodity, which occurs regardless of the level of income and prices. As income rises, however, households allocate additional income among commodities according to their relative prices and incomes.

Having specified both government and private consumption, the discussion now turns to the capital accounts, which in this case include a specification for inventories and investment. Because no meaningful relationship can be specified for inventory accumulation, the rate is pegged to the change in GDP growth.

Both private and public investment are specified exogenously in the model. The economy studied, Vanuatu, best fits the stylized characteristics. In other economies of the region, investment may be determined by the volume of domestic savings and capital inflow. In this case, investment becomes endogenous. The treatment of investment has important consequences for the distribution of income and model outcome. It has generated an important controversy in the literature, which is known as the "closure" problem (see Sen 1963; Taylor 1978; Dervis, DeMelo, and Robinson 1982). A Keynesian closure is specified here, while the second variant is Neoclassical.

The remaining items needed to complete the specification of the commodity accounts are tourism expenditure and re-exports. Tourism in many South Pacific island nations makes a significant contribution to economic activity, and a demand function is included that is dependent on changes in world incomes and relative prices between the host country and the competing tourism destinations. Allowance has been made for autonomous tourism growth. Re-exports are projected exogenously.

Solution of the model uses the following approach. The price system is first fully determined, which, given the nature of the assumptions, can be solved independently of the productive side of the economy. With outputs of traded activities given, a guess can be made of the non-traded activity levels, which permits a determination of the rest of the SAM following the circular flow of
the accounts, as discussed above. Both the demand and supply of non-traded commodities can now be added up, and the output levels of non-traded activities can be adjusted according to excess demands, thereby improving the guess. The solution of the model is thus iterative, but in practice it nearly always solves within 10 iterations or so.

At this stage, one or two loose ends must be tied up, which includes detailing the total government revenue from indirect taxes and the balance of payments. The details are given in Appendix 2.

This model is a dynamic one in that projections are made over a series of years; in this case, a projection is made for the period 1985-2000. However, the solutions are largely independent of each other because few elements are passed forward from one period to the next. In particular, there is no consistency between the productive capacity of the capital stock and investment. The SIO model does not guarantee that sufficient capital stock exists to support the level of output required by the model. The approach adopted (in the absence of empirical data to support such consistency) is to place a greater reliance on the policy modeler to ensure consistency in a judgmental fashion.

Before the discussion of the SIO model is concluded, a few comments are needed on the statistical requirements. The main ingredient is the SAM, but there are a few additional requirements. These include the labor employed by SAM activity and skill groups, income elasticities for the LES, and a set of consumer retail and wholesale margins. These additional requirements will usually be available if the basic data exist to construct the SAM.

If a household income and expenditure survey exists, an essential ingredient to construct the SAM, then a set of elasticities can be estimated from the survey. Similarly, an employment survey is usually required in the derivation of the factor activity matrix of the SAM. A matrix of the number of people employed by activity and skill will have been computed in the process of generating the SAM. Finally, the trade margins can usually be estimated from a wholesale and retail survey if one exists or through discussions with traders if it does not.

### 2.3 The Computable General Equilibrium (CGE) Model

In this section the basic SIO model developed above is extended into a Computable General Equilibrium (CGE) model. The Semi-Input-Output model was chosen as the basis because it provides the operational economist with a
robust framework, which is simple to use and which incorporates many of the basic stylized characteristics of small open developing economies. The framework developed is well suited to the development planner because it focuses attention on the various macroeconomic constraints likely to occur.

In the real world of a mixed economy, however, the output levels of productive activities are usually decided not by government planners but rather by private sector entrepreneurs. The SIO model thus lacks one of the main ingredients we might like to incorporate into the policy framework. This chapter relaxes this element of the SIO model to permit autonomous production decisions by entrepreneurs. This main ingredient differentiates the CGE models from their Input-Output counterparts.

In essence, the CGE model describes a mixed economy where entrepreneurs are responsible for productive decisions. The economy will be driven through the price mechanism where the relevant commodity and factor prices will equilibrate in the market. In the SIO model, prices played no part in productive decisions, and in the non-traded goods sector the adjustment of supply to demand through iteration of activity outputs ensured consistency. The model also describes the labor market in some detail. While unemployment is incorporated for urban unskilled labor, wages will equilibrate elsewhere. Substitution will be allowed between high cost expatriate labor and indigenous ni-Vanuatu labor. Various other refinements have been built in, which will be described in subsequent chapters.

In the SIO model, economic activity results from the productive use of capital and labor in the production of commodities. A given level of output is derived from fixed quantities of capital and labor, and no substitution between them is possible. In the jargon of the literature, the production function is a "fixed factor proportions" model. The CGE model permits substitution between capital and labor, depending on relative factor prices. Entrepreneurs employ resources to maximize profits. Capital is fixed in the short run but may be augmented over time through investment. Labor, however, is free to move between activities, but the total supply is fixed in any period and grows over time with population growth.

The entrepreneur is faced with a historical endowment of capital, given product prices and known level of wages. The entrepreneur chooses the level of production and employment of labor to maximize profits. In the SIO model the "planner" projected the output level of "traded" activities, and the "non-traded" goods production was determined to maintain equality between
supply and demand. In the CGE case, production decisions are now made by entrepreneurs for all categories of activities.

In the SIO formulation the category of traded goods was subdivided into exportables and importables due to differences in pricing, but the model treated them essentially in the same manner. After domestic demand requirements were met, net exports equilibriated. However, the CGE model has treated them differently. We still hold the small country assumption for exportables, and the treatment remains the same. Entrepreneurs are free to produce any amount of these commodities, given factor resource availability.

In the importable department, however, a distinction is made between imports and domestically produced importables. The two commodities are not perfect substitutes and compete with each other. We introduce product differentiation and allow consumers of these products to select a combination that minimizes their costs. There is thus a demand in the economy for the combined commodity, the precise composition of which is given by the relative prices of the two competing products.

Unlike the producers of exportables who face infinitely elastic demand curves, the producers of importables face normal downward sloping demand curves determined by domestic demand conditions. In this segment of the economy, domestic prices of importables are not given through international markets but rather are determined so that supply equates with demand. Prices thus act to clear the domestic market. The non-traded goods market acts in an identical fashion in this regard, but, of course, there are no competing imports.

We now turn to the specification of the labor market, which is modeled in some detail to realistically represent the operations of South Pacific island economies. Special focus is given to incorporating the subsistence economy in a dynamic way. For the labor market there are three important ingredients: (1) the rural subsistence economy where production is for own consumption, (2) the rural cash economy, and (3) the urban cash economy. In the rural sector (incorporating both the subsistence and cash economies), it is assumed the labor market is composed of two important components: a pool of unskilled labor and a supply of skilled labor, which is employed only in the rural cash economy. The pool of unskilled labor has three choices: remain in the subsistence economy, enter the rural cash economy, or migrate to urban areas.
Migration is specified following the well-known Harris and Todaro (1970) model: rural unskilled labor migrates depending on the real wage differential between rural and urban areas and the probability of finding work. The decision of rural unskilled labor to leave the subsistence sector and join the rural cash economy is also dependent on the rural wage. As the real wage increases, more labor is drawn out of the subsistence sector into the cash economy. The level of production in the subsistence economy is then determined residually by the remaining amount of rural unskilled labor.

On the supply side, all skilled labor is in fixed supply and is augmented each year through education and training. Unskilled labor is determined through the nexus of interactions described above, except that the rural labor pool and the supply of urban unskilled labor (before migration) are assumed to grow by exogenously specified rates and are dependent on population growth.

The labor market is complicated by two additional factors. First, labor is differentiated by four skill classes, three skilled groups, and one unskilled. Labor of one group is permitted to substitute for labor belonging to the other categories. Second, a distinction is made between indigenous labor and expatriate labor. Many South Pacific island economies are heavily dependent on expatriate labor and have vigorous programs of localization. It seems appropriate to incorporate these factors into the model. Again, the model allows substitution between expatriate labor and indigenous labor depending on the relative wage levels.

All markets clear for indigenous labor with wages adjusting until there is no excess demand or supply. The only exception to this approach is in the urban areas where unskilled labor may be unemployed if demand is inadequate to achieve full employment. In the urban unskilled case, nominal wages have been left unaltered from their 1985 levels, which seem to reflect the stylized facts of the Vanuatu economy. Expatriate labor is considered to be in infinite supply at the going wage, which is indexed to the local cost of living.

This version of the model permits the growth in households to reflect the changes in the urban and rural labor supply. Over time, modification is needed to allow for changes in household size. The number of expatriate households is directly linked to the demand for expatriates.

As in the case of the SIO model, we have projected private investment exogenously in accordance with past trends and realistic projections, given the
overall rate of economic growth. The capital stock thus does not tend to an equilibrium level in the long term. However, although the overall gross level of investment has been set, the sectoral allocation does reflect sectoral profit differentials, and in the long term, sectoral rates of profit will tend to equalize.

The solution procedure for the CGE model, like the SIO, is iterative. However, two sets of markets need to be solved in the system: the product market and the labor market. The approach is to divide the process into outer and inner loops. The outer loop consists of the product market while the inner loop consists of the labor market. An initial guess is made for product prices, the outer loop. The labor market, the inner loop, is then solved iteratively through adjusting wages until there is no excess supply or demand (except in the urban unskilled group). Attention is then returned to the outer loop, and an improved guess is made for product prices. This procedure is followed until the product market clears. The inner loop solves quickly within 10 or 15 iterations. The outer loop takes much longer and can require over 50 iterations. The CGE model is considerably more demanding of computer resources than the SIO.

Finally, this chapter now turns to the additional data requirements of the CGE model. The main additional ingredient is a set of elasticities of substitution in the various areas where the model allows substitution. This set includes elasticities for substitution between capital and labor, between imports and domestically produced importables, between labor of different skill categories, and between indigenous and expatriate labor. Because none of these requirements exists for the economy under study, Vanuatu, we describe this model as a prototype.

To drive the model, elasticities are selected from third country sources. Derivation of properly estimated parameters for South Pacific island countries requires a substantial statistical exercise. However, through sensitivity analysis it is possible to isolate the parameters that are the most critical to the model results and thereby determine those that should receive the greatest resources.
Chapter 3

The Base Projection

This chapter discusses the base projection of the SIO and CGE models described in the previous chapter. The introduction stressed that the results of this projection were not in themselves the most important aspect of the findings. The results reflect the assumptions built into the projections of the exogenous variables, and these assumptions depend on the disposition of the modeler, planner, etc. The base projection lays the foundation from which the model economy can be subjected to different policies. The effectiveness of these policies can be examined through comparative analysis. It is, of course, sensible to make the base projection as realistic as possible, but this is not essential for the purpose of this paper. The exogenous inputs are given in detail in Appendix 6, but a descriptive summary of the more important elements is given first before the base projection is discussed.

The assumed rate of labor force growth was about 3.5 percent, reflecting the high growth rate of the population. The projected world prices of commodities used the World Bank figures (see IBRD 1987). Of particular significance to this discussion is the large deterioration of real copra prices from 1985 onward, and copra is Vanuatu's main export. This decrease results in a particularly adverse movement in the terms of trade, which is artificial to the extent that copra prices were unusually high in 1985.

In late 1986 Vanuatu devalued by 14 percent, which was incorporated in the input data. Although the treatment of wages was different in the two models, the nominal wages of ni-Vanuatu were projected to remain unchanged during the time horizon, which reflects current policy. For expatriates, wages were indexed to the local consumer price index.

Of the major components of final demand, government expenditure was projected to grow by about 4 percent annually, while private investment and public investment were expected to grow by 4 and 3 percent, respectively. The autonomous part of tourism growth was projected to show little change initially but to grow rapidly from 1988 onward.

The results of the CGE and SIO models are presented in tandem, with annual average growth rates between 1985 and 1988, 1988 and 1991, and 1991 and 1995. The data have been grouped into three periods, which represent
three distinct phases of projected development: (1) the short run (1985-1988),
which is heavily influenced by falling copra prices and a depressed domestic
economy; (2) a more buoyant intermediate period (1988-1991) where condi-
tions are perceived as more favorable to development; and (3) the long run

Simultaneous discussion of the base run of the two models not only will re-
veal the quantitative differences between the two models but also will reflect
their structural differences. The results will thus provide additional insight
into the analytical structure of the respective frameworks of the models.

In Table 3.1 the discussion of value added by sector can be conveniently di-
vided into four groups: the subsistence economy, exporting, import substi-
tuting, and non-traded activities. The level of production of the subsistence
economy revolves around the outcome of the rural labor market, which will
be discussed in this chapter.

The figures for the export activities clearly indicate the essential differences
between the two models; in the SIO model the outputs are projected exoge-
nously, while in the CGE the activity levels adjust to commodity price levels.
In the initial period copra prices fall significantly, as well as production, while
the SIO model reveals an exogenous increase. However, production does not
drop to the extent of the fall in prices in the CGE case. As unemployment
develops at the going wage, downward pressure is exerted on real wages to

<table>
<thead>
<tr>
<th>Table 3.1 GDP by activity (average annual growth rates)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Subsistence</td>
</tr>
<tr>
<td>Primary export copra</td>
</tr>
<tr>
<td>Primary export cattle</td>
</tr>
<tr>
<td>Primary export other</td>
</tr>
<tr>
<td>Primary other</td>
</tr>
<tr>
<td>Manufacturing</td>
</tr>
<tr>
<td>Building and construction</td>
</tr>
<tr>
<td>Tourism activities</td>
</tr>
<tr>
<td>Private services</td>
</tr>
<tr>
<td>Government activities</td>
</tr>
<tr>
<td>GDP (constant factor cost)</td>
</tr>
<tr>
<td>Real income (t of t adj GDP)</td>
</tr>
</tbody>
</table>
clear the rural labor market, which reduces costs, and copra producers maintain production to a certain extent. However, the decline in copra prices reduces costs in the rural economy as a whole, and production in other activities becomes relatively more attractive. Both the cattle and residual exporting activities show rapid annual growth. The SIO model in contrast shows more moderate growth for cattle and even a negative projection for the "other" category due to the closure of a fish freezing plant.

In the two later periods a significantly different picture also emerges between the two models for this group of activities. In both models demand is infinitely elastic at given world prices according to the small country assumption. In the SIO model the production is projected exogenously, but in the CGE case it is constrained by fixed supplies of labor and capital, given output prices. Under these conditions the results can be erratic if there are sizable movements in export commodity prices. In all other main producing groups of the economy, demand is not infinitely elastic (in some cases it is exogenous), and the results will tend to be less volatile. This observation suggests the model results are likely to be sensitive to the choice of elasticities of substitution in exporting activities, which is the subject of one of the sensitivity experiments in Chapter 5.

Both the primary import and manufacturing activities are import substituting sectors, and the two models show similar results except for the last period. Clearly, movements in world prices and domestic costs are favorable to these activities in this period and appear to present more profitable opportunities than foreseen by the "planners" in the SIO case.

The non-traded group shows extremely similar results for the two models in the building and construction sectors, which is to be expected given the exogenous projections for public and private investment. Tourism also reveals a similar outcome, the difference reflecting the disparities between domestic prices in the two models. Tourism demand is a function of world incomes, an exogenous growth factor, and the relative prices between Vanuatu and the rest of the world. It is only in the last factor that a different outcome between the models may occur. Private services is a completely endogenous sector, output levels being driven by domestic demand. Growth rates are similar in the two models and mirror the rate of growth in constant and real GDP. Government activity levels are extremely similar in the two models, reflecting the exogenous projection of government expenditure.

Because the only substantive difference in the two models is the output in the exporting activities, it is not surprising that the overall rates of GDP growth
are similar. The CGE model shows a lower growth in the early period, reflect ing the unfavorable terms of trade facing Vanuatu exporters. In the last period the CGE model is more buoyant, reflecting the improvement in the terms of trade facing both exporters and import substitutes.

The set of results presented in this chapter includes a measure of GDP adjusted for terms of trade movements or real GDP or income. While constant price GDP may grow in any period, adverse terms of trade movements will erode the value of production. Although the level of production in an economy may expand, the level of consumption it affords through international trade may be reduced. There are numerous possible treatments of this problem (Gutmann 1981), but we have followed the simple procedure of deflating current price exports by import prices. The method assumes that exports are produced to consume imports, and thus the correct measure of real income will adjust exports to account for their real purchasing power in the rest of the world.

As Table 3.1 reveals, the growth in real income is always less than the increase in production; the terms of trade effect is always negative. However, the effect is particularly strong in the early period, reflecting both the devastating impact on the economy of the collapse of copra prices in the international market and the 14 percent devaluation in 1987. Not only does the level of falling prices depress domestic production, but also it further reduces demand for other sectors of the economy.

Table 3.2 is divided into three parts: the first deals with employment or the demand for labor, the second with labor supply, and the last with rural-urban migration. The supply of labor is projected exogenously for both the rural and urban economies, but migration will occur between the two sectors, depending on relative wage movements and the rate of urban unemployment. Thus while the labor supply is fixed for the economy as a whole, the urban and rural supply will grow at different rates.

In both models unemployment exists only in the urban areas for unskilled labor. In the rural economy a pool of unskilled labor exists, which participates in either the cash or the subsistence economies. In the CGE case, a supply function, which is dependent on the real wage, effectively allocates labor between the two components of the rural labor market. The SIO case assumes that labor not employed in the cash economy (through the fixed proportions assumption of the production functions) enters the subsistence sector.
Table 3.2  Employment, labor supply, and migration (average annual growth rates)

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th></th>
<th>SIO model</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total employment</td>
<td>2.7</td>
<td>4.0</td>
<td>4.1</td>
<td>2.7</td>
<td>3.2</td>
</tr>
<tr>
<td>Urban unemployment no's</td>
<td>3872</td>
<td>2318</td>
<td>0</td>
<td>3844</td>
<td>4491</td>
</tr>
<tr>
<td>Urban unemployment %</td>
<td>26.3</td>
<td>13.3</td>
<td>0.0</td>
<td>27.6</td>
<td>26.8</td>
</tr>
<tr>
<td>Expatriate demand</td>
<td>-2.8</td>
<td>2.1</td>
<td>2.3</td>
<td>1.1</td>
<td>3.9</td>
</tr>
<tr>
<td>Rural pool</td>
<td>2.5</td>
<td>2.7</td>
<td>2.9</td>
<td>2.4</td>
<td>2.6</td>
</tr>
<tr>
<td>Rural supply (cash sector)</td>
<td>1.5</td>
<td>2.7</td>
<td>3.6</td>
<td>8.4</td>
<td>6.9</td>
</tr>
<tr>
<td>Urban supply</td>
<td>5.6</td>
<td>5.7</td>
<td>5.5</td>
<td>6.7</td>
<td>6.5</td>
</tr>
<tr>
<td>Rural-urban migration</td>
<td>-1.0</td>
<td>5.1</td>
<td>0.7</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
<tr>
<td>Rate of migration %</td>
<td>2.2</td>
<td>2.2</td>
<td>1.8</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
</tbody>
</table>

* The data in the table are expressed as annual average growth rates. When the information is annotated by No's, it indicates that the information is no longer an annual growth rate but an absolute figure. Similarly, when the item in the table is annotated by a %, it indicates that the information is a percentage. In this case, urban unemployment is the actual rate of urban unemployment and not the rate of annual change.

In the urban economy for the CGE model, wages equilibrate the market but are sticky downward for unskilled labor, and unemployment may result. In the SIO case, unemployment is the difference between the demand for labor (again determined through the fixed proportions assumption of the production functions) and the supply.

The results of the two models reflect their basic structures; employment growth accelerates in the CGE case, and by the end of the last period full employment is reached. In the SIO case, employment growth is more restrained, and the number of unemployed grows significantly although the rate of unemployment shows little variation.

In the CGE model the growth in demand for expatriates is lower than the SIO case, up to 1995. Expatriate wages are indexed to the local CPI, whereas upward movement in ni-Vanuatu wages occurs only when the full employment ceiling is reached. In this case, wages of expatriates are rising relative to ni-Vanuatu, and ni-Vanuatu labor is substituted. When the full employment ceiling is reached in 1995, this differential in relative wages ceases to exist, and a similar growth in demand for expatriates occurs in the two models. In the SIO case, expatriate demand grows in line with ni-Vanuatu, and any differences reflect shifts in the sectoral composition of output.
Growth in the rural labor pool (unskilled rural ni-Vanuatu labor) is similar in both models, reflecting largely exogenously specified growth rates adjusted for endogenous rural-urban migration, which is small. For the CGE model the supply of labor in the cash sector is a function of the real rural wage. In the early period it reflects the depressed state of the rural economy and expands slowly. The supply of labor accelerates toward the end of the period as conditions improve until it matches the exogenous growth rate of the labor force. For the SIO model the results reveal the demand for labor, which matches the growth rates of rural economic activities.

Returning now to the subsistence sector in Table 3.1, we see a more rapid growth of output in the CGE model. This reflects the lower rate of growth in the labor supply of the rural cash economy. With a given size of the rural labor pool, more labor is available for subsistence production. By 1995 this force ceases to operate.

Urban labor supply growth is more rapid than the rural growth in both models, reflecting the addition of rural-urban migration. Given that Vanuatu is largely a rural economy, migration has a more dominant effect on the urban figures than on the rural ones. The growth in migration reflects two factors: (1) the change in the urban-rural wage differential and (2) the chances of obtaining a job in the urban areas. For the CGE model in the first period, unemployment in the urban areas is high, which discourages migration. In the intermediate period the chances of obtaining a job improve and migration rises. In the last period, even with full employment, the gains in the terms of trade affecting rural wage rates have a neutral effect on migration.

Table 3.3 shows the growth in final demands in constant prices for the two models. The exogenous elements (government consumption, private investment, public investment, and re-exports) not surprisingly are the same in both models and reflect the input data. Stock taking is linked to the growth in GDP, and because the overall growth of GDP is similar in the two models, the results are similar.

The growth rate of consumption, however, differs significantly. In the early period the low commodity price of copra depresses production and drives down the rural wage, and real incomes are depressed. These factors result in a falling rate of consumption. In the SIO model the copra production is specified exogenously at a level above the equilibrium rate established in the CGE case, which results in a less severe drop in consumption. In the inter-
Base Projection

Table 3.3 Expenditure on GDP (constant prices, annual average growth rates)

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Private consumption</td>
<td>-3.4</td>
<td>2.3</td>
<td>4.4</td>
<td>-1.3</td>
<td>2.5</td>
<td>1.4</td>
</tr>
<tr>
<td>Government consumption</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
</tr>
<tr>
<td>Private investment</td>
<td>4.6</td>
<td>4.0</td>
<td>4.0</td>
<td>4.6</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Public investment</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Stock taking</td>
<td>7.2</td>
<td>5.0</td>
<td>4.9</td>
<td>8.1</td>
<td>4.9</td>
<td>3.8</td>
</tr>
<tr>
<td>Tourism</td>
<td>12.4</td>
<td>11.5</td>
<td>7.8</td>
<td>10.6</td>
<td>12.1</td>
<td>8.4</td>
</tr>
<tr>
<td>Re-exports</td>
<td>-24.3</td>
<td>10.0</td>
<td>10.0</td>
<td>-24.3</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Exports</td>
<td>10.2</td>
<td>3.3</td>
<td>4.0</td>
<td>14.0</td>
<td>2.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Imports</td>
<td>0.6</td>
<td>4.4</td>
<td>5.2</td>
<td>1.6</td>
<td>4.2</td>
<td>4.1</td>
</tr>
<tr>
<td>Less indirect taxes</td>
<td>-0.4</td>
<td>3.7</td>
<td>5.5</td>
<td>2.0</td>
<td>3.7</td>
<td>4.5</td>
</tr>
<tr>
<td>GDP (factor cost)</td>
<td>2.6</td>
<td>4.7</td>
<td>4.6</td>
<td>3.1</td>
<td>4.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>

mediate period the growth in consumption is similar in both models but still below the rate of constant price GDP and even real income. In the final period the CGE model shows expansion in consumption, above the rate of the SIO version. In the CGE case, the economy has reached full employment and wages rise, driving up the level of household incomes. In the SIO model Ni-Vanuatu wages are not allowed to rise and are fixed in nominal terms.

Tourism demand is similar in the two models, and the differences reflect changes in tourism prices. In the CGE case in the initial period, prices are lower due to the depressed nature of the economy and the reduced rate of nominal wages. These factors feed into tourism prices, which stimulate tourism demand. In the last period prices are rising faster in the CGE case, which is a disincentive to tourism demand.

Exports show significant growth in the early period, and the difference between the two models is the level of copra production. In the final period copra continues to expand, albeit slowly, and thus exports are higher in the CGE case than in the SIO model where no growth is projected. Imports reflect the general demand conditions in the economy, and the results may be explained by the growth in GDP. The differences between the growth of imports and GDP are due to changes in the composition of final demand. Indirect taxes are largely collected on imports, and thus the pattern reflects that of imports.
Table 3.4 details the model outcome for the government budget in current prices. Current prices are more appropriate to the analysis of the fiscal deficit because the Minister of Finance must cope with the situation in current prices and must not be misled by a favorable outcome in constant prices. Although the data are expressed in percentage change terms, both the recurrent and overall balance are represented in current Vatu. Percent change of a residual often gives a misleading indication.

Most items in the budget are exogenously specified—budgetary aid, final expenditure, government investment, and most transfers. The recurrent and overall balances reveal the extent to which these projections are consistent with indirect tax revenues, the only endogenous element. In the CGE case, while the recurrent balance is acceptable, the overall balance has grown significantly by 1995. In percent of GDP it grows from 5.6 to 5.1 and 5.9 percent in the three periods, respectively. These figures are relatively high, but given the development objectives of the economy and the degree of foreign assistance, they are probably not unacceptable. The comparative outcome for the SIO model is more reasonable, which mainly reflects the different pricing assumptions of the two models.

