THE SAM APPROACH IN RETROSPECT AND PROSPECT

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I What is a SAM?[1]

There is only one fundamental law of economics. It states that for every income there is a corresponding outlay or expenditure. The law is the equivalent for economists of the physicists' law of energy conservation. And it plays a similar role in defining the completeness of a model or analytic formulation: no theory or model can be correct unless it is complete in the sense that all incomes and outlays are fully accounted for.

A social accounting matrix, or SAM, is a simple and efficient way of representing this fundamental law. The SAM approach that then follows from it is a way of addressing problems or issues in economics which starts out by setting the problem within the framework of a social accounting matrix.

To elaborate this point, we can note first that a SAM is a square matrix which is designed to provide a record of transactions using a single-entry form of booking. It can be represented as

$$T = [t_{jk}] \quad (1)$$

and is structured so that each transactor or group of transactors that needs to be considered in relation to some particular issue should have their own row and their own column of the matrix. These rows and columns are identically ordered. By definition, there must be two sides to every transaction and, by convention, receipts of transactor j are entered in row j of the SAM; and expenditures by k are entered in column k. Hence, following this convention, t_{jk} is the the value of all receipts of j from k during the accounting period. Correspondingly, t_{kj} measures payments to k by j.

Two things now follow. Firstly, T must be a square matrix, since each transactor has their own row and column. And, secondly, corresponding row and column totals of T must be equal.

This second restriction can be written as

$$Ti = y = T'i \tag{2}$$

where i is a summation vector so that the jth element of y, i.e. y_j, is both the sum of all elements in the jth row of T (i.e. $\sum_k t_{jk}$), and also of all elements in the jth column ($\sum_j t_{jk}$). Thus y_j is both the total income of transactor j and their total outlay or expenditure. The two must be equal because, according to our law, for every receipt and, hence, for each transactor's income in total, there have to be some matching expenditures or outlays which must be equal in aggregate to the total income. In other words, the fundamental law is satisfied if and only if condition (2) is satisfied.

Since every economic model has its corresponding accounting framework,[2] and since every such framework can be set out as a SAM, it follows that every economic model has a corresponding SAM. We now see that this SAM will satisfy condition (2) if the model is correct in the sense that it satisfies the fundamental law. Accordingly, the condition (2) provides the initial link between SAMs and models.

The SAM approach can be used to tackle problems in any field of economics: it can, for example, be focused on a particular region or type of commodity or on some particular set of institutions.[3] However, SAMs are most familiar in their application to macroeconomic issues and the discussion here will therefore be restricted to this context.

Table 1 sets out a SAM for a national economy in which elements of the matrix are labelled according to the type of transaction they represent. While these correspond to aggregates which are familiar from national income accounting, it will nevertheless be helpful to the subsequent development of our argument to rehearse here certain aspects of the table.

Table 1 shows a distinction between our economy (accounts 1 to 5) and the rest of the world (account 6). If our economy was completely closed, then there would be no need for an account for the rest of the world. But, setting this possibility aside, the SAM must always have an account for the rest of the world if condition (2) is to be satisfied since, if our economy is not entirely closed then, *a fortiori*, there must be some transactions which take place outside its confines.

Within our economy, there are two main types of accounts. Firstly, there are both current and capital accounts for institutions, i.e. for households, the corporate sector and government. The SAM could, of course, have been drawn up with separate accounts for each of these different institutions. Indeed, there could well be further disaggregation, with separate accounts for different types of households (socio-economic groups), different types of companies (state versus private; domestic versus foreign) and different branches of government. However, the possibility of these and other disaggregations is set aside for now.

In addition to the accounts for institutions, Table 1 also has a set of accounts (#s 3 to 5) for production. Since every transaction is, in reality, a transaction between two institutions (A pays B) the introduction of the production accounts is essentially an abstraction which allows economic concepts to feature in the system. How this works can now be explained.

To start with the transactions between our economy and the rest of the world, we can note from Table 1 that our economy receives income from the rest of the world in payment for exports (row 6, column 7) and pays to it for imports. Similarly, some factor income is received from abroad, and there are offsetting factor income payments. All other international transactions are transfers between institutions. Thus, our economy receives both current and capital transfers from the rest of the world and makes corresponding transfers to it.

On balance, these international transfers must finance the difference between imports and exports, i.e. the balance of commodity trade, plus that of factor payments. Otherwise condition (2) would be violated. This is avoided by noting that the sum of all elements in column 6 is the aggregate of foreign exchange receipts for our economy. This is equal to the aggregate of row 6 if we define the latter as total foreign exchange payments plus any increase in reserves (which could, of course, be negative). Accordingly, condition 2 will be satisfied for account 6 provided that the item in row 6, column 2 is defined as shown in the table.

Turning now to the transactions wholly within the domestic economy, we see that institutions engage in both current and capital transfers among themselves, and that they also make transfers from their current to their capital accounts. These last are, by definition, domestic savings and can, of course, be negative. Savings are a net concept, so that the entry in row 1, column 2 is zero.

Since only institutions can have assets and financial resources, the three items we have already discussed in row 2 of Table 1 are the only sources of investible funds for domestic institutions. These are allocated in column 2 as domestic and foreign capital transfers, increases in reserves, and real investment in stocks and fixed assets.

The proposition that the condition (2) is satisfied for account 2 can be loosely phrased as the statement that savings and investment must be equal. It can be argued directly or indirectly. The indirect approach is to note that, as a mathematical necessity, if condition (2) is satisfied for all but one of the SAM accounts, then it must be satisfied for the remaining account. This indirect approach is the one we will follow here.

Turning now to the production accounts, the basic conceptualisation is that activities buy raw materials and hire factor services in order to produce commodities. In the process they generate value added. Accordingly, the only receipts of activities derive from sales of their output to commodity markets. This revenue is partially offset in column 4 by purchases of raw materials. The remainder is, by definition, value added, of which a part may be payable to government as a tax on activity (e.g. value added tax). Value added is treated as a payment to factors for their services. Its definition as a residual ensures that condition (2) is satisfied for account 4.

Since the only role of factors of production is to provide services to production activities (domestic or foreign) the income of factors is restricted to the two items in row 3 which have already been discussed. And since factor services are provided by institutions, it follows that this income must either be paid abroad in column 3, or it accrues to the domestic institutions and is therefore entered in row 1. The amount involved is a residual which therefore guarantees that account 3 satisfies condition 2. Its magnitude is given by domestic value added (otherwise known as the gross domestic product) plus net factor income received from abroad. This sum is known as the national product (net of taxes on activities).

The national product is the primary source of income for the domestic institutions. The other sources previously discussed are transfers from abroad and taxes on activities. To these we must now add any taxes on commodities. Taxes on incomes are then a part of the current transfers within the domestic economy. By summing all these items we can arrive at the total incomes of domestic institutions as the sum of row 1 of Table 1.

Total income is allocated in column 1, either as transfers or as current expenditure on commodities, i.e. consumption. Income that is not allocated in this way is, by definition, saved. Domestic savings are therefore the residual which guarantees that condition (2) is satisfied by account 1.

It remains to discuss the account for commodities, account 5.

Row 5 brings together all the various sources of demand for commodities: consumption, investment, exports and raw material requirements. These demands are met in column 5 by imports or by domestic production of goods and services. However, since the demands are expressed in market prices, the supply must be valued similarly. Therefore, taxes on commodities have to be included in the costing of aggregate supply.

Aggregate demand and supply of commodities must be equal. Hence account 5 must satisfy condition (2). And at this point we have shown that every account except account 2 must satisfy condition (2). Hence, by virtue of the mathematical necessity previously noted, it follows that account 2 satisfies condition (2) also, or, in other words, that savings must be equal to investment.

To conclude this brief discussion of 'What is a SAM?' three final points can be noted.

Firstly, we have already commented on the possibility of disaggregating the accounts for instutitions so as to show, for example, separate accounts for different socio-economic groups of households. We can now also note that it is similarly possible to disaggregate the production accounts so as to distinguish different factors of production viz land, labour, capital; and to have further differentiation among these e.g. by types of labour. Production activities can similarly be disaggregated to distinguish agriculture from industry, the formal sector from the informal, etc. And, finally, the SAM can recognise a whole range of different goods and services within the commodity accounts.

The second point to mention at this stage is that the accounts for the rest of the world can also be disaggregated into different regions (currency areas, for example) or even into separate national units. Moreover, the SAM need not be restricted to having only one account for each of these separate parts of the rest of the world.

