COMMODITY BALANCES AND NATIONAL ACCOUNTS: A SAM PERSPECTIVE

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This paper is concerned with the treatment of commodity and activity balances in a national accounts context. It makes use of a general method for reducing the size of a social accounting matrix (SAM) by apportioning the elements of one or more accounts to the rest. The national accounts are looked at in terms of their usefulness for policy analysis, not least analysis of the impact of price changes. The SNA convention of separately distinguishing activities and commodities is endorsed. However, in contrast to the SNA, it is argued that for analytic purposes commodity transactions should be recorded at market prices, with a separate account for each of the markets for a given commodity in which a distinct price prevails. The SNA SAM is shown to be a reduced form of the SAM resulting from this recommended treatment of commodity transactions, while a further round of reductions (apportionments) yields SAMs which are familiar from input-output analysis, in which activities and commodities are not separately distinguished. It is argued that no special effort would be required to produce SAMs in which commodity balances are recorded at market prices as recommended here (the necessary data are also required to produce the conventional SNA tableaux), and that all reduced form versions of such SAMs, including the SNA, are inferior as a basis for the analysis of price effects on the structure of production.

1. INTRODUCTION

The first objective in this paper is to set out, in schematic form, a social accounting matrix (SAM) tableau for the representation of commodity balances in an economy, and to discuss appropriate criteria for classifying activities and commodities within such a framework.

A second objective is to present a mathematical technique which eliminates a subset of the accounts in a SAM and proves to be an interesting way of reducing its size, in the sense that it formalizes methods commonly adopted in practice.

These two elements of a data framework and a mathematical technique are brought together by applying the latter to the former at two levels. To begin with, it is shown that the SAM framework promoted as the UN System of National Accounts (SNA)[1] can be obtained by reducing the data framework which is initially presented here. Accordingly, the SNA SAM can be described as a reduced form of the SAM which provides the starting point for discussion in this paper. It is then shown that, by a further stage of reduction, tables can be obtained which show commodity balances and interindustry relationships on either a commodity $\times$ commodity or an industry $\times$ industry basis, thus eliminating the extra details which are necessary when commodities and industries are separately distinguished.

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[1]See UNSO (1968).

In demonstrating how the SNA format can be obtained mathematically from the SAM initially presented, it is by no means implied that this step is to be encouraged. On the contrary, the spirit of the discussion is that the SNA format and, in particular, the approximate basic price structure adopted there for presenting commodity balances, implies a very special mathematical structure or economic model. Some of its implied ambiguities in the measurement of price effects have been discussed by Greenfield and Fell (1979). Here, two consequences of assuming this model can be noted. One is to cloud commodity balances in a mystique which reduces their intelligibility; and the other is to yield a derived set of data which cannot support analysis of problems which are assumed away by the highly specialized economic theory which alone justifies the SNA construct. These problems center around import substitution, economic duality and the deepening of the industrial structure, all of which are important characteristics of economic development. The argument, therefore, is that the SNA format encourages national income statistics in a direction that is not only unnecessarily complicated but also counterproductive from the perspective of economic analysis for developing countries. In promoting a reduced form SAM, the SNA encourages loss of important information on structure.

2. Accounting for Commodities and Activities

2.1. *The Basic SAM Framework*

The SAM which provides the starting point for discussion in this paper is set out in Table 1. It follows the SNA in distinguishing separate accounts for production activities (industries) and comodities, and also has a detailed set of accounts for indirect taxes (and subsidies) on commodities. All other accounts are consolidated into a single acocunt since their detail is not important for

TABLE 1

A Schematic SAM

		Expenditures					Totals
		All Other Accounts (Consolidated)	Indirect Taxes on Commodities	Production Activities	Commodity Markets: Primary	Commodity Markets: Higher Level	
Receipts	All other accounts (consolidated)	0	y'_t	v'	m'	0	y_0
Receipts	Indirect taxes on commodities	0	0	0	0	$T_{t,h}$	y_t
Receipts	Production activities	0	0	0	$T_{a,p}$	0	y_a
Receipts	Commodity markets: Primary	f_p	0	0	0	$T_{p,h}$	y_p
Receipts	Commodity markets: Higher level	f_h	0	$T_{h,a}$	0	$T_{h,h}$	y_h
Totals		y_0	y'_t	y'_a	y'_p	y'_h	—

present purposes.[2] A difference from the SNA which is important is that all commodity transactions are recorded at purchaser (market) prices.

Since "All Other" is a single, consolidated account, its total income, y_0, is a scalar. This is made up of three types of elements: (i) the total revenues from various types of commodity taxes, recorded in the row vector y_t'; (ii) the value added of the various production activities, recorded in the vector v' and defined to include taxes on activities; and (iii) the value of imports of various commodities as recorded in the row vector m'.