As with the government budget, the balance of payments is also expressed in current prices in foreign exchange. Although items in Table 3.5 are given in percentage change, the current account balance is given in actual foreign exchange. The current account balance deteriorates in nominal terms during the period but changes little as a percentage of GDP; it is 11.8 percent in 1988, 11.4 in 1991, and rises to 11.8 again by 1995. Given the historical levels

Table 3.4 Government budget (current prices, average annual growth rates)

<table>
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<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect tax income</td>
<td>6.9</td>
<td>10.7</td>
<td>8.4</td>
<td>9.0</td>
<td>10.7</td>
<td>7.7</td>
</tr>
<tr>
<td>Budgetary aid</td>
<td>4.0</td>
<td>8.5</td>
<td>4.5</td>
<td>7.7</td>
<td>9.3</td>
<td>4.1</td>
</tr>
<tr>
<td>Other incomes</td>
<td>1.4</td>
<td>8.8</td>
<td>5.9</td>
<td>6.6</td>
<td>9.4</td>
<td>4.2</td>
</tr>
<tr>
<td>Government final expenditure</td>
<td>3.1</td>
<td>9.1</td>
<td>7.6</td>
<td>6.5</td>
<td>9.7</td>
<td>5.1</td>
</tr>
<tr>
<td>Other recurrent expendi</td>
<td>10.5</td>
<td>9.2</td>
<td>6.0</td>
<td>12.0</td>
<td>9.5</td>
<td>5.8</td>
</tr>
<tr>
<td>Recurrent balance (Vatu)</td>
<td>-123</td>
<td>762</td>
<td>2012</td>
<td>-189</td>
<td>315</td>
<td>2580</td>
</tr>
<tr>
<td>Government investment</td>
<td>9.8</td>
<td>8.6</td>
<td>6.4</td>
<td>12.3</td>
<td>12.4</td>
<td>6.2</td>
</tr>
<tr>
<td>Overall balance (Vatu)</td>
<td>-8600</td>
<td>-10104</td>
<td>-15938</td>
<td>-8998</td>
<td>-11097</td>
<td>-11917</td>
</tr>
</tbody>
</table>
of foreign private and official investment in the Vanuatu economy, this level
does not appear unsustainable. Both models present a similar outcome for
the balance of payments.

The performance of the various elements of the balance of payments reflects
their different analytical treatment in the two models. Exports are treated as
a residual in both formulations—their what remains after domestic de­
mand has been accounted for. However, the basic level of production of the
exporting activities is different. In the SIO case, the output of the exporting
activities is projected exogenously, whereas in the CGE format it is respon­
sive to international prices.

Although the output of the copra sector is much lower in the CGE case, ex­
ports of the exporting sectors are actually higher than under the SIO format
in the initial period. This result occurs through the effects of the general
equilibrium formulation in the rural economy where the exporting sectors re­
side. The depressed level of copra prices drives down wages and shifts labor
to the other rural activities where performance improves. This effect is prob­
ably overstated because these effects would be likely to take longer to occur
in the real world. However, the CGE model does emphasize that producers
respond to price levels—something the SIO model does not incorporate.

Exports of non-tradables and importables are projected exogenously in both
models, and the different outcomes reflect differences in the price solutions.
Imports of importables reflect both the internal demand for importables and
the substitution of domestic products for their traded counterparts. The ele­
ment of substitution is not readily extracted from the figures in Table 3.5,
which is demonstrated more clearly in the experiments in Chapter 4. Imports of non-competitive items are driven purely by domestic demand conditions. Given sectoral differences, the lower growth in the initial period and the higher growth in the later periods coincide with GDP growth.

Earnings from tourism are similar in the two models, and the largest element of the projections is attributable to exogenous factors. The domestic price level, however, is important because tourism demand is influenced by the relative prices between Vanuatu and the rest of the world. Re-exports are projected exogenously, and accordingly the two models show similar results. The factor service account shows significantly different outcomes in the two models and is the result of the assumption that the level of foreign grants to Vanuatu was indexed to the CPI. As a first approximation it has been assumed that the level of foreign aid is maintained in real terms, an assumption that might need re-examination.

The model results show an interesting range of price indicators, and the essential differences between the two models are revealed clearly in Table 3.6. In the SIO model both the factor and commodity prices are largely exogenous; only in the non-traded sectors are prices endogenous. In the CGE case, although export commodity prices are given, both the factor and commodity prices of importables and non-traded goods are flexible. In these areas, prices equilibriate to clear markets and are a fundamental component of the model dynamics. Analysis of these indicators thus becomes a very important element in understanding the CGE model results.

The first indicator in Table 3.6 is the consumer price index. The results for the two models are similar except in the first period. The depressed nature of the economy, reflecting the low commodity prices of copra, requires a substantial adjustment in the economy, and both commodity and factor prices rise significantly less than in the SIO case. This increase is more readily visible in the index of value added or producer prices, which actually fall in the first period (consumer prices do not fall to the same extent due to the large volume of imports in the consumption basket). Interestingly, the rural-urban terms of trade rise in the CGE case but fall in the SIO. In the SIO model, traded activities are squeezed; as commodity prices fall with constant wages, profit margins bear the brunt of adjustment. In the CGE model, labor also shares in the adjustment process, and the real wage falls to clear the rural labor market. Profits are not squeezed to the same degree, and the rural-urban terms of trade show improvement.
The real exchange rate measures the ratio of traded to non-traded commodity prices. It is a measure of competitiveness because it reflects the ratio of international prices to domestic prices. The two models show similar outcomes, except in the initial period when the CGE model shows a real depreciation and the SIO an appreciation. Movements in prices of traded goods will be similar in the two models, and the explanation for the difference lies in the non-traded goods department. In the SIO case, prices of non-traded goods are determined through the cost-plus markup rule, and there is no room for other forces in the economy to affect the outcome. In the CGE case, there will be a relative downward movement in non-traded prices, reflecting the depressed economic conditions, which leads to a real depreciation.

Two indicators are given for the international terms of trade. The first indicator includes only goods entering international trade, while the second includes services, in particular, tourism. The commodity terms of trade are identical in both models, as expected, reflecting the small country assumption, which implies that this economy faces a given set of terms of trade. The full pressure exerted on the economy in the initial period is revealed by a massive drop of over 30 percent in the commodity terms of trade. The second indicator shows that this drop is ameliorated to a significant extent through the inclusion of the service account. Tourism prices in the present model formulation are predominantly determined by supply conditions; the demand function is relatively insensitive to prices. These factors result in tourism prices reflecting the domestic price level, which insulates the overall terms of trade movement. Surprisingly, little attempt has been made in international statistics to include the service account in the terms of trade. As the results reveal in Table 3.7, the omission can be quite misleading.
Table 3.7  Real wages and household incomes (average annual growth rates)

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th>SIO model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real wages</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ni-Vanuatu rural</td>
<td>-11.5</td>
<td>-8.6</td>
</tr>
<tr>
<td>Ni-Vanuatu urban</td>
<td>-7.8</td>
<td>-8.7</td>
</tr>
<tr>
<td>Others (mainly expatriates)</td>
<td>-0.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Household incomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural ni-Vanuatu</td>
<td>-7.7</td>
<td>-0.2</td>
</tr>
<tr>
<td>Urban low income ni-Vanuatu</td>
<td>-10.8</td>
<td>-2.2</td>
</tr>
<tr>
<td>Urban middle income ni-Vanuatu</td>
<td>-9.9</td>
<td>-3.3</td>
</tr>
<tr>
<td>Urban high income ni-Vanuatu</td>
<td>-9.6</td>
<td>-4.0</td>
</tr>
<tr>
<td>Others (mainly expatriates)</td>
<td>-4.0</td>
<td>4.1</td>
</tr>
</tbody>
</table>

Table 3.7 reveals the results of the models for the level of the real wage and the household distribution of income. For the rural economy the average real wage falls dramatically in the first period reflecting poor economic conditions. Production is also down, and real household incomes also fall. In the second period real wages continue to fall, but employment and production improve, resulting in a slight loss in real household incomes. In the final period both wages and real household incomes remain relatively unchanged. Although too much importance should not be given to the results, they are striking for a developing economy. According to our assumptions, the Vanuatu economy can expect real rural incomes to decline for a significant period of time. These results are influenced through the unfavorable terms of trade, the low level of investment, and the rapid projected population growth.

In the urban economy for ni-Vanuatu, real wages fall throughout the period, reflecting the model assumptions. Initially, there is a large pool of urban unemployed, nominal wages are fixed for unskilled labor, and as prices rise the urban real wage falls. By 1995 the urban economy has expanded to full employment, and the reduction in the urban wage is not so severe. These factors are translated into urban household incomes, which fall continuously throughout the period. The loss in urban incomes is greater than that for rural households, and it is not surprising that the projected rate of rural-urban migration is not excessive (see Table 3.2).
Although the model results are far from satisfactory for a developing country and certainly point to the need for increased foreign assistance, the policy of fixing nominal wages adopted by the Vanuatu authorities is probably a sensible one. It minimizes migration and places the emphasis on rural development, where it is most needed.

Reflecting the assumption of indexed wages of expatriate labor, real wages for this group remain more or less constant. Any deviation may be explained by the lagged structure of the indexation. Expatriate household income also includes income from business and thus differs from the wage level.
Chapter 4
Policy Analysis

This chapter discusses the main purpose of this exercise, that is, to examine the functioning of the modeling framework under alternative policy formulations. The mode of analysis compares the results of the base projection with the set generated under the different policy specifications. From a long list of possible alternatives, we discuss the effects of devaluation, wage constraint, and fiscal expansion. By these "experiments" we can examine some major tools of macroeconomic adjustment. Also examined are the consequences of including a copra price support fund in the model specification. The results are presented in comparative form; that is, the tables indicate the percentage change on the base projection, but in some cases the absolute differences are given when they are more meaningful for analysis.

4.1 Devaluation

This scenario examines the consequences of a 10 percent devaluation of the Vatu in 1988.

If the results for the CGE model are examined first in Table 4.1.1, the sec-

Table 4.1.1 GDP by activity (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsistence</td>
<td>-0.7</td>
<td>-0.3</td>
<td>0.2</td>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Primary export copra</td>
<td>-4.3</td>
<td>1.7</td>
<td>-1.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Primary export cattle</td>
<td>0.2</td>
<td>0.7</td>
<td>0.8</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Primary export other</td>
<td>1.7</td>
<td>1.7</td>
<td>0.4</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Primary other</td>
<td>-1.3</td>
<td>0.0</td>
<td>1.1</td>
<td>-0.7</td>
<td>-0.2</td>
<td>-0.2</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>1.3</td>
<td>1.5</td>
<td>-0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Building and construction</td>
<td>-0.0</td>
<td>0.1</td>
<td>0.2</td>
<td>-0.2</td>
<td>-0.1</td>
<td>-0.1</td>
</tr>
<tr>
<td>Tourism activities</td>
<td>1.7</td>
<td>0.6</td>
<td>-0.4</td>
<td>1.2</td>
<td>0.5</td>
<td>0.4</td>
</tr>
<tr>
<td>Private services</td>
<td>-1.5</td>
<td>-0.4</td>
<td>0.9</td>
<td>-2.0</td>
<td>-0.5</td>
<td>-0.3</td>
</tr>
<tr>
<td>Government activities</td>
<td>-0.1</td>
<td>-0.0</td>
<td>0.0</td>
<td>-0.0</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>GDP (constant factor cost)</td>
<td>-0.3</td>
<td>0.1</td>
<td>0.5</td>
<td>-0.7</td>
<td>-0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Real income (t of t adj GDP)</td>
<td>-3.3</td>
<td>-1.7</td>
<td>0.0</td>
<td>-3.3</td>
<td>-1.7</td>
<td>-1.8</td>
</tr>
</tbody>
</table>
toral information in the initial period produces the anticipated results. Resources are shifted toward the traded sectors away from the non-traded. In the rural cash economy the devaluation has strong expansionary effects on the copra sector with little significant change in the other primary sectors. As resources are diverted to the cash economy, through providing more rewarding prices to producers, labor is drawn out of the subsistence sector with a consequent drop in subsistence production.

The primary "other" activity shows a drop in production, reflecting that the sector is a combination of import replacing and non-traded subactivities. In Table 4.1.1, the non-traded activity dominates the result. The manufacturing sector, primarily import replacing, shows the anticipated outcome and reveals moderate expansion.

The building, construction, and government sectors show no variation, as expected, because both investment and government expenditure are exogenous and invariant to the price of foreign exchange. Tourism shows the expected results and reveals moderate expansion as the price of the product becomes more attractive to foreign tourists. Private services, a wholly non-traded sector, declines, as expected, with less attractive prices for producers.

Interestingly, the devaluation does not generate any improvement in the level of GDP. The gains from redirecting resources to the traded sectors are balanced by a reduction in the non-traded sectors. Real income shows a significant decline in 1988. Although the commodity terms of trade will reveal no change due to the devaluation, export prices, in terms of foreign currency in tourism and other services, will decline. This result is standard when the small country assumption is not valid, i.e., when the country does not face infinitely elastic demand curves in world markets for its exports. The devaluation thus leads to a decline in the terms of trade, and consequently real income declines.

Three preconditions are necessary for any devaluation to be successful: unemployed resources must exist in the economy, supply is responsive to changing prices, and wages are not indexed. All of these conditions are met. However, while there is substantial urban unemployment (about 25 percent) for the whole economy, unemployment is only about 4 percent. The model assumes full employment in the rural economy and for skilled labor in the urban; only for urban unskilled labor do we allow unemployment. The devaluation thus has the effect of redeploying resources toward the rural cash economy. In the urban economy with the depressing effects on real wages and the non-traded sectors, demand is reduced to such an extent that it com-
pensates for the gains in the rural economy. This result is surprising and sug-
gests that exchange rate policy is unlikely to be successful in stimulating pro-
duction.

We have concentrated thus far on the 1988 period. In 1991 we see a similar
set of results but with the results reduced in significance. Because the effects
of the devaluation have had time to work themselves through the economy,
the impact is reduced. This result also implies that exchange rate decrepa-
tion has only temporary effects. By 1995 the economy has reached full em-
ployment, and the impact of the devaluation is ambiguous with some export-
ing sectors declining and the non-traded activities expanding. However, as
noted, devaluation is not expected to have any benefits in a situation of full
employment.

In the SIO model the framework is insensitive to the price of foreign ex-
change except in consumption. The improved prices of producer goods for
traded goods and the reduced incentive for non-traded producers do not af-
flect supply. Traded goods activities have been projected exogenously, and
non-traded goods production matches demand. However, the devaluation re-
duces the value of the real wage because prices of imports and non-traded
goods rise relative to fixed nominal wages. This situation results in a reduced
demand for consumer goods and consequently for non-traded goods. The
consequences of a devaluation must depress output in an SIO world.

The above analysis of devaluation reveals the following information about the
likely effect in the real world. The models present two extremes. The SIO
model is short term; prices are not allowed to affect production decisions. In
the CGE case, "supply side" effects are allowed to work, and the picture pre-
sented is long term. Whichever position in the spectrum we want to focus on,
devaluation is not likely to have any positive impact on the overall level of
economic activity. In all probability the GDP will fall.

As shown in Table 4.1.2 in the CGE case, total employment expands
marginally in 1988, with greater gains in 1991 and, of course, reveals no
change in 1995 when the economy is fully employed. The reduction in urban
unemployment is more substantial because the devaluation brings more re-
sources into active use. The rural labor supply in the cash economy expands
as rural wages increase, encouraged by improved producer prices. Because
the total labor pool is fixed in any year, subsistence production will decline
residually.
Table 4.1.2  Employment, labor supply, and migration (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th></th>
<th></th>
<th>SIO model</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total employment</td>
<td>0.3</td>
<td>1.1</td>
<td>0.0</td>
<td>-0.1</td>
<td>-0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Urban unemployment</td>
<td>-6.8</td>
<td>-46.2</td>
<td>0.0</td>
<td>1.1</td>
<td>0.1</td>
<td>-0.0</td>
</tr>
<tr>
<td>Rural labor supply</td>
<td>1.7</td>
<td>0.7</td>
<td>-0.3</td>
<td>-0.1</td>
<td>-0.0</td>
<td>-0.0</td>
</tr>
<tr>
<td>Expatriate demand</td>
<td>0.3</td>
<td>-1.1</td>
<td>0.7</td>
<td>-1.0</td>
<td>-0.2</td>
<td>-0.1</td>
</tr>
<tr>
<td>Rural-urban migration</td>
<td>0.3</td>
<td>-0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>-0.2</td>
<td>0.0</td>
</tr>
</tbody>
</table>

In 1988 there is little change in rural-urban migration because migration is a lagged function. By 1991 migration is falling compared with the base run as the improved rural conditions make the rural economy more attractive. The demand for expatriates rises in 1988 and falls in 1991. The expansion in the economy will increase the demand for expatriates, but the reduced real urban wage of the ni-Vanuatu will cause substitution between expatriates and ni-Vanuatu. The combined outcome of the two different forces--expansion in the economy and reduced real urban wage--is ambiguous.

In the SIO case, the effects of the devaluation on employment all stem from the reduction in demand for non-traded goods. Employment falls, unemployment rises, and the rural labor supply falls as real wages fall. The only positive effect is on subsistence production. However, although the effects on employment are wholly negative in the SIO case, the impact is not strong. Combining the results of the two models suggests that in the real world, employment will probably rise but not by any significant extent.

The results of the devaluation on the final demands are as expected. In the CGE case, subsistence production falls because rural labor prefers to enter the rural cash economy. Private consumption also falls in the first two periods because as the urban real wage declines and reduces demand. In the last year the devaluation has the perverse result of increasing consumption through raising real urban wages. On the external side the devaluation has all the expected results in 1988 and 1991. Exports and tourism rise while imports fall. Indirect taxes also fall in sympathy with the reduction of imports. (Those elements of final demands not indicated in Table 4.1.3 show no variation in the base run.)
Table 4.1.3  Expenditure on GDP (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th></th>
<th></th>
<th>SIO model</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsistence consumption</td>
<td>-0.7</td>
<td>-0.3</td>
<td>0.2</td>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Private consumption</td>
<td>-4.3</td>
<td>-1.1</td>
<td>2.8</td>
<td>-4.6</td>
<td>-1.1</td>
<td>-0.8</td>
</tr>
<tr>
<td>Tourism</td>
<td>2.6</td>
<td>0.8</td>
<td>-0.5</td>
<td>2.0</td>
<td>0.4</td>
<td>0.2</td>
</tr>
<tr>
<td>Exports</td>
<td>2.6</td>
<td>1.3</td>
<td>-0.4</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Imports</td>
<td>-1.6</td>
<td>-0.4</td>
<td>0.9</td>
<td>-2.0</td>
<td>-0.6</td>
<td>-0.4</td>
</tr>
<tr>
<td>Less indirect taxes</td>
<td>-1.4</td>
<td>-0.3</td>
<td>1.0</td>
<td>-2.1</td>
<td>-0.6</td>
<td>-0.4</td>
</tr>
<tr>
<td>GDP (factor cost)</td>
<td>-0.3</td>
<td>0.1</td>
<td>0.5</td>
<td>-0.7</td>
<td>-0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

The results of the SIO model are very similar in magnitude to those of the CGE but generally stronger. The only significant difference is in the level of exports. In the SIO case, exports are all traded goods whose output levels are fixed. The devaluation reduces the small amount of domestic demand, making slightly more goods available for export.

As shown in Table 4.1.4, the outcome for the government budget is similar in both models, and the results are mixed. Indirect taxes rise, and although they are nearly all levied on imports, they do not rise to the extent of the devaluation. This is due to two forces: (1) import demand is reduced; and (2) while most import duties are ad valorem, some are specific. Budgetary aid is linked to the CPI and therefore will mirror the rise in the CPI. Government final

Table 4.1.4  Government budget (percent difference on base run)*

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th></th>
<th></th>
<th>SIO model</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect tax income</td>
<td>4.8</td>
<td>6.6</td>
<td>8.9</td>
<td>4.3</td>
<td>6.5</td>
<td>7.0</td>
</tr>
<tr>
<td>Budgetary aid</td>
<td>5.8</td>
<td>8.0</td>
<td>10.6</td>
<td>7.3</td>
<td>8.8</td>
<td>9.0</td>
</tr>
<tr>
<td>Other income</td>
<td>3.4</td>
<td>7.3</td>
<td>12.4</td>
<td>5.4</td>
<td>8.0</td>
<td>8.4</td>
</tr>
<tr>
<td>Government final expenditure</td>
<td>1.2</td>
<td>6.8</td>
<td>12.7</td>
<td>2.1</td>
<td>7.1</td>
<td>7.8</td>
</tr>
<tr>
<td>Other recurrent expenditures</td>
<td>8.3</td>
<td>9.1</td>
<td>10.0</td>
<td>8.7</td>
<td>9.3</td>
<td>9.4</td>
</tr>
<tr>
<td>Recurrent balance</td>
<td>1866</td>
<td>336</td>
<td>-2629</td>
<td>1949</td>
<td>388</td>
<td>329</td>
</tr>
<tr>
<td>Government investment</td>
<td>7.3</td>
<td>8.6</td>
<td>10.5</td>
<td>8.0</td>
<td>8.8</td>
<td>9.0</td>
</tr>
<tr>
<td>Overall balance</td>
<td>1248</td>
<td>-602</td>
<td>-4091</td>
<td>1243</td>
<td>-621</td>
<td>-980</td>
</tr>
</tbody>
</table>

* The overall and recurrent balance in this table are not shown in percentage change terms but rather as the absolute difference between the "experiment" and the base projection.
expenditure largely reflects the rise in prices of the import component of final expenditure and thus does not rise significantly in the initial period because the major element of expenditure is wages. In the later period, because the impact of the devaluation is largely transformed into inflation, final expenditure rises in line with prices.

In summary, the recurrent budget improves in the first two periods with the devaluation but actually deteriorates in 1995 in the CGE case as inflationary pressure mounts. Although the overall balance improves in 1988, it deteriorates in 1991 and 1995. Public investment has a large import component and thus tends to rise in nominal terms faster than other elements of the budget. The gains in the current account become eroded overall. These results for the overall balance in the CGE case are ambiguous. Even when the conditions for a successful devaluation exist as in 1991, the results for the public sector deficit are not always positive.

The main difference between the two models in Table 4.1.5 in the balance of payments lies in the level of exports. In the CGE case, exports of exportables rise in the early periods in line with the expansion of the copra production. In the SIO case, the expansion is due to a reduction in domestic demand for exportables rather than to any increase in production. Exports of non-tradables and importables decline in terms of foreign exchange. Although these exports are projected exogenously and remain unchanged in real terms, the export price is different in the two models. The export price of these commodities is the domestic price times the rate of exchange. Because the rate of depreciation is greater than the rise in domestic prices, these exports decline. How-

Table 4.1.5 Balance of payments (percent difference on base run)*

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th>SIO model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exports (exportables)</td>
<td>3.9</td>
<td>2.0</td>
</tr>
<tr>
<td>Exports (n-tbles &amp; importibs)</td>
<td>-5.7</td>
<td>-1.6</td>
</tr>
<tr>
<td>Imports (importables)</td>
<td>-2.9</td>
<td>-1.0</td>
</tr>
<tr>
<td>Imports (non-competitive)</td>
<td>-1.3</td>
<td>-0.2</td>
</tr>
<tr>
<td>Tourism earnings</td>
<td>-2.1</td>
<td>-1.1</td>
</tr>
<tr>
<td>Re-exports</td>
<td>-3.2</td>
<td>-2.0</td>
</tr>
<tr>
<td>Current account balance</td>
<td>2111</td>
<td>570</td>
</tr>
</tbody>
</table>

* The current account balance in this table is not shown in percentage change terms but rather as the absolute difference between the "experiment" and the base projection.
ever, the decline is sharper in the CGE case because domestic inflation is less (see Table 4.1.6).

Imports of importables are treated differently in the two models. In the SIO case, imports of importables are perfect substitutes for domestically produced importables. In the CGE model they are not, and we include product differentiation in the formulation allowing less than infinite substitution. Imports of importables fall in both models but to a greater extent in the SIO, reflecting both the higher elasticity and the stronger reduction in demand.

Non-competitive imports complement domestic production and fall with the devaluation because they become more expensive to consumers in domestic currency (and production declines in the SIO case). However, the reduction in non-competitive imports is less than with imports of importables, which suggests an element of import replacement. As prices of importables become more expensive, consumers switch to the domestic counterparts.

Interestingly, tourism foreign exchange earnings actually fall with the devaluation. While real demand for tourism rises (Table 4.1.3), the volume of receipts actually falls because the export price of tourism in foreign exchange falls more than the rise in production. The importance of this perverse result suggests careful econometric estimation of the elasticities in the tourism demand function. If the parameters selected for the models are at all reflective of real world conditions, devaluation would not seem a sensible policy to generate foreign exchange when viewed from a tourism perspective.

Re-exports fall in terms of foreign exchange. While most of the value of re-exports is attributable to non-competitive imports, a certain element of the value is expended on local distribution and warehousing costs. This element declines in terms of foreign exchange, and so the total value of re-exports falls.

Finally, and of most importance, the cumulative effect of the devaluation on the current account of the balance of payments is positive, except in 1995 when there is full employment and the depreciation has negative effects.

In Table 4.1.6, the two models show similar directional changes in prices. In general, the different results of the two models can be interpreted through the effect of the devaluation on prices of non-traded goods. In the SIO case, producers pass on the full increase in import costs. In the CGE case, producers absorb some of the cost increases as demand falls. We thus expect that
Policy Analysis

Table 4.1.6  Price indexes (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th></th>
<th>SIO model</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer prices</td>
<td>5.8</td>
<td>8.0</td>
<td>10.6</td>
<td>7.3</td>
</tr>
<tr>
<td>Value added prices</td>
<td>0.7</td>
<td>6.6</td>
<td>13.3</td>
<td>3.8</td>
</tr>
<tr>
<td>Rural-urban terms of trade</td>
<td>12.6</td>
<td>4.0</td>
<td>-4.6</td>
<td>8.0</td>
</tr>
<tr>
<td>Real exchange rate</td>
<td>7.2</td>
<td>2.3</td>
<td>-2.6</td>
<td>4.9</td>
</tr>
<tr>
<td>Commodity terms of trade</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Terms of trade (inc services)</td>
<td>-7.6</td>
<td>-4.9</td>
<td>-2.0</td>
<td>-6.3</td>
</tr>
</tbody>
</table>

Consumer prices will rise more in the SIO case and that the changes in the rural-urban terms of trade and real exchange rate will be stronger in the CGE.

