Theory of Social Accounting:

An Introduction

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Abstract

*Social Accounting Matrices (SAM) can be used to present the data used in any empirical whole economy model from parsimonious macroeconomic models to large scale general equilibrium models. An important difference between SAMs and Supply and Use Tables (SUT) and Input-Output Tables (IOT) is the inclusion as standard of multiple institutional, factors and tax accounts that facilitate the use of SAMs as databases for the exploration of the 'social' and economic dimensions of economic issues. When using SAMs as databases it is important to recognise three features of any SAM. First, the datapoints – transaction values (TV) – are point estimates, i.e., measured with error. Second, the TVs must be complete **and** consistent, i.e., consistency (equality of incomes and expenditure for all accounts) is not adequate. And third, when a SAM is used to calibrate a mathematical economic model the cause of most simulation results that are hard to explain can be found in the data.*

The document is subject to ongoing development. It was last revised at the date above.

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"It is perhaps of interest to realise that the framework of any model concerned with the economy as a whole is always an accounting system. This is true whether we work with highly aggregated models such as that underlying Keynes' General Theory, the input-output model of Leontief or the still more complicated variant with which this series [A Programme for Growth] is concerned."

(Stone, 1962 ,p v).

"Since every economic model has its corresponding accounting framework, and since every such framework can be set out as a SAM, it follows that every economic model has a corresponding SAM."

(Pyatt, 1987, p 330)

"The issue of whether the SAM is deterministic or stochastic is crucial as the SAM provides the underlying data set upon which simple SAM-multiplier analyses and more complex Computable General Equilibrium Models (CGEs) are calibrated. Increasingly, these models are used to explore and simulate the impact of policies and exogenous shocks on the whole socio-economic system. An erroneous or inaccurate SAM invalidates the results obtained from these models"

(Thorbecke, 2003, p 186).

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1. Introduction

At the heart of all quantitative analyses of economic systems, be it a modern macroeconomic model and/or some other form of whole economy model, will be found **estimates** of national accounts. Indeed, so central are national accounts to the study of whole economy systems by empirical economists it is easy to forget how short the history is of (formal/institutionalised) national accounting, especially since the 'wealth of a nation' appears to be a concept that has lain at the very root of economic analyses for more than two centuries (Stone, 1978, provides a brief historical review). But despite the importance of national accounts, it is surprising to find how ill-informed many economists are about the issues and problems faced by national account statisticians; with the gap between economists and statisticians seeming to grow with the increasing technical 'sophistication' of modern economics. This is arguably a source of substantial concern. It suggests that economists are forgetting that the development of national accounts was inspired directly by developments in macroeconomics, especially the Keynesian revolution, and with it an attendant need to understand and quantify how economic systems operate.

This is not of historical interest. Throughout the development of national accounts there was a strong history of dialogue between the compilers and the users of national accounts; this dialogue has had important consequences in that it has ensured that conventions for the compiling of national accounts have incorporated considerations about the use of national accounts in economic analyses. Indeed, this is one of the enduring legacies of Richard Stone's contribution to economics.[1] This has meant that national accounts, if compiled in line with SNA guidelines, adopt definitions and conventions that ensure they can be used meaningfully as a basis for economic analyses and not solely as a mechanical accounting exercise that describes an economy at a point in time. Consequently, it is disappointing that so many economists fail to recognise the difficulties confronted by national account statisticians and the extent to which the task of compiling national accounts is often as much art as science.

A social accounting matrix, or SAM, is a single-entry transactions matrix where the core data records the values of current income and expenditure transactions between different agents. A SAM serves two major purposes: a framework within which transactions value data

[1] "The fact that others have not had to reinvent the architecture of the national accounts in particular is perhaps the most telling measure of the importance of Richard Stone's contributions and their enduring significance." (Pyatt, 2005).

can be organised and the statistical basis for the creation of economic models. As a system for organising information, it is a powerful tool whereby the economic and social structure of a country, region, city, village etc., can be described in a **complete** and **consistent** way. A SAM provides a unifying structure within which the statistical authorities of a state can compile and present national accounts. In some respects, this is the task to which SAMs were first applied. Under the leadership of Stone, a series of SAMs for the UK were constructed during the late 1950s and early 1960s as extensions and developments of national accounts. Subsequently Pyatt and colleagues extended the process through the development of SAMs for several developing countries (Pyatt *et al.*, 1974 and Pyatt and Round, 1985). More recently the potential benefits of SAMs have been recognised in the United Nations' 1993, 2008 and 2025 revisions of the System of National Accounts (see Keuning, 1994, and UN, 1993, 2009 and 2025). As an organisational framework, SAMs are not limited to transactions data. SAMs have been extended by adding satellite accounts that encompass quantitative data about, *inter alia*, social, demographic, and environmental interactions within economic systems; these extensions are particularly useful for economic models that include issues of ever wider scope, e.g., energy and emissions, water use environmental sustainability and climate change.

A SAM is a **not** an economic model. A SAM can only provide the numerical basis upon which an empirical model can be built. A mathematical economic model requires the specification of a series of behavioural economic relationships, e.g., production and consumption functions, and an institutional structure within which these economic relationships are played out. The relationships specified may be linear functions, e.g., as in input-output and SAM multiplier models, or they may be complex non-linear functions, e.g., nested CES and translog functions, while the institutional arrangements can range from command to market economies. The choice of model will depend critically upon the nature of the economic system and the policy issues and variables analysts wish to analyse, e.g., trade or taxation policies, and the outcomes analysts wish to emphasise, e.g., income distribution, government budgets, foreign exchange availability, etc., and the economic/social events that will drive the model, e.g., global trade negotiations and climate change policies. Moreover, the choice of model will depend upon the school of economic thought to which the analyst adheres. Hence a single SAM can provide the data used to calibrate many different models.

All national accounts data are **estimates**, i.e., measured with error, that must be **complete** and **consistent**: 'complete' in the sense that it covers all transactions in an economy

and 'consistent' in the sense that every expenditure by an agent has a matching and corresponding income for another agent (often described as reconciled). It must be recognised and understood that all national accounts data are estimates, i.e., there are implicit, if not explicit, error bounds on all data points. Hence, reported national accounts data e.g., GDP, private consumption (C), investment (I), exports (X) and imports (M), etc., should be treated as estimates. Hence the development of a SAM is a process of estimation wherein data from multiple sources are confronted with each other to derive prior and **complete** estimates of the transaction values in a SAM; once such a **complete** (prior) SAM is compiled it is possible to embark on a process of estimating a **consistent** system.

The detail of any SAM constructed therefore depends not only on the economic system for which it is developed, and the wealth of data about the system that is available, but also on the purposes for which the SAM will be used. This generates a potentially disconcerting feature about SAMs: while SAMs as a class have a general structure, the specific structure of each SAM tends to differ. This introduction will presume, initially, that a SAM is constructed using inter-industry data formulated as Supply and Use tables (SUT): this formulation ensures that the system of prices in a SAM are transparent and easily explained. A brief section, Appendix A1, provides information about the transformation of a SAM from one based on SUT to one based on Input-Output tables (IOT).[2] This introduction does **not** refer to a SAM as balanced **nor** the process of reconciling a SAM as balancing. If a SAM is **complete** and **consistent** the row and column totals will automatically equate, i.e., be reconciled. However, it is possible that a SAM is consistent, i.e., the row and column totals are equal, but incomplete, i.e., some transactions have been excluded. If a SAM is incomplete but consistent then several transaction values must have been distorted. Unfortunately, and all too often, mechanical mathematical methods are used to render a SAM consistent subject to strong assumptions about completeness and that selected totals are known and certain. (See section 5.2 for more on the topic of complete and consistent.)

