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Abstract

Using the example of a small comparative static model of Thailand for 1980, the paper sets out an approach to macro-economic model building which is based on having two versions of a social accounting matrix (SAM) - one version contains data for a base year, while the cell-entries of the other are algebraic expressions for the determination of the corresponding transaction values. Thus the model is developed in transaction value (TV) form, and this is one distinguishing feature of the approach. Other features derives from different aspects of the relationship between the two SAMs. It is argued that the approach has distinct advantages for model description, calibration and solution and that these are important if models are to be used for policy purposes which place a premium on inteligibility and replicability within the context of a flexible modeling capability.

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1. Introduction [1/]

This paper introduces an approach to macroeconomic modeling which we have been developing over several years. [2/] It does so through an example, which is taken from a recent study of development planning issues in Thailand. [3/] The example was chosen to reflect our primary concern in developing the approach, which has been to support the use of macromodeling techniques in the formulation of economic policy, not least by making the relationship between models and their supporting data bases more explicit. There are certain features of our approach which have been built into its design from the outset with this objective in mind. These will be commented on below as they arise in the course of the exposition.

We refer to our approach as the SAM (Social Accounting Matrix) approach. We also refer to the TV (Transactions Value) form of a model to describe the way in which a model is expressed within the SAM approach. This terminology requires some comment.

There is a dictum, usually attributed to Lord Keynes, that every economic model has a corresponding accounting framework. For macroeconomic models, this accounting framework must be complete in the sense that every receipt must be offset by a corresponding expenditure. One consequence is that all the transactions in a model can be expressed within a social accounting matrix (SAM) framework. The values assumed by all the different types of transactions can therefore be set out as the elements of a SAM matrix. Moreover, these elements can either be expressed as numbers, in which case the SAM is a data framework, or they can be expressed algebraically as functions which describe how the value of each type of transaction is determined. Accordingly, we shall be concerned here with two versions of any given SAM, one numeric and the other algebraic. Our approach derives its essential character firstly from this explicit recognition of two versions of the SAM for a given model and, beyond this, from the possibilities for exploiting the relationships between these two versions.

The use of a matrix (SAM) framework for reconciliation and presentation of data is not new. It is basic to the work of the Cambridge Growth Model 4/, for example, which in turn provided important foundations for the international standards on estimation and presentation of national income accounts as set out in United Nations Statistical Office (1968). It is less usual to present a model in a SAM framework. Indeed, the convention in economics has been to present models as a set of equations showing how prices and quantities are determined. Our approach departs from this convention by modeling prices and value flows instead. We refer to the resulting set of equations as an expression of the model in TV form, where the mnemonic 'TV' derives from the use of equations to describe how 'transaction values' are determined. Such equations replace the more conventional quantity equations in our approach. Thus a model in TV form is simply a set of equations which describe how prices and transaction values are determined. As we shall see, using the TV form of a model fits neatly within the SAM approach.

Since quantities are implied by value flows and prices, it is quite straightforward to translate a model expressed in TV form into the more conventional format of prices and quantities. By the same token, a model expressed in prices and quantities can always be translated into the TV form. There is no logical distinction between the two formulations. But there are real advantages to choosing the TV form within our approach, since this facilitates the creation of complementary pairs of SAMs, for data and algebra, respectively. Such pairs are a help both in specifying a model which can be implemented from available data sources, and also in subsequent model calibration. In addition, we find that it is of some pedagogic value to display a model, via its TV form, as a social accounting matrix.

In general, our SAM approach would seem to have advantages for modeling in four main areas:

- the choice of details in relation to issues, on the one hand, and the availability of data, on the other. This follows directly from the fact that the same SAM is to capture both the theoretical specification of behavior/technology and the empirical facts. This is our starting point.
- making the best use of available data. The SAM framework and its inherent balances serves to constrain and hence reinforce individual datum, one with the other, so that data of mixed quality (including 'guestimates') can be enhanced in value and the best use made of them.
- understanding model behavior. Expressing a model within a SAM via its TV form turns out to be a useful way of understanding its structure. As we shall see later, column summation of the SAM provides a check on adding up conditions within the model, and otherwise generates supply equations. Similarly, row summation corresponds to the demand side. To the extent that these two types of equation are insufficient to completely determine the model, it remains to add a third set of equations, which are known as closure rules. 5/
- calibration and solution. With a complementary pair of SAMs, the theoretical formulation can always be calibrated to reproduce exactly the quantitative estimates of actual transactions in a base year. This does

not guarantee that the model will always have a solution for arbitrary changes in exogenous parameters. But it does guarantee that there is a solution in the base case, to which solutions in alternative cases can then be compared.

Taken together, these different aspects of our approach take us a long way down the road from building a model to having a modeling capability, i.e. a capability to maintain models; reproduce their results; transfer them to multiple locales; and to modify both calibration and specification with relative ease. It is important from this point of view that our Thailand example is drawn from a larger exercise which has demonstrated all these advantages of the SAM approach. For example, changing data implies a new SAM to which the model is then necessarily recalibrated. In this sense the data base can be kept up-to-date, and the model along with it. Similarly, a new model specification, calibrated to base data, necessarily reproduces the base solution. As a result it is quite straightforward to compare the implications of alternative specifications or scenarios when using this approach.

These and other features derive essentially from our starting point of having a pair of complementary SAMs for data and model specification. They are important features if we want to dispel notions of modeling as an *ad hoc* exercise and to replace them with a constructive sense of using models in a substantive dialogue on policy issues. As will be shown later, we have had to sacrifice some flexibility in order to capture these features, at least for the present. But this is not unacceptable, we think. If models are to be used substantively in policy dialogue, then the overriding considerations in our view are that they should be understandable and replicable. If, to start with, this means that the formulations must be kept relatively simple, then so be it. In the dialogue on policy, arguments derived from model results which others cannot replicate are unlikely to carry much weight; and if such results are eventually found to be internally incorrect, then the use of models to advise on policy is set back accordingly.

Our Thailand example serves to illustrate some of the above points. It is developed in six sections following this introduction.

Section 2 sets out the initial SAM which is our starting point. This requires the type of data base which can be put together (with more or less facility) for most countries, using standard national accounts data and supplementary information on inter-industry transactions and commodity trade.

This is followed, in section 3, by some general discussion of modeling in TV form, which is then translated, in sections 4 and 5, into a specific model for Thailand.

The discussion in sections 4 and 5 concentrates on modeling the transaction values that are identified at the outset in the initial SAM. The result is a system which is not fully determined. To make it fully determined, i.e. to close the system, some further restrictions are needed. These are the closure rules previously referred to. They are discussed in section 6.

Finally, section 7 provides a brief discussion of some alternative closures, and results for Thailand derived from them.

2. An Initial SAM

Our starting point for discussion is the social accounting matrix (SAM) shown as table 1. This is a square table. It has 12 rows and columns in our example. The table illustrates the characteristic of all SAMs that corresponding rows and columns are labeled identically. These row and column labels identify different accounts in the economic system, while the elements of the SAM itself refer to the value of transactions between these accounts for a particular time and place. The data for Thailand in Table 1 record transaction values in 1980. For any given account, and therefore for each particular row and column pair, the entries in the row are to be read as receipts or the revenue for that account, while the entries in the corresponding column represent outlays or the expenditure side of the account. In aggregate, within any economic system, all incomes must be matched by corresponding outlays. It follows that the totals for all corresponding row and column pairs must be equal. Beyond this, the SAM is a system of single entry bookkeeping. Any element of the SAM is a receipt for the account specified by the row in which the item is located, and it is an expenditure for the account identified by its column location. An item in row i, column j is therefore an expenditure or outlay by account j which is received by account i.

The basic structure of table 1 recognizes five types of accounts: (i) factor account(s)) (account 1); (ii) institution accounts (2 to 5); (iii) accounts for production (accounts 6 to 8); (iv) for commodities (accounts 9 to 11); and one or more accounts for the rest of the world (account 12). Each of these types of account must be represented (implicitly, if not explicitly) in any SAM which tries to capture the full range of macroeconomic transactions in a real economy. However, the disaggregations (if any) within each type of account are a matter of choice. For example, the SAM in table 1 divides production into Agriculture, Industry and Services. Some other disaggregation could have been chosen, involving a more or less detailed treatment of production structure. The split into only three sectors in table 1 serves our present need for an illustrative example which is relatively small in size. Considerably more detailed SAMs are possible. 6/ Whether more detail would be useful is yet another matter, and one which is of strategic importance in modeling. The extent of disaggregation for production, as for other parts of the SAM, is limited by the availability of suitable data. Equally, it is critical in determining whether specific issues are adequately captured in a particular model. It is unfortunately rare for the written description of a model to justify at any length the choice of classifications adopted. This seems to us a great weakness since the choice of classifications is important in our experience. 7/

A brief description of table 1 is as follows. The first account is for factors of production. In row 1, factors receive value added of 176 from agriculture, 153 from industry, and 273 from services. GDP (or total value added) is therefore 602. From this we must subtract 15 units of factor income paid abroad to obtain the total factor income of 587. This is allocated in column 1 to domestic institutions. Wages, plus unincorporated business profits (a total of 520) accrues to households, and the rest (67) is corporate profit. This last figure splits into 63 units of private sector corporate profits and 4 units of profit in state enterprises.

Accounts 2 to 5 are the accounts for domestic institutions. Just as we have only one account for factors, so in table 1 there is only one (shared) capital account for the domestic institutions (account 5). However, there are three separate current accounts for institutions: one for government (account 4), and two for the private sector, viz households (account 2) and the private corporate sector (account 3).

Entries at the intersection of rows and columns 2 to 4 are current domestic transfers, e.g. direct taxes paid to government, dividends paid to domestic shareholders, etc. Government also receives indirect tax revenues from the commodity accounts (6 units of tax on agricultural commodities, 48 on industrial products, and 17 on services). Both households and government are shown as receiving (non-factor) transfer income from abroad: 5 units and 3 units, respectively.

The total current income of domestic institutions is disbursed in columns 2 to 4. Some goes, as we have seen, in current transfers to other domestic institutions (rows 2 to 4). In addition, both households and government consume commodities as recorded in rows 9 to 11. Any remaining income for each of the three institutions is saved. These savings show up in row 5 as transfers from the current accounts of institutions to their (combined) capital account. Domestic savings are shown as 72 for households, 65 for companies and 3 for government, making a total of 140. Because savings are by definition a residual, the accounts 2 to 4 (rows and columns) must necessarily balance.

To domestic savings of 140, we must add 49 of foreign savings (the deficit on the balance of payments) to obtain the total of 189 available to finance real investment. This is spent in column 5 mainly on industrial goods (presumably plant, machinery, vehicles and buildings) but also to some extent on such agricultural goods as seed stocks, trees and other perennials, as well as on, say, irrigation systems to the extent that these also are treated as an output of the agricultural sector.

The next set of accounts to consider are those for production activities, accounts 6 to 8. The SAM shows that the three activities distinguished in the table have gross outputs of 301, 521 and 448, respectively. To produce these outputs requires inputs of raw materials (commodities) the costs of which are shown at the intersection of rows 9 to 11 and columns 6 to 8. Net outputs, or value added, can now be obtained as gross outputs less raw material purchases for each production sector. The resulting figures are shown in row 1 as accruing to factors of production as previously discussed.

Accounts 9 to 11 capture commodity balances. The columns record supplies, while demand is measured in the rows. On the supply side we have sales of gross output by the domestic institutions in rows 6 to 8 as the main source. To these must be added imports, from row 12, of 2, 182 and 26, respectively, so that the total import bill is 210. Imports are valued c.i.f. while gross outputs (the revenue from sales by production activities) are measured at producer prices. Both are subject to (net) indirect taxes (row 4) before we arrive at total supplies of commodities at market prices: 309 for agricultural commodities, 751 for industrial commodities, and 491 for services.

The demands which match total supplies are recorded in rows 9 to 11. These are consumption demands (columns 2 and 4); investment, including any changes in stocks (column 5); raw material requirements (columns 6 to 8); and, finally, exports (column 12).

The last account to consider is the external account, number 12. The rest of the world receives payment for imports as previously noted. It pays the Thai economy for exports of 77, 59 and 32 so that there is a trade deficit of 42 units. This is aggrevated by net factor income paid abroad of 15; and it is partially offset by net non-factor income receipts of 8. The net deficit is therefore 49 units, and this balancing residual is shown as foreign savings in row 5.

Subject to some qualifications which are noted below, a matrix such as table 1 can be assembled from the national accounts of most countries. Indeed experience in many countries, including Thailand, shows that substantially more detailed tables are possible, especially with respect to the disaggregation of the production and commodity dimensions of the SAM. It is potentially more difficult to refine the factor and institution accounts. This is a topic for discussion in the next section, since it leads to data requirements which go beyond those which can normally be met from the details of the national accounts.

There are three important respects in which table 1 calls for modification of national accounts data. Two of these concern the entries in the commodity accounts. The third concerns what national income accountants refer to as 'residual error'.