Table 4.1.6 indicates that the devaluation has a strong initial effect on consumer prices. This is not surprising given the high level of consumption imports in Vanuatu, which would also be true of most South Pacific island nations. By 1991 and 1995 the level of rise in the consumer price index matches that of the devaluation, indicating that all the benefits of the depreciation have been eroded in the rising prices.

Value added prices show little change initially in the CGE case. While the value added prices of the traded sectors rise, those in the non-traded sectors will fall. In 1988 an average of 1 and 4 percent will be yielded for the two models, respectively. By 1991 and 1995 value added prices in the non-traded sectors have also risen.

Because most of the traded sectors are in the rural economy, the strong effects on the rural-urban terms of trade (the ratio of value added prices in the rural to urban areas) are not surprising. The real exchange rate (the measure of traded commodity prices to non-traded) reveals a similar but less dramatic change. Clearly, an important initial depreciation occurs in the economy, but as the prices of non-traded commodities catch up in 1991 and 1995, the benefits of the devaluation have been eroded.

The commodity terms of trade indicate no change in accord with the small country assumption, but as discussed, the devaluation results in deteriorating terms of trade when services are included. This effect occurs because the foreign exchange cost of these exports falls, while no compensation reduction
occurs in import prices. For services, the small country assumption does not hold, and the country faces the normal downward sloping demand curve.

The two models in Table 4.1.7 show different results for wages. In the CGE case, rural wages rise quite strongly as production increases in the copra sector and demand for labor increases. In the SIO model this effect is absent, nominal wages remain constant by assumption, and real wages fall as consumer prices rise. Urban real wages fall in both models because the nominal wage of unskilled labor is fixed and consumer prices are rising. Expatriate wages also decline, but this result is the consequence of the lagged structure in the indexing formula.

As shown in Table 4.1.8, the effects of the devaluation on the household distribution of income are marked and stronger in the CGE case. Rural households benefit initially, to the detriment of the urban. Clearly, devaluation is an important tool in redistribution policy, provided the benefits are sustained and not eroded as in this case.

In conclusion to this section, devaluation has an interesting set of divergent consequences for this economy. Not all the results are standard; GDP actu-

**Table 4.1.7 Real wages (percent difference on base run)**

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th></th>
<th>SIO model</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ni-Vanuatu rural</td>
<td>10.8</td>
<td>4.2</td>
<td>-2.8</td>
<td>-6.7</td>
</tr>
<tr>
<td>Ni-Vanuatu urban</td>
<td>-8.4</td>
<td>-8.0</td>
<td>3.2</td>
<td>-6.8</td>
</tr>
<tr>
<td>Others (mainly expatriates)</td>
<td>-6.6</td>
<td>-0.9</td>
<td>2.2</td>
<td>-6.4</td>
</tr>
</tbody>
</table>

**Table 4.1.8 Household incomes (percent difference on base run)**

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th></th>
<th>SIO model</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban low income ni-Vanuatu</td>
<td>-5.4</td>
<td>-0.7</td>
<td>3.2</td>
<td>-3.6</td>
</tr>
<tr>
<td>Urban middle income ni-Vanuatu</td>
<td>-5.6</td>
<td>-1.4</td>
<td>3.0</td>
<td>-5.7</td>
</tr>
<tr>
<td>Urban high income ni-Vanuatu</td>
<td>-5.6</td>
<td>-2.2</td>
<td>2.8</td>
<td>-5.4</td>
</tr>
<tr>
<td>Rural ni-Vanuatu</td>
<td>6.2</td>
<td>2.5</td>
<td>-1.0</td>
<td>0.2</td>
</tr>
<tr>
<td>Others (mainly expatriates)</td>
<td>-6.4</td>
<td>-1.7</td>
<td>1.1</td>
<td>-5.0</td>
</tr>
</tbody>
</table>
ally falls in the CGE case after the initial devaluation, although only marginally. Other effects are more standard with the usual consequences on the traded and non-traded sectors of the economy. The consequences for income distribution are also important. However, the longer-term aspects of the depreciation suggest caution in the use of this powerful instrument of economic policy. By 1995 many beneficial aspects have been eroded and actually become negative in the CGE case.

4.2 Wage Indexation

This scenario examines the consequences of indexation of ni-Vanuatu wages to the last period's increase in consumer prices. In the SIO model, all categories of ni-Vanuatu wages are indexed. In the CGE case, only urban unskilled wages are indexed because wages for all other categories are determined through market clearing.

If the CGE model is examined first, the results of wage indexation are the reverse of devaluation (Table 4.2.1). The output of traded activities falls while non-traded goods production rises. In the rural sector (largely export oriented) the costs of production rise as the increases in urban wages filter through the system. Rural output falls with declining profitability, and rural wages fall as the demand for labor is reduced. With the reduction of the real rural wage, labor returns to the subsistence economy where output rises.

Table 4.2.1 GDP by activity (percent difference on base run)

<table>
<thead>
<tr>
<th>Activity</th>
<th>CGE model</th>
<th>SIO model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsistence</td>
<td>0.0</td>
<td>0.7</td>
</tr>
<tr>
<td>Primary export copra</td>
<td>-0.3</td>
<td>-5.8</td>
</tr>
<tr>
<td>Primary export cattle</td>
<td>-0.1</td>
<td>-0.7</td>
</tr>
<tr>
<td>Primary export other</td>
<td>-0.2</td>
<td>-4.2</td>
</tr>
<tr>
<td>Primary other</td>
<td>0.2</td>
<td>1.5</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>-0.2</td>
<td>-4.0</td>
</tr>
<tr>
<td>Building and construction</td>
<td>-0.0</td>
<td>-0.2</td>
</tr>
<tr>
<td>Tourism activities</td>
<td>-0.1</td>
<td>-2.0</td>
</tr>
<tr>
<td>Private services</td>
<td>0.1</td>
<td>2.2</td>
</tr>
<tr>
<td>Government activities</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td>GDP (constant factor cost)</td>
<td>0.0</td>
<td>0.4</td>
</tr>
<tr>
<td>Real income (t of t adj GDP)</td>
<td>0.1</td>
<td>3.3</td>
</tr>
</tbody>
</table>
Urban traded activities (manufacturing and tourism) become less competitive as costs increase and output falls. Private services production (a non-traded sector) rises as demand increases from the additional pay awards created by the indexation. This increase is sufficiently strong to override all the other negative effects and leads to an increase in GDP. The effect on the terms of trade adjusted GDP is even stronger because the world prices of exports of services rise.

The results of the SIO model are similar, but the mechanism of transmission is different. In this case, there is no change in traded goods production (which is fixed by assumption), but production of non-traded goods rises to meet the additional demand. The overall effect on GDP is consequently stronger. The only sector sensitive to prices is tourism where output falls in the CGE case when losses occur in competitiveness. Subsistence production also falls because increased demand for non-traded agricultural production pulls rural labor out of the subsistence sector.

In the CGE case, wage indexation has positive effects for some sectors and negative effects for most, although the overall result is an increase in GDP. In the SIO model the negative effects are largely absent.

The results of the two models for employment in Table 4.2.2 are radically different and reflect their structural differences. In the CGE case, the demand for labor is affected by the level of wages, whereas it is not in the SIO. In the CGE case, the consequences for employment are disastrous. The rate

| Table 4.2.2 Employment, labor supply, and migration (percent difference on base run) |
|----------------------------------|-------|-------|-------|-------|-------|-------|
| Total employment                 | -0.2  | -2.9  | -7.3  | 0.0   | 0.2   | 0.2   |
| Rural labor supply               | -0.1  | -2.2  | -6.4  | 0.1   | 0.4   | 0.5   |
| Urban labor supply               | 0.0   | 0.7   | 4.3   | 0.0   | 0.1   | 0.2   |
| Expatriate demand                | 0.2   | 4.6   | 10.1  | 0.6   | 3.0   | 4.0   |
| Rural-urban migration            | 1.5   | 12.2  | 51.0  | 0.0   | 1.3   | 1.6   |
| Rate of urban unemployment       | 27.1  | 29.0  | 36.0  | 27.5  | 25.9  | 34.7  |
| Base run                         | 26.2  | 13.4  | 0.0   | 27.6  | 26.7  | 35.6  |

*The rates of urban unemployment are actual rates and percentage changes of the base projection. The base projection rates are also included for comparison.
of urban unemployment increases from 27 percent in 1988 to 36 percent in 1995; in the base run, urban unemployment was eliminated by 1995. The higher level of urban wages attracts rural labor out of the rural economy and increases migration by 51 percent compared with the base rate. The number of workers entering the rural labor market also declines significantly. As the cost of ni-Vanuatu urban labor becomes more expensive, employment of expatriates becomes more attractive, and the number employed rises.

The SIO model tells a different story. Reflecting the changes in output, the demand for labor will increase in most non-traded activities, except tourism. Consequently, unemployment falls although the model suggests that the drop is not substantial. Clearly, increases in demand from the private services sector are depressed by a reduction in tourism. According to the assumptions adopted for the SIO model, both rural and urban wages are indexed equally, and there is no reason for any emerging differential between them. Given the small change in urban unemployment, people do not have a strong incentive to migrate.

Clearly, proper empirical measurement of the key parameters in the CGE model is essential here, but if the results are at all reflective of real world conditions, this model (through wage indexation) highlights the disastrous consequences for employment, migration, and urban poverty. If the readers feel that producers in the real world are not as sensitive to the level of wages as the CGE model suggests, they can follow the projections of the SIO case, but they may be unwise to do so.

As shown in Table 4.2.3, the results of these experiments on the final demand side of the picture reflect the major impact of the indexation process on con-

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th></th>
<th></th>
<th>SIO model</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsistence consumption</td>
<td>0.0</td>
<td>0.7</td>
<td>1.3</td>
<td>-0.0</td>
<td>-0.3</td>
<td>-0.5</td>
</tr>
<tr>
<td>Private consumption</td>
<td>0.3</td>
<td>7.0</td>
<td>19.9</td>
<td>3.1</td>
<td>17.1</td>
<td>21.8</td>
</tr>
<tr>
<td>Stock taking</td>
<td>0.0</td>
<td>0.1</td>
<td>0.5</td>
<td>0.5</td>
<td>2.4</td>
<td>3.1</td>
</tr>
<tr>
<td>Tourism</td>
<td>-0.2</td>
<td>-3.0</td>
<td>-6.5</td>
<td>-0.9</td>
<td>-3.4</td>
<td>-2.7</td>
</tr>
<tr>
<td>Tourism</td>
<td>-0.2</td>
<td>-4.1</td>
<td>-11.7</td>
<td>-0.2</td>
<td>-1.0</td>
<td>-1.2</td>
</tr>
<tr>
<td>Exports</td>
<td>0.1</td>
<td>2.4</td>
<td>6.6</td>
<td>1.4</td>
<td>7.4</td>
<td>8.5</td>
</tr>
<tr>
<td>Imports</td>
<td>0.1</td>
<td>2.4</td>
<td>6.8</td>
<td>1.6</td>
<td>7.9</td>
<td>8.8</td>
</tr>
<tr>
<td>GDP (factor cost)</td>
<td>0.0</td>
<td>0.5</td>
<td>1.4</td>
<td>0.5</td>
<td>2.6</td>
<td>3.4</td>
</tr>
</tbody>
</table>
sumption, which rises directly from the increased purchasing power of wage earners. Reflecting the additional demand in the system, both imports and indirect taxes show a strong upward movement. However, the impact on exports is quite different in the two models. With traded goods production fixed in the SIO model, exports show little variation. In the CGE case, the exports fall in line with the reduction in the production levels of traded goods. The impact on tourism is also stronger in the CGE case, reflecting the more dominant price effects.

The two models in Table 4.2.4 show the same facts for the government budget. Wages form the large majority of government expenditure, and the indexation has disastrous consequences. Some additional revenue is generated from the extra indirect tax collections, but it is nowhere nearly sufficient to compensate for the additional wage bill. The cost of government investment also rises as the cost of building and construction increases. By 1995 the overall deficit is so large that adjustment would have long ago been forced on the unfortunate population.

As with the deterioration in the government account, the balance of payments also shows signs of disaster (Table 4.2.5). In the CGE case, exports of exportables fall in line with the reduction of real exports given in Table 4.2.3 above. In the SIO case, as already noted, exports do not fall by any significant amount, reflecting the assumptions of the model. Exports of non-tradables (fixed exogenously) rise in terms of foreign exchange as domestic prices rise. The price effects of the indexation are stronger in the CGE case (Table 4.2.6), which these results reflect.

Table 4.2.4 Government budget (percent difference on base run)*

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th></th>
<th>SIO model</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect tax income</td>
<td>0.2</td>
<td>3.7</td>
<td>10.9</td>
<td>1.8</td>
</tr>
<tr>
<td>Budgetary aid</td>
<td>0.2</td>
<td>4.4</td>
<td>12.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Other incomes</td>
<td>0.4</td>
<td>8.5</td>
<td>26.6</td>
<td>2.2</td>
</tr>
<tr>
<td>Government final expenditure</td>
<td>0.4</td>
<td>10.5</td>
<td>31.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Other recurrent expenditure</td>
<td>0.1</td>
<td>1.6</td>
<td>4.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Recurrent balance</td>
<td>-112</td>
<td>-3774</td>
<td>-15199</td>
<td>-1418</td>
</tr>
<tr>
<td>Government investment</td>
<td>0.2</td>
<td>3.7</td>
<td>10.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Overall balance</td>
<td>-129</td>
<td>-4182</td>
<td>-16604</td>
<td>-1517</td>
</tr>
</tbody>
</table>

* The overall and recurrent balance in this table are not shown in percentage change terms but rather as the absolute difference between the "experiment" and the base projection.
Table 4.2.5  Balance of payments (percent difference on base run)*

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th>SIO model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exports (exportables)</td>
<td>-0.3</td>
<td>-5.9</td>
</tr>
<tr>
<td>Exports (n-tbles &amp; importbts)</td>
<td>0.3</td>
<td>7.5</td>
</tr>
<tr>
<td>Imports (importables)</td>
<td>0.2</td>
<td>4.9</td>
</tr>
<tr>
<td>Imports (non-competitive)</td>
<td>0.1</td>
<td>1.9</td>
</tr>
<tr>
<td>Tourism earnings</td>
<td>0.1</td>
<td>3.7</td>
</tr>
<tr>
<td>Re-exports</td>
<td>0.1</td>
<td>2.6</td>
</tr>
<tr>
<td>Current account balance</td>
<td>-158</td>
<td>-4529</td>
</tr>
</tbody>
</table>

* The current account balance in this table is not shown in percentage change terms but rather as the absolute difference between the "experiment" and the base projection.

Imports of non-competitive imports rise with the increased domestic demand, which is stronger in the SIO case. However, imports of importables rise much faster because consumers substitute cheaper imports for domestic goods. Ironically, tourism demand rises in terms of foreign exchange although the real level of production of tourism services falls; domestic prices rise faster than the fall in demand. The final outcome for the current account of the balance of payments is unsustainable and disastrous.

As shown in Table 4.2.6, the increased cost of urban wages feeds back directly into consumer prices and value added prices and causes a deterioration in the rural-urban terms of trade. The impact of the indexation on prices is generally stronger in the CGE case. Reflecting both the deteriorating balance of payments position and the reduced competitiveness in the economy, the real exchange rate falls. Although the commodity terms of trade remain unchanged, the terms of trade including service exports improves.

Table 4.2.6  Price indexes (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th>SIO model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer prices</td>
<td>0.2</td>
<td>4.4</td>
</tr>
<tr>
<td>Value added prices</td>
<td>0.5</td>
<td>12.0</td>
</tr>
<tr>
<td>Rural-urban terms of trade</td>
<td>-0.8</td>
<td>-14.8</td>
</tr>
<tr>
<td>Real exchange rate</td>
<td>-0.4</td>
<td>-8.8</td>
</tr>
<tr>
<td>Commodity terms of trade</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Terms of trade (inc services)</td>
<td>0.3</td>
<td>5.9</td>
</tr>
</tbody>
</table>
Real rural wages fall in the CGE case as a consequence of depressed conditions in the rural economy and rising prices in the urban areas (Table 4.2.7). Urban wages clearly demonstrate the impact of the indexation on urban unskilled labor. In the SIO case, rural wages are also indexed by assumption and consequently show no real deterioration but rise in line with the urban increase. Expatriate wages are indexed in the base projection, and the changes reveal alterations in the sectoral employment of labor and the lagged structure of the indexation process.

As shown in Table 4.2.8, the effects on the household distribution of income match those of the increases in real wages. In the CGE case, rural incomes fall while urban ones rise; in the SIO model both rise but less so in the rural areas.

Apart from the obvious desirable feature of increasing income, the wage scenario described here has little to recommend it. In the CGE case, GDP shows marginal improvement, urban unemployment grows rapidly, urban migration increases, the government and external accounts become unsustainable, and the consequences for the distribution of income are adverse. In the SIO model the consequences for unemployment and migration are not as serious, but there is little quantitative difference in the results for the government and external budget.

In some respect, it is difficult to compare the results of the two models due to their different assumptions. The SIO model is indexed for all wage groups, while the CGE is effectively indexed only for urban unskilled labor. The results could be made more compatible through appropriate modification in the respective formulations, but the essential message would remain unaltered. While the choice of parameters for the CGE model gives cause for caution, the real world picture must lie somewhere between the two scenarios described.

Table 4.2.7  Real wages (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th>SIO model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ni-Vanuatu rural</td>
<td>-0.8</td>
<td>-12.8</td>
</tr>
<tr>
<td>Ni-Vanuatu urban</td>
<td>1.5</td>
<td>31.0</td>
</tr>
<tr>
<td>Others (mainly expatriates)</td>
<td>0.2</td>
<td>5.0</td>
</tr>
</tbody>
</table>
Table 4.2.8  Household incomes (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th></th>
<th></th>
<th>SIO model</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban low income ni-Vanuatu</td>
<td>0.2</td>
<td>6.1</td>
<td>14.5</td>
<td>4.4</td>
<td>23.3</td>
<td>28.3</td>
</tr>
<tr>
<td>Urban middle income ni-Vanuatu</td>
<td>0.3</td>
<td>7.6</td>
<td>18.0</td>
<td>7.2</td>
<td>40.8</td>
<td>51.4</td>
</tr>
<tr>
<td>Urban high income ni-Vanuatu</td>
<td>0.4</td>
<td>9.9</td>
<td>23.1</td>
<td>6.8</td>
<td>38.4</td>
<td>47.8</td>
</tr>
<tr>
<td>Rural ni-Vanuatu</td>
<td>-0.6</td>
<td>-7.6</td>
<td>-18.8</td>
<td>1.7</td>
<td>7.1</td>
<td>7.7</td>
</tr>
<tr>
<td>Others (mainly expatriates)</td>
<td>0.3</td>
<td>8.1</td>
<td>20.0</td>
<td>-0.9</td>
<td>0.6</td>
<td>2.5</td>
</tr>
</tbody>
</table>

4.3 Fiscal Expansion

This scenario examines the consequences of an increase in government expenditure of 1, 3, and 6 percent in 1988, 1991, and 1995, respectively. As with the wage indexation experiment, we notice that the experiment is expansionary and has many similar consequences, but also it has the merit of creating jobs rather than reducing them. The key to interpreting this set of results is that fiscal expansion has inflationary consequences in the CGE model but none in the SIO.

As shown in Table 4.3.1, the experiment has negative effects on the exporting sectors in the CGE case, while it encourages the output of the import re-

Table 4.3.1  GDP by activity (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th></th>
<th></th>
<th>SIO model</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsistence</td>
<td>0.0</td>
<td>0.2</td>
<td>0.6</td>
<td>-0.0</td>
<td>-0.0</td>
<td>-0.1</td>
</tr>
<tr>
<td>Primary export copra</td>
<td>-0.4</td>
<td>-1.8</td>
<td>-5.3</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Primary export cattle</td>
<td>-0.1</td>
<td>-0.3</td>
<td>-1.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Primary export other</td>
<td>-0.1</td>
<td>-0.5</td>
<td>-2.3</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Primary other</td>
<td>0.3</td>
<td>0.9</td>
<td>2.2</td>
<td>0.0</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>0.2</td>
<td>0.7</td>
<td>0.2</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Building and construction</td>
<td>0.1</td>
<td>0.2</td>
<td>0.5</td>
<td>0.0</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Tourism activities</td>
<td>-0.0</td>
<td>-0.2</td>
<td>-0.7</td>
<td>0.1</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Private services</td>
<td>0.5</td>
<td>2.0</td>
<td>4.9</td>
<td>0.3</td>
<td>1.3</td>
<td>2.6</td>
</tr>
<tr>
<td>Government activities</td>
<td>0.7</td>
<td>2.9</td>
<td>6.2</td>
<td>0.7</td>
<td>2.9</td>
<td>6.2</td>
</tr>
<tr>
<td>GDP (constant factor cost)</td>
<td>0.4</td>
<td>1.5</td>
<td>3.3</td>
<td>0.3</td>
<td>1.3</td>
<td>2.8</td>
</tr>
<tr>
<td>Real income (t of t adj GDP)</td>
<td>0.6</td>
<td>2.6</td>
<td>6.4</td>
<td>0.4</td>
<td>1.6</td>
<td>3.6</td>
</tr>
</tbody>
</table>
placing and non-traded activities. The additional demand generated pushes up domestic prices and costs. In the exporting sectors, rising domestic costs discourage production and drive down wages in the rural economy. As wages decline the rural labor supply falls, and subsistence production rises. In summary, GDP rises, and real income rises faster with the export prices of services increasing faster than import prices.

In the SIO case, the rise in government expenditure increases the demand for non-traded goods, and production rises. There is no fall in the traded department of the economy by definition. However, the overall impact on GDP is surprisingly not as strong as in the CGE case, where it has inflationary consequences and generates additional demand for private services.

As in the indexation case, employment reacts more strongly in the CGE model (Table 4.3.2). Urban unemployment falls significantly through the additional activity generated by expansion in government services. By 1995, however, there is no increase because the economy is already fully employed.

Urban wages rise in the skilled sectors because the additional demand pushes up rates. Falling unemployment and higher wages encourage rural-urban migration, and the rural labor supply falls as the urban rises. Unemployment is significantly reduced in 1991 compared with the base run. The demand for expatriates rises as government activities (which are a heavy user of foreign labor) increase and as the cost of expatriates falls relative to ni-Vanuatu.

In the SIO model the results are not nearly so dramatic, but a significant reduction occurs in urban unemployment.

Table 4.3.2 Employment, labor supply, and migration (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th></th>
<th></th>
<th>SIO model</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total employment</td>
<td>0.1</td>
<td>0.5</td>
<td>0.1</td>
<td>0.1</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Rural labor supply</td>
<td>-0.1</td>
<td>-0.5</td>
<td>-1.7</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td>Urban labor supply</td>
<td>-0.0</td>
<td>0.1</td>
<td>0.4</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td>Expatriate demand</td>
<td>0.6</td>
<td>2.2</td>
<td>6.3</td>
<td>0.3</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Rural-urban migration</td>
<td>0.3</td>
<td>3.4</td>
<td>4.6</td>
<td>0.0</td>
<td>0.4</td>
<td>0.6</td>
</tr>
<tr>
<td>Urban unemployment</td>
<td>-1.9</td>
<td>-19.3</td>
<td>0.0</td>
<td>-1.0</td>
<td>-3.8</td>
<td>-5.2</td>
</tr>
</tbody>
</table>
As shown in Table 4.3.3, the results on the expenditure side of GDP are to be anticipated, and they follow a pattern similar to those of the indexation scenario. Interestingly, in the CGE model, private consumption rises faster than the growth in government consumption. This result is dependent on the cost pressure building up on urban wages. Wages are proportionately pushed up more than the increase in government expenditure, particularly in 1995 when the economy is fully employed. The other results are standard; exports and tourism fall, and imports and indirect taxes rise.

There are no surprises for the government budget! The rise in final expenditures swamps all other movements. The outcome is unmanageable, and adjustment is inevitable. However, the results are much stronger in the CGE case. The increase in government expenditures has inflationary consequences in the CGE model, whereas the SIO counterpart has none. In the latter, wages are fixed by assumption, whereas in the former, wages rise with the additional demand created. This rise in wages pushes up the nominal cost of government expenditure, together with the actual increase in real consumption. The inflationary element in the CGE model is reflected in Table 4.3.4 as the difference between the CGE and SIO results for final government expenditure.

As shown in Table 4.3.5, the results are anticipated and reflect the pattern in the government budget. In the CGE case, exports fall, but exports of non-tradables and importables rise in terms of current foreign exchange values because these exports are exported at domestic prices. Imports of non-competitive imports rise but not as fast as those of imports of importables. In the latter case, as domestic prices rise, imports are substituted for domestic goods. Perversely, as in the indexation case, tourism earnings rise although

Table 4.3.3 Expenditure on GDP (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th>SIO model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private consumption</td>
<td>0.8</td>
<td>3.6</td>
</tr>
<tr>
<td>Government consumption</td>
<td>0.7</td>
<td>3.0</td>
</tr>
<tr>
<td>Stock taking</td>
<td>0.4</td>
<td>1.6</td>
</tr>
<tr>
<td>Tourism</td>
<td>-0.1</td>
<td>-0.5</td>
</tr>
<tr>
<td>Exports</td>
<td>-0.2</td>
<td>-1.2</td>
</tr>
<tr>
<td>Imports</td>
<td>0.4</td>
<td>1.9</td>
</tr>
<tr>
<td>Less indirect taxes</td>
<td>0.4</td>
<td>1.5</td>
</tr>
<tr>
<td>GDP (factor cost)</td>
<td>0.4</td>
<td>1.6</td>
</tr>
</tbody>
</table>
the real level of activity falls. The overall impact on the balance of payments is disastrous, necessitating adjustment.

In the SIO model no associated price effect is associated with the fiscal expansion. Consequently, we see no increase in foreign exchange terms for exports of non-tradables or tourism. Exports of exportables fall marginally as a larger proportion of production is directed to the home market. Production of tradables, of course, remains unaltered. The demand for imports is less dramatic and reflects the lower level of private consumption compared with the CGE case. In summary, however, the balance of payments deteriorates seriously.