The process of compiling a SAM depends on who and why a SAM is being compiled. In an idealized world national accounts agencies would produce highly detailed SAMs for their country on a regular basis: this will not happen. If a national account agency were to compile a SAM in accordance with the SNA it would be using a bottom-up procedure. The

[2] The approach follows the SNA wherein Input-Output tables (IOT) are derived from SUT (see section A1 below on the derivation of IOT from SUT).

compiler would start with detailed disaggregated data, and the resultant SAM would be used to benchmark aggregate national accounts, e.g., GDP, C, I, G, X and M. Others seeking to produce a SAM will normally, if not always, follow a top-down process. The resultant SAM would be 'consistent' with published national account aggregates, where the national accounts aggregates provide 'control' totals used in the estimation process so that they are 'matched' by the SAM data. This paper assumes that compilers are following a top-down process.

This introduction begins with an overview of the concepts underpinning a SAM, section 2, and follows this with a description of a generic SAM, section 3, built assuming the inter-industry data are presented as SUT. All SAMs are constructed using the concept of a production boundary and include a detailed system of price formation. In the fifth section, the production boundary and price systems embedded within the System of National Accounts are explored: in all the discussions in this document, and the models explored in this paper, the concepts underpinning the SNA's production boundary and price system are taken as given.[3] This is not an uncritical acceptance of the SNA (see Pyatt, 1994), but it is an acknowledgement that the SNA is the international standard and that the acceptability of the results from economic analyses is influenced by acceptability of the underlying data. Among the advantages of the presentation of data in SAM format is the ability of the viewer to appreciate the interrelationships within an economic system identified by a SAM. But understanding these interrelationships takes practice, so the fifth section is given over an interpretation of data in an aggregated SAM for Botswana; this SAM is useful because it demonstrates some uncommon relationships. However, it is noted that interpreting a SAM takes practice combined with an understanding the accounting conventions used and the price system embedded in SAMs. The main text concludes with some summary comments.

Finally, there are two appendices. The first explores the relationship between SUT and IOT, and the second illustrates the transition from T-accounts to a SAM.

[3] A subsequent paper is planned where a SAM is presented using 'general' production boundaries.

2. An Introduction to Social Accounting Matrices

This section provides an overview of the key concepts underpinning a SAM. The guiding principles of a SAM are the concept of the circular flow and the requirements of double entry bookkeeping.

2.1 The Circular Flow

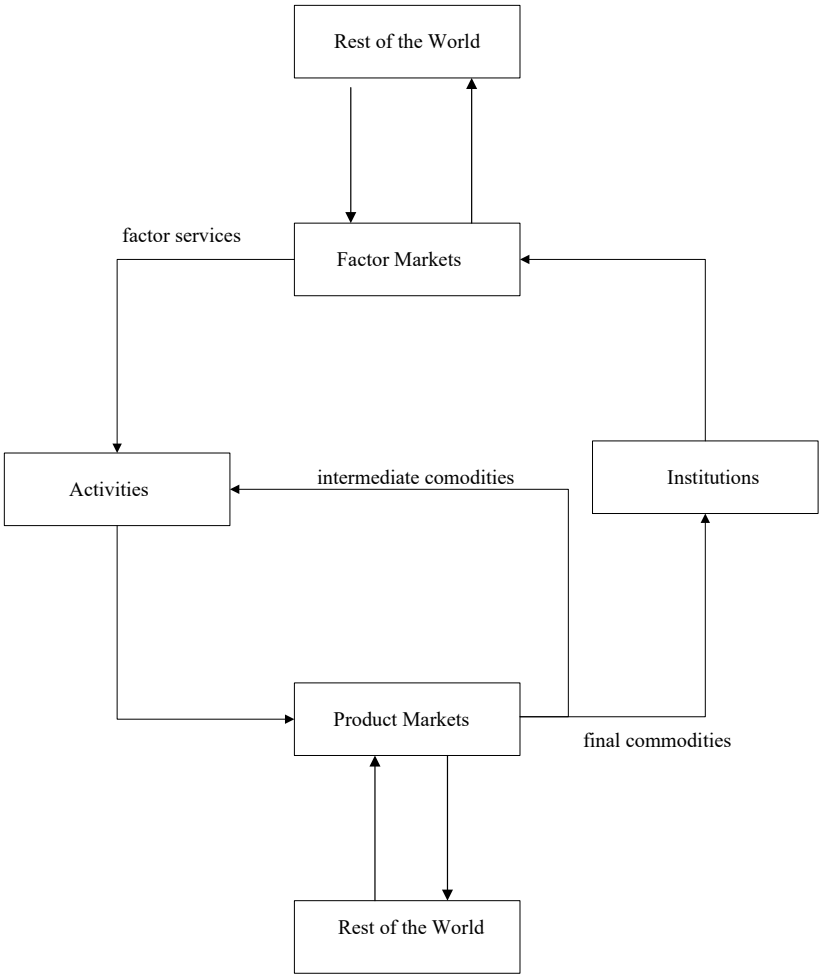
The concept of a circular flow represents a vision of economic systems. In its simplest form, going one way around the circular flows involves tracing out the flow of goods and services while going the other way around traces out the flows of funds (see Figure 2.1): the arrow heads in Figure 2.1 indicate the direction of physical flows with associated flows of funds going in the opposite directions. Assume, initially, that the economy is closed and hence the Rest of the World agents/accounts can be ignored. Institutions (a term that encompasses households, non-profit organizations, government, investment, etc.,) sell the services of the factors/endowments they own in factor markets where activities (producers, industries, firms, etc.,) are the purchasers. This generates flows of funds, incomes, to the institutions, which can be used to fund purchasers of final commodities (goods and services) by the institutions on product markets. The activities realise part of their incomes from the sale of final commodities; the remainder of their incomes are realised from the sale to other activities of intermediate commodities on the product markets. Hence, a circular flow is generated between the institutions and activities that are linked via factor and product markets.

Opening the economy to the Rest of the World is a simple extension of the system. Institutions can sell their factor services to domestic or foreign activities, while activities can source factor services from domestic or foreign institutions. Similarly, domestic institutions can source final commodities from domestic or foreign activities, while domestic activities can source intermediate commodities from domestic or foreign activities.

The full circular flow is somewhat more complicated, although the principles remain simple. Figure 2.1 (deliberately) does not illustrate certain transactions. There are usually multiple transactions between institutions; these include savings (transactions between the investment account and other institutions), indirect taxes (transactions between government, activities and other institutions), direct taxes (transactions between government and other institutions) and transfers (transactions between institutions and between domestic and foreign

institutions). Also excluded are representations of various taxes levied on commodities and activities. Whilst such transactions are important and are often the instruments through which policies are implemented, none alter the basic principles of the circular flow.