Because Table 1 is a SAM, corresponding row and column totals must be equal. For the "All Other" account, the column details of matching expenditures are simply final demands for commodities, which are here split as between primary commodities, the column vector f_p, and higher level commodities, the column vector f. The nature of this split in commodity accounts is crucial in what follows.

As can be seen from the fourth column of Table 1, primary commodity markets are supplied by imports, m', and by the outputs of domestic production activities as given by the make-matrix $T_{a,p}$. In aggregate, these supplies yield totals, y_p', which are sold either to meet final demands, f_p, or to higher level commodity markets, $T_{p,h}$. Note that there are no sales from higher level commodity markets to the primary level, and that output of domestic production activities is sold only to primary markets.

As shown by Table 1, the higher level markets buy from primary markets and these transactions are recorded in $T_{p,h}$. Sales by the higher level markets are sales to final buyers, f_h; to production activities, (i.e. intermediate demand), $T_{h,a}$; and to each other, $T_{h,h}$.

This apparently elaborate scheme of commodity accounting is necessary to provide a SAM which adheres to the rule of having a separate account for each market in which the price of a commodity is different. Since there can be wide variations in commodity prices across markets, a single account for each commodity will not suffice, and several may be needed.

A simple example which illustrates the SAM framework in Table 1 relates to the case of a fisherman who retains some of his catch for home consumption and sells the remainder at the quayside to a trader, who subsequently sells it in distant markets. These distant markets constitute the higher level market(s) for fish: the quayside is the primary market in this case. Thus the fish retained for home consumption, valued at the quayside price, is recorded as an element of f_p, while the sale of the remainder is recorded in $T_{p,h}$. Buying this remainder is not the only cost for the trader. He must also provide distribution and transport services to move his fish to distant markets. These costs will also be recorded in $T_{p,h}$ or in $T_{h,h}$, depending on whether they are purchased from primary or higher level markets. The resulting total costs of the higher level market for fish are then matched by final or intermediate sales, recorded in f_h and $T_{h,a}$, respectively.

This example serves to illustrate that the role of primary markets is to buy the outputs of domestic and foreign production activities at their point of origin within a country, and to sell these to any buyers at that point, but otherwise to

[2]I have written elsewhere with various collaborators on how these other accounts might be treated. See for example, Pyatt and Round (1977), Pyatt, Roe and associates (1977) and Pyatt and Thorbecke (1976).

simply make these outputs available as commodity supplies to the higher level commodity markets. The role of the latter is then to bring these primary commodities to market(s) and otherwise reconstitute them as available supplies to be bought at market prices.

Clearly, there can be numerous different commodity market accounts in Table 1 and, in particular, the number of such accounts is likely to exceed the number of production activities. This is partly because it would be conventional to think of $T_{a,p}$ as a square matrix on the understanding that there are equal numbers of primary commodity markets and production activities; and partly because there may be a hierarchy of higher level markets for any given commodity. The guiding principle here should be to recognize a separate commodity market wherever distinct prices maintain. For example, the export and home markets for a commodity may require separate higher level accounts.

2.2. *The Classification of Commodities*

The schematic treatment of commodity and activity accounts as shown in Table 1 is implicit or explicit in the worksheets of national accountants using the commodity balance method. Primary data on final demand (f_p and f_h) and intermediate purchases by industries, T_{ha}, are obtained in purchaser prices. The proposal here, therefore, is to set out these data as such, distinguishing as separate commodities goods and services which are physically the same but sold at different prices in different markets. Similarly, import data can be obtained in standard ways, while the sales of output by production activities are naturally recorded at ex-factory prices, thus providing the details of the make matrix $T_{a,p}$.

The various goods and services that the economy produces, as recorded in $T_{a,p}$, and those imported, m', constitute total supplies of primary commodities, y'_p. In general it is useful for subsequent domestic analysis and international comparisons if the classification of these supplies follows the SITC. Otherwise, use of standard international classifications is not at a premium in designing the SAM, relative to the importance of describing the domestic economy in ways that are useful for domestic analysis.

Within the primary commodity classification, the amount of detail which it is useful to retain must be a matter of judgement. However, it is helpful to distinguish goods and services which are only produced domestically (non-traded goods) and those which have to be imported because there is no domestic production capacity. This leaves a third category of goods which are imported, but for which domestic substitutes are available. These need not be perfect substitutes, of course, and one of the important recent innovations in trade analysis has been to develop methods for handling various degrees of substitutability,[3] thus breaking away from the straitjacket of extremes prescribed by the dichotomy between (perfect) complements and (perfect) substitutes.

Primary commodities are all sold to higher level commodity accounts except in so far as they are not subject to tax, packaging, transport, distribution, etc. Hence the final demand for primary commodities will be restricted to items such

[3]The best known source for this is Armington (1969).

as rice which the grower retains for personal composition, or imports which simply add to stocks.