These results clearly indicate the essential difference between the two models in the impact of fiscal expansion; there are strong price effects in the CGE case and none in the SIO (Table 4.3.6). The CPI rises and value added prices increase significantly. The rural-urban terms of trade deteriorate, reflecting the increase in urban prices in the non-traded sectors and the effects of increasing rural production costs given fixed world commodity prices. This pattern is mirrored in the real exchange rate, which emphasizes that the economy has become less competitive and that an effective appreciation has occurred. The terms of trade, including services, improve as the export price of services rises.

As shown in Table 4.3.7, this experiment has no effect on wages in the SIO model, but the results reflect the change in sectoral use of labor. Our comments are restricted to the CGE model. The effect of the wage increase is

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th>SIO model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect tax income</td>
<td>0.4</td>
<td>1.7</td>
</tr>
<tr>
<td>Budgetary aid</td>
<td>0.3</td>
<td>1.1</td>
</tr>
<tr>
<td>Other incomes</td>
<td>0.7</td>
<td>3.0</td>
</tr>
<tr>
<td>Government final expenditure</td>
<td>1.5</td>
<td>6.6</td>
</tr>
<tr>
<td>Other recurrent expenditure</td>
<td>0.1</td>
<td>0.3</td>
</tr>
<tr>
<td>Recurrent balance</td>
<td>-568</td>
<td>-3241</td>
</tr>
<tr>
<td>Government investment</td>
<td>0.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Overall balance</td>
<td>-580</td>
<td>-3305</td>
</tr>
</tbody>
</table>

*The overall and recurrent balance in this table are not shown in percentage change terms but rather as the absolute difference between the "experiment" and the base projection.*
Table 4.3.5 Balance of payments (percent difference on base run)*

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th>SIO model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exports (exportables)</td>
<td>-0.4</td>
<td>-1.8</td>
</tr>
<tr>
<td>Exports (n-tbles &amp; importbles)</td>
<td>0.5</td>
<td>2.1</td>
</tr>
<tr>
<td>Imports (importables)</td>
<td>0.5</td>
<td>2.2</td>
</tr>
<tr>
<td>Imports (non-competitive)</td>
<td>0.4</td>
<td>1.8</td>
</tr>
<tr>
<td>Tourism earnings</td>
<td>0.1</td>
<td>0.7</td>
</tr>
<tr>
<td>Current account balance</td>
<td>-542</td>
<td>-3106</td>
</tr>
</tbody>
</table>

* The current account balance in this table is not shown in percentage change terms but rather as the absolute difference between the "experiment" and the base projection.

Interesting, not because of the significant rise in urban real ni-Vanuatu wages but rather because of the sizable drop in rural real wages, which is greater than the CPI rise. The rise in consumer prices not only erodes rural wages but also increases the rural costs of production; this process reduces the rural demand for labor and drives down wages indirectly.

As expected, the increase in government expenditure adversely affects the household distribution of income (Table 4.3.8). Rural incomes deteriorate while urban incomes rise.

As has been noted, the essential difference between the models is the treatment of inflation. Although additional demand can be expected to have inflationary consequences and the SIO model was expected to understate the case, the CGE results are striking. In the early stages of the time horizon, unemployment exists and the additional demand has less impact on inflation.

Table 4.3.6 Price indexes (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th>SIO model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer prices</td>
<td>0.3</td>
<td>1.1</td>
</tr>
<tr>
<td>Value added prices</td>
<td>0.7</td>
<td>3.3</td>
</tr>
<tr>
<td>Rural-urban terms of trade</td>
<td>-0.9</td>
<td>-4.2</td>
</tr>
<tr>
<td>Real exchange rate</td>
<td>-0.6</td>
<td>-2.7</td>
</tr>
<tr>
<td>Commodity terms of trade</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Terms of trade (inc services)</td>
<td>0.3</td>
<td>1.3</td>
</tr>
</tbody>
</table>
Table 4.3.7 Real wages (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th>SIO model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ni-Vanuatu rural</td>
<td>-1.0</td>
<td>-3.9</td>
</tr>
<tr>
<td>Ni-Vanuatu urban</td>
<td>0.7</td>
<td>2.7</td>
</tr>
<tr>
<td>Others expats</td>
<td>0.1</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Table 4.3.8 Household incomes (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th>CGE model</th>
<th>SIO model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban low income ni-Vanuatu</td>
<td>0.9</td>
<td>4.1</td>
</tr>
<tr>
<td>Urban middle income ni-Vanuatu</td>
<td>1.2</td>
<td>5.0</td>
</tr>
<tr>
<td>Urban high income ni-Vanuatu</td>
<td>1.3</td>
<td>5.2</td>
</tr>
<tr>
<td>Rural ni-Vanuatu</td>
<td>-0.3</td>
<td>-1.7</td>
</tr>
<tr>
<td>Others (mainly expatriates)</td>
<td>0.2</td>
<td>2.8</td>
</tr>
</tbody>
</table>

By 1995, however, the model economy is fully employed and the macro balance can be reached only through inflation and a balance of payments deficit. In 1988 and 1991 the inflationary impact is of the same order as the increase in expenditures. By 1995 it has doubled.

4.4 Copra Support Fund (CGE Model Only)

This scenario examines the consequences of the inclusion of a price support fund for copra. Commodity prices fluctuate significantly for many primary commodities in the South Pacific region, and some countries have developed elaborate support schemes (see Guest 1985). An interesting exercise examines the impact of such schemes using the model framework. The primary impact of stabilizing prices on the model will be to reduce fluctuations in production levels of copra. Because production levels do not respond to prices in an SIO economy, we restrict this experiment to only the CGE model.

Various specifications for the support price are possible; the most common index is to peg the support price to a moving average of the international price over some specified historical period. Without sufficient information to adopt this procedure, we have pegged the support price to the long-term in-
ternational price. This price is obtained from the price projections given in the exogenous input data. The fund operates through (1) paying bounties to growers when the international price drops below the support price and (2) collecting levies when the international price rises above the support price. The international price is below the support price in the initial period and rises above it in the last period. This results in the fund being in debt throughout the time horizon, an undesirable consequence but unimportant for our present needs.

The fund is assumed to be held by some agency (e.g., the central bank) in foreign exchange. Only when there are bounties or levies does the fund interact with the domestic economy. The monetary consequences of the fund are thus effectively sterilized from the domestic economy, although the models do not incorporate any mechanism through which monetary infusions are transmitted to the local economy.

In 1988 the support of copra prices has substantial consequences for the model (Table 4.4.1). Copra output is more than 50 percent above the level without the scheme, which creates additional demand for rural labor, bidding up wages and drawing resources away from other rural activities where profitability is reduced. Subsistence production falls as labor is attracted into the rural cash economy. In the urban sectors the increased level of domestic demand pushes up prices and production in the non-traded sectors. In the process, tourism prices also rise and production falls. GDP rises significantly by 2 percent in 1988. In 1991 and 1995 the world price rises above the support

<table>
<thead>
<tr>
<th>Table 4.4.1 GDP by activity (percent difference on base run)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1988</strong></td>
</tr>
<tr>
<td>Subsistence</td>
</tr>
<tr>
<td>Primary export copra</td>
</tr>
<tr>
<td>Primary export cattle</td>
</tr>
<tr>
<td>Primary export other</td>
</tr>
<tr>
<td>Primary other</td>
</tr>
<tr>
<td>Manufacturing</td>
</tr>
<tr>
<td>Building and construction</td>
</tr>
<tr>
<td>Tourism activities</td>
</tr>
<tr>
<td>Private services</td>
</tr>
<tr>
<td>GDP (constant factor cost)</td>
</tr>
<tr>
<td>Real income (t of t adj. GDP)</td>
</tr>
</tbody>
</table>
price, and copra producers are faced with paying levies. The model's results mirror the situation where producers were receiving bounties in 1988.

The outcome of the scheme on the employment situation is not discussed because by this stage the reader can anticipate the outcome.

The results in Table 4.4.2 are also standard; private consumption rises with the additional money flowing into the hands of the rural population in the initial period. Tourism falls as discussed above, but exports rise significantly, and imports rise to a much lesser extent. Indirect taxes also rise with the additional demand in the economy. The reverse effects occur from 1991 onward.

As shown in Table 4.4.3, for the government budget the additional tax revenue generated has a beneficial impact on the overall balance in the first period but a negative impact in the last two when demand is depressed. In this scenario the major items of expenditure are held constant, and so the budget improves as additional demand in the economy generates additional taxes. The inflationary consequences of the support scheme for the government budget are not strong enough to nullify the additional revenue.

Most of the movements in the balance of payments occur in the anticipated direction and do not require explanation (Table 4.4.4). Exports of copra are valued at international prices, and an adjustment is needed to account for the difference between the price paid to producers and the world price. This difference is assumed as a payment from the fund and is treated as a receipt in the balance of payments. However, this occurs at the cost of accumulation of foreign debt in the form of the copra support fund. The level of debt is the

| Table 4.4.2  Expenditure on GDP (percent difference on base run) |
|----------------------|--------|--------|
| Private consumption  | 4.4    | -0.7   | -4.1 |
| Stock taking         | 2.6    | -0.4   | -1.6 |
| Tourism              | -0.7   | -0.0   | 0.4  |
| Exports              | 13.2   | -1.7   | -5.8 |
| Imports              | 2.4    | -0.4   | -2.0 |
| Less indirect taxes  | 5.2    | -0.8   | -3.5 |
| GDP (factor cost)    | 2.5    | -0.3   | -1.4 |
Table 4.4.3  Government budget (percent difference on base run)*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect tax income</td>
<td>5.2</td>
<td>-1.0</td>
<td>-4.3</td>
</tr>
<tr>
<td>Government final expenditure</td>
<td>1.5</td>
<td>0.0</td>
<td>-1.8</td>
</tr>
<tr>
<td>Recurrent balance</td>
<td>913</td>
<td>-428</td>
<td>-1302</td>
</tr>
<tr>
<td>Government investment</td>
<td>0.6</td>
<td>-0.0</td>
<td>-0.7</td>
</tr>
<tr>
<td>Overall balance</td>
<td>859</td>
<td>-425</td>
<td>-1205</td>
</tr>
</tbody>
</table>

* The overall and recurrent balance in this table are not shown in percentage change terms but rather as the absolute difference between the "experiment" and the base projection.

accumulative position at the end of each period together with accrued interest at 5 percent. In the first two periods the debt rises steeply as copra prices are depressed, but by 1995 the fund is almost returned to surplus.

This analysis has evaluated the merits of the scheme through discounting the stream of benefits and costs to present values. There is a wide selection of possible evaluation measures, but in this instance we selected the gain in GDP and foreign exchange. In terms of foreign exchange the discounted value of additions to the current account less the value of the fund debt by 1995 is -$1.7 million. (Because the balance of payments is in current foreign exchange prices, we have deflated the annual benefits/costs by the rate of world inflation.)

Table 4.4.4  Balance of payments (percent difference on base run)*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Exports (exportables)</td>
<td>14.2</td>
<td>-2.3</td>
<td>-7.5</td>
</tr>
<tr>
<td>Exports (n-ables &amp; importables)</td>
<td>2.4</td>
<td>-0.2</td>
<td>-2.3</td>
</tr>
<tr>
<td>Imports (importables)</td>
<td>3.2</td>
<td>-0.6</td>
<td>-3.0</td>
</tr>
<tr>
<td>Imports (non-competitive)</td>
<td>2.2</td>
<td>-0.4</td>
<td>-1.9</td>
</tr>
<tr>
<td>Tourism earnings</td>
<td>0.5</td>
<td>0.0</td>
<td>-0.9</td>
</tr>
<tr>
<td>Re-exports</td>
<td>0.7</td>
<td>-0.1</td>
<td>-0.7</td>
</tr>
<tr>
<td>Copra support fund receipts</td>
<td>1549</td>
<td>-553</td>
<td>-2505</td>
</tr>
<tr>
<td>Current account balance</td>
<td>698</td>
<td>-379</td>
<td>-901</td>
</tr>
<tr>
<td>Copra support fund debt</td>
<td>4855</td>
<td>5983</td>
<td>734</td>
</tr>
</tbody>
</table>

* The current account balance in this table is not shown in percentage change terms but rather as the absolute difference between the "experiment" and the base projection.
In terms of GDP the discounted present value of additions to constant price GDP is $3.6 million. If the gain in GDP is added and the loss in foreign exchange is subtracted, the copra fund support scheme has net positive benefits. This evaluation has not given any account to the benefits accruing from stabilization or income distribution, which are the main advantages.

If we return now to the conventional set of indicators in Table 4.4.5, there is little impact on consumer prices. However, as the figures show, the scheme has significant impact on value added prices, particularly on the rural-urban terms of trade.

As shown in Table 4.4.6, movements in real rural wages are dramatic while little relative change occurs in urban wages. These changes are reflected in the household distribution of income.

Table 4.4.5 Price indexes (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer prices</td>
<td>1.4</td>
<td>-0.2</td>
<td>-1.4</td>
</tr>
<tr>
<td>Value added prices</td>
<td>4.6</td>
<td>-0.6</td>
<td>-4.4</td>
</tr>
<tr>
<td>Rural-urban terms of trade</td>
<td>16.3</td>
<td>-4.1</td>
<td>-9.8</td>
</tr>
<tr>
<td>Real exchange rate</td>
<td>3.5</td>
<td>-1.2</td>
<td>-2.1</td>
</tr>
<tr>
<td>Commodity terms of trade</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Terms of trade (inc. services)</td>
<td>1.3</td>
<td>0.0</td>
<td>-1.3</td>
</tr>
</tbody>
</table>

Table 4.4.6 Real wages and household incomes (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Real wages</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ni-Vanuatu rural</td>
<td>34.9</td>
<td>-7.0</td>
<td>-19.6</td>
</tr>
<tr>
<td>Ni-Vanuatu urban</td>
<td>-0.8</td>
<td>0.3</td>
<td>-1.6</td>
</tr>
<tr>
<td>Others (mainly expatriates)</td>
<td>-3.6</td>
<td>0.8</td>
<td>1.9</td>
</tr>
<tr>
<td>Household income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural ni-Vanuatu</td>
<td>23.3</td>
<td>-4.9</td>
<td>-15.9</td>
</tr>
<tr>
<td>Urban low income ni-Vanuatu</td>
<td>3.7</td>
<td>-0.4</td>
<td>-3.0</td>
</tr>
<tr>
<td>Urban middle income ni-Vanuatu</td>
<td>2.2</td>
<td>-0.2</td>
<td>-2.2</td>
</tr>
<tr>
<td>Urban high income ni-Vanuatu</td>
<td>1.8</td>
<td>-0.2</td>
<td>-2.1</td>
</tr>
<tr>
<td>Others (mainly expatriates)</td>
<td>4.8</td>
<td>0.1</td>
<td>0.6</td>
</tr>
</tbody>
</table>
In conclusion, the conventional measures of an evaluation of the scheme suggest the results are beneficial. The present value is positive although not strongly so. However, this result does not include any recognition of the major externalities, namely, stabilization of GDP and incomes, particularly in the rural areas. The merits of the system appear strong. However, a proper estimation of certain elasticities, that is, the copra supply elasticity, would be warranted before any firm conclusions are drawn.
Chapter 5
CGE Sensitivity Analysis

This chapter undertakes a set of experiments to test the sensitivity of the CGE model to changes in parameters. As discussed in Chapter 2, most parameters in the CGE model were derived from third party sources. There was little econometric estimation for the country being used as the test case, Vanuatu. Thus it is important to ascertain the sensitivity of the model results to misspecification of the parameters.

This exercise suggests areas for greatest emphasis in future statistical policy. The discussion in this paper is mainly illustrative, and the results demonstrate the feasibility of the approach and the ways these models can be used in practice. Although our main interest in the results for Vanuatu is as illustrations, the solutions here do raise the general point that often the benefits of constructing a CGE model will initially be to define the appropriate directions for statistical policy.

The following set of sensitivity tests undertakes three experiments: (1) a reduction in the elasticity of substitution of copra by 25 percent, (2) a similar reduction of 25 percent in all rural exporting sectors, and (3) an increase of 50 percent in all elasticities used to differentiate imports from domestic products (Armington elasticities).

5.1 A 25 Percent Reduction in the Elasticity of Substitution for Copra

As shown in Table 5.1.1, the impact of a 25 percent reduction in the elasticity of substitution for copra results in important changes for the rural economy.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsistence</td>
<td>-0.2</td>
<td>-0.2</td>
<td>-0.2</td>
</tr>
<tr>
<td>Primary export copra</td>
<td>3.7</td>
<td>3.2</td>
<td>3.2</td>
</tr>
<tr>
<td>Primary export cattle</td>
<td>-0.9</td>
<td>-1.0</td>
<td>-1.1</td>
</tr>
<tr>
<td>Primary export other</td>
<td>-1.3</td>
<td>-0.9</td>
<td>-0.9</td>
</tr>
<tr>
<td>Primary other</td>
<td>-0.5</td>
<td>-0.5</td>
<td>-0.4</td>
</tr>
<tr>
<td>GDP (constant factor cost)</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
</tbody>
</table>
but has little consequence for the urban economy. Copra production rises because the sector is less able to respond to the unfavorable movements in prices. With the rise in copra production, other rural activities decline because resources are redirected to the copra sector. The overall impact on GDP is minimal.

The impact of the change in parameters on the labor market, GDP by expenditure, and government budget are all negligible.

The results in Table 5.1.2 show that some expansion occurs in commodity exports, but other movements in the balance of payments accounts mean that the final impact on the current account is small. Because the impact is confined largely within the rural economy (reallocating production between activities), this impact should not be surprising.

The data in Table 5.1.3 show that the parametric shift improves rural wages and real incomes but has little consequence elsewhere.

Table 5.1.2  Balance of payments (percent difference on base run)*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Exports (exportables)</td>
<td>1.1</td>
<td>1.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Exports (n-tbles &amp; importables)</td>
<td>0.2</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Imports (importables)</td>
<td>0.2</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Imports (non-competitive)</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Current account balance</td>
<td>37</td>
<td>56</td>
<td>2</td>
</tr>
</tbody>
</table>

* The current account balance in this table is not shown in percentage change terms but rather as the absolute difference between the "sensitivity test" and the base projection.

Table 5.1.3  Real wages and household incomes (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Real wages</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ni-Vanuatu rural</td>
<td>3.8</td>
<td>5.2</td>
<td>5.1</td>
</tr>
<tr>
<td>Ni-Vanuatu urban</td>
<td>-0.1</td>
<td>-0.0</td>
<td>0.4</td>
</tr>
<tr>
<td>Household income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural ni-Vanuatu</td>
<td>1.4</td>
<td>1.7</td>
<td>1.8</td>
</tr>
<tr>
<td>Urban middle income ni-Vanuatu</td>
<td>0.1</td>
<td>0.1</td>
<td>0.3</td>
</tr>
</tbody>
</table>
5.2 A 25 Percent Reduction in the Elasticity of Substitution for Rural Exporters

This experiment is similar to the experiment in section 5.1 except all rural exporting activities have their elasticities reduced by 25 percent. Table 5.2.1 shows that the impact is directionally similar to the last experiment when only the copra elasticity was reduced; however, the results are much stronger. Copra becomes a considerably more attractive sector, and labor shifts relative to the other categories.

This result indicates that although the parametric shift affected all the important activities in the rural areas by a similar proportion, the impact was not uniform. It favored one sector in particular. Thus we must have the correct data not only for the elasticity of the leading sector but also for the other exporting rural activities.

Although the impact on rural households (Table 5.2.2) is similar to the sensitivity experiment described in section 5.1, the impact on rural wages is lower. This result is not surprising because the rural labor market comprises the set of activities whose elasticities were uniformly reduced. The impact on the rural labor market of uniform shifts in these parameters should be small.

Other results either are similar to the first case or show small variations. From the results presented here within the range of parametric variations allowed for, the consequences are serious for the outcome of the rural economy, but macroeconomically they appear less important.

Table 5.2.1 GDP by activity (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsistence</td>
<td>0.1</td>
<td>-0.2</td>
<td>-0.2</td>
</tr>
<tr>
<td>Primary export copra</td>
<td>8.4</td>
<td>5.5</td>
<td>5.8</td>
</tr>
<tr>
<td>Primary export cattle</td>
<td>-6.6</td>
<td>-6.8</td>
<td>-7.1</td>
</tr>
<tr>
<td>Primary export other</td>
<td>-3.0</td>
<td>-0.9</td>
<td>-1.4</td>
</tr>
<tr>
<td>Primary other</td>
<td>0.3</td>
<td>-0.2</td>
<td>-0.2</td>
</tr>
<tr>
<td>Private services</td>
<td>0.4</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>GDP (constant factor cost)</td>
<td>0.4</td>
<td>0.2</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Table 5.2.2  Real wages and household incomes (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Real wages</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ni-Vanuatu rural</td>
<td>1.0</td>
<td>3.1</td>
<td>3.3</td>
</tr>
<tr>
<td>Household income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural ni-Vanuatu</td>
<td>1.7</td>
<td>1.7</td>
<td>1.8</td>
</tr>
</tbody>
</table>

5.3 A 50 Percent Increase in the Armington Elasticities

This sensitivity test increases the Armington elasticities, which affect the rate of substitution between domestic and imported importables. As the elasticities rise, resources are expected to shift toward these sectors, which are largely urban, drawing labor away from the rural activities.

At the sectoral level the change in elasticities has the anticipated result for the primary import and manufacturing activities (Table 5.3.1). The increase in production in these activities draws resources away from the other activities where production falls. Overall, however, there is little impact on the level of GDP.

The effects of the parametric change are quite strong on the labor market (Table 5.3.2). The urban unemployment rate falls significantly, encouraging rural-urban migration and growth in the urban labor market. The rural labor supply expands initially but falls in the later period as the urban full employment limit is reached and labor is attracted away from the rural areas.

Table 5.3.1  GDP by activity (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsistence</td>
<td>-0.1</td>
<td>-0.4</td>
<td>-0.2</td>
</tr>
<tr>
<td>Primary export copra</td>
<td>-2.0</td>
<td>-5.1</td>
<td>-7.7</td>
</tr>
<tr>
<td>Primary export cattle</td>
<td>-0.6</td>
<td>-1.5</td>
<td>-2.0</td>
</tr>
<tr>
<td>Primary export other</td>
<td>-0.5</td>
<td>-1.1</td>
<td>-2.8</td>
</tr>
<tr>
<td>Primary other</td>
<td>2.9</td>
<td>6.1</td>
<td>8.3</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>2.5</td>
<td>5.1</td>
<td>4.4</td>
</tr>
<tr>
<td>GDP (constant factor cost)</td>
<td>0.0</td>
<td>-0.0</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Table 5.3.2  Employment, labor supply, and migration (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total employment</td>
<td>0.6</td>
<td>1.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Rural labor supply</td>
<td>0.1</td>
<td>0.3</td>
<td>-0.6</td>
</tr>
<tr>
<td>Urban labor supply</td>
<td>-0.0</td>
<td>0.6</td>
<td>1.3</td>
</tr>
<tr>
<td>Expatriate demand</td>
<td>0.1</td>
<td>0.2</td>
<td>3.0</td>
</tr>
<tr>
<td>Rural-urban migration</td>
<td>4.3</td>
<td>10.6</td>
<td>11.1</td>
</tr>
<tr>
<td>Urban unemployment</td>
<td>-12.3</td>
<td>-57.8</td>
<td>0.0</td>
</tr>
</tbody>
</table>

In constant prices Table 5.3.3 shows that the additional demand for labor pushes up consumption, particularly in the last period. The results for 1995 are similar to those of the "fiscal expansion" experiment in Chapter 4 and reveal the inflationary impact of additional demand when the economy is fully employed. Exports drop in line with the reduction in copra production, but imports also fall initially because they are replaced by domestic production, outweighing the consumption effect. In the last period the consumption effect is stronger than the substitution effect and import demand rises.

With the additional demand created for urban labor, wages rise and the government deficit deteriorates. Much the same situation is true for the balance of payments (Table 5.3.4). The general equilibrium effects on exportables is strong, but the counteractive expansion in import replacement is insufficient to outweigh the loss of foreign exchange. Tourism receipts show growth in foreign exchange, but the overall current account position is adverse.

This scenario in Table 5.3.5 has significant price effects; consumer prices rise in line with value added prices, and, as anticipated, the rural-urban terms of trade deteriorate with the fall in rural profit margins and rising urban prices. The real exchange rate deteriorates, indicating the economy has become less competitive with rising prices for the non-traded goods producing industries.

Table 5.3.3  Expenditure on GDP (percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Private consumption</td>
<td>0.1</td>
<td>0.4</td>
<td>3.4</td>
</tr>
<tr>
<td>Exports</td>
<td>-1.0</td>
<td>-2.7</td>
<td>-4.6</td>
</tr>
<tr>
<td>Imports</td>
<td>-0.1</td>
<td>-0.2</td>
<td>0.7</td>
</tr>
</tbody>
</table>
Table 5.3.4 Government budget and balance of payments
(percent difference on base run)*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Government final expenditure</td>
<td>0.1</td>
<td>0.4</td>
<td>4.6</td>
</tr>
<tr>
<td>Government overall balance</td>
<td>-152</td>
<td>-650</td>
<td>-3206</td>
</tr>
<tr>
<td>Exports (exportables)</td>
<td>-1.5</td>
<td>-3.8</td>
<td>-6.3</td>
</tr>
<tr>
<td>Imports (importables)</td>
<td>-1.9</td>
<td>-4.1</td>
<td>-2.7</td>
</tr>
<tr>
<td>Imports (non-competitive)</td>
<td>0.2</td>
<td>0.5</td>
<td>1.3</td>
</tr>
<tr>
<td>Tourism earnings</td>
<td>0.1</td>
<td>0.2</td>
<td>2.2</td>
</tr>
<tr>
<td>Current account balance</td>
<td>-154</td>
<td>-616</td>
<td>-3211</td>
</tr>
</tbody>
</table>

* The government overall balance and current account balance in this table are not shown in percentage change terms but rather as the absolute difference between the "sensitivity test" and the base projection.

Although real urban wages fall initially, urban household incomes rise; the employment effect outweighs the downward movement in real wages. The consequences for rural wage earners and households are not good.