Figure 2.1 A Simple Circular Flow



2.2 Overview of Social Accounting Matrices

An important distinction exists between inter-industry tables, which record the costs incurred in the production of commodities\products (goods and services) by activities\industries, the expenditures on factors by activities and the purchases of commodities by domestic and foreign institutions, and SAMs. This can be intuitively explained by reference to the illustration of the circular flow in Figure 2.1. A SAM captures the full circular flow whereas inter-industry tables only capture part of the circular flow. Specifically, inter-industry tables do not record details of the interactions in factor markets: there are no links between factors

sales and the incomes of institutions, sometimes called the functional distribution of income. Consequently, inter-industry tables do not provide information about how institutions generate the incomes, through interactions on factor markets, that enable them to fund expenditures on product markets. In addition, inter-industry tables do not record the transactions between the various institutions in an economic system, or between the various components of an economic system and the rest of the world except for commodity transactions. These differences and their importance will become clearer in due course.

A SAM is an extension of an inter-industry table; it extends the information about inter-industry transactions to include more detailed information on institutions and factor markets. A SAM records details of transactions during the period for which it is constructed – current account transactions – and does not record details of the historical transactions that determine the stocks of factors etc., - capital account transactions. Hence a SAM contains details of all real transactions on the current account of an economy and therefore embraces the full circular flow.

The development of fully articulated SAMs was largely undertaken by the Cambridge Growth Project and, in the context of developing countries, by Graham Pyatt and associates. The first modern SAM for a developed economy was produced by Stone (1962), then in 1972 the first SAM for a developing country was produced for Iran by Graham Pyatt; subsequently Pyatt and various associates produced SAMs for Sri Lanka (Pyatt *et al.*, 1977) and several other developing countries, e.g., the country studies in Pyatt and Round (1985).

While the revised 1968 SNA established the integration of macroeconomic and inter-industry data, SAMs did not become an integral part of the SNA until the 1993 revision (ISWGNA, 1993). As is made clear in the SNA, a SAM provides a comprehensive synthesis of the (real) accounts of the whole economy, supply and use data and inter-institutional transactions for an economy; hence it is the most comprehensive method for presenting data about the real economy at an aggregate level. In most SAMs the focus is however still on the production structure, at the expense of details about the distribution of factor payments to households and inter institutional transactions; this appears to be largely a reflection of data

collection, estimation and reconciliation problems rather than a deliberate decision by national account statisticians. It is not an inherent limitation of the SNA.[4]

A SAM is a square matrix in which each agent/account has both a row and a column. The expenditures/payments/out-goings for each account are recorded as column entries while the incomes/receipts/in-comings for each account are recorded as row entries. A SAM is a form of single-entry bookkeeping where each entry is a transaction, i.e., each entry has both price and quantity dimensions, which identifies both the source and destination of the transaction. Accordingly, the total expenditures by each account must be exactly equal to the total receipts for each account: hence the respective row and column sums for a SAM must equate. Moreover, it will provide that information in a manner that is consistent with the aggregate accounts for the system. Thus, in the context of an entire economy, a SAM will contain not only the information provided by the aggregate national accounts but also further details on the transactions between various groups of agents within the system. A SAM is an efficient and, ultimately, simple way to record economic transactions.

Formally, a SAM is a system of single-entry bookkeeping presented in the form of a square matrix wherein each account is represented by a row and a column. The entries in the SAM are transaction values (TV), i.e., prices multiplied by quantities: the row entries represent incomes to the accounts and the column entries represent expenditures by the respective accounts. Hence, the entry in the i^{th} row and j^{th} column is simultaneously the expenditure by the j^{th} account on the 'product' of the i^{th} account AND the income to the i^{th} account from sales of its 'product' to the j^{th} account. A SAM must be complete and consistent: complete in the sense that it covers all transactions in an economy and 'consistent' in the sense that every expenditure by an agent has a matching and corresponding income for another agent. A consequence of being consistent is that the total income and the total expenditure for every account must equate, i.e.,

$$\sum_i p_{ij} \cdot q_{ij} = \sum_i T_{ij} = \sum_j T_{ij} = \sum_j p_{ij} \cdot q_{ij} \quad \forall i = j$$

where p_{ij} and q_{ij} are the price and quantity of account j used by account i and T_{ij} the transaction (value) between account j and i. But consistency does not ensure that the SAM is

[4] If a SAM only has a single household account the ability to use that SAM to calibrate models that will provide useful information about the implications of different distributions of income or the impacts on income distribution are limited (see Defourney and Thorbecke, 1984, for an elegant demonstration of the potential importance of income distribution in policy analyses).

complete: mathematical techniques can, and regrettably are often used, to ensure that a SAM is consistent despite being incomplete.

By **definition**, the price for any transaction in a row is the same irrespective of the agent/account that makes the purchase. This means that the quantities in any row are homogenous (undifferentiated) and can measured in commensurate units; hence they can be meaningfully summed so that the row totals are defined as the product of the respective price and the sum of the quantities that are recorded in each transaction in the row

$$T_{ij} = \sum_j p_i q_{ij} = p_i Q_i \qquad \text{and} \qquad \sum_j q_{ij} = Q_i .$$

Since the transactions in each row refer to items that are homogenous, the prices do not differ by reference to the purchasing agent. This characteristic is a consequence of the 'law of one price' (LOOP) that applies to any SAM and is important for an understanding of a SAM and its underlying system of prices and is central to calibrate any model using that SAM. (see section 5.3 for more on the topic of prices.)

The LOOP is critical to the understanding of the price system in a SAM and the strictures placed upon the price system in any model calibrated with a SAM. Indeed, the price system embedded within a SAM defines the price system that must be applied in any model calibrated with that SAM; if not there will be a fundamental tension between the data and the model's behavioural relationships.[5] Moreover, an understanding of LOOP and the price system in a SAM is critical to an understanding of the behavioural relationships in ALL whole economy models, since the databases for all whole economy models can be presented as SAMs.

[5] For instance, all CGE models that use CET functions violate the LOOP; including the models I use. In our defence we do knowingly violate, and justify violating, LOOP.

3 Structure of a SAM

An illustration of the structure of an archetypal SAM is provided in Table 3.1; however, it needs to be recognised that the concepts underpinning a SAM are flexible and can support a plethora of structures. The presumption in the following description assumes the SAM is constructed using Supply and Use Tables (SUT) for the inter-industry accounts; relationship between SUT and Input-Output Tables (IOT) is discussed in appendix A1.

Typically, a SAM is constructed with 6 or 7 groups/types of account, and each type may contain numerous individual accounts:

- Commodity (or product) accounts
- Margin accounts (optional – often subsumed within the commodity accounts)
- Activity (or production/industry) accounts
- Factor accounts
- Institutional accounts
- Investment Savings accounts
- Rest of the World accounts.

The SAM in Table 3.1 identifies 3 categories of domestic institutional accounts: private households, (incorporated business) enterprises and government. Each of these can have numerous sub accounts as can the other types of account. Also, while Table 3.1 has a common ordering of accounts the ordering is irrelevant to the information content.[6]

Ultimately the ability to understand the information content of a SAM is a product of experience, and a description of the structure of a SAM can only serve as a starting point. Thus, while Table 3.1 is a reasonable illustration of SAMs used to calibrate economic models it is not an exhaustive illustration and departs from the representation in recent revisions to the SNA (see section 4 on this difference). In part this reflects the fact that there is no

[6] Arguably the reason for starting with the commodity accounts stems from the notion of 'consumer sovereignty', which implies that production activities supply outputs in response to consumption choices. This paper follows this ordering of accounts, which is consistent with the order followed by the first developers of SAMs. But given the circular flow the ordering of arguments has little meaning. For instance, many SAMs originating in the USA, or derived by practitioners inspired by US practice, start with activity accounts.

deterministic structure for a SAM, although all SAMs must conform to a series of principles. This explains why it can be difficult to interpret some SAMs; the structure chosen for a SAM may be one with which the reader is not familiar.[7] Hence while the structure illustrated in Table 3.1 has been chosen to provide an introduction SAMs, those interested in using SAMs as databases will need to spend time learning how to interpret the information content.