Typically, then, primary commodities are sold to higher level commodity markets where they are, in effect, assembled for sale to final buyers. This "assembly" involves payment of any commodity taxes and the combination of primary goods, such as steel ex-factory and transport services, to move the steel to the shipyard, where it is bought as a composite good, ready for use. Thus transport and distribution margins will all feature in the matrix $T_{p,h}$. The matrix $T_{h,h}$ is allowed to be non-zero in the system simply for generality, given the contingency that it may be useful to allow for a hierarchy of commodities, as when a commodity can be sold in one market or, by addition of further transport and distribution services, moved on to another.

The appropriate number and detail of the higher level accounts should derive from the number of primary commodities, statistical convenience, and otherwise from proximate adherence to the rule that different commodity markets should be distinguished as such when they reflect differences in market prices. Thus in defining the classification of the higher level commodity accounts it may be more important to recognise different marketing conditions for physically identical goods than to separately distinguish goods solely on account of some physical differences. By the same token, a strong regional dimension (or simply urban/rural) may be an important feature of the commodity classification. In general, a large number of commodity accounts may be indicated, and there is considerable scope without necessarily reaching the upper bound of several hundred accounts which has been encouraged for many countries via the Japanese tradition in input-output.

The established argument against having large numbers of commodity accounts is in part a matter of what is manageable, and in part a question of the amount of information that can be fitted onto the printed page. Both aspects deserve reconsideration in the light of evolving data storage and processing capabilities, since more detail can now be managed, and the printed table is not the only means of conveying numerical information. To the extent that the SNA reduced form of Table 1 is an ingenious solution to this problem of size, the argument for it is increasingly dated and runs against the emerging trend towards computer storage of micro databases to be accessed directly for whatever purpose is at hand. In the absence of appropriate computing capability, the fact that the commodity balance approach to national accounts requires worksheets that correspond more or less to Table 1 may be sufficient to argue its technical feasibility at a useful level of disaggregation. The fact that the table may be too large to print does not seem sufficient reason for rejecting its preservation as the basic detail on commodity balances.

2.3. *The Classification of Activities*

By convention, the classification of activities is usually based on their principal products, and the detail of the principal products which are recognized corresponds to the detail of the primary commodities which are domestically produced. This has two implications. First, matrix $T_{a,p}$ will be square (if there are no separate accounts for imported goods which are not produced domestically), and it will be dominated by elements on its main diagonal, since the off-diagonal elements will be non-zero only to the extent that an activity produces goods other than its principal product.

There is an important case for having a commodity dimension to the classification of activities. But there is only a weak case at best for carrying this to the extreme of precluding all other classification considerations. This point is conceded most often in allowing that activities might be classified by region as well as by principal product, although there has yet to be a move towards recognizing separately within the accounts those activities which take place offshore or within free trade zones. Yet to do so would typically be convenient for statisticians since they correspond to separate data sources; and it would be most helpful to economists because the quite distinctive technologies and market relationships of such activities could then be recorded as such and analyzed.

More generally, in developing economies, the form of organization is at least as important as the product produced. Plantation rubber or coconuts are very different in their factor demands, input structures and yields when compared with the analogous small-holder sectors. The same can be said for sharecropping versus freehold farming. In services, the modern, formal sector is again quite different from the traditional, informal sector, as it is in industry. The public sector differs from the private and, within the latter, technology often differs between domestically and foreign owned corporations. All these distinctions are easily recognized in primary data sets and therefore could be readily retained in national accounts tabulations. To do so would make the data much more useful and interesting to governments in monitoring development and for policy analysis. The main reason given for not doing so seems to be that it is not recommended in the SNA, which in turn invokes the theory of commodity technology in support of the exclusive use of the principal product criterion. Yet if there is a distinct branch of economics associated with the study of development, it owes much to the recognition of structural duality, which depends a good deal on differences in level of technology, and relatively little on whatever commodities are being produced.

Breaking away from the principal product basis for classification of activities implies that $T_{a,p}$ will no longer be approximated by a square, diagonal matrix. Rather, it will now contain information on the vector of goods produced by each of the plantation sector, modern private industry, public corporations, etc. Hence the role of each of these sectors in development, and in relation to imports, can now be quantified and anlayzed. It is important for managing development to be able to do so, while the formal mathematical modeling of such make-matrices is not a major difficulty. In the simplest case, it is probably less seriously wrong to assume fixed proportions for the outputs of activities defined according to their form of organization, than it is to assume a common input structure for production of a given commodity, irrespective of the form in which production is organized. Less extremely, a blend of commodity produced and organizational form as criteria for classifying activities is clearly superior to present practice, which essentially ignores the latter.