While the above picture is depicted as the consequence of an increase in the parametric values of the Armington elasticities, the results show the effects of increasing the attractiveness of import replacing industries. We have not used the CGE model to examine questions of trade policy, but the results of this scenario suggest the likely impact of any strategy of import replacement be-

Table 5.3.5 Price indexes, real wages, and household incomes
(percent difference on base run)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer prices</td>
<td>0.2</td>
<td>0.5</td>
<td>2.3</td>
</tr>
<tr>
<td>Value added prices</td>
<td>0.3</td>
<td>1.0</td>
<td>5.8</td>
</tr>
<tr>
<td>Rural-urban terms of trade</td>
<td>0.3</td>
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hind protective tariffs. The results on employment are quite strong, encouraging urbanization and effectively taxing the rural areas. The outcome for the government deficit and current account is not advantageous.

5.4 Conclusion

The above selection of parametric tests is only a small sample of the possible choices but should give the reader an idea of the type of results to be expected. The choice of parameters in the CGE model clearly has an important bearing on the results, and the model should not be used in its present state for projection purposes without an improved estimation of the many required parameters.

Perhaps the SIO model, with its more limited demands on data, would be a more suitable choice for current use. However, this choice would be misleading because the apparent lack of data requirements is, in fact, an implicit choice of parameters, which is made explicit with the CGE model. The elasticity of substitution in production, which is chosen in the CGE case, is zero in the SIO; the choice of Armington elasticities in the CGE is infinite in the SIO, and so on. In fact, the SIO model is a restricted example of the CGE case.

The results of this chapter demonstrate the sensitivity of the results to different specifications of the parameters and therefore the weakness in using the model for projection purposes. However, policy analysis of the type conducted in Chapter 4 is still appropriate. Although not reported here, the policy experiments in Chapter 4 were rerun in conjunction with two of the sensitivity tests conducted above (the reduction in elasticities of production for the exporting activities and the increase in Armington elasticities). For example, we reran the devaluation experiment with the new production elasticities, estimated the change on the base run with the new elasticities, and compared the results with the experiment conducted in Chapter 4.

This procedure was repeated again for the fiscal restraint, copra fund, and wage indexation cases, with the alternative parametric sets. These tests showed that the results in comparative form varied little, regardless of the selection of parameters. Only in exceptional instances did any of the policy experiments produce substantially different results when a different set of parameters was selected. However, we did not proceed to test the sensitivity of the model to whole ranges of different parameters, and perhaps the results may not be stable even in comparative form.
The introduction stated that this paper would examine two general issues. The first was the general feasibility, practicality, and appropriateness of policy modeling in the South Pacific. The second was the information the models could provide on the use of certain important tools of economic policy. Chapter 4 extensively investigated selected policy tools. This conclusion discusses the first issue as well as certain statistical matters.

This paper proves the feasibility of building a policy modeling framework for a small economy in the South Pacific. However, the construction of this framework is not achieved without substantial inputs of scarce resources. These resources are statistical and economic.

Regarding the economic resources, considerable experience and training are required for a person to achieve the level of expertise necessary to construct the type of frameworks developed here. The requirements are post-graduate training and a firm grasp of macroeconomics. Most economies of the South Pacific presently do not have people with these skills. However, these skills are being acquired, and in time the type of exercise conducted here will be both practical and feasible. In the meantime, technical assistance will be needed.

Sound economic analysis and planning require a framework of the type developed here if economic management is to progress beyond a judgmental approach. This does not deny the importance of personal intuition in policy formulation; there is no substitute for good judgment. However, macroeconomics is the result of complex forces and interactions, which, as Chapter 4 illustrates, are better understood through the careful use of a suitable framework. These tools supplement rather than replace personal judgment.

Statistical resources in the Pacific island nations are weak and good data scarce. However, the purpose of the approach here is not to make projections per se but rather to shed light on the main tools of economic analysis. While we cannot foresee the discovery of large mineral deposits or a major natural disaster such as a cyclone, the economy is likely to react in the same fashion to, say, wage restraint or devaluation with or without these factors. Policy-makers still have to implement economic policy even if the future is erratic, and they should have some means to make rational decisions.
The statistical requirements of the models are clearly substantial. Hopefully, the above discussion has delineated the basic requirements. If policymakers are aware of these requirements, they are in a position to impress their needs on the relevant statistical offices. Much routine business in statistical offices leads to the collection of historical information, which, although providing useful facts about our world, is not of great value to policy formulation and has limited potential to affect our future. The type of framework discussed here is explicitly developed to improve economic well-being in the future. Thus the additional statistical resources required to implement the framework should be given high priority.

Another important statistical problem is the matter of reliable and accurate data. Construction of the SAM requires data from a diverse set of sources, which may not always be reliable. This observation has led some statisticians to outright rejection of the database as being misleading for policy formulation.

The results of the SAM-based models can provide information at the macro level as well as at the micro or individual sectoral level. The accuracy of predictions should be considered at both levels. The construction of the SAM has to reconcile the various macroeconomic balances. Most of the main aggregates are known with a high degree of accuracy, e.g., imports, exports, government accounts, and the output of certain key sectors. The SAM incorporates this information, and its predictions about these aggregates are likely to be equally reliable.

At the micro level the user should be very cautious about the results concerning an individual sector, especially if the original data describing the activity were dubious. For example, many sensitivity tests in Chapter 5 revealed that variation in parameters had important consequences for individual sectors. However, while the choice of parameters was important at the micro level, it had less effect on the main aggregates. In other words, although the SAM-based models often contain unreliable information, the results are likely to be reliable at the macro level because macro consistency was forced on the original database.
Appendix 1

The 1985 Vanuatu SAM

This appendix discusses the basic features and accounts of the Vanuatu SAM. (See Table A1.1 at the end of this appendix for the complete matrix.) It is assumed the reader is already familiar with the basic principles of social accounting (see Pyatt, Roe et al., 1977 for an introductory guide), and the emphasis will be on providing a background to the models described in Appendixes 2 and 3. The Vanuatu SAM contains the normal sets of accounts including factors, institutions, commodities, activities, rest of the world, and capital accounts. This appendix discusses only the important features of the SAM that have repercussions for the model.

1.1 Important Features of the Vanuatu SAM

Commodities and Activities

The Vanuatu SAM distinguishes between the two sets of accounts for commodities and activities. This treatment means the SAM contains both an "absorption" and a "make" matrix. This distinction was necessary for two reasons. First, in agriculture, farmers frequently produce more than one commodity. In this case, copra farmers usually mix production with cattle grazing and produce two commodities: copra and cattle. Some cattle farmers produce only beef. Thus while we have matching commodities and activities, we also have subsidiary production. Second, from a policy perspective it was desirable to distinguish between the modes of production in agriculture. Much copra is produced by small holder ni-Vanuatu (the indigenous Melanesians) and also by expatriate concerns under estate production. The Vanuatu SAM thus has more than one activity corresponding to the same commodity.

Valuation

Valuation in social accounting can be measured in basic, producer, and purchaser values. The differences in approach concern the treatment of indirect taxes, trade, and transport margins. In basic prices, commodities are valued before the imposition of any indirect taxes. In producer prices, commodities are valued inclusive of indirect taxes but before any payment of trade and transport margins. Finally, in purchaser prices, valuation includes indirect taxes, trade, and transport margins.
Producer values have been used in this SAM. Although households buy commodities at purchaser values, the majority of activities purchase their inputs directly from other producers rather than through any distribution network. Because evaluation in purchaser prices would not suit production practices in Vanuatu, producer prices were used, which meant that household consumption had to be revalued in producer values, deducting the trade and transport margins.

Indirect taxes are collected on commodities and are identified in the "make" matrix of the SAM. The value of domestic supply before inclusion of indirect taxes is thus revealed in basic values, with the value of indirect taxes shown separately. The sum of commodity production in the "make" matrix together with the value of indirect taxes shows the total value of supply in producer values. Accordingly, in the absorption matrix, commodities are valued at producer values, thus guaranteeing the balance of the commodity accounts in the SAM. Commodity valuation in the SAM is thus not consistent throughout in that supply is at basic prices while disposition is at producer prices.

Imports

Various treatments of imports can be followed in SAMs. They can be treated essentially in two ways. First, some imports can be regarded as non-competitive or complementary to domestic supply. Thus there are no substitution possibilities between commodities of domestic and foreign origin. With this treatment imports enter the Input-Output system in the "make" component of the SAM, but there is no domestic counterpart augmenting supply.

Other imports may be considered as competing with commodities of domestic origin. In this case, imports also enter the system in the "make" matrix of the SAM, but they have a counterpart domestic item. In the compilation of the Vanuatu SAM, imports were considered item by item regarding their possible substitution by domestic commodities. In the long run nearly all imports must be considered as potential candidates, but the criterion used in the classification was the possibility of domestic production within a five-year horizon.

The inclusion of competitive imports into the system has implications for any derived technical coefficients. In this system, commodities that are absorbed by user accounts become composite commodities; that is, they contain both a domestic and an imported component. Technically, this treatment is correct because it makes no difference to the producers of steel, for example, whether the coal consumed originates domestically or from the rest of the
In practice, however, not all commodity inputs are as homogeneous as this example, and some degree of product differentiation should be accommodated.

Other Features
Although the SAM contains a capital account, it is extremely rudimentary, consisting only of savings and investment accounts. Unfortunately, little data were available for identification of the flow of funds. No accounts were detailed for home ownership or imputed rent because this is not important in a modeling perspective. Subsistence or non-marketed production, an extremely important feature in the Vanuatu economy, also was not included directly in the SAM, although national accounts data were available, which were used in the models.

1.2 Classification of Accounts

This section discusses the individual accounts and some of their important features. The complete list of the accounts in the SAM is shown in Table A1.2 at the end of this appendix.

Factors
As is the normal practice, the factor account has been split into accounts for labor and capital. The labor accounts have been differentiated by four skill levels and by the ethnic composition of the labor force. Two ethnic groups have been identified in the process: the ni-Vanuatu and "others" (mainly expatriate). The two reasons for this split are income distribution and localization. Because wages for expatriate staff are several times those of the ni-Vanuatu, separation of the accounts in this fashion is important to an adequate mapping of income distribution. The interaction between the education of ni-Vanuatu, the greater supply of local skilled manpower, and the demand for labor have important policy implications in the long run.

There is only one account for capital, which in effect captures the residual value added. It also includes self-employed labor and thus incorporates an element for imputed wages.

Indirect Taxes
Two accounts for indirect taxes have been included in the SAM. The first account includes taxes paid on domestic commodities, and the second includes
taxes paid on imported commodities. This split improves the modeling of
government revenue, depending on the source of the tax.

Institutions
The SAM has three main categories of institutions: households, private sec­
tor, and public sector. The household accounts have been split between urban
and rural and between ni-Vanuatu and "others." For the urban ni-Vanuatu
three groups have been separated by income level. No distinction was made
between rural and urban "others." The urban-rural dichotomy, as in most de­
veloping economies, is also important in Vanuatu. Unincorporated business
is included in the household accounts. The private corporate sector includes
only one account, which reflects the paucity of data. It is usually desirable to
isolate the financial sector, but this was not possible although Vanuatu does
have an important off-shore banking community. Because there are no im­
portant parastatal or local government bodies in Vanuatu, the public sector is
adequately reflected by the one account in the SAM.

Commodities and Activities
Three main data sources existed for the compilation of these accounts, and
accordingly the accounts reflect data availability. The agricultural data were
derived from an agricultural census, and activities were isolated into all the
main sectors, reflecting the importance of agriculture in the Vanuatu econ­
omy. As already noted, the main activities such as copra growing have been
separated by the main modes of production, i.e., estate or capitalist agricul­
ture and small holder or peasant farming. We thus have two activities but
only one commodity.

In secondary and tertiary production an establishment survey provided the
main source of data. Activities were isolated according to their anticipated
importance in the future. Manufacturing is not significant in Vanuatu, and
thus only two activities have been isolated. Because infrastructure and ser­
vices have greater importance (particularly tourism and financial services),
various accounts are shown.

A complete set of information was available for the public sector from the
government accounts. Apart from administrative services, accounts were iso­
lated for education, health, and economic services. Education is particularly
important in Vanuatu for the achievement of localization.

A close correspondence exists between domestic commodities and activities;
the only reason for departure from strict correspondence is the identification
of activities by modes of production. However, we still have a set of non-competitive commodities that complement domestic supply. A fairly disaggregated set has been included rather than the usual single account. This procedure allows the user to isolate the particularly important imported commodities such as fuel, fertilizers, etc.

Finally, a dummy account for imputed bank services has been included, which allows consistency with national accounting procedures in the treatment of interest.

Rest of the World Accounts
The current accounts for the rest of the world are straightforward with the identification of accounts for exports, re-exports, imports, factor services, and transfers. Tourism was isolated as a separate account to reflect its importance in the Vanuatu economy. A balancing account for the balance of payments' current account was included.

Capital Accounts
These accounts tie together the remaining elements of the SAM, namely, savings and investment. The savings account collects together the savings of all the institutions and pays this amount to the gross capital formation account, which together with the balance of payments' deficit, forms the supply of funds for investment. Private and public gross fixed capital formations were identified separately, as well as inventory accumulation of "goods for resale" and "output of goods." The former category includes commodities held by retailers and wholesalers, and the latter shows the accumulation of commodities produced by activities but as yet unsold.
Table A1.1 Vanuatu SAM 1985: Producer Values (Vatu ’00,000)

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**Commodities**

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Appendix 2
The Formal Exposition of the SIO Model

The SIO model can be conceived of as having two self-contained sections. The first deals with the specification of commodity and factor prices and is discussed in section 2.1 below. Non-traded commodity prices are computed directly from solving a set of simultaneous equations. All remaining prices are then computed in a straightforward fashion.

The model's second section deals with the solution of the productive component of the economy or the level of outputs. In the process of solving for outputs, the factor and institutional accounts are derived. The solution proceeds iteratively. An initial guess is made about levels of non-traded goods production. Based on this guess, we solve for the factor and institutional accounts in sections 2.2 and 2.3 below. The demand and supply of commodities is then established in section 2.4, and in section 2.5 an improved guess is made about output levels based on excess supply conditions. Iteration continues until a required degree of accuracy is achieved. Finally, the indirect tax accounts and the balance of payments are computed in sections 2.6 and 2.7. Section 2.8 describes Walras's law in an SIO framework.

Before discussing the SIO model in detail, we itemize the various conventions used in the formal exposition of the two models discussed in this appendix and Appendix 3.

In the following algebraic formulation, the variable names and syntax follow those used in the computer program to solve the two models, as described in section 2.4. The symbols indicate matrix operations as follows:

- \(+, -, *, \sqrt{\cdot}, ^\wedge\) represent addition, subtraction, multiplication, division, and the power function. They operate in an element-by-element fashion between matrices, and
- \(\cdot\) represents matrix multiplication, and
- \(\%\) computes a matrix inverse, and
- \(\cdot\) transposes a matrix, and
- \(\cdot\) generates a diagonal matrix from a row or column vector, and
- \(\text{matrix}[s1,s2]\) indicates a submatrix with the rows defined by the set \(s1\) and columns by the set \(s2\).
The next exposition follows computing conventions whereby the right-hand side of an expression is evaluated and the result stored in the left-hand side. A variable may thus be specified on both the left-hand and right-hand sides of an equation and should not be confused with normal mathematical logic.

Various conventions have been adopted in the following exposition:

- The first letter of any variable representing transaction values is a capital letter. Coefficients are preceded by a small letter. Other variables may be preceded by either.
- Major sets are identified before the minor. For example, producer prices are \( Pd \), non-traded producer prices are given by \( Pdn \), and \( Pdnb \) is the producer price of the non-traded commodity banking.
- Where a variable is a matrix, the row set precedes the column. For example, \( Bxn \) refers to a submatrix of the "make" matrix \( B \) with exportables in the rows and non-traded activities in the columns. However, \( bxn \) is a coefficient's matrix, specifying the amount of production of exportables per unit of gross output of non-traded activities.
- In the factor set, \( w \) refers to wage incomes, while \( c \) refers to incomes out of the operating surplus. The letter \( n \) refers to ni-Vanuatu factor rewards, while the "other" group is specified by \( o \). These may be divided between urban \( u \) and rural \( r \) factor rewards. Thus \( Fwnu \) refers to factor rewards from wages accruing to urban ni-Vanuatu.
- In the household accounts, households are referred to by \( hlds \). This is subdivided between \( uhlds \), as urban ni-Vanuatu households, \( rhlds \) as rural ni-Vanuatu households, and \( ohlds \) as other households.
- In the allocation of transfers between institutions, a \( T/t \) as the first letter indicates that we are referring to a transfer. The next letter refers to the institution of origin, and the last letter specifies the institution of destination: \( h \) refers to households, \( g \) to government, \( p \) to private sector, and \( r \) to rest of the world. Thus \( Tgh \) refers to the transaction value of transfers between government and households. Consistent with the first item above, however, \( tgh \) refers to a transfer coefficient between government and households.
- In the activity and commodity sets, \( t \) stands for traded goods, which maybe split between \( x \) for exportables and \( m \) for importables. Non-traded goods are referred to by \( n \), and non-competitive items are given by \( o \).
2.1 Price Determination

The SIO model has four classes of commodities: traded exportables, traded importables, non-traded goods, and non-competitive imports. The prices of non-traded goods are determined at home endogenously, while the prices of the other three categories of commodities are determined in international markets. For importables and non-competitive commodities we have:

\[
\begin{align*}
P_{dm} &= e \cdot P_{wm} \cdot (1 + dm) + um \\
P_{do} &= e \cdot P_{wo} \cdot (1 + do) + uo
\end{align*}
\]

(2.1.1)  (2.1.2)

where \( P_{dm} \) and \( P_{do} \) are row vectors of domestic producer prices of importables and non-competitive goods, respectively; \( P_{wm} \) and \( P_{wo} \) are row vectors of the respective world prices; \( e \) is the rate of exchange; \( dm \) and \( do \) are vectors of ad valorem tariffs; and \( um \) and \( uo \) are vectors of specific or unit tariffs.

For exportables we have:

\[
e \cdot P_{wx} = (P_{dx} + (m_x \cdot P_{dnw}) + (f_x \cdot P_{dnf})) \cdot (1 + dx)
\]

(2.1.3)

where the notation is as in the above but includes the following:

\( P_{dnw} \) and \( P_{dnf} \) are the producer price of wholesaling and freight; and \( m_x \) and \( f_x \) are vectors of trade and freight margins, respectively.

Equation 2.1.3 assumes that exporters must ship their products from production site to point of export with associated freight and distribution charges. Export taxes are levied ad valorem, and the total value must equal the FOB world price times the rate of exchange.

This formulation for domestic producer prices of exports causes some problems because both distribution and freight costs are included on the right-hand side of equation 2.1.3. Domestic producer prices of exports cannot be determined directly without knowing \( P_{dnw} \) and \( P_{dnf} \), both of which are non-traded prices and endogenous. Equations 2.1.1 and 2.1.2 can be solved directly for domestic producer prices of importables and non-competitive imports, but equation 2.1.3 must form part of the general price system of simultaneous equations.
Because the valuation of commodities in the SAM occurs in both basic and producer prices, we need to solve for both. But the only domestic tax on commodities is levied on hotel and restaurant turnover. Thus the basic prices for traded commodities are identical to producer prices (i.e., $P_{bx} = P_{dx}$, $P_{bm} = P_{dm}$); only for non-traded commodities is there a difference. We have the following equation defining basic prices of non-traded commodities:

$$P_{bn} = P_{bn} \cdot (1 + d_n) + u_n$$  \hspace{1cm} (2.1.4)

where $P_{bn}$ and $P_{dn}$ are basic and producer prices of non-tradables, respectively, and the other items follow the above conventions.

To complete the price system we need the adding up condition for non-traded activities; that is, the sum of inputs valued at their respective producer prices equals the sum of outputs valued at basic prices. Accordingly, we employ a cost-plus pricing rule as follows:

$$P_{bx} b_{xn} + P_{bm} b_{mn} + P_{bn} b_{nn} = (P_{dx} a_{xn} + P_{dm} a_{mn})$$
$$+ P_{dn} a_{nn} + P_{do} a_{on} + I: (w_{n}*l_{on})*(1 + r_n)$$  \hspace{1cm} (2.1.5)

where $bxn$ etc. is a matrix whose columns indicate the amount of production valued in basic prices of exportables per unit of gross output of each non-traded activity,

$axn$ etc. is a matrix whose columns indicate the amount of input of exportables valued in producer prices required per unit of gross output required in the production of each non-traded activity,

$wn$ is a matrix of wage rates by skill group for each non-traded activity,

$Ion$ is a matrix of labor-output ratios by skill group for each non-traded activity, and

$rn$ is a vector of markups on prime cost used by producers of non-traded activities.

Solution of the system proceeds by substituting equations 2.1.1 through 2.1.4 into 2.1.5 and solving for $P_{bn}$. The rather complicated equation-derived $P_{bn}$ can be reduced as follows:
\[ Pbn : lhs = rhs \]  
\[ lhs = (bnn - (1 + dn)l: (ann + ((mdx'mx) + (fdx'fx)) : axn) : (1 + r n)l) \]
\[ rhs = ((e*Pwx/(1 + dx)) : axn + Pdm : amn + Pdo : aon + 1 : (wn*lon)) * (1 + r n) \]

where \( mdx \) and \( fdx \) are index vectors with "1s" corresponding to the trade and freight commodities, respectively, and "0s" elsewhere.

At this stage it is useful to solve for capital rentals as follows. Dropping the partitioning between traded and non-traded commodities and activities, we have:

\[ r\cdot ko = Pb:b - Pd:a - 1 : (w*lo) \]  
\[ (2.1.7) \]

where \( ko \) is a vector of capital output ratios by activity, \( Pb \) is a vector of basic prices, \( Pd \) is a vector of producer prices, \( b \) and \( a \) are the "make" and "absorption" matrices, \( w \) is a matrix of wage rates by skill and activity, and \( lo \) is the corresponding matrix of labor output ratios.

Finally, we need to determine purchaser prices of commodities for use in the Linear Expenditure System (LES) given below:

\[ Pr = Pdh + mc*Pdnw + fc*Pdnf \]  
\[ (2.1.8) \]

where \( Pdh \) is an extended vector of producer prices, and \( mc \) and \( fc \) are trade and freight margins, respectively.

In the Vanuatu SAM, household consumption includes both outlays on commodities and domestic servants. The inclusion of the latter item requires us to extend the basic vector of producer prices \( Pd \) to form the vector \( Pdh \). This breaks our normal conventions because \( Pdh \) is a super and not a subset of \( Pd \); however, it is more convenient to treat it in this way.

In summary, the price formulation shows that this set of equations is self-contained and can be solved independently from the other aspects of the model. This is an advantage of the SIO model in comparison with the CGE variants; the SIO is considerably easier to solve and less demanding on computing resources.
2.2 Factor to Institution Mapping

Having solved the price system, we now turn to the main part of the model. Our approach is to reproduce the SAM, account by account. We start by summing the factor rewards and mapping the result to institutions. Next we detail the institutional accounts and determine household expenditure in particular. Finally, we specify the commodity accounts, which allows calculation of excess commodity demands, from which we proceed to an improved guess at the activity levels of non-traded activities. Iteration continues until a required degree of tolerance is achieved.

We start by making a guess about the values of certain variables needed in the course of reproducing the SAM. The most important of these are the non-traded activity outputs $X_n$, which is a subset of the full vector $X$ of activity levels. Also at this stage we need to make a guess at the levels of trade $M_x$ and freight $F_x$ margins paid on exports. We will also need to make a guess at the remuneration of domestic servants $d_{serv}$, but these other variables will be discussed in section 2.5.

We can now replicate the matrix of value added in the SAM, which has factors in the rows and activities in the columns. First, we generate the demand for labor by skills and activity $L$ and, second, the wage bill $W$ as follows:

\[
L = l_0 \cdot X' \quad (2.2.1) \\
W = w \cdot L \quad (2.2.2)
\]

Mapping of factor incomes to institutions does not proceed on a simple fixed proportional basis; rather we attempt to preserve the relationship between activities, factors, and institutions. In essence, factor rewards of rural activities are mapped to rural households, while urban factor rewards are allocated to urban households. At the same time, the distinction is preserved between ni-Vanuatu and "others." Let us consider the following set of equations:

\[
F_{wnr} = W[labvan,act]:1 \\
F_{wnu} = W[labvan,uact]:1 \\
F_{wo} = W[labotr,act]:1 \\
F_{wnu[serv,1]} = F_{wnu[serv,1]} + d_{serv}
\]
where \( Fwnr \) is the factor rewards from labor of rural ni-Vanuatu, \( Fwnu \) is the corresponding item for urban ni-Vanuatu, and \( Fwo \) is the factor rewards from labor of "others."

Equation 2.2.3 thus takes a subset of the wage bill matrix, with dimensions corresponding to the ni-Vanuatu skills in the rows (defined by the set \( \text{labvan} \)) and rural activities in the columns (defined by the subset \( \text{ract} \)) and sums this matrix along the rows. Equation 2.2.4 does an equivalent calculation for urban activities \( \text{uact} \). Equation 2.2.5 sums the value of factor rewards for the "other" factor group \( \text{labotr} \) across all activities \( \text{act} \). Finally, equation 2.2.6 adds the rewards from domestic service into the ni-Vanuatu unskilled group \( \text{serv} \) of \( Fwnu \).