Just as Table 1 allows five accounts for our own economy, so it could be extended to have five accounts for each of the regions within the rest of the world which are separately of interest. In this way, some of the many transactions which take place within the rest of the world would become explicit. As matters stand in Table 1, these transactions are implicit in the asterisk entered in the bottom right-hand corner of the table. Their magnitude does not, of course, affect the balance of the remaining items in the table.

Finally, it can be noted that the accounts in Table 1 could be arranged in any order and our discussion of them could have proceeded in any sequence. The ordering is largely a matter of taste, as is the sequence of discussion here. However, the sequencing we have adopted has the consequence of showing how the demand for output from domestic activities leads to a demand for factor services which, in turn, generates income for domestic institutions. This income leads on to demand for commodities and hence back to the demand for output from domestic activities. This is the classic circular flow of income within the macro economy. It is illustrated in Figure 1 as a simpified and diagramatic form of Table 1 which can be obtained by ignoring all taxes and transfers and leaving out of account all the external transactions of our economy.

II The early years

While the early years of social accounting are generally well documented, there is some doubt about the earliest use of a matrix format.[4] However, there can be little doubt that the format itself did not become familiar until the 1960's, and that the process which then got under way was started by Sir Richard Stone and the late Alan Brown, working together on what become known as the 'Cambridge Growth Project'. It was largely this effort which lead to the formulation of a revised international standard for national accounts, the 1968 United Nations System of National Accounts (the SNA), of which Stone was the primary architect.[5]

This early work with SAMs was restricted to their use as a framework for data. However, the design of the SAM was in many ways led by the data requirements of a specific model, the Cambridge Growth Model. And this was, of course, very much in keeping with Stone's personal experience during the Second World War when he worked under Lord Keynes in preparing the first official national income estimates for the U.K.[6] Just as those early estimates were driven by the concepts of Keynesian economics and the predominant policy issue of paying for the war, so the work in Cambridge was geared to the conceptualisation provided by the growth model and the perception of policy priorities in U.K., circa 1960. And since work of both vintages has led directly to successive versions of the U.N. standards, it is not surprising that these standards have evolved from being largely a quantification of the major Keynesian aggregates to a form, in 1968, which emphasises the production structure of an economy and its trade patterns in relation thereto. Thus, in terms of Table 1, the 1968 SNA envisages considerable disaggregation within the production accounts, but relatively little disaggregation of the accounts for institutions. Such disaggregation is discussed at length as part of the U.N. System of Social and Demographic Statistics.[7] And the definitions adopted in the two systems are fully compatible.[8] However, the disaggregation of the household sector within the national accounts was not thought to be a priority in those days, and so it was not attempted. The problems of the U.K. at that time were problems of growth and external balance. Internally, the level of employment was high and an extensive social security system was in place. Questions of poverty and income distribution were therefore not to the fore.

These arguments support the view that data systems do not develop in a vacuum but rather they reflect both the theory and policy needs of their day. This point is important not only for understanding the way in which the SAM approach has evolved, but also because the United Nations Statistical Office now has a new revision of the SNA in the early stages of preparation. It is to be hoped that this revision will similarly reflect contemporary policy priorities and methods for their analysis. In a recent essay, Sir Richard Stone has stated that

> "It seems that of all the interesting things that could be done to improve the national accounts, the one most worthy of consideration is the disaggregation of the household sector."[9]

Perhaps, therefore, this latest revision of the SNA will recognise Stone's suggestion.

The fact that people and the households to which they belong are not at the centre of the 1968 SNA has for a long time been a source of criticism for a few. One of the most vociferous of these critics was the late Dudley Seers, who illustrated some of his innovative ideas with reference to Zambia.[10,11]

The case for including data on income distribution via disaggregation of the household sector in the SNA is not restricted to the fact that it is important to measure the level and distribution of incomes.[12] Beyond this, it is important to disaggregate households within the SNA SAM because the effects of macro-economic policy on poverty and income distribution cannot otherwise be analysed within it. Since such effects are obviously important as criteria for evaluating policy alternatives, the usefulness of the SAM is evidently dependent on this feature.

Since one of the main channels through which policy can influence income distribution is through employment, it is perhaps not surprising that much of the next phase in the development of the SAM approach was stimulated through the activities of the World Employment Programme (WEP) instigated by the International Labour Office.

The WEP involved a series of country missions of which the first three are especially important to the SAM approach. The first was a mission to Colombia, involving a large team headed by Dudley Seers. Its otherwise interesting report was vulnerable to criticism insofar as it lacked a consistency framework, so that there was no real way of knowing how the ideas within it would add up.[13] The mission which then followed was this time to Sri Lanka, and again with Seers as its leader. But now the question of consistency was on the agenda. And, as luck would have it, it so happened that this second mission had available a recently constructed multi-sector macro-economic model of the Sri Lankan economy which was based directly on the Cambridge Growth model.[14] In this way, the concerns of Seers and Stone were confronted. The fact that the model allowed changes in income distribution to influence final demand, and hence the structure of production, did not of itself provide a sufficient basis from which to construct answers to the questions faced by the mission, not least those questions which concerned the way in which different groups would be affected by any radical attempt to restructure the economy.

The third WEP mission organised by the ILO was to Iran. It provided a unique opportunity to persue the issues raised by the earlier missions, and a number of developments were possible as a result.[15]

The macro-economic model developed for Iran involved two main innovations.[16] Firstly, it had an explicit SAM framework which was used both as a framework for data and for the algebra of the model. Secondly, within the SAM framework, the household sector was disaggrgeated (into three types: urban rich, urban poor and rural) alongside a disaggregation of production into several sectors. In this way the structure of production and the distribution of income were shown to be intimately related via the circular flow of income within the economy. One consequence was that the model touched on matters which were politically sensitive, i.e. the approach led to a focus on very real issues of which not all observers of Iran were fully aware at that time.[17]

This work in Iran was an important step in the development of what I shall refer to later as the SAM approach to modeling, not least giving stimulus to it by the relevance of the findings for the policy debate. However, the study was exceptional in the sense that the direct analytic and modeling application of SAMs is otherwise a more recent development, which followed on from the extended use of SAMs as a framework for data. Accordingly, it is appropriate to say something about this aspect first, returning later to models and the use of SAMs as frameworks for analysis.

III SAMs as data frameworks

The Iran model was calbirated directly from a SAM which was obtained only after a good deal of 'guestimation', which was inevitable in view of the weaknesses of the underlying data.[18] Moreover, there were no explicit factor accounts in this particular SAM so that value added and other factor income receipts were all paid directly to one or other of the institutions according to the factor services which they provided. All of which implies a series of weaknesses in the basic formulation. The research priority was therefore to attempt the design and quantification of a SAM framework which included factor accounts and was otherwise better able to support the type of modeling which had been initiated in relation to Iran.

The results of such an exercise in Sri Lanka are set out in Pyatt and Roe (1977). As explained there (and also in Pyatt and Round (1977)) the major difficulties encountered were of two types. Firstly, it was necessary to use household survey data and other sources of information to estimate the incomes of different institutions (notably 18 different types of households) and their generation through transfers and the provision of factor services to different types of production activity, and then to associate with each income, again relying heavily on household surveys, a pattern of expenditure on different types of commodities, and savings. This was one major difficulty which can be characterised as the need to construct a mapping from production structure, through factor markets, to income levels and their distribution, and hence to domestic savings and the pattern of final consumption demand for each household type. The second problem was to reconcile all this with the existing data in the national accounts (of which there were three versions).

This problem of reconcilition was far from trivial, and it has remained a source of considerable difficulty in subsequent exercises.[19] It derives from the fact that national income estimates are typically based on the commodity balance method; and the usual method of obtaining such balance is to estimate consumption by type of commodity as the residual balancing items. Such estimates are then modified, if at all, in relatively minor ways, using whatever other information about consumption levels may be to hand. This is hardly a rigorous approach. In attempting to disaggregate factor markets and private income within the national accounts, the SAM quantification exercises which have been undertaken to date formally juxtapose national accounts with other data sets, and notably with household surveys. The act of doing so invariably reveals major discrepancies in the numbers.[20]

Put more generally, a rough but approximate description of common practice in national accounting is that it employs just enough real numbers to estimate cells of the SNA SAM so that, by then invoking the accounting constraint (2), all other cells of the table can be estimated as residuals. Additional information is generally unwelcome under such a scenario. The reason for such practice is not hard to find. If all cells are estimated directly, then the numbers will not add up exactly as condition (2) requires that they should, simply because the estimates are subject to error. Statisticians usually allow themselves to publish just one discrepancy in the national accounts totals, and this is known as 'the residual error'. But the more primary information is brought to bear on the matter, the greater is the number of residual errors or discrepancies which will pop up in different parts of the matrix. A good deal of hard work and judgement is needed to resolve such discrepancies. One way of avoiding this is to have fewer discrepancies to start with, and this is achieved by having less information at the outset.