3. Reduced Forms of a SAM

The most common technique for reducing the size of a SAM is to consolidate some of the accounts. This technique has been adopted implicitly in Table 1 by consolidating the detail of all accounts other than those for activities, commodities and taxes on the latter. In this section an alternative way of reducing a SAM is to be explained, and then applied in section 4 to yield reduced form versions of Table 1. This alternative method can be applied quite generally. It formalizes the common accounting practice of apportioning elements of costs (i.e. of expenditures) to other accounts. The method is presented here in the context of Table 2.

TABLE 2

Partitioning of a Suitably Ordered SAM

		Expenditures		
		Accounts of Immediate Interest	Accounts of No Immediate Interest	Totals
Receipts	Accounts of immediate interest	T_{11} $(m \times m)$	T_{12} $(m \times n)$	y_1 $(m \times l)$
	Accounts of no immediate interest	T_{21} $(n \times m)$	T_{22} $(n \times n)$	y_2 $(n \times l)$
Totals		y_1' $(l \times m)$	y_2' $(l \times n)$	

Table 2 sets out a SAM with $m+n$ accounts, partitioned into a set of m accounts which are to be retained, and n accounts to be eliminated by apportionment. Without loss of generality, the accounts are ordered so that those to be retained are leading. It is also useful at this point to define matrices A_{jk}, corresponding to the T_{jk}, by the relationship

(1) $$A_{jk} = T_{jk}\hat{y}_k^{-1}$$

where $\hat{y}_k$ is a diagonal matrix formed from the vector y_k. This implies that elements of A_{jk} are proportions: an element of A_{jk} is given by the corresponding element of T_{jk}, expressed as a proportion of the aggregate of all elements in the same column of the SAM, i.e. as a proportion of the corresponding column sum.

With this notation, the following result describes the reduced form SAM which can be obtained by apportionment:

Result 1: If $B = A_{12}(I - A_{22})^{-1}$ exists, then there exists a reduced form SAM, T_{11}^*, such that $T_{11}^* = T_{11} + BT_{21}$,

where: (i) the row (and column) totals of T_{11}^* are given by y_1 (and y_1'); and

(ii) the column sums of B are all unity.

Proof is omitted in the interest of brevity.

In comment on this result, it is useful to consider first the case $n = 1$, i.e. the situation in which a single account is to be eliminated. In this case A_{12} is a column vector, elements of which add up to $1-a_{22}$, where matrix A_{22} is now the scalar a_{22}. Hence B is simply a column vector, elements of which add to unity (as required by (ii) of the result). Moreover, all elements of this vector will be positive if all elements of A_{12} are positive. So B is simply a vector of proportions in this case, and this vector is proportional to the vector A_{12}.

Similarly, with $n=1$, T_{21} is a row vector. Hence BT_{21} is a matrix which apportions the elements of T_{21} to the first m rows of the SAM, according to the proportions specified in B. Thus the first row of BT_{21} is the row vector T_{21}, scaled by the first element of B. The second row of BT_{21} is the same vector, but now scaled by the second element of B. And so on. It is evident, then, that column sums of BT_{21} are given by T_{21}, while row sums are given by the row sum of T_{21}, multiplied by the appropriate element of B, i.e. by $B(1-a_{22})y_2 = A_{12}y_2 = T_{12}$. It follows that row (and column) sums of T_{11}^* as defined in Result 1 will be y_1 (and y_1'). Matrix T_{11}^* is therefore a SAM.

The above scenario, eliminating a single account from a SAM by apportionment, can obviously be repeated several times so as to remove a set of accounts *seriatum*. Result 2 answers the question as to whether the order in which a set of accounts might be so eliminated makes any difference to the eventual answer:

> *Result 2*: If a given set of n accounts are eliminated from a SAM, then the reduced form SAM so obtained is independent of the sequence of steps involved.

Since the proof of this result is lengthy and the algebra tedious, it is not presented here. However, the result is important because it establishes that a series of n individual eliminations by apportionment yield a final result which is independent of the sequencing of the individual steps. It is this final result, which shows the consequences of apportioning out all n accounts, which is given by Result 1.

4. Reduced Forms of the Basic SAM

4.1. *The SNA SAM*

By applying the mathematics of the previous section to the SAM shown in Table 1 a reduced form SAM can be obtained in which the accounts for higher level commodity markets have been eliminated. This new SAM is shown in Table 3. It is important because the SAM in Table 3 corresponds to that recommended in UNSO (1968) as the basis for international standards, i.e. the SNA.