Compilation of table 1 requires details of raw material inputs into each production activity. For many countries the required input-output information is available. But for some it is not. In such cases a way of proceeding is to estimate the gross output for each activity and hence, by addition of imports, the aggregate supply of each commodity can be calculated. From such information the row and column totals for the technology matrix (i.e. for the matrix of transactions at the intersection of the rows for commodities and the columns for activities) can be derived. These totals can then be used, together with the technology matrix for some other (but proximate) time or country, to estimate the required technology matrix via the RAS technique or in some other way. 8/

The second respect in which table 1 differs from normal national income accounts is that all commodity transactions are here recorded in market prices, while the standard reference on national income accounts (UNSO, 1968) recommends that (approximate) basic prices should be used to value commodity transactions. The distinction is discussed in Pyatt (1985), where it is argued that the official recommendation in UNSO (1968) is justified only if a particularly rigid theory of price formation and non-substitutability of inputs is maintained. As is recognized in UNSO (1968), data beyond those required for the standard system of national accounts are needed to reconstitute transaction values at market prices from those at basic prices. Since primary data sources typically provide figures for transactions valued at market prices, some effort may be needed to reverse the efforts of the national income statisticians so as to work back from accounts which are balanced at (approximate) basic prices to the balanced set of accounts required by table 1 in which commodities are valued at market prices.

Finally, it can be noted that there is no 'residual error' in table 1: the table is exactly balanced for every account. It would take us too far from our main thesis to discuss possible sources of 'residual error' in national accounts and ways in which it can be eliminated. 9/ We therefore just note that it is important to eliminate 'residual error' as a preliminary to model calibration. And that to do so ideally requires that the accuracy of all the primary data sources which underly the figures in table 1 must first be reviewed in order that the adjustments eventually made to the published (unbalanced) figures, are in fact sensible.

This need to review the accuracy of data sources is complemented in the SAM approach by the need to decide on the taxonomies to be adopted. The implication is that sources of primary data are scrutinized both for their accuracy and for the disaggregations which they can sustain. This scrutiny is relative to the data and disaggregations one would like to have in order to address particular economic policy issues. Hence a strong sense of priorities for development of statistical information is an early spin-off from adopting a SAM approach to modeling.

3. Modeling in TV Form

Given the initial SAM provided by table 1, the next step in our approach is to explore ways in which the various elements in the table might be determined. This involves discussion both of how institutions behave and of the constraints set by technology. It leads to an alternative version of table 1 in which each of the numbers in the SAM is replaced by an algebraic specification of how that number is determined. So let T be the SAM matrix, with typical element t_{ij}. Let y_i be the sum of all elements in row i (and therefore also the sum of elements in column i).
Hence

$$y_i = \sum_j t_{ij} = \sum_k t_{ki} \tag{1}$$

Further, define p_i and q_i such that

$$y_i = p_i \, q_i \tag{2}$$

for all accounts i which relate to factors, activities or commodities, where p_i is understood to be the price of a particular factor, product or commodity and q_i is the corresponding quantity. Finally, let x be the exchange rate (the domestic price of a unit of foreign exchange); let $\underline{\pi}$ be a vector of parameters, such as international prices; and let θ be time. Then, given this notation, the next step in our approach is to specify a functional relationship

$$t_{ij} = t_{ij} (\underline{p}, \underline{y}, x : \underline{\pi}, \theta) \qquad (3)$$

for every i and j, and to form a new SAM the elements of which are the functional relationships given by equations (3).

The first point to note about equations (3) is that the variables q_i do not appear in them. This is a matter of choice, given the equations (2), since it follows that each q_i is given by y_i/p_i. However, the choice is unusual, as noted earlier in our introduction, to the extent that normal practice in economics is to express a model as a set of relationships between prices and quantities. Our preference for model formulation in terms of prices and the value flows y_i and t_{ij} leads us to refer to the equations (3) as expressing a model in TV (transactions value) form. The advantages of doing so will emerge as we proceed. Meanwhile it can be suggested that the connotation of television invoked by this terminology is not inappropriate, since it is pedagogically useful to picture the model (in TV form) as a SAM, the cells of which are the functional expressions (3) determining each t_{ij}, rather than the numerical values of these functions in the base year.

Equations (2) show that the aggregates y_i can, in appropriate cases, be decomposed as the product of a price and quantity. This is also the case for particular cells of the SAM, so that it would be possible to write $t_{ij} = p_{ij}\, q_{ij}$. Such relationships are implicit in our approach, but subject to the strong restriction that $p_{ij} = p_i$ for all i and j : the price of any factor, product or commodity is independent of the account which buys it. Hence

$$t_{ij} = p_i\, q_{ij} \qquad (4)$$

This is a very strong and important assumption. It implies that if the same good or (factor) service is sold at different prices in different markets, then we should provide separate accounts in the SAM for each of these markets. The modeling assumption is that prices are homogeneous along each row of the SAM. This rule can be expressed alternatively as the proposition that physically identical goods and services which sell at different prices in different markets are in fact different goods and should accordingly have their own separate accounts in the SAM. This, then, is an important criterion to consider when deciding on how much disaggregation there should be in the SAM. To the extent that a highly detailed set of disaggregations is not adopted, then the model will be subject to aggregation problems to the extent that prices are not homogeneous along each row. These may or may not severely diminish the value of results. The lesson of experience seems to be not that considerable disaggregation is necessary or desirable, but rather that disaggregations should be carefully chosen to focus on distinctions which are of strategic importance.

To develop our illustration we need to consider the processes and behavior which determine the various non-zero entries in table 1, and hence to produce a new SAM which has functional relationships, rather than numerical values as its elements. The consequences of doing this are shown in table 2, the derivation of which needs to be explained at some length. But before coming to these details, two general points about table 2 need to be noted.

The first point to note about table 2 is that there are two entries in every non-empty cell. One is a number and this is the numerical value in the base year of the transactions t_{ij} . Such base year values are to be denoted by t^{o}_{ij} . The other cell entry is one of a set of Greek characters α , β , γ etc. These characters refer to members of a set of alternative versions of equations (3). Their specification is shown in table 3 and will be discussed subsequently. Meanwhile, from what has been said so far, it follows that, in effect, table 2 superimposes two SAMs. One is a data SAM (for the base year), while the other displays a model in TV form. For example, from table 2 it follows from the entries in row 5.1, column 3, that corporate savings had a base year value of 65, and that behaviorally these savings are to be modeled as functional form ε, which is interpreted via table 3 as saying that corporate savings are determined as a fixed proportion of total corporate income.

The second point to note about table 2 is that it is bigger than table 1. The relationship is in fact a nested one: table 2 is a 'blown-up' version of table 1 such that table 2 can easily be reduced to correspond to table 1 exactly. The way to effect this reduction is implied by the numbering of accounts in table 2. Table 1 has 12 accounts, while table 2 has 33. As a typical example of how the number of accounts has expanded it can be noted that table 1 has one account for factors of production, and this is labeled as account #1. In table 2 there are four accounts for factors of production, and these are labeled as accounts 1.1, 1.2, 1.3 and 1.4. If these four accounts in table 2 are consolidated into a single account [10/], then this single account will be equivalent to account #1 in table 1. Similarly, consolidation of accounts 2.1, 2.2 and 2.3 in table 2 yields account #2 in table 1; and so on.

The reason for expanding the SAM in table 1 to that in table 2 is related to the assumption that prices are constant along any row of the SAM and to the list of functional forms for t_{ij} shown in table 3. If the elements in table 1 were expressed directly in terms of the functional relationships which might be thought to determine them, then some of these functional relationships could be quite complicated. Table 3 would then need to provide a long list of alternatives in order to cover most likely cases. However, it turns out that, in practice, most of the specifications which have in fact been used by modelers, while quite complex in themselves, are found on examination to be equivalent to a sequence of relatively simple steps. If each step in such a sequence is recognized by giving it a separate account in the SAM, then the specification of behavior within any one account is a correspondingly simple matter which can potentially be captured by some option within a relatively simple and restricted menu of behavioral specifications. The resulting model is simpler to implement and also simple to understand. Just how this works will become clearer as we go through our example. As we do so the point to keep in mind is that, while the list of alternative specifications shown in table 3 could easily be extended, practice shows that there is little need to do so. Our approach to modeling restricts the choice of algebraic specifications to a list more or less like that in table 3, but otherwise allows total freedom in the accounting dimension, corresponding to any sequencing of these elementary specifications to describe technology and behavior. Most of the modeling formulations which we have come across so far in different planning models can be accommodated within this approach. Indeed it is only in relatively recent exercises which attempt to model quantity restrictions on imports or multiple outputs from individual activities that some need to extend the menu provided by table 3 has in fact arisen.

4. The First Stage of Modeling: Activities and Commodities

For present expository purposes it is convenient to present the development of table 1 to the form provided by table 2 in two steps, starting first with the activity and commodity accounts and then modeling the accounts for factors, institutions and the rest of the world as a subsequent step. Since all modeling is approached via columns of the SAM in table 1, this means that we start by modeling the expenditure of the activity and commodity accounts, i.e. columns 6 to 11 of table 1.

The production account for agriculture shows a gross output of 301 in table 1. From column 6 of the table, this is evidently made up of 125 units of raw material purchases, and 176 units of net output or value added. Suppose our modeling decision is to assume that raw material inputs are strictly complementary, i.e. a Leontief technology, while net output or value added is generated as a CES combination of factor inputs, labor and capital. Table 2 shows that we model this in two steps. In column 6.1 of table 2, labor and capital are combined to generate net output, which is then purchased, as an aggregate, by account 6.2 where it is combined according to a Leontief (fixed coefficients) specification with raw materials in column 6.2.

These are the specifications implied by the notations α and β defined in table 3 which appear in columns 6.1 and 6.2.

In elaboration of this procedure, the first point to note is that table 1 does not provide all the data needed for columns 6.1 and 6.2 of table 2. The missing information is the split of value added in agriculture into wages and profits: if value added is to be modeled as a CES combination of labor and capital, then we need base year data on the corresponding split of factor payments. If our model of net output generation was more sophisticated, involving, for example, several different types of labor then the data requirements implied would be more extensive accordingly.

It can also be noted that table 2 goes beyond a simple split of value added into wages and profits insofar as account 1 in table 1 is replaced by four accounts, labeled 1.1 to 1.4, in table 2. The first of these is an account for labor, so that row 1.1 receives all wage payments. The three remaining accounts are distinct accounts for the capital employed in each of the three production activities 'agriculture', industry' and 'services'. Recalling our rule that each factor price is assumed to be independent of where that factor is employed (i.e. constant along the row), it follows that the layout of factor accounts in table 2 corresponds to the notion that labor is homogeneous across all sectors while capital is (potentially) sector specific.

The proposition that the elements of column 6.1 are generated via a CES production technology also requires some elaboration. We can write the production function as

$$q_j = \{\sum_i F_{ij}(\theta) q_{ij}^{-\rho_j}\}^{-1/\rho_j} \qquad (5)$$

where q_j is output; the variables q_{ij} are inputs, and $F_{ij}(\theta)$ stands for functions of time, θ , which allow for exogenous technical change. For simplicity, constant returns to scale are assumed; and the constant elasticity of substitution between factor inputs in column j , i.e. σ_j is given by $1/(1 + \rho_j)$. To arrive at the specification implied by α in table 3, three more assumptions are needed. The first two of these are: (i) that each input q_{ij} is available in perfectly elastic supply at a price p_i; and (ii) that inputs q_{ij} are combined so as to minimize the cost of producing output q_j . These assumptions imply the familiar result that marginal cost is given by the second part of

$$p_j = MC_j = \{p_i/F_{ij}(\theta)\} (q_{ij}/q_j)^{1/\sigma} \text{ for all } i \qquad (6)$$

The proposition that price equals marginal cost is now the third assumption to complete the specification.

To translate this result into TV form we substitute t_{ij}/p_i for q_{ij} and y_j/p_j for q_j in equation (6) to obtain

$$t_{ij} = [F_{ij}(\theta)]^{\sigma_j} (p_i/p_j)^{1-\sigma_j} y_j \qquad (7)$$

$$= a_{ij}^o f_{ij}(\theta) (p_i/p_j)^{1-\sigma_j} y_j \qquad (8)$$

where, in general, the notation a_{ij} is used for the expression of t_{ij} as a fraction of the column total y_j:

$$a_{ij} = t_{ij}/y_j \tag{9}$$

and a_{ij}^{o} is the value of a_{ij} in the base year. Also, as a matter of convention, all prices are taken to be unity in the base year. Hence a_{ij}^{o} is equal to $[F_{ij}(0)]^{\sigma_j}$; and $f_{ij}(\theta)$ is equivalent to $[F_{ij}(\theta)/F_{ij}(0)]^{\sigma_j}$. It follows that $f_{ij}(\theta)$ is also unity in the base year.

Given these normalization conventions, the expression (8) for t_{ij} defines specification α in table 3. It can be noted that the base year data in table 2 determine a_{ij}^{o} , so that to complete the calibration of specification α requires additionally only a value for the substitution elasticity σ_j , and specification of the (exogenous) functions of time $f_{ij}(\theta)$.

We can build on these results to model column 6.2 of table 2. Our assumption is that expenditures in this column correspond to Leontief technology, in which inputs are strictly complementary. This is specification β in table 3. It is a special case of the CES formulation, corresponding to a zero value for σ_j . Hence, from (8), specification β implies

$$t_{ij} = a_{ij}^{o} f_{ij}(\theta)\ (p_i/p_j)\ y_j \tag{10}$$

where a_{ij}^{o} is the base year Leontief coefficient which determines the initial value of the ratio q_{ij}/q_j ; and the functions $f_{ij}(\theta)$ allow such coefficients to change exogenously over time.

Production of industrial goods and services is specified in the same way as the production of agricultural goods in table 2. We can therefore now turn our attention to modeling the expenditure accounts for commodities, starting with the cost (or supply) of agricultural commodities.