At least one formal method of addressing this problem has been developed.[21] The method recognises that estimates of individual cells of a SAM are linearly restricted by the constraints (2). One possibility, therefore, is to use a form of constrained least squares to reconcile inconsistencies among the initial estimates of the individual cells and so obtain a balanced table of numbers. The approach gives specific form to the notion that, under the constraints (2), error variances in initial estimates lead to negative covariances among final estimates.

One virtue of this method of constrained least squares is that it can be used to develop priorities for the development of basic statistical information, i.e. for obtaining new or better initial estimates of particular elements of a SAM. The method can also be invoked to formalise a case for using a certain amount of 'guestimation'. Since all the numbers in a SAM must ultimately be a part of an integrated and balanced whole, any 'wild guestimates' which are proposed initially are likely to be rejected before long, if other, more substantial, data are to hand, even if this better data has only an indirect bearing on those cells which are guestimated initially.

Such formal methods of reconciling inconsistent data are important in improving the quality of SAM estimation, and I include in this the estimation of national accounts. The formal methods also make the revision of initial estimates a relatively straightforward matter, so that revisions can be undertaken over time as the availability of primary information steadily improves. Similarly, the formal methods make replication of final estimates a practical possibility. In their absence one can rarely if every resurrect exactly the methods by which particular SAM estimates were constructed.

The desirability of further work on formal methods of SAM quantification seems to be one general conclusion to emerge from experience subsequent to that in Sri Lanka.[22] Another is that, even without the aid of formal methods, the use of a SAM framework to reconcile inconsistent data is to be strongly recommended. Not only does the rigour of the framework tend to encourage careful work, but also the framework itself provides a context in which a wide range of information including, at some point, casual empiricism, can be brought to bear. Quantification of a SAM is a difficult and painstaking task. It can be rewarded by obtaining a final set of estimates which are at least as good as anything that went before and, to that extent, reliable. Among the additional rewards, the process teaches a great deal about priorities for improving the primary data base. It also turns out to be an extremeley efficient way of learning about the economy itself.

The robustness of the conclusions to emerge from the Sri Lanka study were tested first in Swaziland and, by now, in an extended series of country studies undertaken by a variety of individuals and institutional groups. Only a fraction of this work has been documented in the published literature, although the coverage is growing. Pyatt and Round (1977) and Hayden and Round (1982) present some material from several studies on a comparative basis while the country studies in Swaziland and a sequel in Botswana are both reported in Pyatt and Round (1985). This same volume also includes a report on a study of the Muda region in Malaysia, thereby illustrating the use of SAMs at the regional level.[23] By now SAMs have been designed and quantified for well over 30 countries, and a careful stocktaking of this experience would be appropriate. Such a task is well beyond the scope of this essay. However, it is appropriate to single out some particular studies which are interesting because they illustrate significant points in the development of our subject.

Firstly, the study in Botswana previously referred to made an important contribution. The extensive disaggregation of the production accounts for both activities and commodities was established at the outset by the 1968 SNA building on earlier work in input-output and commodity balances. This was followed, in the Sri Lanka study, by an attempt to disaggregate both the factor accounts and the current account for institutions, motivated by a concern to capture in detail the generation of income levels and also their distribution. The breakthrough in Botswana was to now extend disaggregation to the capital accounts for institutions, thus bringing the flow of funds and investment financing into the detailed description of the economy.

The formal problems of integrating flow-of-funds data into a SAM framework are resolved in UNSO (1968).[24] However, while there had previously been a number of separate compilations of such data, especially in developed countries, none of these (as far as I know) were integrated with the basic national accounts statistics in an overall SAM framework.

Secondly, reference can be made to a large study for Malaysia which endeavoured to be innovative in at least two respects.[25] This SAM, which was constructed for 1970, was designed from the outset to support what is now known as a computable general equilibrium model.[26]

In it, Malaysia was treated as a two-region economy (the peninsular and East Malaysia) with full and consistent SAMs being calibrated for each region.[27] This was the first innovation. The second was in the treatment of commodity accounts and balances.

In the SAM presented as Table 1, all commodity purchases are recorded at market prices. However, the tradition in input-output analysis and national accounts, including the 1968 SNA, has been to record commodity transactions at basic (or approximate basic) prices.[28] The essential difference is to remove both commodity taxes and margins for transport and distribution from the cost of each commodity. In this way, for example, rice which a cultivator retains for his own consumption is valued at the same price as rice which is sold to a wholesaler and ultimately, through a distribution chain, to a remote consumer. Yet, in market price terms, the same rice is two quite distinct commodities, each corresponding to a different final markets.

The traditional treatment has the advantage that it reduces the number of commodities because goods do not have to be differentiated according to their distribution. The disadvantage, however, is that real, i.e. important distinctions are lost. If the purpose in quantifying the SAM is to subsequently move on to the analysis of behaviour, then it is important to value sales at market prices because it is market prices to which behaviour responds. The convention promoted in the 1968 SNA is acceptable from this perspective only under the most stringent restrictions on the formulation of consumer behaviour.[29]

I have not checked whether the Malaysia SAM for 1970 or one of the series of more recent SAMs for Indonesia is the largest to have yet been calibrated. However, the Indonesia SAMs are important for a more substantive reason. They represent a rare case, and possibly the best, of SAM calibration being formally integrated into the continuing work programme of a government statistical office.[30] Botswana would provide a second example. And a third case in point is provided by Thailand, where the emphasis is much more on the use of a model for planning purposes.[31]

IV SAMs and theory

The use of SAMs as a data framework requires that a suitably disaggregated version of Table 1 (or some variant of it) be compiled so that each cell is represented by a numerical estimate of the value of the corresponding transactions. To use a SAM as a framework for theory requires instead that the cells of such a matrix be filled out with algebraic expressions which describe in conceptual terms how the corresponding transaction values might be determined.

To introduce this basic idea, a simple example will be useful. Many economists will be familiar with the use of the SAM framework shown as Table 1 for an exposition of the basic Keynesian analysis of equilibrium in the market for goods.[32] This is rehearsed here in Table 2, with the notation '..' used for non-zero entries in Table 1 which are now assumed to be negligible. Otherwise, the interpretation of the notation follows directly from a comparison of the two tables.

As a first step in analysis, Table 2 is simplified by consolidating together accounts 1 and 2 and accounts 3 to 5.[33] The resulting SAM is now a 3 by 3 matrix

$$\begin{bmatrix} O & Y & F \\ C+I & O & X \\ O & M & * \end{bmatrix} = \begin{bmatrix} O & Y & F \\ I+(1-\sigma)Y & O & X \\ O & \mu Y & * \end{bmatrix} \qquad (3)$$

where the second version of the matrix follows from formulating the Keynesian proposition that C and M are endogenous (with X and I exogenous) in terms of fixed propensities to consume and to import, denoted $(1-\sigma)$ and μ respectively. For Keynesian analysis, the formulation of F does not matter: condition (2) imposed on (3) yields

$$Y = [1/(\sigma + \mu)] \; (I + X) \qquad (4)$$

which is, of course, the standard multiplier result for this case. The formulation of F does matter for two-gap analysis, however. With an upper limit of $\bar{F}$ on F, imposing conditions (2) on (3) also implies

$$I - \sigma Y \leqq \bar{F} \text{ and } \mu y - X \leqq \bar{F} \qquad (5)$$

so that both the two-gap analysis and the multiplier analysis can be developed simply and directly from the SAM.

The above is a very simple example of how a SAM can be used in order to develop theory. It represents only a beginning of what may become important in future as a way of thinking about and communicating our analytic results, and as a way of breaking out from the restrictive domain of two factors, two goods, etc. It is partly with a view to such developments that what is now called the TV approach to model formulation has been developed.