Total operating surplus \( Fcv \) must now be derived for each activity:

\[
Fcv = r^k_0 X' 
\]  
\text{(2.2.7)}

Now it is useful to split the operating surplus into various components before allocating it to institutions. The operating surplus \( Fcv \) is split between that destined for government \( Fcg \), that destined for rural households \( Fcr \), and a residual category \( Fco \).

\[
Fcg = Fcv[1,\text{commact}] * \text{commcoef} 
\]  
\text{(2.2.8)}

\[
Fcr = (Fcv[1,\text{smhldr}:1]) + (Fcv[1,\text{othagact}:1]) \times 0.5 
\]  
\text{(2.2.9)}

\[
Bksc = Xbk * \text{bksccoef} 
\]  
\text{(2.2.10)}

\[
Fco = Fcv:1 - Fcg - Fcr - Bksc * \text{Pdnb} 
\]  
\text{(2.2.11)}

The first equation 2.2.8 defines that part of the operating surplus of the communication's activity \( \text{commact} \), which is part of the profits of the public sector. Rural activities are divided between two modes of production: a small-holder mode (defined by the set \( \text{smhldr} \)) and an estate mode. The rewards of the small-holder mode are to be allocated to rural households. The operating surplus of the activity "other agriculture," a residual category of all agricultural activities not elsewhere specified, is to be allocated on a 50:50 basis between the small-holder and estate modes of production. Thus equation 2.2.9 sums up the income from the operating surplus belonging to the small-holder mode of production, which will be allocated to rural households. Equation 2.2.10 calculates the imputed bank service charge as a fixed proportion \( \text{bksccoef} \) of the gross output of the banking activity \( Xbk \) in constant prices. Finally, equation 2.2.11 derives the residual amount of the surplus after deducting that destined for the other institutions.
To complete this section we now proceed to sum the total of factor rewards by institutions. For this task we employ two mapping functions. The first \( \text{maplu} \) gives the ownership by individual ni-Vanuatu urban households of labor skills (ni-Vanuatu). The second gives the ownership of capital by urban households \( \text{mapcu} \) and \( \text{mapco} \) and the private corporate sector \( \text{mapcp} \).

\[
\begin{align*}
\text{Labor} & \\
\text{Capital} & \\
F_{hu} & = \text{maplu} : F_{wnu} + \text{mapcu} \cdot F_{co} \\
F_{hr} & = 1: F_{wnr} + F_{cr} \\
F_{ho} & = 1: F_{wo} + \text{mapco} \cdot F_{co} \\
F_{g} & = F_{cg} \\
F_{p} & = \text{mapcp} \cdot F_{co}
\end{align*}
\]

Equation 2.2.12 allocates urban labor factor rewards to ni-Vanuatu urban households using \( \text{maplu} \) and includes ni-Vanuatu urban household ownership of the operating surplus. Equation 2.2.13 sums all the rural household rewards from factors, while equation 2.2.14 adds together the sum of "other" labor skills and the ownership of the operating surplus of the "other" household group. Equation 2.2.15 is an identity, and equation 2.2.16 allocates that portion of the operating surplus owned by the corporate sector to itself.

2.3 The Institutional Accounts

Households

This section begins by providing various rules for allocating household transfers. These rules are often necessarily rather arbitrary but should be regarded as a useful first approximation. Given a set of transfers that interact with households, we calculate disposable household income, which is the level of income that is either consumed or saved. Aggregate household consumption is then allocated among commodities, following the Linear Expenditure System (LES).

\[
\begin{align*}
c_{pi} & = P_{dh} : c_{wght} : c_{wght}' \\
T_{gh} & = T_{gh85} \cdot t_{gh} \cdot c_{pi} \\
T_{rh} & = T_{rh85} \cdot t_{Pw} \cdot t_{Yw} \cdot e \\
T_{hg} & = F_{h} \cdot t_{hg} \\
T_{hr} & = F_{h}' \cdot t_{hr} \\
T_{thhr} & = F_{h}' \cdot t_{thhr}
\end{align*}
\]
The first equation needed is a determination of the average consumer price index (CPI). This is a simple weighted index, with weights \( cwght \) (average propensities to consume by commodity and household group) and \( chwght \) (the relative importance in aggregate consumption of each household group). Equation 2.3.2 states that government transfers to households are related to the base SAM level \( Tgh85 \), exogenously specified by \( tgh \) and indexed to the CPI. Equation 2.3.3 states that household receipts from the rest of the world are based on base SAM levels \( Trh85 \) and related to the growth of income in the rest of the world \( tYw \), the world inflation rate \( tPw \), and the rate of exchange \( e \). In other words, foreign households remit to Vanuatu households a fixed proportion of their real incomes.

On the payment side, households pay a fixed proportion of their factor incomes to government (2.3.4) and the rest of the world (2.3.5). As yet there are no direct taxes on incomes in Vanuatu. Intra-household transfers occur only between rural and urban households and are related to their respective factor incomes (2.3.6, 2.3.7).

Disposable income of households is defined in equation 2.3.8, but an adjustment is needed to rural households \( rhlds \), equation 2.3.9, to allow for receipts and payments of transfers from urban households. Household savings and consumption are determined by a simple proportionate savings function as follows:

\[
\begin{align*}
Hsav &= Yh \ast hsav \\
Hcon &= Yh \ast (1 - hsav)
\end{align*}
\]  

(2.3.10) \hspace{1cm} (2.3.11)

We can now complete the household accounts with a specification of the LES, which is specified as follows:

\[
\begin{align*}
Ch &= Alpha + (beta / Pr):(Hcon - Subsist)! \hspace{1cm} (2.3.12) \\
Alpha &= Alpha85 \ast pop' \hspace{1cm} (2.3.13) \\
Subsist &= I:(Alpha \ast Pr) \hspace{1cm} (2.3.14) \\
C &= Ch:1 \hspace{1cm} (2.3.15) \\
C[trade,1] &= (I:(Ch \ast mc):1) \hspace{1cm} (2.3.16) \\
C[freight,1] &= C[freight,1] + (I:(Ch \ast fc):1) \hspace{1cm} (2.3.17)
\end{align*}
\]
The first equation, the LES function, defines consumption to be the sum of two terms. The first term gives the level of subsistence expenditures, which households consume regardless of the level of total consumption. This is updated by the rate of population growth in equation 2.3.13. The second term allocates expenditures in excess of subsistence requirements between the various commodities. The term \( H_{\text{con}-\text{Subsist}} \), or "supernumerary expenditure," subtracts the current price subsistence demands given in equation 2.3.14 from total consumption. Households thus consume a basic level of consumption given by \( \text{Alpha} \), but as total consumption rises above the subsistence level, households allocate their additional demands according to the marginal budget coefficients \( \beta \). Equation 2.3.15 simply totals household expenditures over commodities, while equations 2.3.16 and 2.3.17 derive the total demand for the trade and freight margins. The two matrices \( \text{mc} \) and \( \text{fc} \) give the margins paid by commodity and household group.

**The Private Corporate Sector**

The private corporate sector account may be detailed by the following set of rules:

\[
\begin{align*}
    S_p &= F_p + T_{gp} + T_{rp} - T_{pg} - T_{pr} \\
    T_{gp} &= T_{gp85} \times t_{gp} \times cpi \\
    T_{rp} &= T_{rp85} \times t_{Yw} \times t_{Pw} \times e \\
    T_{pg} &= T_{pg85} \times t_{pg} \times cpi \\
    T_{pr} &= F_p \times t_{pr}
\end{align*}
\]

The first equation defines the private sector account as the sum of factor rewards \( F_p \) and transfer receipts \( T_{gp} \) and \( T_{rp} \) less transfer payments \( T_{pg} \) and \( T_{pr} \). The following equations itemize the individual transfer payments. The transfers to and from the public sector \( T_{gp} \) and \( T_{pg} \) are exogenous and indexed to the CPI. \( T_{gp85} \) and \( T_{pg85} \) are the base SAM levels, and \( t_{gp} \) and \( t_{pg} \) are the exogenous growth rates on base year values. Because there is no satisfactory way to model many of these transfers, the course taken here is to make the formulation as neutral as possible to the model outcome. If values are left at their base year values, by the end of the model horizon they become out of alignment with the rest of the model’s results. Transfers to the rest of the world (profit remittances) are given as a fixed proportion of factor incomes \( t_{pr} \). Receipts from the rest of the world are based on base SAM levels \( T_{rp85} \) and are related to the growth in world real incomes \( t_{Yw} \), world inflation \( t_{Pw} \), and the rate of exchange \( e \).
The Public Sector

The public sector account runs similarly to the other institutions:

\[ Sg = Fg + Grit + Thg + Tpg + Trg - Gpc - Tgh - Tgp - Tgr \]  \hspace{1cm} (2.3.23)

\[ Gcon = Gcon85 \times gc \]  \hspace{1cm} (2.3.24)

\[ Gpc = Pdg : Gcon \]  \hspace{1cm} (2.3.25)

\[ Tgr = Tgr85 \times tYw \times tPw \times e \]  \hspace{1cm} (2.3.26)

\[ Trg = trg \times Trg85 \times cpi \]  \hspace{1cm} (2.3.27)

The first equation defines the public sector account as the sum of factor rewards \( Fg \) plus income from indirect taxes \( Grit \), plus transfer receipts, less government expenditure \( Gpc \), and less transfer payments. Equation 2.3.24 specifies real government expenditure to be related to the base-level SAM \( Gcon85 \) and to an exogenous growth factor \( gc \). Equation 2.3.25 gives the aggregate level of government expenditure in current prices \( Pdg \) is a subset of \( Pd \). Equation 2.3.26 (transfers to the rest of the world), which is mainly foreign debt service, relates debt payments to the base-level SAM, plus growth in world incomes and prices. Clearly, this equation is only approximate and a more thorough formulation would include a detailed analysis of the external debt position. Equation 2.3.27 indicates the level of transfers received by Vanuatu in foreign aid, which is specified exogenously. The only remaining undefined term is government revenue from indirect taxes, which is described in detail below. The institutional accounts are now completed.

2.4 The Commodity Accounts

We start by calculating the supply of domestically produced commodities:

\[ Qs = b : X \]  \hspace{1cm} (2.4.1)

where \( b \) is the "make" or "output" coefficients matrix. A column in the matrix gives the level of production (in basic values) of each commodity per unit of gross output of each activity. In Input-Output terminology, we are adopting the commodity technology assumption.

We now turn to the demand side of the system.

\[ Qwnx = Qwnx85 \times qwnx \]  \hspace{1cm} (2.4.2)

\[ Qwmx = Qwmx85 \times qwmx' \]  \hspace{1cm} (2.4.3)
The above equations define the exogenous values of exports of importables and non-traded commodities.

\[
P_{dtrsm} = P_{d} : trsmc \\
Trsm = Trsm_{85} * (trsm + (tYw - 1) * yelt - ((P_{dtrsm} / (e * tPw)) \ast pelt)) \\
Trsmq = Trsm \ast trsmc \\
Rexq = rex \ast (Rex_{85} \ast rex) \\
\]

Tourism demand for commodities is given in equations 2.4.5 and 2.4.6, while equation 2.4.4 defines a price index of the average cost of tourism. Equation 2.4.5 gives the aggregate level of real tourism demand; it contains three terms. The first term \( trsm \) is an exogenous factor allowing for arbitrary shifts in the function. The second term relates the demand for tourism to the level of world income and the income elasticity of demand \( \gammaelt \). The last term introduces relative price effects through the cross price elasticity \( pelt \). Both elasticities are determined from separate econometric investigation. Equation 2.4.6 translates the aggregate demand for tourism into commodity demands \( Trsmq \) through a set of coefficients \( trsmc \). Finally, equation 2.4.7 is included giving an exogenous specification for re-exports.

\[
Ivpq = pinvc * (Pinvc_{85} \ast pinv) \\
Ivgq = ginvc * (Ginvc_{85} \ast ginv) \\
grwth = 1: (X \ast vcoef) / 1: (X_{85} \ast vcoef) \\
Stckq = (stotc \ast Stot_{85} + strsc \ast Strs_{85}) \ast grwth \\
\]

The above set of equations gives an exogenous specification for both private and public investment. The model "closure" is thus Keynesian in type. Vanuatu has no restrictions on capital account of the balance of payments, and savers may invest their funds domestically or externally as they wish. Under these circumstances, investment is not determined by savings availability (although it may act as a constraint on small domestic entrepreneurs), and the Neoclassical closure does not seem appropriate. Changes in inventories are related to the overall growth in the economy. This specification is only approximate, but as with the specification of certain transfers, it is intended to be neutral with respect to model results.

The following equations bring together all the elements of the demand for commodities in \( Qd \). The latter group of equations 2.4.13 through 2.4.18 requires special treatment in ASAP because the appropriate vectors corre-
spond to subsets of the commodity set. The last two equations below include, in the demand for commodities, the trade and freight margins on exports.

\[
Q_d = a: X + C[\text{com}, 1] + T_{smq} + R_{exq} + I_{vpq} + I_{vgp} + S_{ckq}
\]

\[(2.4.12)\]

\[
Q_{d[gcon, l]} = Q_{d[gcon, 1]} + G_{con}
\]

\[(2.4.13)\]

\[
Q_{d[ntexp, l]} = Q_{d[ntexp, 1]} + Q_{wnx}
\]

\[(2.4.14)\]

\[
Q_{d[mcom, l]} = Q_{d[mcom, 1]} + Q_{wmv}'
\]

\[(2.4.15)\]

\[
Q_{d[banking, l]} = Q_{d[banking, 1]} + B_{ksc}
\]

\[(2.4.16)\]

\[
Q_{d[trade, l]} = Q_{d[trade, 1]} + M_{x}
\]

\[(2.4.17)\]

\[
Q_{d[freight, l]} = Q_{d[freight, 1]} + F_{x}
\]

\[(2.4.18)\]

By defining the demand for traded and non-traded commodities as a subset of \(Q_d\), we can now estimate excess demands for commodities as follows:

\[
Q_{dd} = Q_{d[dcom, 1]}
\]

\[(2.4.19)\]

\[
E_{ss} = Q_s - Q_{dd}
\]

\[(2.4.20)\]

### 2.5 Solution Techniques

Having now come full circle, we can improve our guess at the output of non-traded activities \(X_n\). We do this simply through adjusting the level of \(X_n\) by the excess supply of non-traded commodities \(E_{ss}\) (defined over the non-traded commodity set \(ncom\)). Although the SAM does not contain an identical number of activities and commodities, the sets are identical in the non-traded parts. This feature allows the relatively simple solution procedures adopted here to function efficiently.

\[
X_n = X_n * (1 - E_{ss[ncom, 1]} / Q_{sn})
\]

\[(2.5.1)\]

Although an inversion procedure would be possible due to the simple linear relations contained in the model, we have chosen an iterative procedure as our solution method for three reasons. First, the solution procedure allows us to follow the logical connections in the SAM in an intuitive fashion. In other words, we can follow the economics inherent in the SAM rather than view the system as a set of simultaneous equations. Second, the solution procedure is simple to debug and to verify the specifications at every stage. In a large simultaneous system it is easy to make errors, which are not easy to correct when lost in a jumble of substitutions. Finally, the step-by-step approach
means that at the end of this process we will have specified and reproduced all the accounts in the SAM.

We now need to update the level of certain variables. This problem arises because items like trade and freight margins on exports can be calculated only when the volume of exportables is known. This is defined through the excess supply equations, 2.5.3 and 2.5.4 below, immediately following the solution procedure. However, a knowledge of these amounts is required before we sum the demand for commodities. The approach is thus to guess the level of these variables in the initial instance and to update them for consistency as we proceed iteration by iteration. A similar approach is needed for domestic servant's wages, which are required in the factor-institution mapping but which are not defined until the LES is solved.

\[
d_{serv} = C[serv,1] \cdot dwage \\
M_x = m_x : Exss[xcom,1] \\
F_x = f_x : Exss[xcom,1]
\]

(2.5.2)  (2.5.3)  (2.5.4)

### 2.6 The Indirect Tax Accounts

The completion of these accounts follows the collection of all the various indirect taxes paid by the system. Equation 2.6.1 specifies the payment of taxes on exportables, while equation 2.6.2 does likewise for importables. Equation 2.6.3 specifies the taxes paid on non-traded commodities, which in this instance are the hotel and restaurant turnover taxes. Equation 2.6.4 adds together taxes paid on non-competitive imports, while equation 2.6.5 is the airport departure tax paid on tourism.

\[
It_x = ((Pdx + mx*Pdnw + fx*Pdnf) \cdot dx) : Exss[xcom,1] \\
It_m = e*(Pwm * dm) * (-1) : Exss[mcom,1] \\
It_n = (dn * Pbn) : bnn : Xn \\
It_o = (e*(Pwo * do) + uo) : Qd [ocom,1] \\
It_t = Trsm * deptxc \\
Grit = It_x + It_m + It_n + It_o + It_t
\]

(2.6.1)  (2.6.2)  (2.6.3)  (2.6.4)  (2.6.5)  (2.6.6)

### 2.7 The Rest of the World Accounts

The rest of the world accounts follow straightforward accounting procedures and should cause no surprises. The noteworthy item is that the balance of payments is valued in foreign exchange. This treatment is appropriate if the
consequences of exchange rate variations are to be examined without compensating for price effects.

The first equation below sums the value of exportables, and the second adds together exports of non-tradables and importables. Equations 2.7.3 and 2.7.4 give the level of tourism receipts and re-exports, respectively. Equation 2.7.5 is the sum of imports of importables, while 2.7.6 is the volume of non-competitive imports. Equation 2.7.7 gives the balance of trade. Equation 2.7.8 gives the factor service and transfers account, and the current account balance is shown in 2.7.9.

\[
\begin{align*}
B_x & = P_{wx} : Exss[xcom, 1] \\
B_{xn} & = ((P_{dnx} : Q_{wnx}) + (P_{dm} : Q_{wmx}')) / e \\
B_t & = ((P_d : Trsmq) + lt) / e \\
B_r & = ((P_d : Reqq) / e \\
B_m & = P_{wm} : Exss[mcom, 1] * (-1) \\
B_o & = P_{wo} : Qd [ocom, 1] \\
B_{gs} & = B_x + B_{xn} + B_t + B_r - B_m - B_o \\
B_{fstr} & = ((Thr:1) + Trp + Trg - (Thr:1) - Tpr - Tgr)/e \\
B_{cb} & = B_{gs} + B_{fstr}
\end{align*}
\]

(2.7.1) \hspace{2cm} (2.7.2) \hspace{2cm} (2.7.3) \hspace{2cm} (2.7.4) \hspace{2cm} (2.7.5) \hspace{2cm} (2.7.6) \hspace{2cm} (2.7.7) \hspace{2cm} (2.7.8) \hspace{2cm} (2.7.9)

2.8 Walras's Law

In any accounting system such as the SAM, when all but one of the accounts have been correctly specified, the remaining account must balance; in other words, the accounts of the SAM are not independent. The number of degrees of freedom is one less than the number of equations and variables in the system. This feature is known in this context as Walras's Law.

\[
\begin{align*}
S & = Hsav:1 + Sg + Sp \cdot B_{cb} * e \\
\text{Walras} & = St - Pd:lpvq - Pd:lyvq
\end{align*}
\]

(2.8.1) \hspace{2cm} (2.8.2)

Equation 2.8.1 brings together the sum of domestic savings in the economy plus the current account deficit on the balance of payments. Walras's Law is given in equation 2.8.2, which states that savings less investment must be zero. This feature can be used to our advantage as an error check on the results of the model. Thus if after convergence, equation 2.8.2 does not hold, some misspecification has occurred.
Appendix 3

The Formal Exposition of the CGE Model

This appendix describes the CGE model. The discussion concerns only those elements in the CGE model that require a specification different from that of the SIO. Because both models are based on the SAM, many areas of the exposition are common to both models and do not require duplication.

As in most CGE models the solution process starts with a guess at domestic commodity prices. The first section, 3.1, uses this guess to estimate a set of different prices relevant to the different actors in the economy. Most important, we derive value added prices, the prices relevant to productive decisions. This allows us in the second section, 3.2, to estimate the level of production in the economy. The third section, 3.3, discusses the labor market, which has been given a complete treatment. Our formulation has allowed for inclusion of the subsistence economy, rural-urban migration, substitution of expatriate for ni-Vanuatu labor, and a different clearing mechanism in the rural and urban labor markets.

In the fourth section, 3.4, household formation is endogenized, which affects household income and expenditure patterns. The next section, 3.5, discusses the treatment of investment, and section six, 3.6, examines the inclusion of a price support fund for copra, which has been incorporated to smooth the effects of large fluctuations in the international price of copra. The final section, 3.7, draws together the various elements of the model and derives the excess demand conditions, which improves the guess at domestic prices and the move toward equilibrium.

3.1 Prices

In tandem with the SIO model we distinguish between four types of commodities: exportables; importables; non-traded goods, which are all produced domestically; and non-competitive imports, which are consumed but not produced. Following the SIO model we accept the "small country assumption" for both exports and imports. Vanuatu is certainly small, it has no influence on the price of its imports, and its exports are all primary commodities that admirably suit the stylized facts of the small country assumption. The pricing system thus shows little variation from the earlier model, except in one im-
portant regard. For the class of importables we distinguish between imports and domestically produced importables. The prices of the two commodities will be differentiated and formulated separately. The domestic price for exports and non-competitive imports remains the same as before; it is the world price adjusted for exchange rates, tariffs, trade, and freight margins.

The solution procedure begins with a guess at producer prices of commodities, which is the logical starting point of our model description. From here we trace the various elements of the system until we can sum the excess supply of goods over demand. This procedure enables us to improve our guess at prices and continue the iterative process until a required convergence criterion is met. However, a starting point is needed. For the base period we choose the price equal to unity because by definition this is the solution vector. For other periods we let our initial guess be the last period's solution.

Our first equation is thus

\[ P_d = 1 \]  \hspace{1cm} (3.1.1)

Unlike the SIO model, producer prices are not the prices used throughout the economy in the absorption of commodities because we have allowed for product differentiation between imports and importables. Elsewhere, however, for exportables and non-traded commodities, domestic prices are identical to the prices paid by users. Our treatment of the importable sector follows Armington (1969), which is now a well-established procedure. Domestic commodities compete against imports. These two classes of commodities are not perfect substitutes but rather are differentiated, and the user cannot freely switch from one to the other as the law of purchasing power parity would assume. The user is faced with the conventional cost minimization problem, given some functional specification of the substitution possibilities between the two commodities. Following Armington we choose constant elasticity of substitution (CES) functions. Without specifying the Lagrangian cost minimization procedure, which may be found from many sources in the literature, we derive a total cost function for composite prices:

\[ P_{c[1,mcom]} = (dlnmroe*(P_{dm} \cdot omroe)) + dlnmroe*(P_{lm}\cdot omroe))^{(1/omroe)} \]  \hspace{1cm} (3.1.2)

with
\[ dlnmroe = dlnmd \cdot roe \]
\[ dlnmroe = dlnml \cdot roe \]
\[ omroe = 1 - roe \]
\[
\begin{align*}
\text{where } & dlm \text{ and } dlml \text{ are the "distribution" parameters of the function,} \\
& \text{roe is the elasticity of substitution, and} \\
& Pdm \text{ is the vector of domestic producer prices of importables.}
\end{align*}
\]

\(Plm\) the domestic price of imports and \(Plo\) the domestic price of non-competitive commodities are derived in an identical fashion to the SIO model as follows:

\[
\begin{align*}
Plm &= e \times Pwm \times (1 + dm) + um \\
Plo &= e \times Pwo \times (1 + do) + uo
\end{align*}
\]

where \(Pwm\) and \(Pwo\) are row vectors of the respective world prices, \(e\) is the exchange rate, \(dm\) and \(do\) are vectors of ad valorem tariffs, and \(um\) and \(uo\) are vectors of specific or unit tariffs.

Although not required at this point of the exposition, we will later need the share of total demand for composite commodities of both importables and imports. These can be derived from the cost minimization procedures as follows:

\[
\begin{align*}
smd &= Qddm/Qd[mcom,1] = (dlmd \times Pcm / Pdm)^{\text{roe}} \\
sml &= Qdwm/Qd[mcom,1] = (dlml \times Pcm / Plm)^{\text{roe}}
\end{align*}
\]

In a relatively straightforward fashion, we can now bring together the remaining elements of the composite price system.

\[
\begin{align*}
Pc[1,xcom] &= Pdx \\
Pc[1,ncom] &= Pdn \\
Pc[1,ocom] &= Plo
\end{align*}
\]

We simply set the remaining vacant elements of the composite price vector equal to domestic prices for exportables and non-traded goods and equal to the domestic price of non-competitive imports. As before, the Vanuatu SAM contains both basic and producer prices. We therefore need to derive the vector of basic prices. Basic prices are different from producer prices only for non-traded goods; thus we have:

\[
\begin{align*}
Pb[1,tcom] &= Pdt \\
Pb[1,ncom] &= Pdn/(1 + dn)
\end{align*}
\]
Value added prices can now be simply obtained from the adding up condition; the sum of inputs valued at their respective composite prices equals the sum of outputs valued at basic prices.

\[ P_v = (P_{b:b} - P_{c:a}) / v\text{coef} \]  

(3.1.12)

The necessary specification of the price system is now complete, except for an adjustment to the producer price of exportables, which is made in section 3.7.

### 3.2 Production

This study selected two forms of constant returns to scale production functions: CES and Leontief fixed proportions functions. Most of our activities adopt the CES formulation, and we have chosen Leontief for the government activities. The latter choice was made because in the government sectors there is no operating surplus, and accordingly the CES formulation is not operational. Because the Leontief formulation is straightforward, we devote our attention to the CES activities.

It is assumed that output is produced from fixed supplies of composite capital and labor. Capital is an activity specific composite item, and once installed it cannot be relocated elsewhere. Each unit of capital is composed of various commodities in fixed proportions, and no substitution is possible; in other words, we are in a putty-clay world.

Labor is not sector specific and will be employed so that the value of its marginal product is equated with the going wage. Unlike capital, composite labor is not treated as a composite item composed of different skills in fixed proportions. Composite labor is itself determined by a two-level CES function. At the upper level the four skill classes combine to produce composite labor. Substitution is possible between classes. At the lower level each skill group is itself represented by a CES function, combining ni-Vanuatu and expatriate labor. As in the case of product differentiation between imports and importables, we postulate that expatriate labor is not directly substitutable by ni-Vanuatu labor. In the market place there is differentiation by entrepreneurs, and substitution is not infinitely elastic. While ni-Vanuatu labor is in fixed supply, it is assumed that expatriate labor is in infinite supply at the going wage. Because the section 3.3 discusses the functioning of the labor
market in detail, we restrict ourselves here to only the aggregate production function.

Although capital labor substitution is possible, we assume that intermediate inputs are required in fixed proportions to gross output. There are no substitution possibilities between intermediates or between intermediates and either capital or labor. Similarly, activities produce commodities in fixed proportions and no substitution is possible. Because our "make" matrix is largely diagonal, this restriction is not important in practice.