In table 2 there are four accounts for agricultural commodities (accounts 9.1 to 9.4) in place of the single account 9 in table 1. The extra detail reflects an attempt to capture some of the important differences in composition that can maintain within such a broadly defined composite as 'agricultural goods.'

There are essentially two main sources for the aggregate supply of a particular commodity: imports and domestic production. Depending on the source of supply, different taxes may be levied, e.g. import duties and sales taxes. Also, the composition of the bundle 'agricultural commodities' may differ according to who is buying so that we would expect some differences in composition between imports and exports, for example. The modeling in table 2 attempts to capture something of all these points.

From table 1 we learn that domestic output of agricultural goods is 301 units. Imports supply a further 2 units. Hence, with the addition of 6 units of indirect taxes of various types, we arrive at a gross supply at market prices of 309 units. Table 2 tells this same story in a somewhat more elaborate form.

Row 6.2 in table 2 shows that domestic output of agricultural goods has two destinations. One is the domestic market, the other exports. New data are needed to split the gross output of 301 units into the 227 units supplied to the domestic market and the (remaining) 74 units for exports. It is to be noted that the latter are not sold to the rest of the world directly. This is because they are subject to an export duty. Agricultural goods are 'readied' for export in account 9.2. The account buys goods from domestic producers in row 6.2, adds the tax (of 3 units) in row 4.1, and then sells the composite of agricultural commodities f.o.b. in row 9.2 to the rest of the world.

Imports arrive c.i.f. from the rest of the world in column 9.3, where they are readied for the domestic market by paying customs dues in row 4.1.

In this way we have two sources of supply for the domestic market. Some 3 units are supplied by column 9.3 and these have their origin in imports; while 229 units are provided via column 9.1 from that part of domestic output which is not destined for export. Both sources are combined in column 9.4 to yield a composite bundle of imported and domestically produced agricultural products. It is this composite bundle which is sold in row 9.4 to meet the requirements of domestic final demand.

This particular treatment of a commodity account is by no means the only one possible. It serves purely as an illustration which, for example, could be improved by giving some attention to the incidence of transport and distribution margins. As it stands, however, the treatment involves only minor data demands, viz to split the 6 units of indirect taxes on agricultural commodities as shown in table 1 into its three constituent elements, as in table 2. 11/ When this is done 74 (= 77 - 3) units of domestic gross output must be destined for export. Hence 227 (= 301 - 74) units are retained for domestic use and all the other SAM figures fall into place.

Modeling the commodity accounts in table 2 is fairly straightforward. In column 9.1 a tax is added to goods of domestic origin prior to their moving on to help in meeting domestic final demand. This mark-up can be denoted by $\tau_j(\theta)$. The indirect tax revenue is therefore a proportion, $\tau_j(\theta)$, of the value of the commodity before tax. This can be expressed alternatively as a proportion $\tau_j(\theta)/[1 + \tau_j(\theta)]$ of the value of the commodity after tax, i.e. of y_j . Hence, to specify indirect tax revenues, we have

$$t_{ij} = \left[\tau_j(\theta)/(1 + \tau_j(\theta))\right] y_j \qquad (11)$$

and this defines the specification γ in table 3.

It is of some interest to diagnose at this point and note that the incidence of indirect taxes can be related to the Leontief formulation of commodity technology as captured by equation (10). To see this, it is helpful to think of the indirect tax on good j as a label which needs to be attached to each unit of that good before it can be sold. Let $p(j)$ be the price of such a label. Let us further assume that there is a distinct label for each type of good that is taxed, and that each type of label has its own account in the SAM. Commodity accounts buy their respective labels, while revenue from the sale of labels accrues to government. In buying the labels, commodity accounts must purchase them in a fixed proportional relationship to the goods themselves (in fact in a one-to-one relationship), so that the cost of buying labels can be modeled according to the Leontief formulation (10), with $p(j)$ replacing p_i as the unit cost of the input and $f_{ij}(\theta)$ set at unity (since there can be no technological progress to change the one-to-one ratio in which labels are required in relation to goods). Such an approach would be equivalent to the specification (10) provided that the level of $p(j)$ is set as

$$p(j) = \left[\frac{\tau_j(\theta)}{1 + \tau_j(\theta)} \Big/ \frac{\tau_j(0)}{1 + \tau_j(0)}\right] p_j \qquad (12)$$

This states that the cost of the tax label for good j must be a fraction, $\tau_j(\theta)$, of the pre-tax cost of the good itself and otherwise follows from the fact that p_j is a post-tax price which, like $p(j)$, must be normalized to have unit value in the base period.

Column 9.2 of table 2 follows along the same lines as column 9.1, but with a different tax rate $\tau_j(\theta)$. The same holds for column 9.3 also. But here we are dealing with imports as the essential supply source. If $\pi_j(\theta)$ is their price in foreign currency units, and x is the exchange rate, then the domestic price of imports is $x\,\pi_j(\theta)$. Substituting this for p_i in equation (10) and suppressing the technical change term $f_{ij}(\theta)$ yields

$$t_{ij} = a_{ij}\left[x\,\pi_j(\theta)/p_j\right] y_j \qquad (13)$$

which is specification δ for imports in table 3. It can be noted that in assuming that $p_i = x\pi_j(\theta)$, the exchange rate x and the foreign currency price, $\pi_j(\theta)$, of imports are effectively normalized to be unity in the base period. Hence equation (13) is essentially the same as equation (10) but with $\pi_j(\theta)$ substituted for $f_{ij}(\theta)$, and x substituted for p_i .

The final step in modeling the supply of agricultural commodities comes in account 9.4. Here goods of both foreign and domestic origin are brought together to form a composite bundle which is used to meet domestic final demand. In formulating the specification of how this bundle is determined two extreme versions are possible. In one, all imports are strictly complementary to domestic goods in meeting domestic requirements. If this was the case then the Leontief model β would provide the correct specification for the entries in column 9.4. The polar opposite case arises when imports are regarded as being perfectly competitive with domestically produced goods and, therefore, perfect substitutes for them. Between these extremes is a whole range of possible cases which, as Armington (1969) was perhaps the first to point out, can all be captured by the CES specification α . This is in fact the treatment adopted in our illustrative example.

Since 'industrial' commodities and 'services' are treated in the same way as 'agricultural' commodities in our illustrative example, the above effectively concludes our discussion of how activities and commodities are to be treated. It can be noted that the treatments imply that all our specifications can be expressed in effect as being Leontief or CES. Since the former is a special case of the latter, it follows that the CES function defines the most general class of specifications which we have adopted. Relative to the simpler treatment of commodity balances in terms of fixed coefficient models, as in UNSO (1968), for example, our approach can be seen as allowing for a second order of approximation to reality by introducing the influence of relative prices via a set of constant elasticities of substitution.

5. The Second Stage of Modeling: Factors, Domestic Institutions and the Rest of the World

The national income accounts for most countries give very little if any factorial disaggregation of the contribution to domestic product by different production activities. Yet some such disaggregation is necessary if we want to address employment or income distribution issues. There is therefore a tension between the desire to have a significant disaggregation of the factor accounts and the empirical problems of calibrating the resulting model. Table 2 shows a very conservative resolution of this problem. Value added in each production sector is split between wages and profits. Labor is (implicitly) assumed to be homogeneous and freely mobile across sectors, so there is only one account for labor. Capital, on the other hand is treated as being sector specific. Therefore there are three types of capital, each of which is to have its own rental price. This is not, of course, the only possible treatment of the factor accounts. But it serves for illustrative purposes. As we have already seen, this treatment implies that the value added data in table 1 need to be split between wages and profits, as shown in table 2. Then, as a next step, in the outlay accounts for the factors of production, the total income for each of the four factors must be allocated according to who receives it. As can be seen from table 2, the assumptions made are: that (i) all wages accrue to households; (ii) that all profits in agriculture also accrue to households (corporate agriculture or plantations being insignificant in Thailand); (iii) profits earned in industry are partly profits of unincorporated activities (15 units), partly profits of state enterprises (2 units), and otherwise (40 units) are profits of the private corporate sector; and (iv) there is a similar spread over households, companies and government of profits earned in the service industry, as shown in the table. As with the split of value added into wages and profits, so too the allocation of profits earned in industry and services to households, companies and government calls for estimation of data beyond those that table 1 provides.

The crucial consideration in modeling the disbursement of factor incomes in columns 1.1 to 1.4 in table 2 is the distribution of factor ownership. Assuming there is no discrimination in factor markets, then the return to a factor service will be the same irrespective of who provides it. And the opportunity to provide the service will be in proportion to factor ownership, again assuming no discrimination. So, in the absence of discrimination, the share of any particular institution in the income earned by a factor will be equal to the proportion of that factor which is owned by the institution in question. 12/

An important characteristic of the class of models with which we are concerned in this paper is to assume that factor supplies are fixed within the unit time period of the model, and are changed or updated only between periods. We have very little to say about updating in this paper. And the fact that factor endowments and their ownership are frozen at the beginning of each model period implies that, within period, the allocation of factor incomes will be in the same fixed (i.e. the frozen) shares for each factor as its ownership. This is specification ε in table 3 and its implies that

$$t_{ij} = a^o_{ij} f_{ij}(\theta)\ y_j \tag{14}$$

such that

$$\sum_i a^o_{ij} f_{ij}(\theta) = 1 \tag{15}$$

where the variable $a^o_{ij} f_{ij}(\theta)$ measures the share of institution i in the ownership of factor j in time period θ. An implication is that the ratios a^o_{ij} measure the distribution of factor ownership in the base period.

Comparing tables 1 and 2, it is evident that there is to be no attempt in our example to disaggregate the household sector. This may come as a surprise to the reader familiar with the emphasis on disaggregation of the household sector in such early SAM studies of development issues as Pyatt, Roe et al (1977). The explanation is, in part, that households are disaggregated in the more detailed model from which our present example is drawn. In consequence, the distribution of income between different groups of households can be studied. For the rest, there is nothing essential about disaggregating household - or production, for that matter - within a SAM. The appropriate choice of disaggregations is relative to the issues. The implication with reference to our example is that it can be used to explore distributional issues only in so far as they concern the distribution between households, companies, and governments.

The next issue is to model household expenditures. Comparing tables 1 and 2, this is seen to require three new accounts (2.1 to 2.3) in place of the former account 2.

Comparing tables 1 and 2 we see that the gross income account for households (account 2.1) serves the same purpose on the revenue side as the former account 2, i.e. it collects together all the revenue which accrues to households from other accounts. On the expenditure side, account 2.1 pays out a proportion of its income to government as taxes and a further proportion into savings (the combined capital account). The remaining proportion is paid into the consumption account, account 2.2. These outlays are therefore fixed value shares of gross income and they are modeled as specification ε .

We now want to model the allocation of total household consumption expenditure as a linear expenditure system. This requires two steps. The first is to model committed expenditures on particular commodities in account 2.2 and derive total discretionary expenditure as a residual. This residual is to be paid into account 2.3. It constitutes total discretionary expenditure. The second step is then to allocate the total discretionary expenditure over commodities in account 2.3.

Functional form Ψ describes committed expenditures. Since $t_{ij} = p_i q_{ij}$ for all i , j , the specification

$$t_{ij} = t^o_{ij} f_{ij}(\theta)\ p_i \qquad (16)$$

implies that q_{ij} follows some exogenous path given by $t^o_{ij} f_{ij}(\theta)$. This is what is meant by the specification Ψ in table 3.

That part of total consumer expenditure which is not required to purchase committed quantities is determined as a residual in column 2.2 and is otherwise unspecified. This is treated as specification ν in tables 2 and 3.

This unspecified amount (which was 111 units in the base year) is all paid into account 2.3 and constitutes discretionary expenditure. It is allocated to commodities according to fixed value shares (specification ε) in column 2.3, and completes the specification of household expenditures.

It can be noted that the only data required by table 2 to calibrate this formulation of household expenditures beyond those that are supplied in table 1 is the split of consumer expenditure on each commodity in the base year between that part which is committed and that part which is discretionary.

The numerical detail for the corporate sector is the same in table 2 as in table 1. The modeling is also simple. Corporate income is spent as dividends paid to households, as taxes paid to government, or it is saved. The model specification of these allocations shown in table 2 is to treat them as following exogenously given value shares, i.e. specification ε .

The treatment of government expenditures in table 2 is somewhat more complicated. It requires two new accounts (4.1 and 4.2) in place of the former account 4. However, given the details in table 1, no extra data is required. The first step is to allocate sums which are fixed in value terms as transfers to households, to companies, and to the government consumption expenditure account, 4.2. These correspond to specification ϕ in table 3.

$$t_{ij} = t^o_{ij} f_{ij}(\theta) \tag{17}$$

Government saving is then a residual item, which is denoted by a new specification, ν . The next step is to allocate government consumption demand over commodities. The specification chosen assumes that the commodities are purchased in fixed relative quantities. This is specification κ and it requires that

$$t_{ij} = \left[t^o_{ij} f_{ij}(\theta)\ p_i / \sum_k t^o_{kj} f_{kj}(\theta)\ p_k\right] y_j \tag{18}$$

In the capital accounts for domestic institutions, total savings are gathered in row 5.1. Expenditures are modeled in column 5.1 as fixed value shares, and therefore according to specification ε . In other words, a fixed proportion of aggregate investment expenditure is allocated to expansion of the capital stock in each of the three production sectors. These investment allocations are translated into commodity demands in columns 5.2, 5.3 and 5.4. The translation is effectively via what is known in the input-output literature as a B matrix. This means that goods are required in fixed quantity ratios to provide extra units of capacity in each of the production sectors. It therefore implies that the expenditures in these columns should follow specification κ . The data required to implement this approach are details of the two-way classification of investment expenditures by both sector of origin and sector of destination, as in table 2, as an extension of the one-way classification, by sector of origin only, which is provided by table 1.