The convention in economics has been to present a model as a set of equations showing how prices and quantities are determined. The initial novelty in using a SAM as the basic framework for model presentation is to require instead a set of equations which describe how the value of each type of transaction is determined. To emphasise this point, these equations have been referred to as the TV (transactions value) form of the model.[34] To reinforce it, the algebraic expressions themselves are expressed as functions of incomes and prices. Hence, if t_{jk} is the SAM entry for row j and column k, then a model in TV form is a set of equations

$$t_{jk} = t_{jk}(y;\ p, f, \lambda) \qquad (6)$$

where y is the income vector defined in equation (2), p is a vector of prices covering all commodities and the outputs of each activity; f is a vector of factor prices; and λ is the exchange rate i.e. the price in domestic currency of a unit of foreign exchange. Thus, the model in TV form expresses each t_{jk} as a function of incomes and prices.

One of the advantages of presenting a model in TV form is that this can lead to a ready understanding of a number of its properties. To pursue these, it can be noted that substituting expressions of type (6) for each t_{jk} in the conditions (2) will yield two sets of equations, the first following from the row summation of T, and the other as a consequence of column summation. These two sets of equations are basic to model structure. Once they are specified, model formulation is completed with a third set of equations known as closure rules. More will be said about these later. For now we concentrate attention on the TV part of the model, starting with the column summation equations.

Column summation of the activity and commodity accounts in Table 1 yields some interesting results. If total costs must equal total revenue, then price, or average revenue, must equal average cost, which depends, of course, on prices. Hence prices are interdependent and the column summation equations for activities and commodities describe this interdependence, i.e. they yield a set of equations

$$p = p(y;\ p, f, \lambda) \qquad (7)$$

which is the first of the three sets of equations which define any macro model.

The equations (7) show how commodity and activity prices will depend not only on each other, but also on factor prices, f, the exchange rate, λ , and, in the most general case, on the scale of output and, therefore, on the income levels of particular activities.

Two points to note here about equations (7) are, firstly, that typically these equations are linear homogeneous. If input prices double and the scale of production stays constant, then output prices will double. Secondly, while in general equations (7) allow prices to depend on y and, therefore, on the scale of production, these equations also allow as a special case that the price level is independent of the scale of production, provided that factor prices, f, and the exchange rate, λ are given.

This special case would arise if production technology was characterised by constant returns to scale and in the absence of any quantity restrictions on imports, for example, which would otherwise tend to raise prices as the scale of activity expands.

Equations (7) provide a quite general description of the price system, with the Leontief formulation, for example, as a special case. The equations allow domestic and imported goods to be perfect substitutes, or complements, or something in between as originally formulated in Armington (1969). They can allow for any tariffs and taxes that are levied and, by, extension, for quota restrictions on imports as has just been suggested. The equations are quite consistent with an activity analysis view, whereby the choice among a range of alternative activities for producing a given product is determined by cost minimisation. Similarly, issues which turn on the internal terms of trade depend critically on equations (7), as do matters such as the effect on prices in any one sector of inefficiency in another. These, and other important theoretical questions (effective protection, for example) depend on the particular formulation of equations (7) that is adopted.

The remaining column summation equations are less interesting. They provide a check on the TV specification but otherwise no new information. This is because these equations are essentially statements of adding-up conditions which need to be satisfied if all income is to be fully accounted for as an outlay. These conditions will be most familiar as a condition on the consumption expenditure and savings behaviour of households. But they maintain equally in other parts of the matrix. The factor accounts provide a simple example. The income for any one factor is allocated in its column of the SAM. And in the absence of any discrimination in the market for a factor this allocation will simply be in proportion to the ownership of that factor by the different institutions. Hence column summation in this case is a check on the TV specification that the total income for each factor is allocated in proportions which add to 100%.

A somewhat different type of adding-up condition arises when the theoretical specification of the elements of a particular column contains one element which is defined as the balancing residual. Obviously, in the presence of such a residual, there is no possibility that total outlay is equal to anything other than total income. There is, therefore, no new information contained in the column summation equations in this case either. There are other implications, however, and these will be developed later. But for now the point to note is simply that the TV specification of the model can be so formulated that all column summation conditions (2) are satisfied if and only if equation (7) is satisfied.

At this stage of discussion it is useful to note that the TV specifiction of each cell of the SAM must belong to one of three types. Some cells are specified so that t_{jk} depends on the level of one or more of the incomes, y. This is the general case envisaged in equation (6). Such cells are described as endogenous (because they depend on y) and the matrix of endogenous transactions can be denoted by N. Other cells are independent of all income levels, y. These are described as exogenous and can be represented as the positive elements of a matrix X. And then there is a third type of cell, which is a mixture of endogenous and exogenous elements. Any column which contains one or more exogenous elements must also contain an element of this type in order to ensure that the adding-up condition for that column is satisfied. And the specification for this element must be that it is equal to the difference between total income for that account and the sum of all other column elements, be they endogenous or exogenous. Thus residual balancing cells can be interpreted as the difference between an endogenous component and an exogenous component. If the former is recorded in N and the latter as a negative element of X, then it evidently follows that

$$T = N + X \qquad (8)$$

while column summation now gives

$$y' = i'T = i'N + i'X \qquad (9)$$

where $i'X$ is necessarily zero and $i'N$ is necessarily equal to y' if and only if equations (2) are satisfied.

Turning now to row summation it follows from (2) and (8) that

$$y = n + x \qquad (10)$$

where n and x are the column vectors of row sums of N and X respectively.

Equations (10) are the second set of model equations. They correspond to the demand side of the system insofar as they explain how the total income in each account is derived from endogenous and exogenous demands. More specifically, the endogenous sources of income, n, will capture the interdependence of incomes in the different accounts as a result of the circular flow of income.[35]

If $[p]$ denotes the number of elements in vector p, and $[y]$ and $[f]$ are similarly defined, then equations (7) and (10) define $[p] + [y]$ equations in the $[p] + [y] + [f] + 1$ variables, p, y, f and λ. It might be thought, therefore, that these equations could be solved for p and y, given values of the factor prices, f, and the exchange rate, λ. This is not the case, however, since it follows from equation (9) that one of the equations (10) is linearly dependent on the remainder. The system of equations (7) and (10) therefore contains $[f] + 2$ degrees of freedom.

The special case within this framework of a fixed price model is of some interest. In this case, as we have seen, prices are independent of the scale of production, so that for fixed values of f and λ, equations (7) yield prices, p, which are independent of incomes, y. The system can be solved recursively, therefore. For given values of f and λ, equations (7) yield prices, p as already noted. Taken together, the prices p, f and λ allow x to be determined and for n to be expressed simply as a function of y. Hence the linearly dependent equations (10) can be solved for y as a function of one of its elements, say y_j.

A further implication of the fixed price case is that total differentiation of (7) yields

$$dy = C\,dy + dx \tag{11}$$

where C is the matrix of first-order partial derivatives of n with respect to y. The linear dependence of the system precludes a general solution for dy from (11). However, we can write

$$dy_{\bar{j}} = C_j\,dy_{\bar{j}} + c_j\,dy_j + dx_{\bar{j}} \tag{12}$$

$$= (I-C_j)^{-1}\left[c_j\,dy + dx_{\bar{j}}\right] \tag{13}$$

where $y_{\bar{j}}$, and $x_{\bar{j}}$ are vectors with [y] -1 elements, formed by suppressing the jth elements of y and x respectively. Vector c_j is similarly formed from the jth column of C, while C_j is a square matrix of [y] -1 rows and columns, obtained by suppressing both the jth row and column of C.

The notation implies that there are [y] matrices C_j corresponding to the possible choices for y_j. Where $(I-C_j)^{-1}$ exists, it is known as a fixed price multiplier matrix. For the given choice of j this matrix will describe the circular flow of income in the economy and, therefore, the interdependence at the margin of income levels in different parts of the system.[36] Not least, the multiplier matrices characterise the extent to which injections into one part of the system will 'trickle down' to the benefit of others.

The opposite to trickle down is separability. If an economy is totally dualistic, with no connection between, say, its formal and informal sectors, then the matrices C_j will be block diagonal. Or, if one of these sectors generates demands on the other, but not vice versa, then the C_j would be block triangular matrices. Thus the structure of the matrices C_j (and hence the multiplier matrices) indicates the extent to which activities in different parts of the economy are separable. The distinction between formal and informal is only one type of separability which is interesting in this context. Another is that between the public and private sectors, while regional distinctions can also be important in particular cases.[37]

At this point, a word of caution needs to be entered. The multipliers $(I-C_j)^{-1}$ can reveal only as much separability or duality as the underlying classification system will allow. In a SAM framework which recognises only one type of labour, a demand on any part of the system will benefit all households equally to the extent that they are equally involved in supplying labour services. The report on Iran discussed previously could be successful in identifying the duality of the economy and the associated dangers of policy at that time because there was a clear urban/rural distinction throughout every part of the framework. Many recent models have failed to show much effect of policy on income distribution. One reason for this is that the disaggregation of the household sector which they adopt is not carried through with a corresponding and sympathetic disaggregation of factor markets, production activities and commodity accounts.