The description of the SAM in Table 3.1 proceeds in the order of the accounts. The cells that include a '0' entry are those for which such an entry rarely, if ever, makes economic sense, whereas those left blanks may have entries, but they are not included in this description.

3.1 Prices in a SAM – an introduction

An understanding of the system of prices in a SAM is important for an accurate understanding of the data. The System of National Accounts SNA defines two key prices that are critical to understand a SAM (see SNA, 2008, 6.49 to 6.69):

1. Purchaser Prices - the prices paid by purchasers, which include transport and distribution margins and any VAT payable.
2. Basic Prices - the price paid to the producer by the purchaser less any tax payable plus any subsidy receivable but excluding any transport or distribution charges invoiced separately.

In a SAM based around SUT, commodities supplied to an economy by domestic activities and the rest of the world are valued in basic prices, while commodities used by an economy are valued in purchaser prices.

This is sufficient for the purposes of this section, but a more detailed understanding of the SNA's price system in a SAM and the SNA's definitions of the production boundary is needed. These issues will be explored in greater detail in section 5.3.

[7] Indeed, the SAM structure in Table 3.1 relates back to the structure implicit to the SNA of 1968 and departs from the structure advocated by the SNA since 1993, although both structure should contain the same information. One way to simplify the process of understanding a SAM with an unfamiliar structure is to re-order the accounts into a structure with which the reader is familiar.

Table 3.1 Structure of a SAM

	Commodities	**Margins**	**Activities**	**Factors**	**Households**	**Enterprises**	**Government**	**Investment**	**Rest of World**	**Account Total**
Commodities		Margins	(Combined) USE Matrix	0	Household Consumption		Government Expenditure	Investment Expenditure	Exports of Goods & Services	Commodity Demand
Margins	Margins	0	0	0	0	0	0	0	0	Margin Demand
Activities	Production	0	0	0	0	0	0	0		Production
Factors	0	0	Remuneration of Factors	0	0	0	0	0	Factor Income from RoW	Incomes to Factors
Households	**0**	0	0	Distribution of Factor Incomes	Inter Household Transfers	Distribution of Income	Transfers to Households	0	Remittances from RoW	Household Income
Enterprises	0	0	0	Distribution of Factor Incomes			Transfers to Enterprises	0	Enterprise Income from RoW	Enterprise Income
Government	Commodity Taxes	0	Production Taxes	Factor Taxes	H'hold Income Tax & Other payments to Government	Ent'prise Income Tax & Distribution of Income		0	Transfers from RoW	Government Income
Savings	0	0		Depreciation	Household Savings	Enterprise Savings	Government Savings	Stock Changes	Capital Account Balance	Savings
Rest of World	Imports of Goods & Services	0	0	Factor Payments to RoW	Remittances to RoW	Enterprise Payments to RoW	Current transfers to RoW		0	Imports of G&S from and transfers to RoW
Totals	Commodity Supply	Margin Supply	Cost of Production	Expenditure on Factors	Household Expenditure	Enterprise Expenditure	Government Expenditure	Investment Expenditure	Exports of G&S to and transfers from RoW	

3.2 Account Groups

This section provides an overview of the groups of accounts in a SAM. The next section considers the individual accounts within each group.

Commodity (or Product) Accounts

The row entries for the commodity accounts identify the purchases of commodities by the agents in the columns: the entries are transaction values (TVs), i.e., record values and not quantities. Thus, the row entries quantify the distribution of commodity demands between intermediate and final demand where final demands are disaggregated across different institutions, the investment account and the Rest of the World (exports). Notice that the Rest of the World (RoW) is simply another account, i.e., exports are recorded as incomes from the RoW. Total incomes to the commodity accounts are therefore given by the row sums that quantify the total value of demand for commodities in the system. Transactions in the commodity account rows are valued at purchaser prices.

Ex post the total demand for commodities must equal the total supply of commodities, i.e., the row and column totals equate. But for any period, the total demand for and total supply of commodities may not equate due to the drawing down or increasing stocks; this is typically accommodated by including an account for stock changes[8] as a sub account of the investment account.[9]

The total supply of commodities in value terms includes

1. domestic production valued at basic prices, i.e., the price paid at the factory 'gate';
2. imports also valued at basic prices, i.e., price paid to the RoW, plus carriage, insurance and freight (*cif*) paid and any import duties (the price paid at the dock 'gate');
3. any other taxes on commodities paid by domestic agents, e.g., General Sales Taxes (GST), VAT,[10] excise duties, etc.; and

[8] Implicitly changes in stocks can be thought of as evidence that the system is not equilibrium.

[9] Note that a SAM does not contain information that allows the user to track the evolution of stocks. If an entry for stock **changes** is negative it indicates that a stock has been drawn down, and if it is positive that a stock has been added to. But the transactions provide no information on the size of the stocks. A zero entry does not imply that there are no stocks.

[10] NB: VAT is a tax on (final demand) commodities and NOT a tax on value added.

4. the trade and transport costs (margins) associated with the domestic marketing of commodities.

The commodity accounts therefore trace out the sources of commodities supplied to the system and the destinations of commodities once they are in the economic system.

Note that exports, and export taxes, are treated as commodity accounts. The treatment of export taxes as an expenditure by the commodity account is sensible since *de facto* the taxes are paid by domestic agents with the RoW paying free on board (*fob*) prices, which are inclusive of export taxes, for exports. Note how the inclusion of export taxes, and export subsidies, is necessary since they are expenditures (taxes) or incomes (subsidies) to the commodity accounts that ultimately pass down to the activities responsible for their production.[11]

A convention followed in this description of the information in a SAM is to treat all subsidies as negative taxes, which is a common practice. This exploits the fact that entries in a SAM can be transposed, and the sign reversed without affecting the information content, although it does impact on the row and column totals although the requisite accounting identities are preserved.

Margin Accounts

The margin accounts record the trade (wholesale and retail) and transport costs associated with transferring commodities from producers to purchasers within the economy. Thus, trade and transport costs, commonly referred to as marketing margins or margins, are part of the costs of supplying commodities to the system, i.e., entries in the column accounts, and part of the demand for commodities, i.e., commodities used to produce the services, and are therefore entries in the row accounts. The total value of margins supplied must equal the total value of margins demand for each margin service.

It is a common practice to record margins in the Commodity:Commodity sub-matrix, in which case the sum of the entries in this sub matrix must be zero, which requires that at least one entry for each service will be negative, i.e., a demand. The negative entry, or entries, arise because the supply of marketing margins must be matched by demands (expenditures equal incomes) for marketing services, which are recorded as negative expenditures in the columns

[11] The inclusion of exports in the commodity rows does raise several issues relating to the prices in the commodity rows of the SAM. These are discussed further below.

for the commodities that make up marketing services. While the practice of entering marketing services in this sub matrix is parsimonious, in the use of space, it can be confusing.[12]

Activity (or Industry) Accounts

Activity accounts record the inputs and outputs of the production system. The column entries record purchases that include intermediate inputs, both domestic and imported, and value added, where value added is broken down into payments to different factors, broadly or narrowly defined, and taxes/subsidies paid by activities on production, e.g., output taxes, and/or the use of factors, e.g., employer contributions to factor 'insurance' taxes, taxes on value added (NOT VAT). Hence the column entries detail the costs incurred during production by activities and the column sums record the total inputs to productive activities. Entries across the activity rows identify the commodities 'made' by each activity: it is convenient to only record production in the activity rows, i.e., the Activity:Commodity sub-matrix. Note that domestic production is valued at basic prices.