To interpret Table 3, comparison with Table 1 is useful. This shows that the elimination of the higher level commodity accounts has to involve some accommodation of the previous demands on these accounts, viz the final demands f_h and the intermediate demands T_{ha}. The accommodation is via apportionment. Higher level commodities are shown in Table 1 as being combinations of primary commodities (fish plus transport), commodity taxes, and themselves, i.e. other higher level commodities. Hence, on the basis of cost apportionment, with costs as recorded in Table 1, higher level commodities can be traced back to their primary commodity and tax components. These apportionments are given by $A_{th}(I-A_{hh})^{-1}$ for the tax components and $A_{ph}(I-A_{hh})^{-1}$ for the primary commodity components. Hence the final demands for higher level commodities, f_h,

TABLE 3

AN SNA SAM

		Expenditures				
		All Other Accounts (Consolidated)	Indirect Taxes on Commodities	Production Activities	Primary Commodity Markets	Totals
Receipts	All other accounts (consolidated)	0	y_t'	v'	m'	y_0
	Indirect taxes on commodities	$A_{th}(I-A_{hh})^{-1}f_h$ $=t^*$	0	$A_{th}(I-A_{hh})^{-1}T_{ha}$ $=T_{ta}^*$	0	y_t
	Production activities	0	0	0	T_{ap}	y_a
	Primary commodity markets	$f_p+A_{ph}(I-A_{hh})^{-1}f_h$ $=f_p^*$	0 0	$A_{ph}(I-A_{hh})^{-1}T_{ha}$ $=T_{pa}^*$	0	y_p
	Totals		y_0	y_t'	y_a'	

are expressed in Table 3 as commodity taxes, $A_{th}(I-A_{hh})^{-1}f_h$, and as final demands for primary commodities, $A_{ph}(\mathrm{I}-\mathrm{A}_{\mathrm{hh}})^{-1}f_h$. Intermediate demands T_{ha} are treated analogously.

This apportionment process necessarily retains accounting balances, since it is simply an application of Result 1 in the previous section: column sums of $A_{th}(I-A_{hh})^{-1}$ plus those of $A_{ph}(I-A_{hh})^{-1}$ are necessarily equal to unity. A more interesting question is what it means in economic terms, especially since Table 3 is the SNA version of Table 1 and, without ancillary information, if only Table 3 is available, Table 1 cannot be resurrected.

4.2. *The SNA Model*

The economic model underpinning the treatment of commodities in the SNA SAM assumes that the transactions in any commodity row take place at the same price. This, then, is the principle for defining the detail of commodity accounts which has been endorsed earlier in this paper. It implies that vectors of prices, p_p and p_h, can be defined for the commodity accounts, and elements of these will apply uniformly across the individual commodity rows. It follows that the row balance equations for commodities can be deflated by prices to give commodity balances in quantity terms. These may be written as

(2) $$q_a = L_{ap}q_p$$

and

(3) $$q_p = L_{pa}^*q_a + g_p^*$$

where q_a, q_p and g_p^* are the vectors of quantities obtained by deflating the vectors of financial flows y_a, y_p and f_p^* in Table 3 by the appropriate prices. Similarly, matrices L_{ap} and L_{pa}^* are coefficient (quantity ratio) matrices corresponding to A_{ap} and A_{pa}^*. Thus a typical element of L_{ap} shows the quantity of domestic output of a particular activity per unit of total supplies of a particular primary commodity.

It is important to stress that these commodity balance equations are essentially (deflated) accounting balances: they say no more than that accounting balances can be interpreted as commodity balances if the assumption of uniform prices for all sales of a given commodity is justified. More interesting is the question of whether these balance statements are useful as a basis for analysis.

To pursue this question it can be noted that under the convention that the prices p_p and p_h are all unity, the elements of the above quantity balance equations are all observable from Table 3. Under this convention $q_a = y_a$; $q_p = y_p$; and $g_p^* = f_p^*$. Similarly, $L_{ap} = A_{ap}$ and $L_{pa}^* = A_{pa}^*$. It follows that if prices change between two periods for each of which a SAM such as Table 3 is available, and these are the only changes, then the effect of the price changes on each of q_a, q_p, g_p^*, L_{ap} and L_{ap}^* will be observable. This is because each of the two SAMs yields an observation of, say, y_a or A_{ap}, and these observations would have been the same in both cases if there had been no price change. Hence the consequences of changing prices on commodity balances may be analyzed. For example, if domestic prices rise relative to international prices, there will be a tendency to substitute foreign goods for domestic in meeting aggregate primary commodity requirements. The corresponding elements of L_{ap} will tend to fall accordingly, the extent of the fall depending on the elasticity of substitution between the domestic and imported varieties of particular goods.

While interpretation is certainly not trivial, the information provided by Table 3 on q_a, L_{ap} and q_p does provide a basis for analyzing import substitution due to price effects or other mechanisms. However, the situation with respect to the second of the above commodity balance equations (equation (3)) is less straightforward. To understand it, a useful starting point is to note that if Table 1, as opposed to Table 3, constituted the available data base, then the information on commodity balances would correspond to

(4) $$q_a = L_{ap} q_p$$

(5) $$q_p = L_{ph} q_h + g_p$$

and

(6) $$q_h = L_{ha} q_a + L_{hh} q_h + g_h.$$

The first of these equations is the same as the first commodity balance equation previously discussed, equation (2). Apportioning out the higher level commodity accounts therefore makes no difference to the information in the commodity balance equation for domestic production activities. The difference is rather that, after apportionment, there is only one further set of commodity balance equations (equation (3)), while in Table 1, two such sets of balances are recorded as in equations (5) and (6).