Whether the assumptions of the fixed price case maintain or not, the equations (7) and (10) yield [p] + [y] -1 independent equations as previously noted so that a third set of [f] + 2 equations is needed to close the system. Equations in this third set are therefore known as the closure rules.

There is a wide range of choice available for closure rules. Typically they specify how each factor market and the capital account of the economy are closed: are wages fixed (absolutely or relative to the cost of living), or does the wage adjust to bring demand and supply of labour into line; is capital fully employed; and is investment driven by savings (foreign or domestic) or does foreign saving adjust to finance investment? Clearly, there is a wide range of choice, the exercise of which goes outside the domain of the SAM framework and into general macro-economics. As such, these are not matters to be pursued here beyond one final point.

It has already been noted that the price equations (7) are linear homogenous. So too are the row balance equations (10). Consequently, if all the closure rules are formulated as linear homogenous equations in y, p, f and λ, then the system overall will not solve. Therefore at most [f] + 1 of the closure rules can be linear homogenous equations in the system variables. By the same token, at least one closure rule must not be linear homogenous. Usually it takes the form of setting some particular price as numeraire for the system as a whole.

To bring this discussion to a close, we can note that our treatment has shown that the SAM framework will structure any particular theoretical formulation into three parts: (i) a demand side, which shows the interdependence of the economy and, for example, its dualities and the way in which production structure and income distribution are interconnected; (ii) a supply side, showing how commodity prices are determined so as to clear markets; and (iii) a set of closure rules. Since every model has its own SAM framework, every model has this structure. Accordingly, the proposition that for every model there is an associated SAM is now seen to have the corollary that every model has this three-part structure.

V The SAM approach to modeling

Having discussed at some length the use of a SAM as a framework for both data and theory, it is now time to bring these two uses together and explore some implications of adopting the SAM as the common element in an integrated approach to quantitative modeling. The starting point for doing so is Figure 2.

Figure 2 shows, in schematic form, a SAM perspective on model construction. Briefly, it starts with an initial SAM framework leading to two parallel lines of development. The framework implies a scheme such as in Table 1, but with detailed disaggregation within each block of accounts. The development on the data side is to calibrate this SAM, i.e. to use the framework to organise data and to resolve discrepancies in the numbers. The corresponding development on the conceptual side is to formulate a model of behaviour for each cell of the SAM, i.e. a set of equations (6) (the TV form).

The formulation of behaviour and calibration of the SAM are not independent activities. Lack of primary data sources or weaknesses in them will encourage the adoption of a relatively simple and aggregative SAM framework. Against this, theoretical considerations will often tend to argue for detailed disaggregations and particular conceptual distinctions to be made. Invariably some iteration and compromise is needed, and this is reflected in Figure 2 by the broken arrows leading back from formulation and calibration to the initial framework design. When this process of iteration is complete a SAM framework will exist with the SAM itself in two versions, one showing a specification of behaviour in TV form, and the other, corresponding to it, a balanced set of data recording the value for each type of transaction for some base period. Figure 2 then shows these two versions of the SAM being brought together for model calibration. This then leads to analysis as the final step in the approach.

The model for Iran discussed in section 2 above can be regarded as an early prototype for the SAM approach as illustrated in Figure 2. However, this was essentially a fix-price model in which the formulation of closure rules was of the simplest type (both factor prices and the exchange rate were assumed given) so that model calibration could follow more or less directly from that of the SAM with no extra data being needed to estimate elasticities, for example. The two elements of Figure 2 labelled 'Formulation of closure rules' and 'Estimation of non-distributive parameters' were therefore missing in one case and embryonic in the other. Accordingly, it was not until the pioneering work of Arne Drud and Wafik Grais on Thailand that the first worked through example of the SAM approach as envisaged in Figure 2 became available.[38]

Between these studies of Iran and Thailand there were a number of important contributions in the general field of modeling and those concerned with developing countries have been reviewed by Erik Thorbecke using the SAM framework as an expository device.[39] Since then, two general texts on the use of macro-economic models have reviewed the scene. Both included some reference to the use of SAMs.[40] However, the exposition is restricted in both cases to the role of (rather primitive) SAMs in sorting out data and hence model calibration. The idea of using a SAM as a conceptual framework in which to express theory is missing.

This question of the relationship between SAMs and models has several aspects to it. It has already been noted that for each model there is a corresponding SAM. The converse does not hold, however.

For any given SAM there is a variety of possibility models. The choice of SAM restricts the choice of models, but it does not determine it uniquely.

The process of designing a model can usefully be divided into three stages for our present purposes. At the first stage comes the choice of what the model is to be about: what institutions are to be recognised; is it important that asset holding or flow of funds be modelled;[41] what disaggregation of factors, activities and commodities is needed? It is this part of the model design which determines the SAM and is uniquely determined by it. Within the framework which is developed at this stage, there is complete flexibility as to TV specification at the second stage; and complete flexibility again at the third stage in choice of closure rules.

It seems that one of the advantages of the SAM approach is in emphasising this first stage of model design, i.e. the choice of classifications and those aspects of the macro-economy which are considered relevant for the purpose at hand. These matters receive far too little attention in the literature. Unfortunately, however the subject is a big one and it would add greatly to the length of this essay if we were to explore it here in any depth. It must therefore suffice for now to mention two points.

Firstly, as has already been stated, systems of classification are not independent. The choice of commodity disaggregation should not be independent of the way in which activities are grouped.[42] In turn, the grouping of activities should not be independent of the disaggregation of factors and institutions. The fineness of texture which any model can provide in analysing one part of the economy is governed largely by the courseness of treatment elsewhere in the system. This is a direct consequence of the interdependence implicit in the circular flow of income. Within the SAM approach, therefore, the emphasis must be on sustaining a fineness of classification throughout, and in trying to avoid any uneveness in this regard.

Secondly, it can be suggested that the choice of classifications is not simply a question of detail but also of concept. Discussion of this matter in the context of SAMs goes back to the argument in Pyatt and Thorbecke (1976) in favour of approaching income distribution in terms of a household sector disaggregated into socio-economic groups, rather than by income level. There are several reasons for this preference. The one to mention here is that, while the income classification criterion evidently maximises the extent to which income distribition ex post is captured between classes, this is not necessarily the most useful or powerful taxonomy to adopt for the ex ante analysis of changes. In this latter context, homogeneity of behaviour and of interests among groups is potentially a more powerful basis on which to build than the homogeneity of income. Not least, the classification of households into 'segs' (socio-economic groups) relates naturally to ideas about labour market segmentation and communities of interest in relation to them. This is illustrated by the study of Malaysia reported in Pyatt and Round (1984) in which no fewer than 48 different labour types were juxtaposed with 36 different types of household. One finding to emerge from this detail was that race had little or no power in explaining earnings differentials in Malaysia, once education and location (rural vs urban) were taken into account.

Following on from the initial design of a SAM, Figure 2 shows that the next stages in the approach are quantification of the SAM on the one hand, and the TV formulation of behaviour on the other. The subsequent step is then to calibrate the TV specification.

It would, of course, be possible to contemplate the simultaneous estimation of a SAM and model parameters, with full consistancy between the two.[43] However, it is much simpler to proceed sequentially, first quantifying and balancing out the SAM, and then proceeding to calibrate the TV specification with numbers which are taken over directly from the numerical version of the matrix. Every datum in the matrix is useful from this point of view: the functional forms (3) for each t_{jk} can be calibrated in every case so as to reproduce exactly the actual value estimated for the base period.