Without discussing the constrained profit maximizing problem, we proceed directly to the required formula:

\[
V = K \cdot ((gamk / den) ^ (1/sig))
\]

\[
den = 1 - (gaml * ((gaml*Pv/wg) ^ (sig-1)))
\]

\[
Lg = V \cdot ((gaml*Pv/wg) ^ sig)
\]

where

- \( V \) is the level of output,
- \( K \) is the level of capital installed,
- \( wg \) is going composite wage,
- \( Lg \) is the demand for composite labor,
- \( gamk \) and \( gaml \) are the CES "distribution" parameters for the function,
- \( sig \) is the elasticity of substitution, and
- \( den \) is a work array.

Substitution of \( Pv \) and \( wg \) into equation 3.2.2 yields \( den \), which when substituted into equation 3.2.1 with known supplies of capital, yields the level of production \( V \). Equation 3.2.3 indicates the demand for composite labor.

Gross output is in fixed relationship to value added, and commodity production is in fixed proportion to gross output:

\[
X = V / vcoef
\]

\[
Qs = b : X
\]

Finally, we make allowance for technical change. In accord with the main body of empirical evidence, we assume technical progress is labor augmenting or Harrod neutral. The parameter \( gaml \) in the above equations is updated each period so that:
\[ \text{gaml}(t + 1) = \text{gaml}(t) \cdot \exp(\text{pdc} \cdot (\text{sig} - 1) / \text{sig}) \]  
(3.2.6)

where \( \text{gaml}(t + 1) \) is the labor distribution parameter next period, \( \text{pdc} \) is the sectoral rate of technical change, and \( \exp \) is the exponential function.

Our discussion of the productive structure is complete, and we now turn to the labor market.

### 3.3 The Labor Market

The labor market is modeled in some detail to represent the real workings of the Vanuatu economy, especially the incorporation of the subsistence economy in a dynamic way. Three ingredients are important for the labor market: the rural subsistence economy, the rural cash economy, and the urban cash economy. In the rural sector (incorporating both the subsistence and cash economies), the labor market is assumed to be composed of two important components: a pool of unskilled labor and a supply of skilled labor, which is employed only in the rural cash economy. Unskilled labor has three choices: remain in the subsistence economy, enter the rural cash economy, or migrate to the urban areas.

The migration function is the classic Harris and Todaro (1970) model. Labor migrates depending on the real wage differential between rural and urban areas and the probability of finding work. The decision to join the rural unskilled labor market is also dependent on the rural wage, and the exposition includes a standard labor supply function for this category. The level of production in the subsistence economy is then determined by the amount of rural unskilled labor that decides not to migrate or work in the rural cash economy.

On the supply side all ni-Vanuatu skilled labor is in fixed supply and is augmented each year through education and training. Unskilled labor is determined through the above nexus of interactions, except that the rural labor pool and the supply of urban unskilled labor (before migration) are assumed to grow by exogenous projections of the labor force dependent on population growth.

All markets clear for ni-Vanuatu labor except in the urban areas where unskilled labor may be unemployed if demand is inadequate for full employment. In the urban unskilled case, nominal wages are left unaltered from the
base levels, which reflect the stylized facts of the economy. Expatriate labor is in infinite supply at the going wage, which is indexed to the local cost of living.

Using some algebra, we start with the rural-urban migration. The level of migration each period is given by:

\[ Mig = LSrp * migelas * ((Uwage / Rwage) \times (LDu[labusk,1]/LSu[labusk,1]) - 1) \]  (3.3.1)

where \( LSrp \) is the size of the rural labor pool, \( Uwage \) is the average urban unskilled wage, \( Rwage \) is the average rural unskilled wage, \( LDu[labusk,1] \) is the demand for urban unskilled labor, \( LSu[labusk,1] \) is the supply of urban unskilled labor, and \( migelas \) is the rural-urban migration elasticity.

All terms on the right-hand side are lagged one period; thus the rate of migration this period \( Mig \) is a function of variables determined during the last period. The function simply specifies that migration is a function of the size of the rural labor pool \( LSrp \), the rural urban wage differential \( Uwage/Rwage \), and the chances of finding a job \( LDu[labusk,1]/LSu[labusk,1] \). We also need to specify the sets \( labusk, labskl, \) and \( labvan, \) which are the unskilled, skilled, and ni-Vanuatu groups, respectively.

The various labor supply conditions can now be specified:

\[ LSrp = LSrp * lsur[labusk,year] - Mig \]  (3.3.2)
\[ LSrsk = LSrsk85 * lsur[labskl,year] \]  (3.3.3)
\[ LSrus = LSrp * (1-Alsfn/(1+exp(Blsfn*(Rwage-Rwage85)))) \]  (3.3.4)
\[ LSusk = LSusk85 * lsur[labskl,year] \]  (3.3.5)
\[ LSuus = LSuus * lsur[labusk,year] + Mig \]  (3.3.6)

The first equation adjusts the last period's rural labor pool for exogenous growth in the labor supply \( lsur \) this year less urban migration. The set \( year \) defines \( lsur \) during the current period. The second equation simply updates the skilled rural labor supply \( LSrsk \) by exogenous growth \( lsur \). Equation 3.3.4 specifies the unskilled rural labor supply function. It has an upper bound equal to the rural labor pool and an exogenously supplied labor supply elasticity \( Blsfn. Alsfn \) is a parameter determined from base year conditions.
For the urban market the skilled labor supply is simply updated by the exogenous growth in the labor supply $l_{urb}$, while the unskilled portion includes inward migration.

Employment in the subsistence economy is given by:

$$L_{sub} = L_{Sr} - L_{subs} \quad (3.3.7)$$

as the difference between the rural labor pool supply and the supply of unskilled labor in the rural cash economy. Finally, subsistence production is given by:

$$V_{sub} = L_{subs} / \theta_{subs} \quad (3.3.8)$$

where $\theta_{subs}$ is the labor output ratio for the subsistence economy.

Now we can return to the rural and urban labor markets. In the short term the two markets are considered as separate entities with a different wage structure clearing each market independently. In the long term migration will tend to equalize wages. As discussed earlier, the composite labor and wages of equations 3.2.2 and 3.2.3 are determined through a two-level CES function. The upper function differentiates between skills, and the lower function differentiates between expatriate and ni-Vanuatu labor. We can now begin by considering the rural market. We first derive a function for composite wages at the lower level, which is given by the rather complicated expression in equation 3.3.9; this cost function is derived from the lower level CES function. We then derive in equation 3.3.10 a similar expression for composite wages at the upper level. It is this wage rate that enters equation 3.2.2 above.

$$w_{g_r} = \left(i84'(kelr * (wr^p((i8:ome尔)))^q(1/ome尔)) \right) \quad (3.3.9)$$

$$w_{gr} = \left(1:(keur * (wg_r^p((i4:omeur)))^q(1/omeur)) \right) \quad (3.3.10)$$

with $

kelr = ksi_l^* \eta_{arl}$  
keur = ksi_u^* \eta_{aur}$  
$ome尔 = 1 - \eta_{arl}$  
$omeur = 1 - \eta_{aur}$

In the above system $ksi$ are the "distribution" parameters of the CES functions, while $eta$ are the elasticities of substitution. The following conventions
have been followed: \( l \) is for lower function, \( u \) for upper, \( r \) for rural, and \( u \) for urban. Thus \( ksilr \) are the distribution parameters for the lower function and in the rural areas. We note that \( i4 \) and \( i8 \) are unit column vectors of lengths four and eight, whose function is to generate a matrix of identical rows out of the single row vector \( omerlr \), etc.; \( i84 \) is matrix with eight rows and four columns, with the two halves being identity matrices. We can now either turn a matrix with four rows into eight rows with identical halves or add the two halves of an eight-row matrix into one with four rows.

where \( wr \) is a matrix of rural wages by skill group for both ni-Vanuatu and expatriates, (i.e., eight rows) and by rural activity;

\( wg_r \) is a matrix of composite wages containing the four skills at the lower level (i.e., four rows) by rural activity; and

\( wgr \) is a vector of composite wages at the upper level (i.e., it has only one row) by rural activity.

Feeding \( wgr \) into equation 3.2.3 above allows us to determine the demand for composite labor \( Lgr \). This is then used to derive the demand for composite labor at the upper level in equation 3.3.11, as well as the individual demands by skill and group at the lower level in equation 3.3.12 below. These equations are derived from the first order conditions of the cost minimization process.

\[
Lg_r = (i4:Lgr) *((ksiur*(i4:wgr) /wg_r)^(i4:etaur))
\]

(3.3.11)

\[
Lr = (i84:Lg_r)*((ksilr*(i84:wg_r)/wr)^y8:etalr))
\]

(3.3.12)

where \( Lr \) is a matrix of demands for ni-Vanuatu and expatriate labor by skill and rural activity (it has eight rows),

\( Lg_r \) is a matrix of composite labor demands at the lower level by skill and rural activity (it has four rows), and

\( Lgr \) is a vector of composite labor demands at the upper level by rural activity (it has one row).

Because the demand for labor in the rural market is now completely specified, we can derive the excess demand conditions as follows:

\[
LD_r = Lr : 1
\]

(3.3.13)

\[
LXS_r = LSr - LDr[laban, l]
\]

(3.3.14)

where \( LD_r \) is the demand for labor by skills in the rural areas, and

\( LXS_r \) is the excess supply of ni-Vanuatu labor by skills.
We recall that expatriate labor is in infinite supply at the going wage, which in this case is also indexed to the CPI. However, for ni-Vanuatu we assume that wages move to clear the rural market, and we make an improved guess as follows:

\[ \text{wnvr} = (1 - (LXSr/LSr) \times \text{Iconfacr}) \times \text{wnvr} \]  

(3.3.15)

The convergence factor \( \text{Iconfacr} \) dampens the speed of adjustment from one iteration of the rural labor market to the next. With our new guess at wages we re-enter the system at equation 33.9 above and iterate until \( LXSr \) has reached the convergence criteria. In practice, the rural labor market clears very quickly within a few iterations.

The procedures for the urban market are identical to those for the rural market, with two exceptions. First, while the public sector activities are chosen to have Leontief production functions and are not profit maximizers, we allow the activities to minimize costs in the use of labor. Second, the unskilled portion of the urban market clears only if the demand for labor exceeds supply. In this case, urban wages are allowed to rise. Otherwise, they remain fixed at the last period's rate, and unemployment results. The model thus assumes that workers suffer from "money illusion" and wages are sticky downward.

Finally, we need to specify the average rural and urban wage rate as an average of unskilled wages in the two regions:

\[ \text{Rwage} = (wr[labusk, ract] \times \text{lruswght}) / \text{cpi} \]  

(3.3.16)

\[ \text{Uwage} = (wu[labusk, uact] \times \text{luuswght}) / \text{cpi} \]  

(3.3.17)

where \( \text{lruswght} \) and \( \text{luuswght} \) are coefficient vectors used in determining the average rural and urban wage, respectively.

### 3.4 Household Formation

In this version of the model we endogenize the growth of households to reflect the growth in the supply (demand) for labor in the rural, urban, and expatriate markets. Due to the age structure of the population, an upward bias will be placed on household formation because the labor force will be growing faster than households (assuming constant household size). However, this represents a first approximation and is preferential to any exogenous specification. We have:


\[
LDexp = 1 : L_{labotr, act} : 1 \quad (3.4.1)
\]

\[
\text{popgr}[\text{uhlds}, 1] = 1:LSu / 1:LSuo \quad (3.4.2)
\]

\[
\text{popgr}[\text{rhlds}, 1] = 1:LSr / 1:LSro \quad (3.4.3)
\]

\[
\text{popgr}[\text{ohlds}, 1] = LDexp / LDexpo \quad (3.4.4)
\]

\[
\text{pop} = \text{poply} \times \text{popgr} \quad (3.4.5)
\]

where

- \( LDexp \) is demand for expatriate labor,
- \( LDexpo \) is last period's demand for expatriate labor,
- \( LSro \) is last period's supply of rural ni-Vanuatu labor,
- \( LSuo \) is last period's supply of urban ni-Vanuatu labor,
- \( \text{popgr} \) is a vector of household growth rates,
- \( \text{poply} \) is the growth in households from the base period up to the last period, and
- \( \text{pop} \) is a vector of total growth in households from the base period to the current.

The above system is largely self-explanatory. The vector \( \text{pop} \) replaces the exogenous factors given in the SIO version and is used in the LES for the estimation of household demand for commodities.

### 3.5 Private Investment

Because we feel that the standard treatments of investment of economic theory are not acceptable in Vanuatu, we proceed to project gross private investment in line with past trends, anticipated performance of the economy, and current expectations.

\[
Pi = Pinv85 \times pinv \quad (3.5.1)
\]

where

- \( Pi \) is the current level of private investment,
- \( Pinv85 \) is the base period level of investment, and
- \( pinv \) is an exogenously projected growth factor.

However, the supply of investable resources is allocated across private sector activities according to their total share of the private sector capital stock and the real rate of return compared with the average for the economy. In the long term, resources will shift to equalize the real rate of return. The activity and economy-wide rates of real return are given by:
\[ r = \frac{(Pv \cdot V \cdot (1 : w \cdot L))}{(K \cdot (Pc : j))} \]  
\[ R = \frac{(Pv \cdot V' \cdot (1 : (w \cdot L) : 1))}{((K \cdot (Pc : j)) : 1)} \]  

(3.5.2)  
(3.5.3)

where the only unknown term is the capital composition matrix \( j \). Both expressions divide the level of profits by the current value of the capital stock. The first equation defines the real rate of return per activity, and the second determines the average level in the economy. We now proceed to allocate the total investment by sector of destination.

\[ sPi = \frac{r}{R} \]  
\[ sPi = \frac{(K / K : 1) \cdot sPi \cdot rfac}{sPi} \]  
\[ sPi = sPi \cdot (1 / sPi : 1) \]  
\[ K = K + Pi \cdot sPi \]

(3.5.4)  
(3.5.5)  
(3.5.6)  
(3.5.7)

where \( sPi \) is the share of total investment allocated to each activity, and \( rfac \) is a dampening factor (set = 0.5).

The first equation 3.5.4 indicates the relative profitability of each activity compared with the economy-wide average. The second equation derives a first estimate of the share of capital to be allocated to each sector. The factor \( rfac \) reduces the proportion of investable funds going to highly profitable activities and increases the allocation to the less profitable. Equation 3.5.6 linearly adjusts the shares derived to sum to unity. In equation 3.5.7 the activity capital stock levels are updated.

Finally, this section allocates gross private investment by sector of origin:

\[ Ivpq = j : (Pi \cdot sPi)' \]

(3.5.8)

where \( Ivpq \) is a vector of investment demands by sector of origin.

### 3.6 The Copra Price Support Fund

The model has the option of including a copra support price fund. Vanuatu uses the Stabex Fund, and although the formulation presented here is different, it provides a useful mechanism to investigate the impact of such schemes. We indicate the support price in foreign exchange as the long-term world price projection in equation 3.6.1 below:
Appendix 3

\[
csp = Isp \times tPw
\]  
(3.6.1)

where \(Isp\) is the long-term world price in 1985 dollars, 
\(tPw\) is the rate of world inflation, and 
\(csp\) is the long-term price in current dollars.

Now we set the support price in foreign exchange as the difference between 
the current price of the long-term projection less the current world price. We 
notice that in bad years the world price is supported, and in good years the 
fund recuperates. The bounty/levy is given by:

\[
uxc = (csp - Pwxc)
\]  
(3.6.2)

where \(Pwxc\) is the current world export price of copra.

The subsidy/tax is included in the derivation of the producer price of copra, 
which is discussed below in section 3.7.

3.7 Excess Supplies and Solutions

As noted in the introduction to this appendix, we have not discussed the 
mapping of factors to institutions, the institution accounts, or the derivation 
of the final demands. These all remain the same as in the SIO model; the 
only alteration is that equation 3.5.8 replaces our earlier specification for private investment by sector of origin. We can thus calculate the total demand \(Qd\) and the supply of commodities \(Qs\) as before.

However, because product differentiation between imports and importables 
is included, we have to separate the demand for domestically produced im­
portables from the total demand. This is done as follows:

\[
Qdd = Qd[dcom,1]
\]  
(3.7.1)

\[
Qddm = (Qddm \times smd')
\]  
(3.7.2)

\[
Qsm = Qsm - Qwmx'
\]  
(3.7.3)

The first equation 3.7.1 places the total demand for domestically produced 
commodities in \(Qdd\). The second equation adjusts \(Qddm\) (the importable subset of \(Qdd\)) by the share of importables in total demand \(smd\) given in 
equation 3.3.5. Finally, we deduct from the total supply of importables \(Qsm\) 
our exogenous projection of exports of importables \(Qwmx\). We can now set up our excess demand condition as follows:
This equation allows us to make our next guess at producer prices for im­
portables and non-traded goods defined by the set mnccom and for the out­
put of the public sector activities defined by the set lcom as follows:

\[ \text{Exss} = Qs - Qdd \quad (3.7.4) \]

\[
\text{adjust} = ((\text{Exss}[\text{mnccom}, I]/Qs[\text{mnccom}, I]) \times \text{adjv})' 
\times \text{convfac} \quad (3.7.5)
\]

\[
Pd[I, mnccom] = Pd[I, mnccom] \times (1 - \text{adjust}) \quad (3.7.6)
\]

\[
Xul = Xul \times (1 - \text{Exss}[\text{lcom}, I]/Qs[\text{lcom}, I]) \quad (3.7.7)
\]

The first equation defines an adjustment vector, used to update our guess at prices in equation 3.7.6, to be equal to the excess supply over total supply times the vector adjv and the scalar convfac. The first vector is the reciprocal of the elasticity of supply with respect to value added prices, which helps ad­
just our next estimate of prices so that we do not over- or undershoot. The inclusion of this vector improves the speed of convergence by a factor of about 3. The adjv is calculated from the base year solution by increasing in turn each value added price by 1 percent and by estimating the supply re­
sponse. Of course, any sensitivity experiment, which alters the elasticities in the model, requires a re-estimation of adjv. The scalar convfac is a dampen­
ing factor, which may be used to slow down the speed of convergence across all activities. Through trial and error it is made as large as possible while maintaining smooth convergence.

Although the convergence of activities defined by CES functions is made through price adjustment, the convergence of the public sector activities, which uses Leontief production functions, is made through quantitative ad­
justment. The last equation 3.7.7 improves our guess at the output levels of the public sector activities.

Although we have made an improved guess at domestic producer prices of the importable and non-traded commodities, we still need to specify the pro­
ducer prices of exports and the public sector commodities. The producer price of exports is essentially the world price adjusted for the exchange rate and any domestic taxes; the formula in equation 3.7.8 also includes trade and freight margins. The specification thus includes the composite prices of trade \( Pcnw \) and freight \( Pcnf \), which have just been updated in equation 3.7.6 above. We therefore need to make a refinement to the vector of producer prices of exports as in equation 3.7.8. We notice in equation 3.7.8 the inclusion of the
term $ux$, which is the implicit tax or subsidy implied by the copra support fund and which is defined above in equation 3.6.2.

$$Pdx = e^*(Pwx + ux)/(1 + dx)$$

- $(m_Pcnw) - (f_Pcnf)$

$$Pd[lcom] = Pc[a[com,lact]] + (lW[labor,lact])/Xul'$$

Finally, in equation 3.7.9 we define the producer price of the public sector commodities from the adding up condition; that is, the value of total outputs must equal the value of total inputs. The equation makes implicit use of the fact that the public sector activities do not consume public sector commodities. If they did, equation 3.7.9 would entail an inversion.
Appendix 4

Solution Procedures

The solution of both the SIO and CGE models used the software package ASAP. This software (see Evans, Lucas, and Sturton, 1988) was written explicitly to solve SAM-based models. A description and copy of the software can be obtained from Henry Lucas at the Institute of Development Studies, Sussex University, Falmer, Brighton, Sussex, U.K.

This solution of the two systems is demonstrated in the flow diagrams in Figures A4.1 and A4.2.

![Flow Chart](image)

Figure A4.1 The Semi-Input-Output (SIO) Flow Chart
The solution of the SIO model is relatively straightforward. First, the price section is solved directly, and then activity outputs are computed iteratively until the required degree of accuracy is achieved. The model is multi-period, and control is passed back to the beginning, and the next period's solution is determined. This procedure is repeated every year until 1991 when the model skips to 1995 and then 2000.

In practice, the solution of the output component of the model nearly always converges within ten iterations. In total time the model takes about 15 minutes to solve for the nine different periods on a Compaq 286 with 80287 math chip.

The CGE system has three different markets: the product market, the rural labor market, and the urban labor market. Unlike the SIO model the solution of these markets must be consistent with each other. It is no longer possible to solve one part of the model independently of the other.

The solution of the system is managed through an outer and inner iteration. A guess is made at product prices, which form the outer loop. The inner iteration requires finding a solution for each labor market, given the above guess at commodity prices. An improved guess for product prices is then made from the excess commodity supply conditions. Both labor markets are then recomputed. The process continues until the product market clears. The system is set up so that a weak convergence criterion is specified initially for the labor markets, but as solution of the product market nears convergence a stronger criteria is specified. This procedure avoids wasting time on fine tuning the initial iterations of the product market.

The CGE model is more sensitive than its SIO counterpart and takes between 30 to 100 iterations to converge to the same degree of accuracy. Experience is also required in the selection of the adjustment factors in equation 3.7.6. Skillful choice of these factors will ensure the program converges both quickly and smoothly. On a Compaq 286 microcomputer with a 80287 math chip the program takes about two hours to solve for the full solution of nine periods.
If Year = 2000
Print Results
Stop

Control of Model
Make Guess at Prices

Solve Product Market Iteratively

Solve Rural Labor Market Iteratively

If Convergent

No

Yes

Solve Urban Labor Market Iteratively

If Convergent

No

Yes

If Product Market Convergent

No

Yes

Solve for Additional Variables

Figure A4.2 The Computable General Equilibrium (CGE) Flow Chart
Appendix 5
Parameters and Base Year Variables

This appendix describes how the various parameters and certain base year variables used in the models were derived. It is useful to distinguish between (1) the parameters, (2) the exogenous variables, and (3) the endogenous variables. Parameters are largely sets of coefficients that relate to technological aspects of the model. Examples are the Input-Output coefficients and the expenditure elasticities, which are usually invariant in different model experiments. Variables, as the name implies, may take on different values, some of which are exogenously fed into the model, while others are derived in the solution process. The technique often adopted for entering exogenous variables in this model is to multiply the base year values by a vector of exogenous indices. Accordingly, the discussion here will describe not only the parameters in the model but also the derivation of certain key base year values.

Most of these parameters and base year variables originate directly from the SAM, but some have to be derived from other sources. The discussion will highlight these features, and it will also follow the flow of the development of the models described in Appendixes 2 and 3. First, section 5.1 discusses the derivation of the price system variables, and then section 5.2 turns to the main components of the models. These parameters are required for both the SIO and CGE models. In the remaining sections we derive the additional parameters that are required only for the CGE model.

5.1 The Price System Variables

We start with the price system, the derivation of indirect taxes, world prices, and basic prices of commodities. Equation 2.1.1 in Appendix 2 can be split into two components, the first for ad valorem taxes and the second for specific or unit taxes. In the first case, we multiply through by $Q_{wmm85}$, the base year quantity of imports of importables, and substitute for base year prices. We have:

$$P_{dm85}Q_{wmm85} = e_{85}P_{wm85}(1 + dm_{85})Q_{wmm85}$$

rearranging this equation and solving for $dm_{85}$ we have:

$$dm_{85} = \frac{(P_{dm85}Q_{wmm85} - e_{85}P_{wm85}Q_{wmm85})}{(e_{85}P_{wm85}Q_{wmm85})}$$

We have:

$$P_{dm85}Q_{wmm85} = e_{85}P_{wm85}(1 + dm_{85})Q_{wmm85}$$

(5.1.1)

rearranging this equation and solving for $dm_{85}$ we have:

$$dm_{85} = \frac{(P_{dm85}Q_{wmm85} - e_{85}P_{wm85}Q_{wmm85})}{(e_{85}P_{wm85}Q_{wmm85})}$$

(5.1.2)
The first term on the right-hand side of equation 5.1.2 is the value of imports of importables valued in producer prices less the value of importables valued cif. This amount is simply the value of total tariff collections and may be extracted directly from the appropriate elements in the SAM. The second term on the right-hand side of equation 5.1.2 or denominator is the value of importables cif, which is also simply extracted from the SAM. Thus equation 5.1.2 states that the tariff rate is the sum of tariff collections divided by the value of imports cif.

Turning now to the specific tax case, we have a similar treatment:

\[ P_{dm85}Q_{wm85} = e_{85}P_{wm85}Q_{wm85} + u_{m85}Q_{wm85} \]  \( (5.1.3) \)

rearranging this equation and solving for \( u_{m85} \) we have:

\[ u_{m85} = \frac{P_{dm85}Q_{wm85} - e_{85}P_{wm85}Q_{wm85}}{Q_{wm85}} \]  \( (5.1.4) \)

The first term on the right-hand side of equation 5.1.4 is the same as before, but the second term or denominator is different. In the approach adopted in this model, we have normalized the system so that producer prices in the base year are unity. In this case the "quantity" of imports \( Q_{wm85} \) will be equivalent to the value of such imports cif plus tariffs, which can be simply extracted from the SAM. We can now solve for \( u_{m85} \) in a straightforward manner.

In the model described in Appendix 2, section 2.1, we have combined the treatment of specific and ad valorem taxes into a single equation. In this case, we have assumed that tariffs are either one kind or the other, but the approach will allow both treatments simultaneously if considered to be realistic.

Having now solved for indirect taxes in the base period, we must do likewise for world prices. Assuming that producer prices and the rate of exchange are unity, we can rearrange equations 5.1.1 and 5.1.3, dropping \( Q_{wm85} \), and solve for \( P_{wm85} \).

In the model described in Appendix 2, world prices of tradables, indirect taxes, and the rate of exchange are all exogenous. This discussion has described how to find their values for the base year. To move forward in time
the approach has been to input the projected exogenous vectors in index form and to update through multiplication of the base year values.