It remains to determine a specification for each element of the expenditure account for the rest of the world, i.e. column 12 in tables 1 and 2.

The rest of the world's expenditures on commodities (i.e., exports) are modeled by specification μ :

$$t_{ij} = t^{o}_{ij} f_{ij}(\theta) p_i^{1-\eta_i} (x\ \pi_i)^{\eta_i} \qquad (19)$$

Recalling that $t_{ij} = q_{ij} p_i$, it follows that η_i is the own price elasticity of demand for exportable i , while the function $f_{ij}(\theta)$ reflects any shifts in world demand for the domestic product.

A special case of specification μ is used to model the first four items in column 12. These are not commodity exports. They refer to net factor and non-factor income transfers from abroad. And because they are on a net basis, it is difficult to model them with any substantial behavioral content. As an alternative to addressing the data problems of estimating the gross flows, the expedient has been adopted of simply assuming that the net flows have exogenous values. This is achieved by restricting η_i and π_i in (19) to unity. Hence

$$t_{ij} = t^o_{ij} f_{ij}(\theta)\ x \qquad (20)$$

The value flows in question are therefore exogenous at levels $t^o_{ij}\ f_{ij}(\theta)$ in foreign currency units.

The remaining item in column 12 is the current account deficit. This is left unspecified, at least at this stage, using specification ν .

6. Closure of the System

When the modeling specifications we have discussed so far are restricted by the SAM accounting identities (1), the resulting system is underdetermined. It must therefore be restricted further in order that we should arrive at a fully determined system. The further restrictions which fulfill this role are referred to as closure rules.

Let f be the number of factor accounts in table 2 ($f = 4$); let d be the number of domestic institution accounts, current and capital ($d = 10$); and let a and c be the number of activity and commodity accounts, respectively. Now, $a = 6$, $c = 12$ and there is one further account (for the rest of the world). It follows that the total number of accounts, n , is 33, where $n = f + d + a + c + 1$.

The system has variables t_{ij}, y_i, p_i and x . There are n^2 variables t_{ij}; n variables y_i; and a price, p_i, for each factor, activity and commodity, i.e., a total of f + a + c prices p_i . The total number of variables is therefore $n^2 + n + f + a + c + 1 = n^2 + 2n - d$. This gives a total 1145 variables in our example. However, most of these are trivial since they refer to zero values of t_{ij}. With only 85 non-zero values of t_{ij}, the effective number of variables is reduced to 141. It can be noted that quantities q_{ij} and q_i are not counted as variables since they do not enter explicitly at any stage, given that the model is expressed in TV form.

The first set of equations to consider are the specifications of t_{ij} which have been discussed previously and set out in table 2. These cover all elements of the SAM except for those which are explicitly unspecified. There are three of the latter in our example, viz household discretionary expenditure (column 22), government savings (column 4.1) and foreign savings (column 12). In general the number of unspecified elements can be denoted by u , so that the specifications of equation (3) in table 2 provide $n^2 - u$ restrictions.

Having specified the t_{ij}'s as above, the system now has 2n + u - d degrees of freedom remaining. Most of these are taken up by the accounting restrictions of the SAM, i.e. by equation (1), which states that the y_i's are given by the row and column totals of the SAM. There are 2n of these restrictions. But, as we shall see, some of them are redundant.

From tables 2 and 3, it can be seen that our within-period modeling of the outlays by factor accounts assumes that they are determined as fixed value shares. This corresponds to specification ε and the formulation provided by equation (14). Summing this formulation for ε over all rows i yields as an expression for the column sum, y_j , which is

$$y_j = \sum_i t_{ij} = \left[\sum_i a^o_{ij} f_{ij}(\theta)\right] y_j \tag{21}$$

However, equation (15) restricts the term in square brackets to be unity. So equation (21) now reduces to $y_j = y_j$. Consequently, the column sum for the factor accounts will always be equal to the corresponding value of y_j , so that no new restriction on the system is implied.

This same conclusion is reached for any column in which specification κ is used. As we have seen, this specification is expressed algebraically in equation (18). Summing over rows i , in this case yields

$$y_j = \sum_i t_{ij} = \sum_i \left[t^o_{ij} f_{ij}(\theta) p_i / \sum_k t^o_{kj} f_{kj}(\theta) p_k\right] y_j \tag{22}$$

which again reduces to $y_j = y_j$, i.e. a redundancy.

It follows that the only column summation equations which actually restrict the model are those which do not involve either specification ε or κ . This means none of the factor accounts; some, say d^* (where $d^* \leq d$) of the domestic institution accounts; and all of the accounts for activities, commodities and the rest of the world account ($a + c + 1$). Hence accounting consistency in terms of column summation imposes $d^* + a + c + 1 = n - f - (d - d^*)$ restrictions on the system.

The restrictions implied for the activity and commodity outlay accounts are particularly interesting. When a CES formulation is adopted (specification α) , it follows from equation (8) that summing over i and equating the result to y_j , we get an expression which can be rearranged to yield:

$$p_j = [\sum_i a_{ij}^o f_{ij}(\theta)\ p_i^{1-\sigma_j}]^{1/(1-\sigma_j)} \tag{23}$$

In other words, accounting consistency implies an interdependence among prices. Specifically, each output price, p_j , is a CES aggregate of the input prices, p_i , in this case.

Our earlier discussion of the choice of specification for activity and commodity accounts showed that the CES case covered the more restricted specifications β , γ and δ . This result can now be used to make the following inference. If we regard the exchange rate as the price of foreign exchange, then the model contains $f + a + c + 1$ prices. Accounting consistency for each activity and commodity now imposes a restriction like that in equation (23). Hence there are $a + c$ such restrictions in total and therefore $f + 1$ degrees of freedom remain in the determination of prices. One way of interpreting this result is that if the exchange rate and each factor price was known, then all prices would be known, i.e. all other prices could be derived via the requirement of accounting consistency by columns.

Accounting consistency by columns is complemented by a similar requirement from equation (1) for accounting consistency by rows. However, if all columns of the SAM satisfy accounting consistency then, as a mathematical necessity, one of the rows will do so also, provided that all the others do. Consequently, accounting consistency be rows can provide us with only $n - 1$ linearly independent restrictions.

From these arguments, the SAM consistency constraints on rows and columns as given by equation (1) provide $2n - (f + 1) - (d - d^*)$ linearly independent restrictions. By taking them into account, we are then left with a model which has $[2n + u - d] - [n - f - (d - d^*)] - [n-1] = (f + 1) + (u - d^*)$ degrees of freedom. Moreover, we have seen that $f + 1$ of these degrees of freedom must be taken up in order to fully determine prices. The remaining $u - d^*$ degrees of freedom then correspond to the number of unspecified transaction values, t_{ij}, less the number of substantive restrictions imposed by accounting consistency on the outlay accounts for domestic institutions.

To take up the $(f + 1) + (u - d^*)$ remaining degrees of freedom involves the choice of the corresponding number of closure rules from among the alternatives provided by table 4.

The first of the closure rules allowed in table 4 is for any price -- it could be a factor price, such as a wage or any other price -- to be given exogenously. The second option allows relative prices to be fixed. For example, if skilled and unskilled labor are distinguished separately, then we may want to fix their wage differential. It can be noted that if there are exactly $f + 1$ restrictions of the first two types, then the system of prices will be exactly determined in the model. And there cannot be more than $f + 1$ such restrictions because this would over-determine prices. Moreover, it must be the case that there is at least one restriction of the first type: the absolute level of at least one price must be set exogenously. This is because all the other equations in the system are homogeneous of degree one in prices and incomes. The scale of values is arbitrary therefore unless we fix it explicitly.

The third type of closure rule provided for in table 4 implies that q_j is fixed exogenously by the function $y_j^o g_j(\theta)$, so that the ratio of p_i to y_i is fixed. This closure is useful if, for example, we want to assume that the price of some particular factor of production will always adjust to allow full employment of that factor, as when we assume that capital stock is industry specific and fixed within the model period.

The choice of closure rules has an important bearing on the structure and behavior of the model. If there are fewer than $f + 1$ restrictions of the first two types, then the implication within the model is that prices are not independent of the scale of production. If prices are indeed independent of the scale of production, then the resulting system is referred to as a fix-price model. Otherwise it is flex-price, and prices will rise as the scale of production expands.

An overall consequence of following through the SAM approach is that model specification can be thought of as defining seven sets of equations, as presented in table 5.

The first set of equations comprises the specifications for transaction values, t_{ij} , drawing on the alternative forms of equation (3) which are allowed for in the list of options provided by table 3. Since there are n^2 cells in the SAM and t_{ij} is specified for all but u of these, it follows that this first set of equations provides $n^2 - u$ restrictions on the system.

The second, third and fourth sets of equations all derive from the accounting restrictions defined by the SAM. Thus, the second set of equations comprises the row summation equations for the SAM, of which there are n . However, one of these is linearly dependent on the others, given the column summation equations which constitute the third and fourth sets of restrictions. There are therefore $n - 1$ linearly independent row summation equations.

The column summation equations are split into two sets so as to distinguish those for activity and commodity accounts, which can be interpreted as price equations, from those of the summation equations for domestic institutions and the rest of the world which are not redundant.

There are $d^* + 1$ of the latter and $a + c$ of the former.

The last three sets of equations correspond to the three types of closure rule in table 4. In order that the absolute price level should be determined in the system, some ℓ domestic prices or the exchange rate must be set exogenously, where $\ell \geq 1$. However, ℓ cannot exceed $f + 1$ since there is a total of $a + c + f$ domestic prices in the system and $a + c$ restrictions are already placed on these by the column summation equations of the SAM. To the extent that ℓ falls short of $f + 1$, there can be k closure rules which impose restrictions on relative (as opposed to absolute) prices, and k must be such that $k + \ell$ does not exceed $f + 1$.

The remaining set of closure rules restricts income levels, y , in one form or another. This last set must have a sufficient number of elements so as to bring the total number of closure rules up to $(u - d^*) + (f + 1)$ and hence complete the specification of an exactly determined system.

In aggregate table 5 provides a set of $n^2 + n + f + a + c + 1$ equations which can be solved for $f + a + c$ domestic prices; the exchange rate; the n incomes y_i ; and the n^2 elements of the SAM.

7. Calibration and Solutions

Calibration of the model developed in the previous sections calls for the estimation of a number of parameters. These can be divided into two groups. The first group comprises those parameters which can be estimated from the base year SAM, while parameters in the second group cannot. Parameters in the first group have been denoted t^o_{ij} , a^o_{ij}, y^o_i and $\tau_j(o)$ while those in the second group are the exogenous functions $f_{ij}(\theta)$, $g_x(\theta)$ and $g_i(\theta)$, together with various elasticities σ_j and η_i and tax rates $\tau_j(\theta)$.

The parameter values t^o_{ij} , a^o_{ij} and y^o_j can all be taken directly from the base year SAM. Accordingly, to the extent that a balanced base year SAM is readily available, model calibration is a straightforward matter. Alternatively, the base year SAM and parameters such as σ_j and η_i can in principle be estimated simultaneously if suitable time-series data are available. The gain in efficiency may or may not be worth the extra effort involved. But in either event, what is important here is that, whichever approach is adopted, an important consequence will be that the model exactly reproduces the base case as set out in the initial SAM. This has two important advantages. Firstly, it implies that the starting point for all comparative static and dynamic experiments is known exactly. There is no ambiguity about the starting point and hence about the changes which the model generates. Secondly, the fact that the base case is reproduced exactly guarantees that, at least in one case (viz the base case), the model has a solution.

The conditions under which a model will always have a solution are not pursued here because they have little to do with whether the approach to modeling is SAM-based. Similarly, we will not explore here the issue of how to solve such models numerically. Rather, to conclude this paper we present some results for our Thailand example which is calibrated according to the SAM set out in table 2, and otherwise by the parameter values in table 6.

One of the main advantages of the SAM-based approach and the software which now supports it is that it is relatively easy to change a model This is illustrated via table 7 which sets out the results for four different models of the effects of an increase in the tax on agricultural exports of 1% from 4.05% to 5.05%. In all four models, it is assumed that capital stocks are sector specific and fixed in the short run. Hence all three are flex-price models. The first twi models are Keynesian. The exchange rate is assumed to be fixed as is the wage. This implies surplus labor. To close the models, real investment is taken to be exogenous in Model 1 and the inflow of foreign exchange is exogenous in Model 2. Model 3 and 4 differs only from Model 1 and 2, respectively, in endogenizing wages by imposing an assumption of full employment.

The most immediate effect of an increase in the tax on agricultural exports in Thailand would obviously be to reduce their quantity. In Model 1, lower agricultural exports lead to lower agricultural activity; which directly depresses agricultural employment and indirectly depresses employment in the other sectors. The lower level of general activity leads to a drop in GDP and hence in imports. However, these are not sufficient to compensate for the negative effect on the current account deficit of the drop in exports.

In Model 2, the current account deficit is not allowed to increase. Total savings and investments are therefore reduced compared to Model 1, and GDP drops even further.