The above describes the method of calibration which is adopted by most, if not all, the examples of the SAM approach reported in this volume. It can be criticised and, indeed, has been in a recent essay by Bell and Srinivasan on the grounds that the method is inefficient.[44] Against, this, three points about the process should be noted. Firstly, this is a very simple method of calibration. And the parameter values which it yields need to be complemented by others, referred to in Figure 2 as non-distributive parameters, in order that model calibration should be complete.[45] Secondly, since the model will normally be regarded as a description of equilibrium positions for the economy, the SAM used as a base should correspond to this, either by an appropriate choice of base year for calibration or by deliberate adjustment of the base year data so as to more nearly represent an equilibrium situation. And thirdly, it follows directly from the method of calibration that the model will exactly fit the data, i.e. it will fit exactly to the quantified SAM for the base period. Indeed, once the SAM is quantified, calibration of the model to reproduce the base period is an immediate and simple step: there is no need for protracted 'tuning' to ensure that the model passes through the base period data point.

This is a great saving in effort. Another, more subtle advantage of the approach is that it guarantees at least for the base period values of input data, that the model has a solution. This does not guarantee that there will always be a solution but it does guarantee against there never being a solution. And it provides a natural starting point for the search for a new solution when the model is perturbed from its initial, base-year configuration.

A further advantage of the approach is that it lends itself to replication. The description of what the model is about is conveyed through the design of the SAM framework. Its TV formulation and calibration is then uniquely defined by specifying a form of equation (6) for each non-zero element of T, and a number, t^{o}_{jk}, for the value of receipts of j from k in the base period. The only extra information which is then required is a set of non-distributive parameter values, on the one hand, and a set of closure rules on the other.

These advantages of the approach have been neatly encapsulated by Arne Drud in a software package known as 'Hercules'. The input requirements of Hercules correspond closely to those we have been discussing. First, Hercules needs to be given a SAM design, i.e. a listing of all the accounts which the model requires. Next, this design must be calibrated, and Hercules will check that the numbers provided do in fact satisfy condition (2).

The third step is to give Hercules the TV specification of the model. Hercules has a menu of admissible functional forms from which items can be selected such as 'Cobb-Douglas', 'fixed coefficient in real terms (Leontief)', 'linear expenditure system' or 'CES'[46]. The system imposes some checks on the selections made and then proceeds to request values for all non-distributive parameters that are involved in the specification.

The final steps are then to impose closure rules and to specify the scenarios or model runs that one wants to explore. The results are output by Hercules as the new SAMs which are generated by the scenarios specificed.

Hercules is a very powerful tool which renders the specification and computation of computerised general equilibrium models (CGEs) a relatively simple and straightforward task. Indeed, it is probably wrong to think of Hercules simply as a way of constructing a specific model. Rather, the package is better thought of as a modeling capability. If some elements of the data SAM are changed, Hercules will immediately recalibrate the model and hence show how this affects results. Much the same is true if a non-distributive parameter is changed; or if there is a change in TV specification or closure rule. Within the Hercules sytem it is simple and straightforward to make any such changes and to explore their consequences. It offers a way, therefore, of exploring the robustness of results. And this is important if only because, otherwise, the very power of the system makes it potentially dangerous. A word of caution is therefore in order at this point.

Bell and Srinivasan, in the essay previously referred to, have argued strongly that CGE models have inherent weaknesses which caution against taking their results too seriously. The strength of such models, they suggest, is in describing economic interdependence and the price structure of an economy. They are less useful in attempting to explain either short term adjustment or the evolution of long term structure and technology. At the risk of oversimplifying their argument, the position taken by Bell and Srinivasan can be characterised as suggesting that the current state of CGE model building is weak on dynamics and the specification of closure rules. Its strengths lie in those areas where the SAM approach is most supportive: the design of a framework (with interesting disaggregations); the representation of interdependence (not least that between income distribution and production structure) through row summation equations; and the structure of prices, through column summation of the TV formulation. And if these are the strengths, then the weaknesses are also evident. The approach is comparative static and it is agnostic on the question of how factor markets behave and other aspects of the closure of the system.

VI Where to from here?

To the extent that this essay is an attempt to go beyond a description of what SAMs are and where they come from, the hope has been that the SAM framework, and the approach which emanates from it, can emerge as a useful way of setting out problems which require a particular concern with economic structure. Specific concern for poverty, employment or income distribution are, therefore, not essential to the design of a SAM or pursuit of the approach. It is rather the case that, once upon a time, these motivations were critical to the initial development of the ideas reported in this paper. And since these human issues ultimately cannot be avoided now or in the future, it seems that, like it or not, SAMs will be with us for some time to come. Indeed, in pushing forward on the question of how the human aspects of development should be related to economic and financial policy, the work on SAMs may have already been serving some purpose in keeping people and their condition on the agenda at both national and international levels. It is one thing for politicians to articulate general concern for this group or that within a society. It is quite another to have economists formally analyse the role of different socio-economic groups in such terms as the importance of relative performance to the well being of each other, and the way in which policy impinges differentially on their individual circumstances. SAMs have proved to be powerful tools in this context and, if only for that reason, it is likely that they will continue to be invoked.

The point has been made previously that, in bringing employment and income distribution questions into the framework of the national accounts, the development of SAMs has realised a synthesis between the UN SNA and the Systems of Social and Demographic Statistics (SSDS) for which the ground was already well prepared in the original conception of each. A particular development for the future is to envisage this synthesis being taken much further, to the point where household surveys are designed and tabulated expressly with a view to integration of the results with the impersonal economic aggregates.[47] The data base for quantifying that part of the circular flow of income which runs from factor income to households and, hence, to consumption expenditures and savings, is very weak. Initial work on how this should be approach has already been undertaken.[48] For the future we have the prospect of taking this much further. And if this should indeed materialise, then the micro-data base for households could play a leading role in the evolution of economic statistics.

Such a development would encourage the hope that a prospective trend for the future might be an increasing integration of SAM calibration into the work of government statistical and planning offices. However, an important consideration which will mitigate against such a trend is the fact that no two SAMs seem to be alike. While government statistical offices favour standard systems of classification, the tendancy in SAM compilation so far has been towards a healthy non-conformity. This is largely due to the fact that SAMs have been compiled for widely different purposes which often go beyond the objectives of those who construct the national income accounts. Undoubtedly the most important reason to date has been the concern among the non-conformists over questions of income distribution at the factorial and household levels. But there are other reasons also, including the interest of SAM-based modellers in the economic duality which characterises so many developing economies, yet receives no consideration at all in the 1968 SNA. Similarly, official statisticians seem to be unaware of the important distinction between traded and non-traded goods despite the fact that, for economists interested in realignment of the exchange rate, the distinction is crucial.

Little has been said in this essay about the classifications for commodities, factors, institutions and activities which might be adopted in particular contexts. This is a pity since the subject is important. But, as previously noted, to enter into it here would take us too far away from the main themes. We can note, however, that while general principles can be suggested in this area, the arguments ultimately move away from supporting any universal taxonomy to be applied in all countries. Given the force of international statistical conventions, such resistance to standardisation may constitute grounds for questioning whether there will indeed be any significant trend towards the integration of SAM calibration into the work of government statistical offices. The matter must depend in some degree on the recommendations to be made eventually for changing the 1968 SNA. Based on my own experience of SAM compilation, I would hope that these revisions might take into consideration three basic factors.

Firstly, information technology is changing rapidly, so that it is much easier now to envisage micro data sets as being readily accessible and the primary data source for a variety of applications. The current dependence of analysts on secondary sources could therefore be greatly diminished.

Secondly, two things would seem to follow from this. One is that a series of definitions and standards are needed so that different micro data sets can be compared, and consistency of concepts encouraged: as the major statistical compilation for any country, the national accounts have an important role to play in setting these standards. The other is that, while different micro data sets may be conceptually consistent, it is inevitable that numerical inconsistencies will arise between them. Accordingly it will be important to develop formal techniques of data reconciliation.

My third consideration is that alternative versions of the national accounts, i.e. alternative SAMs, are likely to be needed for different purposes. It will, for example, be important to include detailed flow-of-funds statistics for some purposes but not for others. Similarly, alternative levels of aggregation are appropriate in different instances. More radically, entirely different schemes of classification may be needed for a variety of different ends. It is not necessarily appropriate therefore to think of the national accounts as being underpinned by one very large SAM which can be aggregated-up in different ways for different purposes. A more useful conception may be that of a range of alternative SAMs for alternative purposes, all emanating from a common but numerically inconsistent micro data base.

A major extension of the SAM shown as Table 1 remains for future implemenation. It concerns the addition of asset accounts (including an account for money) to those which are already presented. The 1968 SNA has anticipated this development although its practical application has hardly begun for most countries. This development, going way beyond the introduction of flow-of-funds in the complexities it entails, will only serve to strengthen the need for any revision of the SNA to recognise both the variety of achievement and capability in statistical offices around the world and also the multitude of different purposes in support of which the articulation of the micro data base should be encouraged by setting appropriate standards and norms.