The major concern with the activity accounts is the detailing of the cost structures in production and payments to factors. This is reflected in the relatively common practice of only recording incomes to the activity accounts from the sale of commodities.

Note how government subsidies paid directly to activities are recorded as negative input costs despite the arguable case that they represent incomes to activities. It would be defensible to enter such subsidies in Activity:Government sub-matrix. The choice of method largely depends upon the preferences of the agency constructing the SAM. If users have different preferences, then reorganising a SAM does not change the information content and is therefore legitimate.

The activity accounts record all the productive activities of an economic system, i.e., the generation of value added: the Factor:Activity submatrix should record the domestic employment of all factors within the system.

The definition of a productive activity is important. Productive activities are defined as all those processes within an economy that can and/or do use factors to produce commodities, i.e., goods and services. This is relatively straightforward, and intuitive, when referring to

[12] This practice exploits the fact that if an entry is transposed and the sign is changed the SAM remains consistent and the information content is preserved – a negative income is an expenditure, etc.

industries, e.g., farming, manufacturing and services, but in some instances the definition is less transparent where an agent that apparently not an activity/industry apparently employs factors. For instance, the government final demand account should not include direct payments to factors, but rather there should be one or more activity accounts, e.g., education, defense, etc., that employ factors and sell their output to the government. Thus, the government can be classified as both an agent that directly or indirectly controls activities, through which it employs factors and produces outputs, e.g., services, defense, etc. and as an agent that purchases commodities. For instance, defense can be classified as an activity whose output is purchased by the government's final demand account; such a choice of classification may particularly useful if the defense system is part of the analyses or a large part of the economy.

Even less transparent may be what to do about home production for home consumption (HPHC), which are activities within the SNA's production boundary. In such cases the household may be simultaneously an activity and an institution and therefore each household would have a related activity account since only that household can produce output for home consumption. By way of contrast the leisure consumed by each household can only be produced by that household but is not an activity within the SNA's production or general boundaries. The complications, and hence limits, imposed by the SNA and general production boundaries are discussed in section 5.

Factor accounts

The row entries for factor accounts are incomes paid to factor accounts for productive services. The sum of these payments, plus incomes from factor sales abroad are GNP at factor cost. Detailed information about factor income is important if SAM data are used to analyse policy issues relating to the operation of factor markets and/or income distribution. Thus, some SAMs report detailed information about the demand for labour of different types, e.g., skilled, unskilled, clerical, manual, professional, etc., and other factors, e.g., building and machine capital, arable and pastureland, etc., by different activities. The determination of those characteristics that should be used to segment each broad factor type depends upon both the economy and the policy issues being addressed: this is particularly the case for labour accounts where distinguishing characteristics that are relevant to income distribution issues are often country specific, e.g., in South Africa it may be appropriate to distinguish between

labour types on the basis of race to evaluate legacies of apartheid, while in other economies gender may be a particularly important characteristic. But it is important to note that disaggregating factor types will only provide useful information on the transmission of employment changes, e.g., on income distribution, if there is a 'matching' disaggregation of the institutional accounts, especially by household types (see Pyatt and Round, 2012).

The expenditures by the factor accounts are recorded in the columns. Factor incomes are distributed between different types of households as labour income and distributed profits, to (incorporated business) enterprises as non-distributed profits, to government as the payment of taxes etc., and profits from government owned enterprises. It is also necessary to pay overseas owners of factors used in the economy that are resident overseas.[13]

It is the functional distribution of factor incomes implicit in the expenditures by the factor accounts that makes it so important to ensure that the degrees of detail with respect to factor types and domestic institutions are compatible.[14] For instance if there are multiple factor types but only one household type then changes in the incomes of different factors are not reflected in changes in the incomes of different households and hence changes in factor incomes do not feed down into changes in demand associated with differences in preferences across households.[15]

The SAM in Table 3.1 records depreciation as being expenditures by the factor accounts. Given this representation the payment to factors that depreciate, typically capital factors, by activities are defined as gross of depreciation, e.g., gross operating surplus, and therefore contains the implicit presumption that depreciation is an expenditure by a factor account and not by activity accounts. Alternatively, depreciation could be recorded by each activity, which recognises that deprecation rates may differ across activities, and then payments to relevant factors in the activity account columns are net of depreciation, i.e., net operating surplus.[16] Clearly the information contents of the different representations differ as do the data requirements to compile the SAM.

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13 These are NOT payments to migrant labour that is resident in the economy. If persons are resident in an economy, they are part of that economy's household accounts. Hence these payments primarily refer to payments for capital services and labour services rendered by short term visitors.

14 See Pyatt (1991) and Pyatt and Round (2012).

15 The importance of differences in preferences and the functional distribution of income is well illustrated by Defourney and Thorbecke (1984).

16 Gross operating surplus is defined as net operating surplus plus (activity specific) depreciation, which ensures that the total costs for activities are unchanged.

Mixed Income

A complication arises from the convention of reporting some factor incomes as 'mixed income' in SUT. This convention conveniently avoids the problem of separating out payments due for labour and capital services, and for agriculture land services, where there is no separation between the ownership of labour, capital and land factors. This is a common feature of self-employed people, e.g., farmers, where some of the enterprises/establishments in an activity group are self-employed.

For use in standard economic models, it is necessary to find some method, or methods, for distinguishing between the different components of 'mixed income'.

Institutional accounts

The institutional accounts include different household types (Representative Household Groups – RHG), incorporated business enterprises, other domestic institutions, e.g., non-profit organisations, and government. Incomes to institutions are recorded as row entries and expenditures as column entries. Note how the government realises different forms of tax revenue: VAT on commodities, tariffs on imports, direct and profit taxes on institutions, etc.

The distinction between incorporated and unincorporated business enterprises is important. The firms that make up activities can be owned directly by households, so-called unincorporated business enterprises. Alternatively, firms can be owned by domestic incorporated business enterprises, in which case firms are indirectly owned by domestic institutions, i.e., households and governments, who are the ultimate owners of domestic incorporated business enterprises.[17] Typically, this distinction is relevant for the capital and, sometimes, the land factors since ownership of firms is typically defined by reference to the ownership of capital. It is also likely that foreign owned firms are owned by incorporated business enterprises, although it is common to treat payments to foreign owned activities as being made directly from the factor accounts.

Household Accounts

Households primarily receive incomes from factor sales on domestic or foreign markets. Income received directly from the factor accounts are dominated by payments for labour services, with payments for capital and land services being those associated with the incomes

[17] Domestic incorporated business enterprises are often 'owned' by pension funds, and similar funds/instruments, where households are the beneficial owners of the funds.

to those factors earned by unincorporated business enterprises, e.g., self-employed business and farmers[18]. Since self-employed incomes are (typically) relatively more important in less developed economies the proportions of household incomes that come directly from the factor accounts are likely to be proportionally larger.