In Model 3, the wage flexibility dampens the effects of the increase in the export tax rate compared to Model 1. In particular, it allows lower prices for industrial sector output which then leads to an expansion of industrial exports. This expansion compensates for the loss of agricultural sector exports so that the current account deficit improves.

In Model 4, the current account deficit is not allowed to decrease, so investment increases and wages drop less than in Model 3.

Comparison of the results for the four models shows the crucial importance for policy conclusions of the choice of closure rules. By facilitating an easy comparison of alternative closures, our SAM approach and its associated software will not resolve debate about which closures are most plausible. But what it will do is to provide a sound basis for policy debate in terms first of the base year SAM, and secondly by providing comparable results on the implications of alternatives.

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Footnotes

1/ We are indebted to various colleagues and collaborators over several years for encouraging our work and, more recently, for comments on this paper. Of course, neither they nor the World Bank has any responsibility for the views expressed here.

2/ Graham Pyatt is largely responsible for the conception of this approach, while Arne Drud and Wafik Grais have been prime movers of its systems and econometric implementation, respectively. An earlier paper (Drud,Grais and Pyatt, 1983) has been written from the system's perspective. The present paper is intended for economists with a primary interest in policy modeling.

3/ See Grais (1981), Chewakrengkai and Lamsam (1982) and Amranand, P. and W. Grais (1984).

4/ See Cambridge Department of Applied Economics (1962-), especially volumes 1, 2, 5 and 6.

5/ For a discussion of closure rules and their importance in macroeconomic models, see Taylor (1983)

6/ Pyatt and Round (1984) present a SAM which has some 212 accounts (rows and columns), including 51 factor accounts; 36 accounts for institutions; 30 accounts for activities and 59 for commodities. This same SAM is subsequently doubled in size by showing the data separately for each of two regions. Citing this example is not intended to suggest that very detailed SAMs are necessarily a good thing. They have value as a data base for a variety of applications. But for any one application, a more aggregated version of the SAM is likely to prove most useful.

7/ Pyatt and Thorbecke (1976) discuss criteria for classifying factors, activities and institutions. Pyatt (1985) discusses the interdependence of classifications for activities and commodities.

8/ The RAS technique is a method for changing a given (non-negative) matrix by row and column scaling operations so that its row and column totals correspond to prescribed values. The most complete exposition of the method is in Bacharach (1970).

9/ One approach to the problem is discussed in Byron (1978).

10/ Consolidation is a technical term covering an operation which is in two stages. To consolidate two or more accounts, the first step is to replace them with a new account in which the elements are the (vector) sums of the entries in the accounts being consolidated. The second step is to set to zero the element of the aggregate account which lies on the main diagonal of the new SAM.

11/ The simplifying assumption implied by this is that indirect tax rates are the same for all domestic transactions, irrespective of type of buyer.

12/ If there is discrimination, then this is a violation of the axiom that a given factor is paid the same whoever might supply it and wheresoever it is employed. If the seriousness of the discrimination seems to merit it, the correct treatment is to model the different sections of the factor market as being different markets, i.e. to disaggregate to a point at which homogeneity more or less maintains and there is no serious discrimination within any market.

Table 1
The National Income Accounts for Thailand in 1980
(units: billions of baht)

Incomes or Receipts				Outlays or Expenditures: Factors of Production	Institutions: Current Accounts: Households	Institutions: Current Accounts: Companies	Institutions: Current Accounts: Government	Institutions: Combined Capital Account	Production Activities: Agriculture	Production Activities: Industry	Production Activities: Services	Commodities: Agriculture	Commodities: Industry	Commodities: Services	Rest of the World	Totals
				1	2	3	4	5	6	7	8	9	10	11	12	
1			Factors of Production						176	153	273				-15	587
2	Institutions	Current a/c	Households	520		4	1								5	530
3	Institutions	Current a/c	Companies	63	6		10									79
4	Institutions	Current a/c	Government	4	9	10						6	48	17	3	97
5	Institutions		Combined Cap. A/c		72	65	3								49	189
6	Production	Activities	Agriculture									301				301
7	Production	Activities	Industry										521			521
8	Production	Activities	Services											448		448
9	Commodities		Agriculture		132			19	22	47	12				77	309
10	Commodities		Industry		193		8	170	40	232	49				59	751
11	Commodities		Services		118		75		63	89	114				32	491
12			Rest of the World									2	182	26		210
			Totals	587	530	79	97	189	301	521	448	309	751	491	210	

Table 2
An Expanded Social Accounting Matrix
Showing Base Year Data and the First Stages of a Model in TV Form

	Factors of Production				Institutions Current a/c						Combined Capital a/c				Production Activities						Commodity Accounts												Rest of the World	Totals
	Labor	Capital			Households			Companies	Government		Savings	Capital Formation			Agriculture		Industry		Services		Agricultural				Industrial				Services					
		Ag	Ind	Serv	Gross Income	Total Consumption	Discretionary Consumption		Income	Consumption		Ag	Ind	Serv	Net Output	Gross Output	Net Output	Gross Output	Net Output	Gross Output	Domestic	Exports	Imports	Composite	Domestic	Exports	Imports	Composite	Domestic	Exports	Imports	Composite		
	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3	4.1	4.2	5.1	5.2	5.3	5.4	6.1	6.2	7.1	7.2	8.1	8.2	9.1	9.2	9.3	9.4	10.1	10.2	10.3	10.4	11.1	11.2	11.3	11.4	12	
1.1 Factors of Production: Labor															α 141		α 92		α 191															424
1.2 Factors of Production: Capital: Agriculture															α 35																			35
1.3 Factors of Production: Capital: Industry																	α 61																μ -4	57
1.4 Factors of Production: Capital: Services																			α 82														μ -11	71
2.1 Institutions Current a/c: Households: Gross Income	ε 424	ε 35	ε 15	ε 46				ε 4	φ 1																								μ 5	530
2.2 Institutions Current a/c: Households: Total Consum.					ε 443																													443
2.3 Institutions Current a/c: Households: Discretionary						ν 111																												111
3 Companies		ε 40	ε 23		ε 6				φ 10																									79
4.1 Government a/c's: Income		ε 2	ε 2		ε 9			ε 10													γ 2	γ 3	γ 1		γ 29	γ *	γ 19		γ 17	γ *	γ *		μ 3	97
4.2 Government a/c's: Consumption									φ 83																									83
5.1 Combined Capital a/c: Savings					ε 72			ε 65	ν 3																								ν 49	189
5.2 Combined Capital a/c: Capital Formation: Agriculture											ε 38																							38
5.3 Combined Capital a/c: Capital Formation: Industry											ε 66																							66
5.4 Combined Capital a/c: Capital Formation: Services											ε 85																							85
6.1 Production Activities: Ag: Net Output																β 176																		176
6.2 Production Activities: Ag: Gross Output																					β 227	β 74												301
7.1 Production Activities: Ind: Net Output																		β 153																153
7.2 Production Activities: Ind: Gross Output																									β 462	β 59								521
8.1 Production Activities: Serv: Net Output																				β 273														273
8.2 Production Activities: Serv: Gross Output																													β 416	β 32				448
9.1 Commodity Accounts: Agricultural: Domestic																								α 229										229
9.2 Commodity Accounts: Agricultural: Exports																																	μ 77	77
9.3 Commodity Accounts: Agricultural: Imports																								α 3										3
9.4 Commodity Accounts: Agricultural: Composite						ψ 114	ε 18					κ 17	κ 2			β 22		β 47		β 12														232
10.1 Commodity Accounts: Industrial: Domestic																												α 491						491
10.2 Commodity Accounts: Industrial: Exports																																	μ 59	59
10.3 Commodity Accounts: Industrial: Imports																												α 201						201
10.4 Commodity Accounts: Industrial: Composite						ψ 138	ε 55			κ 8		κ 21	κ 64	κ 85		β 40		β 232		β 49														692
11.1 Commodity Accounts: Services: Domestic																																α 433		433
11.2 Commodity Accounts: Services: Exports																																	μ 32	32
11.3 Commodity Accounts: Services: Imports																																α 26		26
11.4 Commodity Accounts: Services: Composite						ψ 80	ε 38			κ 75						β 63		β 89		β 114														459
12 Rest of the World																							δ 2				δ 182				δ 26			210
Total	424	35	57	71	530	443	111	79	97	83	189	38	66	85	176	301	153	521	273	448	229	77	3	232	491	59	201	692	433	32	26	459	210	

Table 3
Alternative Specifications of Equation 3

Specification: Symbol	Specification: Equation Number	Description	Restrictions on Use
Specifications which can only be used in the outlay accounts for commodities and activities			
α	8	Constant elasticity of substitution with constant returns to scale	Must apply to all elements in a column
β	10	Leontief	Must apply to all elements or all elements but one in a column
γ	11	Indirect taxes	Can only be used in row accounts for indirect taxes or Government. All other items in the same columns must be specified as β or δ
δ	13	Imports	Can only be used in row accounts for the rest of the world. All other items in the same column must be specified as γ
The only specification allowed in factor outlay accounts			
ε	14	Fixed value shares	$\sum a_{ij}^{o} f_{ij}(\theta) = 1$. Must apply to all elements in a column
Specifications for use in the outlay accounts for domestic institutions			
Φ	17	Value is exogenous	
Ψ	16	Quantity is exogenous	
ε	14	Fixed value shares	$\sum a_{ij}^{o} f_{ij}(\theta) = 1$. Must apply to all elements in a column
κ	18	Fixed relative quantities	Must apply to all elements in a column
ν		t_{ij} is not specified	
Specifications for use in the rest of the world outlay account			
μ	19	Export demand	
ν		t_{ij} is not specified	

Table 4

Alternative Specifications for Closure Rules

Description	Formulation
Price or exchange rate is exogenous	$p_i = g_i(\theta)$ $x = g_x(\theta)$
Relative prices are exogenous	$p_i = \beta_{ij}(\theta)p_j$
Quantity is exogenous	$y_i = y_i^o g_i(\theta)p_i$

N.B. $g_i(o)$, $g_x(o)$ and $\beta_{ij}(0)$ must be unity.

Table 5

Structure of a SAM-based Model

Equation	Number of Equations	Type of Equation	
$t_{ij} = t_{ij}(\underline{p}, \underline{y}, x)$	$n^2 - u$	Cell equations	
$y_i = \sum_j t_{ij}$	$n - 1$	Row summation equations	
$y_j = \sum_i t_{ij}$	$d^* + 1$	Non-price equations	Column summation equations
$0 = h(p)$	$a + c$	Relative price equations	
$p_i = \bar{p}_i$ or $x = \bar{x}$	$1 \leq \ell \leq f + 1$	Absolute price equations	Closures rules
$0 = k(p, x)$	$k \leq (f+1) - \ell$	Relative price equations	
$0 = g(y, p, x)$	$(u-d^*) + (f+1) - (k+\ell)$	Non-Price equations	

Table 6
Elasticities Used in Model Calibration

Sector	Elasticities of factor substitution σ_i	Import demand functions σ_i	Export demand functions μ_i
Agriculture	0.9	0.8	6.0
Industry	0.6	1.5	2.6
Services	0.8	3.0	2.3

Table 7
Effects of an Increase of 1% in the Tax on Agricultural Exports for Four Models

Model Assumptions	Model 1	Model 2	Model 3	Model 4
Capital stocks	Fixed and fully employed			
Exchange rate	Fixed			
Real investment	Fixed	Adjusts to savings	Fixed	Adjusts to savings
Current account	Residual	Fixed	Residual	Fixed
Wages	Fixed		Adjusts to full employment	
Model Results: % changes				
Wage	none	none	-0.537	-0.511
Employment	-0.747	-0.842	none	none
Consumption Price Index	-0.168	-0.202	-0.356	-0.334
Real Investment	none	-0.529	none	0.198
GDP at current m.p.	-0.653	-0.778	-0.372	-0.338
GDP at constant m.p.	-0.525	-0.601	-0.009	-0.005
Nominal Government revenue	-0.005	-0.186	0.309	0.362
BOP deficit	1.409	none	-0.624	none

Appendix

The SAM approach to macroeconomic model building has been implemented as one of many solution systems under the General Algebraic Modeling System, GAMS. The modeling system has facilities for easy data entry, data manipulation and report generation. These aspects of GAMS are described in [1] and [3]. An introduction to the SAM-based modeling component is under development, [2].

The following pages show the input file representing the four models described in the paper and some summary reports with solution statistics. The SAM in this implementation has a few additional factor accounts to reflect the fact that factors on the domestic factor markets are different from factors earning income from abroad.

References:

1. Bisschop, J. and A. Meeraus: "On the Development of a General Algebraic Modeling System in a Strategic Planning Environment", Mathematical Programming Study, vol. 20, 1982, p.1-29.