The procedures just described are also applied in the derivation of the base year values and parameters for tariffs and prices for non-traded commodities in equations 2.1.1 and 2.1.4. A slightly different treatment is required for the parameters in equation 2.1.3 for export prices. From equation 2.1.3, by putting in base year values, by multiplying top and bottom by the quantity of net exports exported $Q_{wxn85}$, and by rearranging we have:

$$dx85 = \left[ e85 * P_{wx85} - (P_{dx85} + mx*P_{dnw85} + fx*P_{dnf85}) \right] * Q_{wxn85} / (P_{dx85} + mx*P_{dnw85} + fx*P_{dnf85}) * Q_{wxn85}$$

(5.1.5)

The numerator is the volume of taxes collected on each export, while the denominator is the value of exports in producer prices plus freight and transport margins, i.e., exports valued at purchaser prices. The SAM contains details on the value of exports by commodity in producer prices, but the associated export taxes, freight, and trade margins are shown only in aggregate. We thus have to supplement the data contained in the SAM for these items. However, this should not pose any problems because a knowledge of these items was already required in the compilation of the SAM. With this supplementary information, the indirect tax rates $dx85$ can be calculated directly.

The value of $nx$ and $fx$ are derived as follows:

$$nx = Mx85 / Q_{wxn85}$$

(5.1.6)

$$fx = Fx85 / Q_{wxn85}$$

(5.1.7)

where $Mx85$ and $Fx85$ are the levels of margins paid for trade and freight, respectively.

Base year values of world prices for exports may now be derived from equation 2.1.3, assuming unit exchange rate and producer and composite prices.

The next variables required in the price system are the wage rates $w85$ and labor output ratios $lo$. To derive these variables for the base year, we need supplementary data on employment by skills and activities $L85$ that correspond to the SAM accounts. Extracting from the SAM a matrix of wage bills by skill and activity $W85$ we have:
\[ w_{85} = L_{85} / W_{85} \]  
\[ l_{0} = L_{85} / X_{85} \]

where \( X_{85} \) is the base year level of activity gross outputs.

We now need to derive the coefficient's "make" and "absorption" matrices. Extracting value matrices from the SAM for these values \( B_{85} \) and \( A_{85} \), respectively, we have:

\[ P_{d85!} : a : X_{85!} = A_{85} \]  
\[ P_{b85!} : b : X_{85!} = B_{85} \]

which after reorganization and inversion of the diagonal matrix \( X_{85!} \) and \( P_{b85!} \) gives the required coefficients matrices (in practice, inversion is not required because division of the rows and columns of \( A_{85} \) and \( B_{85} \) by the required vectors is all that is needed). We recall from the discussion on the SAM that while the entries in the absorption matrix were in producer values, those in the make matrix were in basic prices. By definition we have set \( P_{d85} \) to unity, and we must calculate \( P_{b85} \) from an equation similar to equation 2.1.4.

The vector of markups for non-traded activities \( r_{n} \) is derived as follows:

\[ r_{n} = O_{sn85} / (X_{n85} - O_{sn85}) \]

where \( O_{sn85} \) is the SAM set of values for the operating surplus of non-traded activities.

In equation 2.1.7 we need a set of capital output ratios \( k_{0} \). These are exogenously supplied to the model and were modified from Fiji data (see Sturton 1983).

Finally, in this section we need a pair of matrices \( m_{c} \) and \( f_{c} \) of trade and freight margins paid on consumer expenditure. These variables enter the system through equation 2.1.8 and are needed in the derivation of the set of purchaser prices for the Linear Expenditure System (LES). Vectors \( t_{marg} \) and \( f_{marg} \) of trade/freight margins are supplied exogenously because the SAM contains only the aggregate of margins paid on all commodities and not the individual amounts paid on each element. These were scaled against the aggregate trade and freight margins paid by households contained in the SAM to ensure consistency.
Appendix 5

\[ mc = \frac{tmarg}{Ch85} : \left( Ch85 / \left( tmarg' : Ch85 \right) \right) \]  
(5.1.13)

\[ fc = \frac{fmarg}{Chf85} : \left( Chf85 / \left( fmarg' : Ch85 \right) \right) \]  
(5.1.14)

where \( Ch85 \) is a matrix of household consumption by commodities, including domestic servants wages, and by household group. \( Chit85 \) and \( Chf85 \) are sub-elements of \( Ch85 \), which relate to household outlays on trade and freight margins, respectively.

5.2 Main System Variables

This section derives those variables and parameters needed for the solution of the main part of the system. Many of these variables have, however, already been derived in the price system, and only the new elements are discussed.

We start with the allocation of factor rewards to institutions, which proceeds in a straightforward manner. Many factor rewards are mapped directly to institutions, and accordingly there is no need for any parameterization. However, we still need a few items. First, we must make provisions to allocate part of the operating surplus directly to the appropriate accounts:

\[ commcoef = \frac{Oscm85}{Oscm85} \]  
(5.2.1)

\[ bksccoe = \frac{Bksc85}{Xbk85} \]  
(5.2.2)

where \( Oscm85 \) and \( Oscm85 \) are the operating surplus of the communications activity and that element of it accruing to the public sector, respectively. \( Bksc85 \) is the base year level of the imputed bank service charge, and \( Xbk85 \) is the gross output of the banking activity.

Certain sets of coefficients are now required to allocate urban ni-Vanuatu rewards from labor to ni-Vanuatu urban households and to allocate the urban private sector operating surplus between the private urban institutions. The following sets of coefficients are derived from the SAM:

\[ maplu = Maplu85 : (1 : Maplu85)!\% \]  
(5.2.3)

\[ mapcu = Mapcu85 / Ospus85 \]  
(5.2.4)

\[ mapco = Mapco85 / Ospus85 \]  
(5.2.5)

\[ mapcp = Mapcp85 / Ospus85 \]  
(5.2.6)
Maplu85 is a matrix derived from the SAM with urban ni-Vanuatu households in the rows and ni-Vanuatu labor skills in the columns. Equation 5.2.3 simply divides the rows of Maplu85 by the sum of its columns. Mapcu85, Mapco85 and Mapcp85 are the SAM values of that part of the operating surplus allocated to urban ni-Vanuatu households, "other" households, and the private corporate sector, respectively. Ospus85 is simply the sum of these items.

We now turn to the transfer elements of the system. In general, for the domestic institutions, transfers are either exogenous or calculated as fixed proportions of factor incomes. In the former case, they are usually indexed to the CPI. Thus we first derive the CPI weights for each household group cwght and the proportion of total household expenditure by group in aggregate household expenditure chwght. These coefficients are used in equation 2.3.1 in Appendix 2.

\[
cwght = \frac{Ch85}{Hcon85} \quad (5.2.7)
\]
\[
chwght = \frac{Hcon85}{(Hcon85 : 1)} \quad (5.2.8)
\]

The transfers, which are direct proportions of institutional incomes, are all extracted from the SAM, and the allocation coefficients are derived along the following lines:

\[
thg = \frac{Thg85}{Fh85} \quad (5.2.9)
\]
\[
thr = \frac{Thr85}{Fh85} \quad (5.2.10)
\]
\[
thhr = \frac{Thhr85}{Fh85} \quad (5.2.11)
\]
\[
thrh = \frac{Thrh85}{Fhr85} \quad (5.2.12)
\]
\[
tpr = \frac{Tpr85}{Fp85} \quad (5.2.13)
\]

The last term on the right-hand side of the equations is the respective factor incomes. Thus Fh85 is the factor incomes of households, Fhr85 the factor incomes of rural households, and Fp85 the factor incomes of the corporate private sector.

We now turn to the household sector and describe the various parameters that are involved with household savings and expenditures.

\[
hsav = \frac{Hsav85}{Yh85} \quad (5.2.14)
\]
In the above equation, household savings rates are determined as simple proportions of disposable incomes; all variables originate from the SAM.

To derive the \textit{Alpha} coefficients of the LES, we solve backward so that when base year consumption levels $Hcon_{85}$ are substituted into the system, the SAM values are reproduced (see Taylor 1979). First, however, we read expenditure elasticities $elas$ by household group and commodity into the system. These were derived from the cross-section regression analysis of the 1985 ni-Vanuatu urban household expenditure survey. With a knowledge of the average propensities to consume by commodity and household group $cwght$, we can derive the marginal budget shares required for the LES as follows:

$$beta = elas \cdot cwght$$ \hspace{1cm} (5.2.15)

For the adding up condition $(1:beta = 1)$ to hold, we adjust our derived values of $beta$ as follows:

$$beta = beta : (1:beta)!\%$$ \hspace{1cm} (5.2.16)

Because the LES is in purchaser prices, we must derive the base period value of purchaser prices (given producer prices equal to unity) as follows:

$$Pr_{85} = 1 + mc + fc$$ \hspace{1cm} (5.2.17)

with $mc$ and $fc$ as before.

We are now able to solve for the value of \textit{Alpha} by back substitution into the LES as follows:

$$Alpha_{85} = Chpr_{85}-(beta/Pr_{85}):(Hcon_{85}-Pr_{85}:Alpha_{85})!$$ \hspace{1cm} (5.2.18)

where $Chpr_{85}$ are the SAM values for consumption by commodity and household group excluding trade and freight margins.

Apart from the last term in the brackets on the right-hand side of 5.2.18, supernumary income, we have all the information we need. To estimate this element we draw on Taylor (1979) and make estimates for the income elasticity of the marginal utility of income, which is defined to be:

$$omega = - Hcon_{85} / (Hcon_{85} - Pr_{85}:Alpha_{85})$$ \hspace{1cm} (5.2.19)
Given values of \( \omega \) for the household groups, we can substitute equation 5.2.19 into equation 5.2.18 and finally derive \( \text{Alpha}_{85} \). However, we have no empirically estimated values of \( \omega \) for Vanuatu, and like many other studies including Frisch (1959), we choose some likely figures and ranges. (Model results are not in any case sensitive to the values chosen for these variables.) Inspection of equation 5.2.19 shows that as subsistence expenditures fall as a proportion of total expenditure, which is expected as income rises, the greater the value of \( \omega \). We have chosen values for \( \omega \) in the range \([-5 -1]\); from the lowest income ni-Vanuatu household group to the highest income "other" income group. We notice that although \( \omega \) is derived from theory, in practice it acts only as a scaling parameter in the derivation of the \( \text{Alpha} \).

We can now turn our attention to the final demand elements of the system. In most cases, the specification is exogenous, and all we need here is the derivation of the coefficients:

\[
\begin{align*}
\text{trsmc} & = \frac{\text{Trsm}_{85}}{\text{Trsm}_{85}} \\
\text{rexc} & = \frac{\text{Rex}_{85}}{\text{Rex}_{85}} \\
\text{pinvc} & = \frac{\text{Pinv}_{85}}{\text{Pinv}_{85}} \\
\text{ginvc} & = \frac{\text{Ginv}_{85}}{\text{Ginv}_{85}} \\
\text{stotc} & = \frac{\text{Stot}_{85}}{\text{Stot}_{85}} \\
\text{strsc} & = \frac{\text{Strs}_{85}}{\text{Strs}_{85}}
\end{align*}
\]

where the defined coefficients are as follows: tourism, re-exports, private investment, government investment, stocks of unsold outputs, and stocks held by wholesalers and retailers. The first terms on the right-hand side are the SAM-based levels by commodity, while the second terms are the aggregate level.

Because the level of stock accumulation is related to the growth in the economy, we need to define the activity value added coefficients as follows:

\[
\text{vcoef} = \frac{V_{85}}{X_{85}}
\]

where \( V_{85} \) and \( X_{85} \) are the SAM levels of value added and gross output by activity.

Finally, we need a few parameters relating to the tourism demand function. The income and own price elasticities of demand for tourism \( yelt \) and \( pelt \) are

\[
\begin{align*}
vcoef & = \frac{\text{V}_{85}}{\text{X}_{85}}
\end{align*}
\]
estimated independently from the SAM through separate econometric exercises, while $deptxc$ is the coefficient for departure tax paid by tourists and is given by:

$$deptxc = \frac{Deptx85}{Trsm85} \quad (5.2.27)$$

where $Deptx85$ is the SAM level of the departure tax paid.

## 5.3 Capital Stocks and Coefficients Matrix

There are no estimates of capital output ratios or capital coefficients (the commodity composition of capital) in Vanuatu. These estimates were taken from Fiji data. The level of capital stocks in the base year was derived as follows:

$$K85 = ko' * V85 \quad (5.3.1)$$

where $ko$ are the Fiji sectoral capital-output ratios, and $V85$ are the base year value added data.

## 5.4 The CES Elasticities and Distribution Parameters

CES functions are used in three different places in the CGE model: in product differentiation between imports and importables, in production, and in the labor market. The elasticities are obtained from third country data or guesstimates, while the distribution parameters are derived so that the functions fit the base year SAM values. If we start with product differentiation, the elasticities of substitution or Armington elasticities were estimated in line with various other studies (see DeMelo and Robinson 1980). Commodities with a high degree of substitution such as agriculture were given elasticities in the range of 1.5 - 2. Where substitution possibilities are less, as in manufacturing, elasticities were chosen at 0.5.

The distribution parameters were estimated from the first order conditions (remember that the domestic prices of imports and importables are unity in the base period) as follows:

$$Sm85 = Tmw85 + Qwmn85 + Tmd85 + Qdm85 - Qwmx85 \quad (5.4.1)$$

$$smd85 = \frac{(Tmd85 + Qdm85 - Qwnx85)}{Sm85} \quad (5.4.2)$$

$$sml85 = \frac{(Tmw85 + Qwmn85)}{Sm85} \quad (5.4.3)$$

$$dlmd = smd85 ^ (1/roe) \quad (5.4.4)$$

$$dlml = sml85 ^ (1/roe) \quad (5.4.5)$$
where \( Sm85 \) is the base year level of supply, 
\( Tmw85 \) is the level of tariffs on imports, 
\( Qwmn85 \) is the base year level of imports CIF, 
\( Tmd85 \) is the level of domestic commodity taxes on importables, 
\( Qdm85 \) is the base year level of production of importables, 
\( Qwmx85 \) is the base year level of exports of importables, 
\( smd85 \) is the base year share of importables, and 
\( sml85 \) is the base year share of imports.

The last two equations, which estimate the distribution parameters \( dilm \) and \( dilm_l \), are the reduced form of the first order conditions with domestic prices equal to unity; \( roe \) is a vector of Armington elasticities.

We now turn to the production functions and go through a similar procedure. The CES elasticities of substitution used estimates derived for Fiji, which were themselves constructed from various international sources. In the derivation of the distribution parameters below, we again make use of the first order conditions and a knowledge that value added prices are unity in the base period. Wages and capital rentals are not unity, and we have to use the data contained in the SAM. We have:

\[
\begin{align*}
\text{gaml} &= wg85 \times ((Lg85 V85)^{(1/sig)}) \quad (5.4.6) \\
\text{gamm} &= r85 \times ((K85 V85)^{(1/sig)}) \quad (5.4.7)
\end{align*}
\]

where \( gaml \) are the distribution parameters for labor, 
\( gamm \) are the distribution parameters for capital, 
\( wg85 \) are the base levels of average wages in each activity, 
\( r85 \) are the base levels of capital rentals, 
\( Lg85 \) are the base levels of aggregate labor demands, and 
\( sig \) are the elasticities of substitution.

Finally, this section derives the distribution parameters of the two-level CES functions for aggregate labor given in equation 5.4.6 above. The elasticities of substitution were chosen as 0.5 at the lower level for substitution between expatriate and ni-Vanuatu labor and at 3 for the upper level for substitution between skills. These elasticities can be described at best as first approximations and are indicative only. Again we make use of the first order conditions, remembering that base year factor prices are wage rates and not unity. The distribution parameters for the two functions are given by:
Appendix 5

\[ ksil = \left( \frac{w85}{i84:wg_85} \right) \cdot \left( \frac{(L85/(i84:Lg_85))}{(1/i8:\text{etal})} \right) \]  

(5.4.8)

\[ ksiu = \left( \frac{wg_85}{i4:wg85} \right) \cdot \left( \frac{(Lg_85/(i4:Lg85))}{(1/i4:\text{etau})} \right) \]  

(5.4.9)

where \( \text{etal} \) and \( \text{etau} \) are the elasticities of substitution for the lower and upper functions, respectively,

- \( w85 \) is a matrix of base year wage rates containing both ni-Vanuatu and expatriate wages,
- \( wg_85 \) is a matrix of composite wages for the four skill groups,
- \( L85 \) is matrix of base year demands for labor containing both ni-Vanuatu and expatriates,
- \( Lg_85 \) is a matrix of composite demands for labor for each skill group,
- \( i4 \) and \( i8 \) are unit column vectors of length four and eight, respectively, used in generating a matrix of identical rows,
- \( i84 \) is a rectangular matrix of eight rows and four columns; the top and bottom halves are identity matrices. In equation 5.4.8, it is used to generate a matrix with eight rows so that the top four rows are identical to the bottom four.

The first equation derives the distribution parameters for the lower function, while the second equation sets the parameters for the upper. Both equations are composed of two ratios, the first of which is the ratio of wages at the lower level to the upper. Similarly, the second is the ratio of the demand for labor at the lower level to the upper. In both ratios some juggling by the \( i \) matrices is required to obtain matrices of the right size. The multiplication of these two ratios is raised to the power of the reciprocal of \( \text{eta} \), again expanded for compatibility.

### 5.5 The Labor Market Parameters

We start by considering the derivation of the migration elasticity in the migration function. This is determined by solving the migration function backward given base year levels:

\[ \text{migelas} = \frac{\text{Mig85}}{L.Sr85} \cdot \left( \frac{(Uwage85/Rwage85)}{(L.Du85[labusk,1]/L.Su85[labusk,1]) - 1} \right) \]  

(5.5.1)
where \( \text{Mig}85 \) is the base level of migration, \( \text{Uwage}85 \) is the average urban unskilled wage in the base year, \( \text{Rwage}85 \) is the average rural unskilled wage in the base year, \( \text{Du}85 \) is the demand for all categories of labor in the base year, \( \text{LSu}85 \) is the supply of ni-Vanuatu in the base year, and \( \text{labusk} \) is the set of unskilled labor.

The next parameter required is \( \text{Alsfn} \) of the labor supply function for rural unskilled labor. The labor supply function from Appendix 3 is:

\[
\text{LSrus} = \text{LSrp} \times (1 - \text{Alsfn}/(1 + \exp(\text{Blsfn} \times (\text{Rwage} - \text{Rwage}85))))
\] (3.3.4)

Now in the base period \( \text{Rwage} = \text{Rwage}85 \); thus the exponential term becomes unity. This allows us to solve for \( \text{Alsfn} \) as follows:

\[
\text{Alsfn} = (1 - (\text{LSr}85 \text{[labusk,1]}/\text{LSrp}85)) \times 2
\] (5.5.2)

However, for equation 3.3.4 in Appendix 3, we still need \( \text{Blsfn} \), and a low value was chosen to maintain a stable solution.

Finally, we need the rates of technical change \( \text{pdc} \) required to update the CES production function distribution parameter for labor in equation 3.2.6 in Appendix 3. These parameters were chosen in consultation with experts working in Vanuatu on labor markets and manpower problems. No statistically estimated data were available, and thus informed guesses were necessary.

5.6 The Long-run Support Price of Copra

The copra price support fund featured in the model uses an estimate for the long-run support price. The actual movement and World Bank projections from 1985 onward for copra commodity prices show a drastic fall in 1986 and thereafter a steadily rising trend. A support price was thus chosen to be less than the long-run price so that some repayment of debt could be made during the horizon of the model.
Appendix 6

The Exogenous Input Data Set

The following discussion and tables itemize the major exogenous inputs into the models. The data are in index form, and base level variables for 1985 are multiplied by the values given below. For example, the commodity price projections for exports are multiplied by the base period prices derived from the SAM. In certain, cases mainly for indirect rates, this approach can lead to some confusion. For example, if a tariff was levied at 25 percent, an input specification of 1.3 would imply the tariff rate had risen to 32.5 percent. For consistency all input data are recorded in this fashion. The abbreviated variable input names given in the tables below are defined in the discussion of the SAM accounts in Appendix 1. Data have been included up to 1990, although the model makes three further projections for 1991, 1995, and 2000. The information in Table A6.1 should be sufficient to give the reader the general direction of movement.

The first set of input data required is the growth rates of rural and urban ni-Vanuatu labor by skill category. There is no distinction between the two groups, although the model allows for differences. The growth rates in Table A6.1 are determined by population factors and education policy. The higher skill groups reveal a faster rate of growth, reflecting the entrance into the labor force of increasing numbers of more highly educated and trained people.

Table A6.1  Projected growth rates of labor supply

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<td>1.000</td>
<td>1.040</td>
<td>1.082</td>
<td>1.124</td>
<td>1.170</td>
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<td>1.071</td>
<td>1.109</td>
<td>1.147</td>
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<td>1.071</td>
<td>1.109</td>
<td>1.147</td>
</tr>
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<td>1.090</td>
<td>1.121</td>
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<tr>
<td>Urban labor supply growth rates</td>
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<tr>
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<td>LV SbPr</td>
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133.
The unskilled group reflects basic trends in labor force participation and population growth. Migration is endogenized in the model so that these data reflect trends before any migration movement.

In Table A6.2 the world prices of the various commodity groups have been taken from the World Bank commodity price forecasts. In general, the nearest World Bank commodity group has been matched to the Vanuatu com-

Table A6.2  Projected world prices

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<td>.474</td>
<td>.464</td>
<td>.583</td>
<td>.679</td>
<td>.870</td>
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<td>Cocoa</td>
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<td>.933</td>
<td>.898</td>
<td>.889</td>
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<td>1.137</td>
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<td>1.302</td>
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<td>1.240</td>
<td>1.420</td>
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<td>1.750</td>
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modity groups. For the various items of manufactures, the input set uses the World Bank forecast of exports of manufactures from the United States. There is considerable variation in these different rates of growth, but the most important is the price of copra, which falls very sharply after the base year by more than 50 percent in 1986. Thereafter it rises but does not regain the same nominal value by 1990. As discussed in Chapter 3, this drop causes a considerable deterioration in Vanuatu’s terms of trade.

Vanuatu devalued their currency by 14 percent toward the end of 1986, which is reflected in the input set. Two and one-half percent has been allowed in that year, rising to the full amount in 1987. An increase of approximately 10 percent in the general tariff rate on imports was levied at the beginning of 1987, which is also incorporated in the data. Changes in tariff rates are not discussed in this appendix because only this alteration was allowed from the base level.

The value of the nominal wage in the input data has been set to remain unaltered in the base run. However, the ASAP program may override this and can index either or both of the ni-Vanuatu and the "other" wage skill groups to last period's CPI.

In Table A6.3 the row name abbreviations indicate the direction of flow. For example, Pub-Pri indicates transfers from the public sector to the private sector. Real transfers between certain institutions have been set to grow by 1 percent per annum, and world incomes were set to increase by 3 percent annually. World inflation coincides with the World Bank projections of exports of U.S. manufactures.

| Table A6.3  Projected real changes in levels of transfers |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Pub-Hlds    | 1.000       | 1.010       | 1.020       | 1.030       | 1.041       | 1.051       |
| Pub-Pri     | 1.000       | 1.010       | 1.020       | 1.030       | 1.041       | 1.051       |
| Pri-Pub     | 1.000       | 1.010       | 1.020       | 1.030       | 1.041       | 1.051       |
| Row-Pub     | 1.000       | 1.010       | 1.020       | 1.030       | 1.041       | 1.051       |
| Growth in real world income and inflation |
| Incomes     | 1.000       | 1.030       | 1.061       | 1.093       | 1.126       | 1.159       |
| Inflation   | 1.000       | 1.071       | 1.144       | 1.222       | 1.308       | 1.401       |
As shown in Table A6.4, government consumption is set to grow at varying rates. Most notably, education services grow rapidly at 5 percent per annum, while the provision of other government activities is set at lesser rates, which reflects the priorities of the Vanuatu government.

Tourism demand originates from the growth in world incomes, relative price movements, and exogenous demand. The exogenous demand shows weak performance initially but grows rapidly in the later part of the period. This performance reflects actual events in Vanuatu up to 1987 but thereafter anticipates the upgrading of the airport and improved tourism potential.

Public investment is set to grow by 3 percent annually, while private investment is initially stagnant, reflecting actual performance, and thereafter grows by 2 percent per annum, a low rate.

Table A6.4 Projected final demands

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<td>1.331</td>
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Exports of importables are projected from sector studies, and exports of non-traded goods are shown to grow by a modest 2 percent per annum.

Finally, the projected rates of growth of the traded activities in Table A6.5 were derived from sector studies. Various rates are shown, but those activities directly benefiting ni-Vanuatu have been given emphasis, namely, small-holder copra, coffee (which has high growth potential), other agriculture, and artisan fishing. The copra estate activity shows little expansion, reflecting the low level of world copra prices and the depressed nature of this industry. The input data also reveal that the tuna freezing plant was closed down in 1986.

Table A6.5  Projected traded activities

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<td>1.170</td>
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Endnotes

Chapter 2

1. See Pyatt, Roe et al. (1977) for the definitive statement on the current use of the Social Accounting Matrix. Dervis, DeMelo, and Robinson (1982) have informative text on the current use of Computable General Equilibrium models. See also Bulmer-Thomas (1982) for a useful guide for Input-Output techniques including the Semi-Input-Output model.

2. See Dervis, DeMelo, and Robinson (1982) for a complete discussion of the differences between Input-Output and CGE models.

3. In the South Pacific the subsistence economy has a special significance, which has important consequences for the macro economy. Most modeling exercises have omitted this topic, but the following exposition actively incorporates it into the system.

Chapter 3

1. The SAM has distinguished in the household and labor accounts between expatriates and ni-Vanuatu, the indigenous people of Vanuatu. This distinction is also important for many South Pacific island economies.

Appendix 3

1. The subsistence economy in the South Pacific has a special significance that has important consequences for the macroeconomy. Most modeling exercises omit this topic. The following discussion of the Vanuatu economy actively incorporates the subsistence economy into the system.
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The Pacific Islands Development Program (PIDP) at the East-West Center helps meet the special development needs of the Pacific islands region through cooperative research, education, and training. Its quality in-depth research provides island leaders with information on alternative strategies to reach development goals and meet the needs of the island peoples.

PIDP serves as the secretariat for the Pacific Islands Conference, a heads of government organization, and for the Standing Committee, composed of island leaders. PIDP's projects—requested and reviewed by the Standing Committee—respond to the development themes discussed at the First (1980) and Second (1985) Pacific Islands Conference. This process is unique within the East-West Center and in other research and educational organizations serving the Pacific.

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