Household incomes from enterprise accounts are dominated by the distributed profits of enterprises, although they would also include any transfers directly from enterprises to households. Similarly, payments to households from government will be dominated by transfers, e.g., unemployment benefits and social security transfers made directly to households. Finally, there are factor incomes from abroad. Again, these will typically be dominated by payments for labour services since payments for capital services will most often be received by the enterprise accounts.

Household expenditures are dominated by consumption expenditures – demand for final commodities.[19] These are valued at purchaser prices, i.e., inclusive of any commodity taxes due on consumption by domestic households[20] and trade and transport (margin) costs. Households engage in transfers with other domestic institutions, principally other households, and with non-domestic institutions, mostly as some form of remittance. Households must also pay income taxes; in many countries, direct taxes on households and transfers from government to households are both substantial and data limitations can make it difficult to separate out these transactions. Hence, they are often treated jointly as net direct tax payments by the households; thus, negative NET income tax rates may be implied, which despite being an appropriate representation of net transactions can cause difficulties for policy experiments. Finally, the *ex post* accounting identity is ensured by the savings of households being a residual category; what is not spent or accounted for elsewhere is recorded as saving/dissaving. This reflects the fact that data on savings by households are often partial and/or difficult to verify, which can result in estimates of savings being derived as a residual.

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18 The difficulties of allocating factor incomes between labour, capital and land services means that incomes from self-employment activities is often treated as 'mixed' income; this must be resolved if the SAM is used to calibrate a CGE model.

19 The shares of consumption expenditures by different RHGs will differ according to preferences. Where RHGs are solely defined by references to differences in income levels the utility functions used in CGE models may be biased, e.g., where the gender of the 'head of household' is an important determinant of preferences.

20 VAT is typically levied on all domestic demand and then rebated, at least partially, to all domestic purchasers except for households.

Incorporated Enterprise Accounts

Incorporated enterprises are in many economies the principal recipients of the profits – returns on capital – from activities. Thus, while incorporated enterprises are ultimately owned by other (domestic) institutions – primarily households but also by government (parastatals and nationalised companies) – they should be included in a SAM, since they are important institutions in terms of their responsibility for a large proportion of domestic savings and in the pathways by which factor incomes are translated into disposable incomes that fund domestic demand.

Incomes to enterprises are dominated by the returns to capital, and to a lesser extent land, both within the domestic economy and the rest of the world – remitted profits. Expenditures are typically dominated by savings out of retained profits – often among the largest sources of investment funds in developed economies – transfers to households and government, who are the domestic owners of enterprises, or to foreign owners of the enterprises. Finally, enterprises pay direct taxes, e.g., corporation taxes, to the government, which, as with households, may be recorded net of transfers from government to enterprises.

Non-Profit Institutions Serving Households

"Non-profit institutions serving households (NPISHs) consist of non-market NPIs that are not controlled by government. They provide goods and services to households free or at prices that are not economically significant. Most of these goods and services represent individual consumption but it is possible for NPISHs to provide collective services." (SNA, 2008, 4.93).

These are institutions that cover a multitude of activities that have legal status for which there are no beneficial owners, i.e., institutions that are recipients of profits and or surpluses. Although they should be separately identified in national accounts this is not always the case. In developed economies they may represent a relatively small share of economic activities, e.g., charities, food banks, etc., in developing countries they may be significant economic agents, e.g., charities that distribute aid payments separate from the government. They are often exempt from taxes.

Government Accounts

Tax revenues are the principal source of government incomes in most countries. Taxes are required to fund government activities while also being potential policy instruments that can affect/influence economic incentives. They are, arguably, the most important single group of

direct policy instruments available to governments. Thus, tax revenues – note that SAMs record transactions (revenues) not rates – are critically important when constructing a SAM.

Ideally tax transactions will be recorded in sufficient detail to identify the major different tax instruments applied by a government; although it is very unlikely all separate instruments will be recorded as separate accounts, all tax revenues must be accounted. Taxes on commodities might separately identify import duties, export taxes, VAT, general sales taxes (GST), subsidies on products, excise taxes, etc., taxes on activities might include taxes on output and factor use – individually or in aggregate, taxes on factors may include national insurance contributions paid directly by the factor[21] and taxes on institutions will be made up primarily by direct (income) taxes. Clearly the balance will vary by country; typically, it may be expected that indirect taxes, especially trade taxes, are relatively more important the less wealthy is a country while direct taxes will be relatively more important the richer is a country and/or household group. Negative taxes, i.e., subsidies, are also possible and although it might be expected that they are positively correlated with a country's wealth, e.g., domestic agricultural support schemes in the EU and USA, there is ample evidence that subsidies are non-trivial in many less wealthy countries.

Ultimately it is the responsibility of the person(s) compiling a SAM to ensure that the detail on tax accounts included in the SAM provides a reasonable representation of the tax system operating in the country. This can however be difficult since all too often the information on tax revenues is limited, e.g., total revenues by each instrument may be recorded but it is rare to find details about actual tax payments by different agents. Ultimately the all too common 'habit' of aggregating multiple tax instruments into a catchall category, e.g., only recording import duties and a residual commodity tax, seriously compromises the usefulness of a SAM for policy analyses. Although it may be tempting to accept the limitations imposed by readily available data there are strong arguments for separating out different tax instruments even if the process may involve a substantial degree of '*guesstimation*'; in particular it may be argued that it is 'better' to analyse policy questions using correctly formulated tax instruments even if the recorded initial applied rates are of low reliability.[22] Consider for instance the case of an economy with both GST and VAT systems

[21] Some contributions to such insurance schemes will be paid by the employer, i.e., activity, and are therefore part of the costs of employment incurred by activities.

[22] Initial tax rates and how they are levied, i.e, influence behaviour, are both important.

for which the SAM only records import duties and other commodity taxes. If the VAT component is ignored and the other commodity taxes are modelled as a GST then – for positive VAT rates – the assumed tax rates on households will be underestimated while those on other agents will be overestimated and the impacts of changes in the commodity tax rates will be biased, e.g., if the GST rates are increased rather than the VAT rates to achieve a given revenue target, then production costs (for activities) will be increased while consumption costs (for households) will not increase as much as they would have done with a VAT system.

Other sources of government income include distributed profits from state owned enterprises and payments from abroad; the components of these depend upon the institutional arrangements but in most cases they will be dominated by inter government transfers.[23] A major component of inter government transfers for some countries will be official development assistance (aid) in all its guises; since in some of the least developed countries aid may constitute a substantial part of government income. These transfers are not under a government's (direct) control, but it is important to record these transfers accurately, since they will be important components of the Rest of the World account. Similarly, expenditures on aid will need accurate recording; given 'target' rates of aid remittances for OECD countries of between c 0.25 and 1 percent of GDP such expenditures are potentially important.

Other government expenditures can be complicated. In a SAM based on Supply and Use tables government consumption expenditures will cover a very limited range of commodities – this reflects the fact that included, implicitly, in such a representation of government will be one or more activities, whereas in an input-output framework government will purchase multiple commodities because it may not be treated as an activity. Whichever option is chosen it is likely consumption expenditure will account for most of government expenditure. Other categories of government expenditure include transfers to domestic and foreign institutions and government savings.

Government savings are typically recorded as an expenditure and therefore a negative entry represents the government's borrowings. Since the internal balance is an important

[23] Returns on investments abroad by state owned enterprises will most commonly be recorded as income to the enterprise accounts.

government policy target that will often require the government to vary tax rates to ensure its achievement it represents an important entry in any SAM.