To follow this difference further, it can be noted that by eliminating q_h from the remaining pair of balance equations from Table 1, i.e. from equations (5) and (6), the second of the two balance equations of Table 3 is obtained. Hence the two are consistent and, moreover, it follows that

(7) $$L_{pa}^* = L_{ph}(I - L_{hh})^{-1} L_{ha}$$

and

$$g_p^* = g_p + L_{ph}(I - L_{hh})^{-1} g_h. \tag{8}$$

These results imply that if L_{ph}, L_{hh} and L_{ha} are all constant, technologically determined matrices then L_{pa}^* is also a constant matrix, and the commodity balance equation (3), ($q_p = L_{pa}^* q_a + g_p^*$), as given by Table 3, is a useful way of describing how a change in the vector of activity outputs consequent on, say, a change in prices, will generate changes in the demand for primary commodities. But if L_{pa}^* is not independent of the change in prices, then for analytic purposes this balance equation has to be complemented by some specification of the way in which price changes effect L_{pa}^*. This is no simple matter. From equation (7), and assuming that L_{ph} and L_{hh} are matrices of technologically determined coefficients, changes in L_{pa}^* can be attributed to changes in L_{ha}. For example, an increase in the price of imported fuel oil may cause some activities to switch to domestic coal, so that the coefficients in L_{ha} are changed by the price change. Such changes can, in principle at least, be monitored and modeled if L_{ha} is observed, as it is in Table 1. But if only L_{pa}^* is observed, then, from equation (7), it is apparent that even with L_{ph} and L_{hh} fixed, a change in any element of L_{ha} will change many elements of L_{pa}^*. It is, therefore, extremely difficult, if not impossible, to model the effects of changes in prices on L_{pa}^* when its separate components $L_{ph}(I - L_{hh})^{-1}$ and L_{ha} are not distinguished. The unfortunate consequence of this is that the SNA format discourages analysis of the effects of price changes on technology matrices and encourages the assumption that there are no changes, even though this may be known to be wrong.

While the argument above focusses on the commodity demands of activities, a similar case can be made in relation to final demands. Equation (8) shows how how final demands for higher level commodities, g_h, map into final demands for primary commodities. The mapping is via the matrix $L_{ph}(I - L_{hh})^{-1}$, which is usually known as a classification converter, particularly in relation to that part of g_h which refers to household consumption expenditure. Now the relationship between household consumption expenditures and market prices is well understood, so that if data on g_h and market prices were given by the SNA (which they are not), then the effects of prices on g_h, and hence g_p^*, can be formalized if the classification converter is also known, and is itself independent of prices. Unfortunately, this last assumption will not always be reasonable, e.g. to the extent that households substitute "do-it-yourself" for the purchase of services as the relative price of the latter increases.

The SNA recognizes this difficulty to the extent that it proposes supplementary data to that in Table 3 by suggesitng that matrix T_{ph} (or A_{ph}) should be recorded separately. But, ignoring T_{hh} for the present,[4] this is equivalent to

[4]Whether T_{hh} is different from zero is a nice technical point. As noted earlier, the possibility of allowing non-zero elements of T_{hh} is useful when commodities form a hierarchy, e.g. when goods are either sold in one market or, with the addition of some of the commodities transport and distribution services, can be moved on to another. It can be noted, however, that all the costs involved in such cases can be included in $T_{a,h}$ if transport and distribution services can be uniquely identified with particular production activities. In this event, therefore, T_{hh} is not required to be other than zero. If the condition that T_{hh} is zero cannot be sustained, then SNA practice should be to recommend the supplementary information leading to $L_{ph}(I - L_{hh})^{-1}$, rather than just L_{ph}.

recommending the full information set in Table 1. And in this event, there would seem to be little point, except for the size of paper required, to prefer Table 3, plus a supplementary table of T_{ph}, to simply having Table 1, especially since the derivation of Table 3 implicitly requires the detail of Table 1 as a starting point. Moreover, in practice, many countries produce Table 3 because that is what the SNA calls for, and omit to document the supplementary table T_{ph}. This means that the fixed technology assumptions under which Table 3 is useful are more or less forced on analysts and therefore circumscribe the usefulness of all the hard work that has to go into the table's construction. This, plus the fact that Table 1 is far more readily understood than Table 3, would seem to establish a strong case for preferring the former as the basic presentation of commodity balances.

To complete this discussion of the SNA SAM format, it can be noted that the SNA refers to the prices p_p as approximate basic prices, defined as the unit costs of primary commodities, deriving from their import content and the ex factory prices of domestically produced goods. These prices are, therefore, independent of domestic commodity taxes and those trade and transport margins which are needed to translate primary goods into higher level commodities which can be purchased on the market. They are not true basic prices, however, because the cost structure of activities includes all indirect taxes and transport and distribution margins which are levied on inputs of intermediate goods into productive processes.