These considerations are likely to be crucial in determining the natural direction of development for economic statistics in the future. SAMs in general will be supportive of these developments. The particular question which arises is whether the current revision of the SNA will flow with this tide.

Finally, in the field of modeling, there are two developments which are already underway. Firstly, the rigorous framework provided by the SAM approach encourages further extension of the menu of relationships which can be treated within the TV specification. Most importantly, the formulation of regime switching as when, say, imports switch from being price constrained to being quantity constrained by a quota, is likely to be endogenised in the very near future.[49] And, secondly, it seems to be likely also that SAMs will very soon start to be applied to multi-period problems. The current restriction to comparative statics inevitably implies that the treatment of investment in SAM-based models is rudimentary. I am sure that this will change and that, for the future, SAM-based modeling will develop not only through inter-temporal recursive behaviour, but also to allow optimisation as well.

While these likely developments are potentially most welcome, it must also be acknowledged that, as discussed in section 4, they leave outstanding the critical difficulty over closure. And to the extent that this is the essence of macro-economics, the deficiency is serious. But it can also be argued that to acknowledge this deficiency is really no more than to recognise a boundary of the SAM-approach, rather than a weakness within it. The pioneering work of Leontief, Stone and Chenery on input-output analysis and economic structure can be carried forward within the SAM approach to include more powerful and flexible formulations of the issues which concerned them, and which continue to concern many economists today. Indeed, it has been a major objective of this essay to show that these issues can be promoted within the SAM approach to arrive at a natural interface with main-line macroeconomics, viz the point at which a specification of closure rules is required. In arriving at this point the SAM approach has perhaps already come a long way towards achieving its initial objective, which was to show how questions of structure and macroeconomic policy might relate one to the other and not least the effects of such policy on living standards and income distribution. Empirical results to date are limited, but these are likely to accumulate more rapidly in future as we become clearer about the approach itself. As Figure 2 shows, the SAM approach to modeling requires important inputs from elsewhere both as to parameter estimation and closure rules. And there is always a need for improved specification, based on better understanding, within the TV formulation itself. The approach is useful only in relation to some aspects of modeling, not all. But it is useful, nontheless, and it may be appropriate to end this section with some thoughts on how the SAM appraoch, articulated through Hercules, might best be used in practice.

Given that the objective is to understand a particular economy, the starting point is to design a SAM which, through appropriate choice of classifications, can capture the important chracteristics of the economy and the problems which it faces.

The next task is to then quantify this SAM so that the overall conceptualisation which is expressed by the design can be confirmed and enhanced by formal empiricism. Experience suggests that, by this stage, one will know a great deal about the economy itself and about the quality of available data on which subsequent analysis can build.

The third step is to set out a very simple TV specification and to explore the multiplier structure which it implies. Such fixed price multipliers can usefully be interpreted from two perspectives. One is the perspective that these multipliers represent a very simple model of how the economy works, and the results can be checked to ensure that the system of classifications initially adopted will, in fact, allow important dualities to emerge. Such investigation may give cause to go back and change some part of the initial SAM design.

The other perspective from which to view the results of a simple multiplier analysis is to interpret them as the results of a counterfactual conditional experiment: if the assumptions of this simple model were correct, then the multipliers would show how the economy would have behaved. Observed departures from this behaviour then provide a measure both of what has been achieved (say, with reference to import substitution) and which parts of the simple model specification should be changed (for example, to move away from fixed import propensities and allow them to be price sensitive).[3] Similarly, by analysing the price structure of the economy, changes in internal and external terms of trade can be identified, together with effective rates of protection, etc. Such an approach can lead not only to improved TV specification, but also to policy insights which derive from the appreciation of economic structure which the approach will afford. A spin-off at this point will be an identification of crucial parameters for the system which may, therefore, require more careful econometric estimation.

Only at this point would it seem useful to venture into experiments with alternative closure rules. And the spirit here, I suggest, should more often be one of exploring trade-offs under alternative closures, rather than to pin one's faith entirely on a particular set of assumptions.

This essay started with the proposition that economics is poorly endowed, having only one fundamental law. As an efficient expression of that law, the role of SAMs is no more or less than to help economists exploit this meagre inheritance.

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FOOTNOTES

1 'What is a SAM?' is the title of an essay by Ben King which was written as an introduction for economists without specialised interest in the subject. This essay has been widely disseminated as a World Bank Staff Working Paper (# 463) and is now published, as originally intended, as Chapter 1 of Pyatt and Round (1985).

2 I have been under the impression for some time that this proposition was first enunciated by Lord Keynes. But I have so far failed to find a reference and would be grateful for any help.

3 Adelman, Taylor and Vogel (1987) provide an excellent illustration of this flexibility.

4 It has been suggested that the earliest examples are from Norway and the Netherlands and date from before the Second World War.

5 See Cambridge, Department of Applied Economics (1962-74) for the early work of the Growth Project, and UNSO (1968) for the final version of the SNA.

6 These estimates were presented in a government White Paper titled 'An analysis of the sources of war finance and an estimate of the National Income and Expenditure for 1938 and 1940'. See United Kingdom, Treasury (1941).

7 See UNSO (1975).

8 This is to be expected, not simply because both sets of publications emanate from the United Nations Statistical Office, but also because Stone was the main architect of both.

9 Stone's essay is in fact titled 'The disaggregation of the household sector in the national accounts'. It is published as Chapter 8 of Pyatt and Round (1985).

10 It is unfortunate that much of Seers' writing in this field has never been finally published. His critique of the 1968 SNA is available only in mimeograph (Seers (1975)), while the only source I know of for his work on Zambia is Frank (1967).

11 Seers ultimately became disenchanted with the possibility that the national accounts would evolve to the point where they would adequately reflect the primary importance which he always placed on people. This was largely because of the inadequacy in his view of income as a measure of living standards. Instead he turned his attention to active life profiles as described in a paper titled 'Active life profiles for different social groups' which was published as Chapter 25 of Syrquin et al (1984) together with an appendix by Stone which sets out the mathematics of the relationship between these profiles and the transition matrices which are at the centre of the SSDS.

12 This evidently was sufficient reason for Gregory King however, whose work, together with that of Sir William Petty, represents the earliest attempts to measure national income. His contemporary estimate of the national income for England in 1688 is built up via estimates of the incomes of each of 22 socio-economic groups. King's main results are reproduced in tabular form in Pyatt and Round (1985).

13 The report was published as ILO (1970). Thorbecke and Sengupta (1972) was an attempt to provide a macro consistency check on its findings.

14 The model was constructed by S. Narapalasingham as a Ph.D. thesis under the supervision of Alan Brown. See Narapalasingham (1970).

15 The mission had the benefit of collaboration with Abdul Meguid who, at that time, was World Bank country economist to Iran. It was largely due to his earlier efforts in Sri Lanka that Narapalasingham had been able to develop a data base to support his model.

16 The macro-modelling exercise which was undertaken for Iran (Pyatt et al (1975)) has never been formally published. However, Clarke discusses this work at some length in Chapter 5 of Blitzer et al (1975). A brief review by Thorbecke is included in Chapter 10 of Pyatt and Round (1985).

17 The report stated that 'Undoubtedly our most important conclusion regarding economic policy in Iran relates to the performance of the livestock and agricultural sectors ... the potential contribution of agriculture to the general development of the economy is very great ... for Iran to ignore these sectors could be disastrous.'

18 Pyatt and Round (1977) discuss problems of quantifying the data SAM for Iran as well as those for Sri Lanka and Swaziland which are discussed below.

19 It is discussed by Stone in his foreword to Pyatt and Roe (1977).

20 The problem is discussed at some length in the editors' introduction to Pyatt and Round (1985).

21 See Byron (1978).

22 An alternative approach to that of Byron (1978) is to set the problem in a (non) linear programming context by using primary source data to set bounds on the true value of numbers. This is potentially more attractive to practitioners as a way of specifying the (un)reliability of primary data and, incidentally, makes it easier to retain zero's and any other fixed magnitudes for the final SAM.

23 'A social accounting matrix for Swaziland 1971-72' by Webster is Chapter 5 of Pyatt and Round (1985), and 'A social accounting matrix for Botswana, 1974-75' is described by Greenfield in Chapter 6. The work on the Muda region by Bell and Devarajan is published as Chapter 11.