Investment and Savings Accounts

This account refers to investment and its funding. Commodities in the investment account column record investments whereas the funding of investment is recorded as savings by institutions and the balance on the capital account. The representation in Table 3.1 ensures that a surplus on the capital account (deficit on the current account) is recorded as positive and a deficit (surplus on the current account) is recorded as negative. Note also that investment expenditures in Table 3.1 are recorded as gross investment: this is consistent with the definition of ***I***(nvestment) in the expenditure measure of GDP.

In many SAMs it is common to include an account that records stock changes: the column account will record the values of stock changes that will be funded by incomes provided by the main investment account. However, since stock changes can be legitimately negative, while (gross) investments must be positive, the merging of the investment and stock change accounts can generate the seemingly odd situation of apparently negative investments.[24]

Rest of the World Accounts

The rest of the world accounts record trade and other foreign transactions. These include the current and capital accounts, and visible and invisible trade. Imports are implicitly valued carriage insurance and freight (*cif*) paid in Table 3.1, which is a typical approach when constructing a SAM for a single region, while exports are recorded free on board (*fob*). When a SAM is constructed to analyse trade issues that may involve changes in trade costs for imports then it may be appropriate to include multiple trade accounts with imports valued *fob* from the source regions and to include accounts that record trade costs by trade partner; this formulation is used in the Global Trade Analysis Project's (GTAP) database.

Visible trade - trade in goods and services – is relatively straightforward but only constitutes part of the current account. Other components of the current account, which have been detailed above, are important. Any transactions missing from the current account are likely to end up either being included in the balance on the capital account, which will then

[24] If the two accounts are combined it may be necessary to address this situation in the formulation of the model.

not be reconciled with the national accounts, or as distortions in the estimates of other transactions on the current account. Where other transactions on the current account are relatively small this may not be an issue, but, as noted above, in some countries aid transfers may make up a substantial proportion of government income and households may receive a substantial proportion of their incomes from remittances.

3.3 Individual Accounts

The choice of individual accounts in a SAM may initially appear straightforward. It is clearly a truism to assert that the choice of individual accounts should reflect the analytical purposes of the SAM. Hence, if the focus is on agriculture, then multiple commodities and activity accounts that reflect the agricultural/rural economy are required. For commodities the choices may be relatively obvious, but for activities the choice may be less obvious. Agricultural production functions are dependent on soil types, (micro) climate, altitude, etc., and such relevant characteristics should be reflected in the choice of individual activities, e.g., sheep may be produced on both upland and lowland farms with very different costs of production and output prices.

Similarly, choice of factor accounts should reflect those factors used by different activities. For agriculture (agricultural) land is a defining factor that may not be used by other activities, while for most activities the distinction between 'fixed' (buildings, etc.,) and 'variable' (vehicles, generic machines, etc.,) capital may be important. For labour the obvious criteria are some measures of skills, crudely unskilled, semi-skilled and skilled, but skilled workers in one activity may be 'unskilled' in another activity so categories may be opaque. It is common practice to use data collected in labour force surveys to categorise labour types, but labour force surveys often follow the International Labour Organisation's (ILO) practice of defining labour characteristics by occupation. The choice of factor accounts is important when the focus is on the 'functional distribution of income' (see Pyatt, 2002)

When the focus is on the distribution of income to household is a concern the choice of Representative Household Groups (RHG) is critical. Here the choice must reflect both income and expenditure considerations. In models the patterns of expenditure by each RHG are represented by utility functions, and thus relevant determinants of preferences should be reflected, e.g., female vv male 'headed', pensioner vv young adults, rural vv urban. On the income side the endowments of the different RHGs need to be reflected. Clearly the choices

will involve compromises, but resorting to crude criteria, e.g., income deciles or educational status of 'head' of RHG, may be inappropriate.

However certain considerations are critical. Pyatt and Round (2012) identified an issue of distributional invariance and demonstrate the importance of the interactions between the numbers of factors, RHG and activities\commodities. Where the analytical focus is income distribution, they identify a 'rule of thumb' that defines the maximum number of RHG (*h*) as being determined by the minimum of the number of factors (*f*) and activities\commodities (*g*)

$$\min\left([f],[g]\right) \geq [h].$$

where [*] is the number of elements in *f*, *g*, and *h* (Pyatt and Round, 2012, p 266). In practical terms this usually comes down to the number of RHG not exceeding the number of factors simple because production data are relatively abundant. Similarly, the options for the number of RHGs that can be derived from household surveys can often exceed the number of factor accounts available from labour force surveys[25].

In a simple case this is obvious, if there is one factor of production but two RHGs then no information about the distribution of income is provided after the system is shocked. Equally, multiple factor accounts can provide no information about income distribution if there is a single RHG, although they will provide information about the functional distribution of income. Hence,

> *"The choice of a classification system or taxonomy for households, say, should not, therefore, be determined independently of the way in which goods or factors of production are classified. This is one general principle that can be recommended. A second is that classification systems should be designed in such a way that any underlying duality is apparent." (Pyatt and Round, 2012, p 267)*

[25] This reflects the fact that statistical agencies typically use the ILO's occupation categories.

4. Macro-SAM and National Accounts Matrix

It is common practice to aggregate accounts within a SAM to produce a, so-called, macro-SAM that may be based on the nine groups of accounts identified in Table 3.1.[26] As a descriptive summary of the national accounts such a macro-SAM is useful. But for a summary of transactions relevant to price driven whole economy models it is, arguably, sensible to identify separately the aggregate values of the different tax instruments operating in an economy, e.g., VAT revenue, excise revenue, and income and wealth tax revenues, especially if it is planned to use the macro-SAM to provide 'control totals'[27] for use when estimating a micro-SAM.

But the structure for a SAM presented in Table 3.1 is superficially inconsistent with the format for national accounts data set out in the SNA. The SNA format, sometimes known as a National Accounts Matrix (NAM) (EC, 2003, Chapter 2), ultimately contains the same information that may be reported in a macro-SAM but uses a difference set of aggregate accounts to report the distribution of resources, see Table 4.1.

The substantive differences between and macro-Sam and a NAM related to the distribution of income accounts: Allocation of Primary Income, Secondary Distribution of Income and Use of Disposable Income with each of these aggregate accounts defined over a set of institutional accounts. Other differences include segmenting the capital accounts to separately identify the sources of savings and investment – the capital account – from gross fixed capital formation and distinguishing between current and capital transactions with the Rest of the World (RoW).

An examination of the NAM in Table 4.1 and a macro-SAM derived from Table 3.1 demonstrates that the transition from a NAM to such a macro-SAM involves a straightforward process of reallocating transaction values (TVs). Hence, a NAM and a macro-SAM could be used interchangeably. However, there are circumstances where using a NAM may be more convenient even if a final micro-SAM will follow the format in Table 3.1.

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[26] The option of collapsing the margins account into the commodity:commodity sub matrix is common.

[27] 'Control totals' are scalars or aggregates that can be used to define, with varying degrees of precision, the total value of different sub-matrices of a SAM. They are crucial components of mathematical techniques used to estimate SAMs.