4.3. *Simple Input-Output Formats*

While the SNA SAM in Table 3 is already too obscure for many economists, there is some demand for further reduced forms, the straightforward use of which is only legitimite under a further round of simplifying assumptions about the nature of cost structures and the independence of technology and prices. These concern more conventional input-output data tableaux in which the distinction between activities and commodities is eliminated. Clearly, there are two versions, one in which commodities do not feature at all, so that demands on primary commodity markets are expressed as demands on activities, and the other, in which activities do not feature, so that the cost structure of activities must be reformulated as cost structures for supplying primary commodities. In either case, the mathematics of a reduced form SAM apply.

Starting with Table 3 and using the notation t^*, T^*_{ta}, f^*_p and T^*_{pa} defined in that table, a new reduced form SAM can be obtained from which primary commodity accounts are eliminated.[5] This new SAM is shown as Table 4. It introduces the notation a'_m for imports, m', expressed as proportions of primary commodity supplies y'_p, i.e. $a'_m = m'\hat{y}_p^{-1}$.

In Table 4 the new entries in the outlay account for 'All Others" are $a'_m f^*_p$ in the first row and $A_{ap} f^*_p$ on the rows for demands on activities. These reflect the apportionment of final demands on primary commodity accounts, f^*_p, in Table

[5]In view of Result 2 of section 3 above it does not matter whether we start with Table 3 and eliminate the accounts for primary commodity markets, or start with Table 1 and eliminate all commodity market accounts simultaneously.

TABLE 4

SAM FORMAT FOR I-O ON AN ACTIVITY×ACTIVITY BASIS

		Expenditures			
		All Other Accounts Consolidated	Indirect Taxes on Commodities	Production Activities	Totals
Receipts	All other accounts consolidated	$a'_m f^*_p$	y'_t	$v' + a'_m T^*_{pa}$	y_0
	Indirect taxes on commodities	t^*	0	T^*_{ta}	y_t
	Production activities	$A_{ap} f^*_p$	0	$A_{ap} T^*_{pa}$	y_a
	Totals	y_0	y'_t	y'_a	

3, as being partly a demand for imports, and partly a vector of demands on domestic activities. Similarly, the previous intermediate demands by activities for primary commodities, T^*_{pa}, are shown in Table 4 as demands by activities for imports $a'_m T^*_{pa}$, (the import content of intermediate demands), and as demands by activities on each other, $a_{ap} T^*_{pa}$, i.e. inter-industry demands.

The commodity balance equations for Table 4 are in fact activity balances, and can be written as:

(9) $$q_a = L_{ap} L^*_{pa} q_a + L_{ap} g^*_p = (I - L_{ap} L^*_{pa})^{-1} L_{ap} g^*_p.$$

As a basis for modeling, equation (9) involves all the difficulties of moving from final demands at market prices, i.e. f_p, to final demands at primary commodity or approximate basic prices, p_p, even when L_{ap} is known. And if L_{ap} is not known, then, given the matrix $L_{ap} L^*_{pa}$ (which can be obtained from Table 4 via $a_{ap} T^*_{pa}$), there are considerable problems in modeling final demand in the form $L_{ap} g^*_p$. These are hardly worth addressing if L_{ap} cannot be assumed to be more or less constant, for example, under the influence of price changes.

The assumption that L_{ap} is independent of relative prices may have proximate validity to the extent that the elements of L_{ap} reflect technologically fixed ratios. But for one set of cases, at least, the assumption that coefficients of L_{ap} are independent of relative prices is clearly not tenable. Such cases arise when domestically produced goods are substitutes, to some degree, for imported goods, as previously discussed. In such cases, primary markets will naturally switch ratios between domestic and foreign sources of supply in response to relative price changes. Accordingly, and because such cases are common and important, Table 4 is a very weak starting point for analysis and modeling.

As an alternative to Table 4, a second reduction of Table 3, in which the activity accounts are now eliminated, can be considered. This yields a SAM in which the remaining accounts are "All other", commodity and indirect tax accounts. In the interest of brevity, this is not presented here, nor is the derivation of the final commodity balance equation which replaces equation (9) in this case, viz.

(10) $$q_p = (I - L^*_{pa} L_{ap})^{-1} g^*_p.$$

To the extent that this is somewhat simpler than equation (9), the commodity × commodity format may be preferred to that of activity × activity. However, the fundamental difficulty remains that the coefficient matrix L_{ap} cannot reasonably be assumed to be independent of prices, so that data requirements for analysis include L_{ap}, and hence imply a SAM format such as Table 1 or Table 3. Combining this with earlier arguments that Table 3 is an inadequate data base takes one back from the simple input-output SAM tableaux to the basic SAM form defined by Table 1.