24 They are also discussed by Roe in Chapter 3 of Pyatt and Round (1985).

25 See Pyatt and Round (1984).

26 See Ahluwalia and Lysy (1979).

27 In addition to the treatment in the original source, this aspect of the work is discussed in Chapter 4 of Pyatt and Round (1985).

28 These terms are defined in UNSO (1968). Their exact interpretation is not important here.

29 Pyatt (1985) sets out these conditions and extends the analysis of Pyatt and Round (1984).

30 See Keuning (1985) and Jakarta, CBSI (1986) for details of the work on Indonesia.

31 The early modelling work on Thailand is described in Drud and Grais (1983), and Amranand and Grais (1984). The underlying work on SAM calibration is reported in NESDB (1982).

32 This has been set out previously in King's introductory chapter to Pyatt and Round (1985).

33 Consolidation is a basic accounting operation which involves simply the aggregation of two or more accounts, and then setting to zero the value of any transactions between them.

34 See Drud, Grais and Pyatt (1983) for an early statement of the approach. A more recent and extended exposition is to be found in Drud, Grais and Pyatt (1986).

35 Analysis of such interdependence has been carried furthest in Defourney and Thorbecke (1984).

36 See Pyatt and Round (1979) for a discussion of these multiplier matrices. This paper is reproduced in Pyatt and Round (1985) together with an interesting contribution on the decomposition of multiplier matrices by Stone (chapter 8).

37 As a third example, I am currently engaged in a study which involves designing a SAM framework for analysis of interdependence between public and private enterprise.

38 This work was first published as Drud and Grais (1985).

39 See Chapter 10 of Pyatt and Round (1985). The most notable contributions were those of Adelman and Robinson (1978) and Taylor et al (1980).

40 See Dervis, de Melo and Robinson (1982) and Taylor (1979).

41 Ahluwalia and Chenery evidently thought it was if one is to take the evidence of their chapter 'A model of growth and distribution' in Chenery and others (1974).

42 Pyatt (1985) is a recent discussion of the classification of activities and commodities.

43 Michael Hartley has some interesting unpublished material on this.

44 See Chapter 20 of Syrquin, Taylor and Westphal (1984).

45 The term 'non-distributive parameters' is used to reflect the fact that the SAM can be used to calibrate all average propensities (the matrix A) as at the base date. Within the endogenous part of the matrix, then, the parameters which have to be calibrated using additional information are typically substitution and income elasticities.

46 Current versions of Hercules allow a choice among some 20 alternative functional forms.

47 Such a development was to the fore at the World Bank when the Living Standards Measurement Study was originally launched, as explained in Chander et al (1980).

48 See Grootaert (1982). Additional unpublished work has been prepared by Louis Fox and Boris Pleskovic.

49 The ground for such a development has been prepared by Grais et al (1984).

50 Roe (1986) reports the use of such an approach in analysing structural adjustment in Kenya during the 1970s.

Table 1 : An aggregate SAM in schematic form

			1	2	3	4	5	6	
			Institutions		Production			Rest of the World	Totals
			Current	Capital	Factors	Activities	Commodities		
1	Institutions	Current	Current transfers	0	National Product x	Taxes on activities	Taxes on commodities	Current transfer receipts from abroad	Aggregate income
2		Capital	Domestic savings	Capital transfers	0	0	0	Capital transfers from abroad	Investible funds
3	Production	Factors	0	0	0	Value added x	0	Factor income from abroad	Aggregate factor income
4		Activities	0	0	0	0	Gross outputs	0	Value of output
5		Commodities	Consumption	Fixed capital and stock formation	0	Purchases of raw material	0	Exports	Aggregate demand
6	Rest of the world		Current transfer payments	Capital transfers abroad +	Factor income paid abroad	0	Imports	*	Foreign exchange payments
Totals			Aggregate income	Aggregate investment	Aggregate factor income	Total costs	Aggregate supply	Foreign exchange receipts	

x net of taxes on activities

+ including the increase in reserves

Table 2

A very simple Keynesian model

			1	2	3	4	5	6
			Institutions		Production			Rest of the World
			Current	Capital	Factors	Activities	Comm-ofities	
1	Institutions	Current	A	O	Y	..	..	..
2		Capital	S	B	O	O	O	F
3	Production	Factors	O	O	O	Y	O	..
4		Activities	O	..	O	O	R	O
5		Commodities	C	I	O	Z	O	X
6	Rest of the World		..	..	..	O	M	*

Figure 1

The circular flow of income

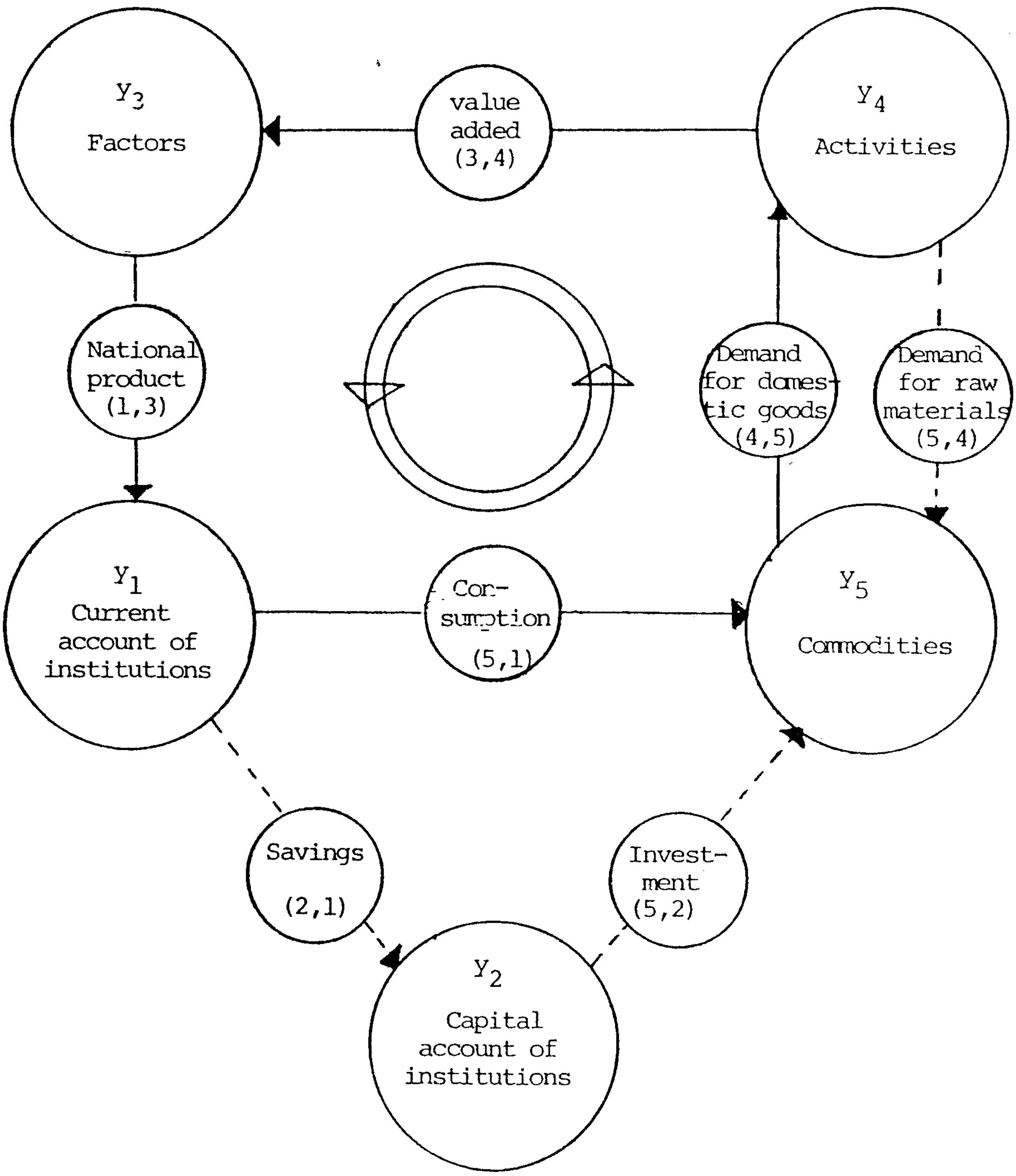

Figure 2

The SAM approach to modeling