2. Drud, A. and D. Kendrick: "An Introduction to GAMS-TV", (preliminary title), World Bank, forthcoming.

3. Kendrick, D. and A. Meeraus: "GAMS: An Introduction", Development Research Department , World Bank, 1985.

```
SET  ACC ACCOUNT SET FOR THE THREE SECTOR THAILAND DEMONSTRATION MODEL /

          FAC-LABOR    FACTOR ACCOUNT FOR LABOR
          FAC-C-AGRI   FACTOR ACCOUNT FOR AGRICULTURAL CAPITAL
          FAC-C-IND    FACTOR ACCOUNT FOR INDUSTRIAL CAPITAL
          FAC-C-SERV   FACTOR ACCOUNT FOR CAPITAL IN THE SERVICE SECTOR
          FOR-C-IND    ACCOUNT FOR NET FOREIGN CAPITAL IN INDUSTRY
          FOR-C-SERV   ACCOUNT FOR NET FOREIGN CAPITAL IN SERVICES
          TOT-C-IND    ACCOUNT FOR TOTAL CAPITAL IN INDUSTRY
          TOT-C-SERV   ACCOUNT FOR TOTAL CAPITAL IN SERVICES
          HOUSE-INCM   ACCOUNT FOR TOTAL INCOME FOR HOUSEHOLDS
          HOUSE-TCON   ACCOUNT FOR TOTAL CONSUMPTION FOR HOUSEHOLDS
          HOUSE-COMM   ACCOUNT FOR COMMITTED CONSUMPTION FOR HOUSEHOLDS
          HOUSE-DISC   ACCOUNT FOR DISCRETIONARY CONSUMPTION FOR HOUSEHOLDS
          COMPANIES    ACCOUNT FOR THE INSTITUTION COMPANIES
          GOVRN-INCM   ACCOUNT FOR TOTAL INCOME FOR THE GOVERNMENT
          GOVRN-CONS   ACCOUNT FOR CONSUMPTION FOR GOVERNMENT
          SAVINGS      CONSOLIDATED SAVINGS ACCOUNT FOR ALL INSTITUTIONS
          CAP-F-AGRI   CAPITAL ACCUMULATION FOR AGRICULTURE
          CAP-F-IND    CAPITAL ACCUMULATION FOR INDUSTRY
          CAP-F-SERV   CAPITAL ACCUMULATION FOR THE SERVICE SECTOR
          ACT-N-AGRI   NET PRODUCTION (VALUE ADDED) IN AGRICULTURE
          ACT-G-AGRI   GROSS PRODUCTION IN AGRICULTURE
          ACT-N-IND    NET PRODUCTION (VALUE ADDED) IN INDUSTRY
          ACT-G-IND    GROSS PRODUCTION IN INDUSTRY
          ACT-N-SERV   NET PRODUCTION (VALUE ADDED) IN THE SERVICE SECTOR
          ACT-G-SERV   GROSS PRODUCTION IN THE SERVICE SECTOR
          CM-DM-AGRI   DOMESTIC COMMODITIES IN AGRICULTURE
          CM-EX-AGRI   EXPORTED COMMODITIES IN AGRICULTURE
          CM-IM-AGRI   IMPORTED COMMODITIES IN AGRICULTURE
          CM-CP-AGRI   COMPOSITE COMMODITIES IN AGRICULTURE
          CM-DM-IND    DOMESTIC COMMODITIES IN INDUSTRY
          CM-EX-IND    EXPORTED COMMODITIES IN INDUSTRY
          CM-IM-IND    IMPORTED COMMODITIES IN INDUSTRY
          CM-CP-IND    COMPOSITE COMMODITIES IN INDUSTRY
          CM-DM-SERV   DOMESTIC COMMODITIES IN THE SERVICE SECTOR
          CM-EX-SERV   EXPORTED COMMODITIES IN THE SERVICE SECTOR
          CM-IM-SERV   IMPORTED COMMODITIES IN THE SERVICE SECTOR
          CM-CP-SERV   COMPOSITE COMMODITIES IN THE SERVICE SECTOR
          INDR-TAX     ACCOUNT FOR INDIRECT TAXES
          R-O-WORLD    ACCOUNT FOR THE REST OF THE WORLD     /

     ACCCP(ACC) SET OF COMPOSITE COMMODITY ACCOUNTS
          / CM-CP-AGRI, CM-CP-IND , CM-CP-SERV /
     ACCFAC(ACC) SET OF FACTOR ACCOUNTS
          / FAC-LABOR, FAC-C-AGRI, FAC-C-IND , FAC-C-SERV /
     ACCEX(ACC) SET OF EXPORT COMMODITY ACCOUNTS
          / CM-EX-AGRI, CM-EX-IND , CM-EX-SERV /
     ACCIM(ACC) SET OF IMPORT COMMODITY ACCOUNTS
```

```
           / CM-IM-AGRI, CM-IM-IND , CM-IM-SERV /
       CONS(ACC) SET OF CONSUMPTION ACCOUNTS
           / HOUSE-COMM, HOUSE-DISC, GOVRN-CONS /;

  ALIAS(ACC,ACCC)

  ACRONYMS   CES      CONSTANT ELASTICITY OF SUBSTITUTION FUNCTION
             EXPORT   EXPORT SPECIFICATION
             FEXO     FIXED IN FOREIGN EXCHANGE
             IDIST    INCOME DISTRIBUTION
             IMPORT   IMPORT SPECIFICATION
             IO       LEONTIEF PRODUCTION FUNCTION
             ITAX     INDIRECT TAX SPECIFICATION
             QEXO     EXOGENOUS QUANTITY CONSUMPTION SYSTEM
             QSHR     FIXED QUANTITY SHARES CONSUMPTION SYSTEM
             TEXO     EXOGENOUS VALUE TRANSFER
             VEXO     EXOGENOUS VALUE CONSUMPTION SYSTEM
             VSHR     FIXED VALUE SHARES CONSUMPTION SYSTEM
             UNSPEC   UNSPECIFIED

             MF       MARKET FACTOR ACCOUNT
             NMF      NON MARKET FACTOR ACCOUNT
             INST     INSTITUTIONS INCOME AND TRANSFER ACCOUNT
             INSTC    INSTITUTIONS CONSUMPTION ACCOUNT
             AC       ACTIVITY OR COMMODITY ACCOUNT
             TAX      TAX ACCOUNT
             ROW      REST OF THE WORLD ACCOUNT

             PQ       PRICE AND QUANTITY EXOGENOUS
             Q        QUANTITY EXOGENOUS
             P        PRICE EXOGENOUS
```

```
       TABLE SAM(ACC,ACC)  SOCIAL ACCOUNTING MATRIX FOR THAILAND IN 1980

                     FAC-LABOR    FAC-C-AGRI  FAC-C-IND    FAC-C-SERV
        TOT-C-IND                                61
        TOT-C-SERV                                            82
        HOUSE-INCM      424           35
        COMPANIES
        GOVRN-INCM

           +         FOR-C-IND    FOR-C-SERV  TOT-C-IND    TOT-C-SERV
        TOT-C-IND        -4
        TOT-C-SERV                   -11
        HOUSE-INCM                                15          46
        COMPANIES                                 40          23
        GOVRN-INCM                                 2           2

           +         HOUSE-INCM   HOUSE-TCON  HOUSE-COMM   HOUSE-DISC
        HOUSE-TCON      443
        HOUSE-COMM                   332
        HOUSE-DISC                   111
        COMPANIES         6
        GOVRN-INCM        9
        SAVINGS          72
        CM-CP-AGRI                               114          18
        CM-CP-IND                                138          55
        CM-CP-SERV                                80          38

           +         COMPANIES    GOVRN-INCM  GOVRN-CONS
        HOUSE-INCM        4            1
        COMPANIES                     10
        GOVRN-INCM       10
        GOVRN-CONS                    83
        SAVINGS          65            3
        CM-CP-AGRI
        CM-CP-IND                                  8
        CM-CP-SERV                                75

           +         SAVINGS      CAP-F-AGRI  CAP-F-IND    CAP-F-SERV
        CAP-F-AGRI       38
        CAP-F-IND        66
        CAP-F-SERV       85
        CM-CP-AGRI                    17           2
        CM-CP-IND                     21          64          85
        CM-CP-SERV

           +         ACT-N-AGRI   ACT-N-IND   ACT-N-SERV
        FAC-LABOR       141           92         191
        FAC-C-AGRI       35
        FAC-C-IND                     61
```

```
FAC-C-SERV                                   82

      +        ACT-G-AGRI   ACT-G-IND    ACT-G-SERV
ACT-N-AGRI        176
ACT-N-IND                      153
ACT-N-SERV                                  273
CM-CP-AGRI         22           47           12
CM-CP-IND          40          232           49
CM-CP-SERV         63           89          114

      +        CM-DM-AGRI   CM-EX-AGRI   CM-IM-AGRI   CM-CP-AGRI
ACT-G-AGRI        227           74
CM-DM-AGRI                                               229
CM-IM-AGRI                                                 3
INDR-TAX            2            3            1
R-O-WORLD                                     2

      +        CM-DM-IND    CM-EX-IND    CM-IM-IND    CM-CP-IND
ACT-G-IND         462           59
CM-DM-IND                                                491
CM-IM-IND                                                201
INDR-TAX           29                        19
R-O-WORLD                                   182

      +        CM-DM-SERV   CM-EX-SERV   CM-IM-SERV   CM-CP-SERV
ACT-G-SERV        416           32
CM-DM-SERV                                               433
CM-IM-SERV                                                26
INDR-TAX           17
R-O-WORLD                                    26

      +        INDR-TAX     R-O-WORLD
FOR-C-IND                       -4
FOR-C-SERV                     -11
HOUSE-INCM                       5
GOVRN-INCM         71            3
SAVINGS                         49
CM-EX-AGRI                      77
CM-EX-IND                       59
CM-EX-SERV                      32
```

```
  TABLE SPEC(ACC,ACCC)  SPECIFICATIONS FOR THAILAND BASE MODEL

                    FAC-LABOR    FAC-C-AGRI   FAC-C-IND    FAC-C-SERV
    TOT-C-IND                                   IDIST
    TOT-C-SERV                                               IDIST
    HOUSE-INCM         IDIST        IDIST
    COMPANIES
    GOVRN-INCM

        +           FOR-C-IND    FOR-C-SERV   TOT-C-IND    TOT-C-SERV
    TOT-C-IND          IDIST
    TOT-C-SERV                      IDIST
    HOUSE-INCM                                  IDIST        IDIST
    COMPANIES                                   IDIST        IDIST
    GOVRN-INCM                                  IDIST        IDIST

        +           HOUSE-INCM   HOUSE-TCON   HOUSE-COMM   HOUSE-DISC
    HOUSE-TCON         IDIST
    HOUSE-COMM                      UNSPEC
    HOUSE-DISC                      UNSPEC
    COMPANIES          IDIST
    GOVRN-INCM         IDIST
    SAVINGS            IDIST
    CM-CP-AGRI                                  QEXO         VSHR
    CM-CP-IND                                   QEXO         VSHR
    CM-CP-SERV                                  QEXO         VSHR

        +           COMPANIES    GOVRN-INCM   GOVRN-CONS
    HOUSE-INCM        IDIST         TEXO
    COMPANIES                       TEXO
    GOVRN-INCM        IDIST
    GOVRN-CONS                      TEXO
    SAVINGS           IDIST         UNSPEC
    CM-CP-AGRI
    CM-CP-IND                                   QSHR
    CM-CP-SERV                                  QSHR

        +           SAVINGS      CAP-F-AGRI   CAP-F-IND    CAP-F-SERV
    CAP-F-AGRI         VSHR
    CAP-F-IND          VSHR
    CAP-F-SERV         VSHR
    CM-CP-AGRI                        IO           IO
    CM-CP-IND                         IO           IO           IO
    CM-CP-SERV

        +           ACT-N-AGRI   ACT-N-IND    ACT-N-SERV
    FAC-LABOR         CES           CES          CES
    FAC-C-AGRI        CES
    FAC-C-IND                       CES
```

```
FAC-C-SERV                                          CES

     +          ACT-G-AGRI   ACT-G-IND    ACT-G-SERV
ACT-N-AGRI         IO
ACT-N-IND                       IO
ACT-N-SERV                                    IO
CM-CP-AGRI         IO           IO            IO
CM-CP-IND          IO           IO            IO
CM-CP-SERV         IO           IO            IO

     +          CM-DM-AGRI   CM-EX-AGRI   CM-IM-AGRI   CM-CP-AGRI
ACT-G-AGRI         IO           IO
CM-DM-AGRI                                                 CES
CM-IM-AGRI                                                 CES
INDR-TAX             ITAX         ITAX          ITAX
R-O-WORLD                                      IMPORT

     +          CM-DM-IND    CM-EX-IND    CM-IM-IND    CM-CP-IND
ACT-G-IND          IO           IO
CM-DM-IND                                                  CES
CM-IM-IND                                                  CES
INDR-TAX             ITAX                       ITAX
R-O-WORLD                                      IMPORT

     +          CM-DM-SERV   CM-EX-SERV   CM-IM-SERV   CM-CP-SERV
ACT-G-SERV         IO           IO
CM-DM-SERV                                                 CES
CM-IM-SERV                                                 CES
INDR-TAX             ITAX
R-O-WORLD                                      IMPORT

     +           INDR-TAX    R-O-WORLD
FOR-C-IND                       FEXO
FOR-C-SERV                      FEXO
HOUSE-INCM                      FEXO
GOVRN-INCM        IDIST         FEXO
SAVINGS                        UNSPEC
CM-EX-AGRI                     EXPORT
CM-EX-IND                      EXPORT
CM-EX-SERV                     EXPORT
```

```
TABLE    AINF(ACC,*)    ACCOUNT INFORMATION TABLE

                          GROUP    FIX    SIGMA
           FAC-LABOR        MF      P
           FAC-C-AGRI       MF      Q
           FAC-C-IND        MF      Q
           FAC-C-SERV       MF      Q
           FOR-C-IND        NMF
           FOR-C-SERV       NMF
           TOT-C-IND       INST
           TOT-C-SERV      INST
           HOUSE-INCM      INST
           HOUSE-TCON      INST
           HOUSE-COMM      INSTC
           HOUSE-DISC      INSTC
           COMPANIES       INST
           GOVRN-INCM      INST
           GOVRN-CONS      INSTC
           SAVINGS         INSTC    Q
           CAP-F-AGRI       AC
           CAP-F-IND        AC
           CAP-F-SERV       AC
           ACT-N-AGRI       AC             0.9
           ACT-G-AGRI       AC
           ACT-N-IND        AC             0.6
           ACT-G-IND        AC
           ACT-N-SERV       AC             0.8
           ACT-G-SERV       AC
           CM-DM-AGRI       AC
           CM-EX-AGRI       AC
           CM-IM-AGRI       AC             0.8
           CM-CP-AGRI       AC
           CM-DM-IND        AC
           CM-EX-IND        AC
           CM-IM-IND        AC
           CM-CP-IND        AC             1.5
           CM-DM-SERV       AC
           CM-EX-SERV       AC
           CM-IM-SERV       AC
           CM-CP-SERV       AC             3.0
           INDR-TAX         TAX
           R-O-WORLD        ROW     P
```

```
    PARAMETER ETA(ACCEX) EXPORT DEMAND ELASTICITIES
             / CM-EX-AGRI 6.0, CM-EX-IND  2.6, CM-EX-SERV 2.3 /

    PARAMETER CINF(ACC,ACC,*) CELL INFORMATION TABLE;

              CINF(ACC,ACCC,"TBASE") = SAM(ACC,ACCC);
              CINF(ACC,ACCC,"SPECS") = SPEC(ACC,ACCC);
              CINF(ACCEX,"R-O-WORLD","ETA") = ETA(ACCEX);

  *  DEFINE THE EXPERIMENT INFORMATION

    SCALAR DELTA  ABSOLUTE CHANGE IN AGRICULTURAL TAX RATE;
           DELTA = 0.01;

    CINF("INDR-TAX","CM-EX-AGRI","THETA") =
       SAM("INDR-TAX","CM-EX-AGRI")/SUM(ACC,SAM(ACC,"CM-EX-AGRI")) + DELTA;

  *  DEFINE SETS AND TABLES FOR STORING THE MODEL SOLUTIONS

    SET VERSIONS / BASE   BASE CASE
                   LSFB   LABOR SURPLUS FREE TO BORROW CASE
                   LSBC   LABOR SURPLUS BORROWING CONSTRAINED CASE
                   LCFB   LABOR CONSTRAINED FREE TO BORROW CASE
                   LCBC   LABOR CONSTRAINED BORROWING CONSTRAINED CASE /

    PARAMETER  SAMS(ACC,ACC,VERSIONS)  SOLUTION SAMS
               CSAM(ACC,ACC,VERSIONS)  CONSTANT PRICE SOLUTION SAMS
               PSOL(ACC,VERSIONS)      SOLUTION PRICES
               QSOL(ACC,VERSIONS)      SOLUTION QUANTITIES
               VSOL(ACC,VERSIONS)      SOLUTION ACCOUNT TOTALS;

    PSOL(ACC,"BASE")       = 1;
    QSOL(ACC,"BASE")       = SUM(ACCC, SAM(ACC,ACCC) );
    VSOL(ACC,"BASE")       = QSOL(ACC,"BASE");
    SAMS(ACC,ACCC,"BASE") = SAM(ACC,ACCC);
    CSAM(ACC,ACCC,"BASE") = SAM(ACC,ACCC);
```

```
* DEFINE AND SOLVE THE LABOR SURPLUS FREE TO BORROW MODEL

  MODEL THAILAND / ACC, AINF, CINF /;

  SOLVE THAILAND USING TV;

  PSOL(ACC,"LSFB")       = AINF(ACC,"PSOL");