5. Providing a Data Base for Policy Formulation

In this paper, as in others I have previously written, the basic concern has been to identify a data base in SAM format that is relevant and useful for economic analysis of those issues which concern people and governments, especially in developing countries, but by no means exclusively. It has generally turned out, and not least in this paper, that the attempt has yielded recommendations for the construction of SAMs which are not only intrinsically more interesting, but more easily understood and less demanding of sophisticated manipulation of primary source data. While my own previous writings have tended to concentrate on the accounts for factor markets and institutions, others[6] have incorporated disaggregated financial flows in the SAM framework, for the most part adopting methods taken from UNSO (1968). Attention to the treatment of commodity accounts, and not least the conviction that market prices should be used to measure commodity transactions, is a more recent focus, which owes a great deal to collaboration with Jeffrey Round in constructing a SAM for Malaysia, aspects of which are discussed in Chander *et al.* (1980). This conviction is supported by recent developments in macro-modeling for developing countries, as described in Taylor (1979) or Dervis, de Melo and Robinson (1982), for example. These models essentially build on Walrasian general equilibrium theory, in which prices play a crucial role in bringing about market equilibria, as opposed to the Leontief approach, in which prices are determined independently of production levels. Both models and SAMs are now closely integrated, not least through recent work of Grais and associates,[7] to the point where the type of SAMs I have argued for here and elsewhere can be underpinned by a conceptual analytic framework which is more general than that which justifies the SNA. The SNA is accordingly now too special to support the analytic framework which is emerging.

At a more mundane level, the SNA is at best an inconvenient and incomplete scheme for describing those processes of change and policy options which are of concern to people and their governments in developing countries. It is for this reason that much attention has been given here not only to the treatment of commodities but also to the classification of production activities. It has been said that the Leontief approach of basing such classification solely on principal products is quite inappropriate in the context of the dualities which characterize developing economies. Given an approach to activity classifications which recognizes the importance of the organization of production, a data framework such

[6]See for example Roe (1978) and Greenfield (1978).

[7]See, for example, Grais (1981) or Drud, Grais and Pyatt (1983).

as Table 1 can provide a rich source of information on what is happening in an economy on a wide range of important issues. Evidently, from the analysis presented here, Table 1 is richer in this regard than Table 3.

Finally, but not least, Table 1 is basic to Table 3, so that no extra difficulty is involved in its compilation from primary sources. Since Table 3 can be obtained from it, while many would find Table 1 more useful, this may be a sufficient reason for urging Table 1 as the format for presentation of commodity balances.

REFERENCES

Armington, P. (1969) A Theory of Demand for Products Distinguished by Place of Production, *IMF Staff Papers*, No. 16.

Chander, R., Gnasegarah, S., Pyatt, G., and Round, J. I. (1980) Social Accounts and the Distribution of Income: The Malaysian Economy in 1970, *Review of Income and Wealth*, Series 26, No. 1, pp. 67–85.

Dervis, K., de Melo, J., and Robinson, S. (1982), *General Equilibrium Models for Development Policy*, Cambridge University Press, Cambridge.

Drud, A., Grais, W., and Pyatt, G. (1983), The TV-Approach: a systematic method of defining economy wide models based on SAMs, Proceedings of the 4th IFAC/IFORS Conference on Modeling and Control of National Economies, Washington, D.C., U.S.A.

Grais, W. (1981), Aggregate Demand and Macroeconomic Imbalances in Thailand: Simulations with the SIAM1 Model, *World Bank Staff Working Papers*, No. 448.

Greenfield, C. C. (1978), Social Accounting Matrices and Developing Countries, *Statistical News*, H.M.S.O., London.

Greenfield, C. C. and Fell, H. A. (1979), The Estimation of Price Effects in a Social Accounting Matrix, *Review of Income and Wealth*, Series 25, No. 1, pp. 65–84.

Pyatt, G. and Roe, A. R., with Lindley, R. M., Round, J. I. and others (1977), *Social Accounting for Development Planning: With Special Reference to Sri Lanka*, Cambridge University Press.

Pyatt, G. and Round, J. I. (1977), Social Accounting Matrices for Development Planning, *Review of Income and Wealth*, Series 23, No. 4, pp. 339–364.

Pyatt, G. and Thorbecke, E. (1976), *Planning Techniques for a Better Future*, International Labour Office, Geneva.

Roe, A. R. (1978), The Flow of Funds as a tool of analysis in the less-developed countries, Proceedings of a Conference on Social Accounting in Development Planning, World Bank (mimeo).

Taylor, L. (1979), *Macro Models for Developing Countries*, McGraw Hill, New York.

United Nations Statistical Office (1968), *A System of National Accounts*, Studies in Methods, Series F, No. 2, Rev. 3, New York.