  QSOL(ACC,"LSFB")       = AINF(ACC,"QSOL");
  YSOL(ACC,"LSFB")       = AINF(ACC,"YSOL");
  SAMS(ACC,ACCC,"LSFB") = CINF(ACC,ACCC,"TSOL");
  CSAM(ACC,ACCC,"LSFB") = CINF(ACC,ACCC,"QCSOL");

*  DEFINE AND SOLVE LABOR SURPLUS BORROWING CONSTRAINED MODEL

  AINF("SAVINGS","FIX") = 0;
  CINF("SAVINGS","R-O-WORLD","SPECS") = FEXO;

  SOLVE THAILAND USING TV;

  PSOL(ACC,"LSBC")       = AINF(ACC,"PSOL");
  QSOL(ACC,"LSBC")       = AINF(ACC,"QSOL");
  YSOL(ACC,"LSBC")       = AINF(ACC,"YSOL");
  SAMS(ACC,ACCC,"LSBC") = CINF(ACC,ACCC,"TSOL");
  CSAM(ACC,ACCC,"LSBC") = CINF(ACC,ACCC,"QCSOL");

  AINF("SAVINGS","FIX") = Q;
  CINF("SAVINGS","R-O-WORLD","SPECS") = UNSPEC;

* DEFINE AND SOLVE THE LABOR CONSTRAINED FREE TO BORROW MODEL

  AINF("FAC-LABOR","FIX") = Q;

  SOLVE THAILAND USING TV;

  PSOL(ACC,"LCFB")       = AINF(ACC,"PSOL");
  QSOL(ACC,"LCFB")       = AINF(ACC,"QSOL");
  YSOL(ACC,"LCFB")       = AINF(ACC,"YSOL");
  SAMS(ACC,ACCC,"LCFB") = CINF(ACC,ACCC,"TSOL");
  CSAM(ACC,ACCC,"LCFB") = CINF(ACC,ACCC,"QCSOL");

*  DEFINE AND SOLVE LABOR CONSTRAINED BORROWING CONSTRAINED MODEL

  AINF("SAVINGS","FIX") = 0;
  CINF("SAVINGS","R-O-WORLD","SPECS") = FEXO;

  SOLVE THAILAND USING TV;

  PSOL(ACC,"LCBC")       = AINF(ACC,"PSOL");
  QSOL(ACC,"LCBC")       = AINF(ACC,"QSOL");
```

```
VSOL(ACC,"LCBC")        = AINF(ACC,"VSOL");
SAMS(ACC,ACCC,"LCBC") = CINF(ACC,ACCC,"TSOL");
CSAM(ACC,ACCC,"LCBC") = CINF(ACC,ACCC,"QCSOL");
```

```
SET  LINCU  LINE ITEMS FOR CURRENT PRICE SUMMARY TABLES
     / CONSUMPTN , INVESTMENT, EXPORT     , IMPORT     , GDP-MARKET,
       GDP-FACTOR, LABOR      , GOVRN-REVN, BOP-DEFICT/
     LINES(LINCU)  LINE ITEMS FOR PRICE AND CONSTANT PRICE SUMMARY TABLES
     / CONSUMPTN , INVESTMENT, EXPORT     , IMPORT     , GDP-MARKET,
       GDP-FACTOR, LABOR      /

PARAMETER AGGCUR(LINCU,VERSIONS)  NATIONAL ACCOUNT AGGREGATES IN CURRENT PRICES
          AGGCON(LINES,VERSIONS)  NATIONAL ACCOUNT AGGREGATES IN CONSTANT PRICES
          PRICES(LINES,VERSIONS)  PRICE INDICES OF NATIONAL ACCOUNT AGGREGATES
          ELASTCU(LINCU,VERSIONS) ELASTICITIES OF NATIONAL ACCOUNT AGGREGATES IN CURRENT
                                                                              PRICES
          ELASTCO(LINES,VERSIONS) ELASTICITIES OF NATIONAL ACCOUNT AGGREGATES IN CONSTANT
                                                                              PRICES
          ELASTPR(LINES,VERSIONS) ELASTICITIES OF PRICES;

AGGCUR("CONSUMPTN",VERSIONS)  = SUM(CONS,YSOL(CONS,VERSIONS));
AGGCUR("INVESTMENT",VERSIONS) = YSOL("SAVINGS",VERSIONS);
AGGCUR("EXPORT",VERSIONS)     = SUM(ACCEX,SAMS(ACCEX,"R-O-WORLD",VERSIONS));
AGGCUR("IMPORT",VERSIONS)     = SUM(ACCIM,SAMS("R-O-WORLD",ACCIM,VERSIONS));
AGGCUR("GDP-MARKET",VERSIONS) = AGGCUR("CONSUMPTN",VERSIONS) +
                                AGGCUR("INVESTMENT",VERSIONS) +
                                AGGCUR("EXPORT",VERSIONS) -
                                AGGCUR("IMPORT",VERSIONS);
AGGCUR("GDP-FACTOR",VERSIONS) = SUM(ACCFAC,YSOL(ACCFAC,VERSIONS));
AGGCUR("LABOR",VERSIONS)      = YSOL("FAC-LABOR",VERSIONS);
AGGCUR("GOVRN-REVN",VERSIONS) = YSOL("GOVRN-INCM",VERSIONS);
AGGCUR("BOP-DEFICT",VERSIONS) = SAMS("SAVINGS","R-O-WORLD",VERSIONS);

AGGCON("CONSUMPTN",VERSIONS) = SUM(CONS,QSOL(CONS,VERSIONS));
AGGCON("INVESTMENT",VERSIONS) = QSOL("SAVINGS",VERSIONS);
AGGCON("EXPORT",VERSIONS)     = SUM(ACCEX,CSAM(ACCEX,"R-O-WORLD",VERSIONS));
AGGCON("IMPORT",VERSIONS)     = SUM(ACCIM,CSAM("R-O-WORLD",ACCIM,VERSIONS));
AGGCON("GDP-MARKET",VERSIONS) = AGGCON("CONSUMPTN",VERSIONS) +
                                AGGCON("INVESTMENT",VERSIONS) +
                                AGGCON("EXPORT",VERSIONS) -
                                AGGCON("IMPORT",VERSIONS);
AGGCON("GDP-FACTOR",VERSIONS) = SUM(ACCFAC,QSOL(ACCFAC,VERSIONS));
AGGCON("LABOR",VERSIONS)      = QSOL("FAC-LABOR",VERSIONS);

PRICES(LINES,VERSIONS) = AGGCUR(LINES,VERSIONS) / AGGCON(LINES,VERSIONS);

ELASTCU(LINCU,VERSIONS) = ( AGGCUR(LINCU,VERSIONS)/AGGCUR(LINCU,"BASE") -1)/DELTA;
ELASTCO(LINES,VERSIONS) = ( AGGCON(LINES,VERSIONS)/AGGCON(LINES,"BASE") -1)/DELTA;
ELASTPR(LINES,VERSIONS) = ( PRICES(LINES,VERSIONS)/PRICES(LINES,"BASE") -1)/DELTA;

DISPLAY AGGCUR,AGGCON,PRICES,ELASTCU,ELASTCO,ELASTPR;
```

```
SYMBOL        TYPE    REFERENCES

AC            ACRNM   DECLARED        76  DEFINED      76       REF      283      284      285      286
                           287       288      289     290       291      292      293      294      295
                           296       297      298     299       300      301      302      303
ACC           SET     DECLARED         3  DEFINED       3  IMPL-ASN      348      361      376      389
                           REF        56      312     313       322      339      340      341      342
                           346       350      351     352       353      354      363      364      365
                           366       367      378     379       380      381      382      391      392
                           393       394      395 CONTROL       312      313      322      338      339
                           340       341      342     350       351      352      353      354      363
                           364       365      366     367       378      379      380      381      382
                           391       392      393     394       395
ACCC          SET     DECLARED        56      REF     312       313      339      341      342      353
                           354       366      367     381       382      394      395  CONTROL      312
                           313       339      341     342       353      354      366      367      381
                           382       394      395
ACCCP         SET     DECLARED        45  DEFINED      46
ACCEX         SET     DECLARED        49  DEFINED      50       REF      314      413      426
                       CONTROL       314      413     426
ACCFAC        SET     DECLARED        47  DEFINED      48       REF      419      432  CONTROL      419
                           432
ACCIM         SET     DECLARED        51  DEFINED      52       REF      414      427  CONTROL      414
                           427
AGGCON        PARAM   DECLARED       405 ASSIGNED     424       425      426      427      428      432
                           433       REF      428     429       430      431      435    2*438      441
AGGCUR        PARAM   DECLARED       404 ASSIGNED     411       412      413      414      415      419
                           420       421      422     REF       415      416      417      418      435
                         2*437       441
AINF          PARAM   DECLARED       264  DEFINED     264  IMPL-ASN      348      361      376      389
                      ASSIGNED       358      369     374       386      REF      346      350      351
                           352       363      364     365       378      379      380      391      392
                           393
CES           ACRNM   DECLARED        58  DEFINED      58       REF    3*220      221      222      223
                           235       236      242     243       249      250
CINF          PARAM   DECLARED       310 IMPL-ASN     348       361      376      389 ASSIGNED      312
                           313       314      322     359       370      387      REF      346      353
                           354       366      367     381       382      394      395
CONS          SET     DECLARED        53  DEFINED      54       REF      411      424  CONTROL      411
                           424
CSAM          PARAM   DECLARED       333 ASSIGNED     342       354      367      382      395
                           REF       426      427
DELTA         PARAM   DECLARED       318 ASSIGNED     319       REF      322      437      438      439
ELASTCO       PARAM   DECLARED       408 ASSIGNED     438       REF      441
ELASTCU       PARAM   DECLARED       407 ASSIGNED     437       REF      441
ELASTPR       PARAM   DECLARED       409 ASSIGNED     439       REF      441
ETA           PARAM   DECLARED       307  DEFINED     308       REF      314
EXPORT        ACRNM   DECLARED        59  DEFINED      59       REF      260      261      262
FEXO          ACRNM   DECLARED        60  DEFINED      60       REF      255      256      257      258
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SYMBOL       TYPE    REFERENCES

                          359      387
IDIST        ACRNM   DECLARED      61  DEFINED       61      REF       177      178    2*179      184
                          185    2*186    2*187    2*188      191      194      195      196      202
                          204      206      258
IMPORT       ACRNM   DECLARED      62  DEFINED       62      REF       238      245      252
INST         ACRNM   DECLARED      74  DEFINED       74      REF       273      274      275      276
                          279      280
INSTC        ACRNM   DECLARED      75  DEFINED       75      REF       277      278      281      282
IO           ACRNM   DECLARED      63  DEFINED       63      REF     2*215    3*216      226      227
                          228    3*229    3*230    3*231    2*234    2*241    2*248
ITAX         ACRNM   DECLARED      64  DEFINED       64      REF     3*237    2*244      251
LINCU        SET     DECLARED     397  DEFINED      398      REF     2*437  CONTROL      437
LINES        SET     DECLARED     400  DEFINED      401      REF     2*435    2*438    2*439
                      CONTROL     435      438      439
MF           ACRNM   DECLARED      72  DEFINED       72      REF       267      268      269      270
NMF          ACRNM   DECLARED      73  DEFINED       73      REF       271      272
P            ACRNM   DECLARED      82  DEFINED       82      REF       267      305
PQ           ACRNM   DECLARED      80  DEFINED       80
PRICES       PARAM   DECLARED     406 ASSIGNED      435      REF     2*439      441
PSOL         PARAM   DECLARED     334 ASSIGNED      338      350       363      378      391
Q            ACRNM   DECLARED      81  DEFINED       81      REF       268      269      270      282
                          369      374
QEXO         ACRNM   DECLARED      65  DEFINED       65      REF       197      198      199
QSHR         ACRNM   DECLARED      66  DEFINED       66      REF       208      209
QSOL         PARAM   DECLARED     335 ASSIGNED      339      351       364      379      392
                          REF     340      424      425      432       433
ROW          ACRNM   DECLARED      78  DEFINED       78      REF       305
SAM          PARAM   DECLARED      84  DEFINED       84      REF       312    2*322      339      341
                          342
SAMS         PARAM   DECLARED     332 ASSIGNED      341      353       366      381      394
                          REF     413      414      422
SPEC         PARAM   DECLARED     174  DEFINED      174      REF       313
TAX          ACRNM   DECLARED      77  DEFINED       77      REF       304
TEXO         ACRNM   DECLARED      67  DEFINED       67      REF       202      203      205
THAILAND     MODEL   DECLARED     346  DEFINED      346      REF       348      361      376      389
UNSPEC       ACRNM   DECLARED      70  DEFINED       70      REF       192      193      206      259
                          370
VERSIONS     SET     DECLARED     326  DEFINED      326      REF       411      412      413      414
                          415      416      417      418      419       420      421      422      424
                          425      426      427      428      429       430      431      432      433
                        2*435      437      438      439  CONTROL       411      412      413      414
                          415      419      420      421      422       424      425      426      427
                          428      432      433      435      437       438      439
VEXO         ACRNM   DECLARED      68  DEFINED       68
VSHR         ACRNM   DECLARED      69  DEFINED       69      REF       197      198      199      212
                          213      214
YSOL         PARAM   DECLARED     336 ASSIGNED      340      352       365      380      393
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SYMBOL        TYPE    REFERENCES

                           REF      411      412      419      420      421


SETS

ACC           ACCOUNT SET FOR THE THREE SECTOR THAILAND DEMONSTRATION MODEL
ACCC          ALIASED WITH ACC
ACCCP         SET OF COMPOSITE COMMODITY ACCOUNTS
ACCEX         SET OF EXPORT COMMODITY ACCOUNTS
ACCFAC        SET OF FACTOR ACCOUNTS
ACCIM         SET OF IMPORT COMMODITY ACCOUNTS
CONS          SET OF CONSUMPTION ACCOUNTS
LINCU         LINE ITEMS FOR CURRENT PRICE SUMMARY TABLES
LINES         LINE ITEMS FOR PRICE AND CONSTANT PRICE SUMMARY TABLES
VERSIONS


ACRONYMS

AC            ACTIVITY OR COMMODITY ACCOUNT
CES           CONSTANT ELASTICITY OF SUBSTITUTION FUNCTION
EXPORT        EXPORT SPECIFICATION
FEXO          FIXED IN FOREIGN EXCHANGE
IDIST         INCOME DISTRIBUTION
IMPORT        IMPORT SPECIFICATION
INST          INSTITUTIONS INCOME AND TRANSFER ACCOUNT
INSTC         INSTITUTIONS CONSUMPTION ACCOUNT
IO            LEONTIEF PRODUCTION FUNCTION
ITAX          INDIRECT TAX SPECIFICATION
MF            MARKET FACTOR ACCOUNT
NMF           NON MARKET FACTOR ACCOUNT
P             PRICE EXOGENOUS
PQ            PRICE AND QUANTITY EXOGENOUS
Q             QUANTITY EXOGENOUS
QEXO          EXOGENOUS QUANTITY CONSUMPTION SYSTEM
QSHR          FIXED QUANTITY SHARES CONSUMPTION SYSTEM
ROW           REST OF THE WORLD ACCOUNT
TAX           TAX ACCOUNT
TEXO          EXOGENOUS VALUE TRANSFER
UNSPEC        UNSPECIFIED
VEXO          EXOGENOUS VALUE CONSUMPTION SYSTEM
VSHR          FIXED VALUE SHARES CONSUMPTION SYSTEM
```

```
PARAMETERS

AGGCON      NATIONAL ACCOUNT AGGREGATES IN CONSTANT PRICES
AGGCUR      NATIONAL ACCOUNT AGGREGATES IN CURRENT PRICES
AINF        ACCOUNT INFORMATION TABLE
CINF        CELL INFORMATION TABLE
CSAM        CONSTANT PRICE SOLUTION SAMS
DELTA       ABSOLUTE CHANGE IN AGRICULTURAL TAX RATE
ELASTCO     ELASTICITIES OF NATIONAL ACCOUNT AGGREGATES IN CONSTANT PRICES
ELASTCU     ELASTICITIES OF NATIONAL ACCOUNT AGGREGATES IN CURRENT PRICES
ELASTPR     ELASTICITIES OF PRICES
ETA         EXPORT DEMAND ELASTICITIES
PRICES      PRICE INDICES OF NATIONAL ACCOUNT AGGREGATES
PSOL        SOLUTION PRICES
QSOL        SOLUTION QUANTITIES
SAM         SOCIAL ACCOUNTING MATRIX FOR THAILAND IN 1980
SAMS        SOLUTION SAMS
SPEC        SPECIFICATIONS FOR THAILAND BASE MODEL
YSOL        SOLUTION ACCOUNT TOTALS


MODELS

THAILAND


COMPILATION TIME =        1.182 SECONDS
```

---- 441 PARAMETER AGGCUR NATIONAL ACCOUNT AGGREGATES IN CURRENT PRICES

	BASE	LSFB	LSBC	LCFB	LCBC
CONSUMPTN	526.000	522.543	522.096	523.656	523.769
INVESTMENT	189.000	188.753	187.667	188.535	188.953
EXPORT	168.000	166.095	166.252	167.407	167.286
IMPORT	210.000	208.785	208.252	209.101	209.286
GDP-MARKET	673.000	668.605	667.763	670.497	670.722
GDP-FACTOR	602.000	597.457	596.748	599.132	599.317
LABOR	424.000	420.834	420.431	421.724	421.831
GOVRN-REVN	97.000	96.995	96.819	97.300	97.351
BOP-DEFICT	49.000	49.690	49.000	48.694	49.000

---- 441 PARAMETER AGGCON NATIONAL ACCOUNT AGGREGATES IN CONSTANT PRICES

	BASE	LSFB	LSBC	LCFB	LCBC
CONSUMPTN	526.000	523.421	523.151	525.526	525.527
INVESTMENT	189.000	189.000	188.001	189.000	189.375
EXPORT	168.000	165.831	166.055	167.511	167.348
IMPORT	210.000	208.785	208.252	209.101	209.286
GDP-MARKET	673.000	669.467	668.954	672.937	672.963
GDP-FACTOR	602.000	598.834	598.431	602.000	602.000
LABOR	424.000	420.834	420.431	424.000	424.000

---- 441 PARAMETER PRICES PRICE INDICES OF NATIONAL ACCOUNT AGGREGATES

	BASE	LSFB	LSBC	LCFB	LCBC
CONSUMPTN	1.000	0.998	0.998	0.996	0.997
INVESTMENT	1.000	0.999	0.998	0.998	0.998
EXPORT	1.000	1.002	1.001	0.999	1.000
IMPORT	1.000	1.000	1.000	1.000	1.000
GDP-MARKET	1.000	0.999	0.998	0.996	0.997
GDP-FACTOR	1.000	0.998	0.997	0.995	0.996
LABOR	1.000	1.000	1.000	0.995	0.995

---- 441 PARAMETER ELASTCU ELASTICITIES OF NATIONAL ACCOUNT AGGREGATES IN CURRENT PRICES

	LSFB	LSBC	LCFB	LCBC
CONSUMPTN	-0.657	-0.742	-0.446	-0.424
INVESTMENT	-0.131	-0.705	-0.246	-0.025
EXPORT	-1.134	-1.040	-0.353	-0.425
IMPORT	-0.578	-0.832	-0.428	-0.340

441 PARAMETER ELASTCU ELASTICITIES OF NATIONAL ACCOUNT AGGREGATES IN CURRENT PRICES

	LSFB	LSBC	LCFB	LCBC
GDP-MARKET	-0.653	-0.778	-0.372	-0.338
GDP-FACTOR	-0.755	-0.872	-0.476	-0.446
LABOR	-0.747	-0.842	-0.537	-0.511
GOVRN-REVN	-0.005	-0.186	0.309	0.362
BOP-DEFICIT	1.409		-0.624	

---- 441 PARAMETER ELASTCO ELASTICITIES OF NATIONAL ACCOUNT AGGREGATES IN CONSTANT PRICES

	LSFB	LSBC	LCFB	LCBC
CONSUMPTN	-0.490	-0.542	-0.090	-0.090
INVESTMENT		-0.529		0.198
EXPORT	-1.291	-1.158	-0.291	-0.388
IMPORT	-0.578	-0.832	-0.428	-0.340
GDP-MARKET	-0.525	-0.601	-0.009	-0.005
GDP-FACTOR	-0.526	-0.593		
LABOR	-0.747	-0.842		

---- 441 PARAMETER ELASTPR ELASTICITIES OF PRICES

	LSFB	LSBC	LCFB	LCBC
CONSUMPTN	-0.168	-0.202	-0.356	-0.334
INVESTMENT	-0.131	-0.178	-0.246	-0.223
EXPORT	0.159	0.119	-0.062	-0.037
GDP-MARKET	-0.129	-0.178	-0.363	-0.333
GDP-FACTOR	-0.230	-0.281	-0.476	-0.446
LABOR			-0.537	-0.511

EXECUTION TIME = 2.210 SECONDS

134. The Tree-Crop Problem by Richard E. Bellman, University of Southern California and Michael J. Hartley, World Bank, October 1985.

135. Are Oil Windfalls a Blessing or a Curse? Policy Exercises with an Indonesia-Like Model by Alan H. Gelb, November 1985.

136. Neoclassical Econometrics: The Kernel by Michael J. Hartley, October 1985.

137. Neoclassical Econometrics: Non-Negativity Constraints by Michael J. Hartley, October 1985.

138. Financial Reforms, Stabilization and Growth under High Capital Mobility: Uruguay 1974-83 by Jaime de Melo, October 1985.

139. A Firm-Level Chronicle of Financial Crises in the Southern Cone by James Tybout, Georgetown University and Development Research Department, World Bank, October 1985.

140. A Systems Approach to the Calibration of Economy-Wide Models with Incomplete Data by Michael J. Hartley, October 1985.

141. Explaining the Trade Balance: A General Equilibrium Approach by Ricardo Caballero and Vittorio Corbo, November 1985.

142. Maximum Likelihood Estimation of the Truncated and Censored Normal Regression Models by Michael J. Hartley and Eric V. Swanson, November 1985.

143. Adverse Selection, Competitive Rationing and Government Policy in Credit Markets by Arvind Virmani, December 1985.

144. The Political Economy of Industrial Regulations: A Survey with Implications for Regulation Studies in Developing Countries by Pablo T. Spiller, Senior Research Fellow, Hoover Institution, Stanford University, January 1986.

145. The Role of the Real Exchange Rate in Macroeconomic Adjustment: The Case of Chile, 1973-82 by Vittorio Corbo, November 1985.

146. Exchange Rate Responses to Exogenous Shocks in Developing Countries by Mohsin S. Khan, January 1986.

147. Adjustment Policies in Socialist and Private Market Economies by Bela Balassa, October 1985.

148. Outward Orientation by Bela Balassa, July 1985.

149. Developing Country Debt: Policies and Prospects by Bela Balassa, July 1985.