Table 4.1 National Accounts Matrix

	Commodities	Activities	Generation of Income	Allocation Primary Income	Secondary Dist'n of Income	Use Disposable Income	Capital	GFCF	Financial	Rest of World, Current	Rest of World, Capital
Commodities	Trade & Transport Margins	Intermdediate Inputs	0	0	0	Consumption Expenditure	Changes in inventories	GFCF	0	Exports of Goods & Services	0
Activities	Production	0	0	0	0	0	0	0	0	0	0
Generation of Income	0	Net Value Added, Production taxes	0	0	0	0	0	0	0	Compensation from RoW Employees	0
Allocation Primary Income	Taxes & Subsidies on Products	0	Net Generated Income (BP)	Property Inomce	0	0	0	0	0	Property Payments, taxes and subsidies	0
Secondary Dist'n of Income	0	0	0	Net National Income	Current transfers	0	0	0	0	Current transfers from RoW	0
Use Disposable Income	Commodity Taxes	0	0	0	Disposable net Income	0	0	0	0	0	0
Capital	0	0	0	0	0	Net Savings	Capital transfers	0	Net Insurance liabilities	0	Capital transfers from RoW
GFCF	0	Consumption of Fixed Capital	0	0	0	0	Net Fixed capital form'n	0	0	0	0
Financial	0		0	0	0	0	Net acquistions fin'l assets	0	0	0	Net Lending of RoW
Rest of World, Current	Imports of Goods & Services	0	Compensation , Employees	Property Payments, taxes and subsidies	Current transfers to RoW	0		0	0	0	0
Rest of World, Capital	0	0	0	0	0	0	Capital transfers	0	0	Current External balance	0
Account Totals	Commodity Supply	Cost of Production	Expenditure on Factors	Institutional Expenditure	Institutional Expenditure	Consumption Expenditure	Investment Expenditure	GFCF			

The NAM format is consistent with the conventions advocated in the SNA. If national accounts agency chooses to present its national accounts in an SNA compliant format, then it is arguable that the NAM format should make identification and allocation of TVs to cells in the matrix more transparent, although at the expense of working with a larger matrix. Among the advantages of transparency are simplification of revising/updating the TVs. In addition, compliance with the SNA conventions may enhance the acceptability of the final micro-SAM to governments, policymakers, and national accounts agencies.

Ultimately the choice of format for summary/aggregate national accounts data will be a matter of pragmatism. If the national accounts are presented using the SNA conventions, then that NAM approach may, arguably, be preferable.

Whichever format is chosen it is appropriate to include as much detail as possible about the revenues realised by different tax instruments. Similarly, the choice of format does not change the need to emphasise completeness as more important in the early phases of developing a SAM over consistency.

Role of NAM or Macro-SAM

The roles of a NAM or Macro-SAM depend on whether the compiler of a SAM is engaged in a bottom-up or top-down procedure. With the former procedure the NAM or Macro-SAM provides summary aggregate economic data, with the latter procedure the NAM or Macro-SAM provides 'control' totals that enter the estimation process as parameters that must, to a greater or lesser extent, be replicated.

Thus, for a top-down procedure a NAM or Macro-SAM is a summary of published national accounts data. In theory the resultant NAM and Macro-SAM will be **complete** and **consistent**, which requires that the national accounts have been reconciled. In practice national accounts are too often incomplete and inconsistent. The compiler then faces a quandary: does s/he reconcile the NAM/Macro SAM or do they use some or all the data point in an estimation process. The choice will depend on the estimation metric.

5. The Production Boundary and Price System in a SAM

The definition of the production boundary in the System of National Accounts and the price system are interrelated. The production boundary defines what is and what is not included in an SNA compliant SAM while the price system explains how prices are defined for activities within the production boundary. Irrespective of the production boundary and price system used in a SAM, all SAMs must be complete and consistent. Hence this section looks more closely at the meaning of complete and consistent.

5.1 Complete and Consistent

All too often SAMs are evaluated solely based on the consistency condition, i.e., that row and column totals for all accounts equate, and the completeness condition, i.e., the SAM does not record all TVs, is not considered. With respect to these conditions, SAMs can be assigned to one of four categories.

> *"[I]t is **impossible** to establish by direct estimation a system of national accounts free of statistical discrepancies, residual error, unidentified items, balancing errors and the like since the information available is in some degree incomplete, inconsistent and unreliable. Accordingly, the task of measurement is not finished when the initial estimates have been made and remains incomplete until final estimates had been obtained which satisfy the constraints that hold between their true values." (Stone, 1982, p 186, emphasis added).*

The task of deriving a complete and consistent SAM is complicated by the fact that the available data will be "in some degree incomplete, inconsistent and unreliable". In essence the compilers of SAM are confronted by a problem of imperfect information, that is further complicated by the (unacknowledged!?) fact that published national accounts data are measured with error.

Incomplete and Inconsistent

This is often the starting point when compiling a prior SAM where the data can be categories as incomplete and imperfect and hence the prior SAM will be inconsistent. Since no prior SAM can be consistent if it does not include estimates for all non-zero cells, i.e., all relevant TVs, the focus must be directed to developing a prior SAM that is complete.

This process may require the compiler to make some 'heroic' assumptions. For instance, economic theory and empirical evidence may dictate that some cells must be non-zero but no, or very limited, data are available. If such cells are assigned zero values, the resultant prior SAM will always be incomplete. Thus, even assigning random, but realistic, TVs to those cells allows for the possibility that the prior SAM will be complete.[28]

Hence the priority when compiling a SAM is completeness, even if the error bounds on some prior cell estimates are very wide. Ensuring completeness is the most difficult and time-consuming activity when compiling a SAM, moreover, determining when a prior SAM is complete is nebulous.

In this case mathematical estimation techniques can be used not only to achieve consistency but also to identify those prior cell estimates that are 'less' reliable, e.g., cells that require large adjustments, and/or prior cell estimates that would most enhance the information content of the priors, e.g., that return the higher marginal value when using SAMEST.

Incomplete and Consistent

Arguably this is the case with all SAMs used for economic analysis. In such cases the prior SAM was incomplete, and a mathematical estimation technique has been used to render the SAM consistent as a single process. The critical issue is the empirical relevance of the missing cell priors.

A consequence of a SAM being incomplete and consistent is that some, or many, TVs in the SAM are biased. The extent and magnitude of the biases may be unknown. In the context of CGE model, it is likely that the most egregious biases will be those that impact on tax rates and factor prices, although all such biases may be important.[29]

The extent to which incomplete biases are problematic depends on the magnitude of the biases, the cells that are biased and the potential impact of biases on behavioural relations in model applications.

It is arguable that to some degree all SAMs are incomplete, which given the opaqueness of completeness, places a large burden on the judgement of the compiler, particularly with

[28] NB: a criterion for all known estimation metrics used to develop SAMs is that a zero-prior estimate for cells ensures that those cells are zero in the final SAM.

[29] In climate change models biases in emission rates, e.g., CO2, will be critical.

respect to identifying missing priors for relevant transactions. To some extent this is an art as much as science.

Complete and inconsistent

This is in some senses the simplest case. The prior SAM is complete, at least in the sense that all relevant cells report transaction values, although, as noted above, completeness is nebulous.

Rendering complete prior SAM consistent is a task well suited to mathematical techniques. Ideally these mathematical techniques will be used to refine the prior SAM to improve the information content of the final SAM.

Complete and Consistent

Satisfying both conditions is a 'gold standard'. Mechanically rendering a prior SAM consistent is trivial, whereas determining that the prior SAM contains non-zero prior transactions for all relevant transactions requires the compiler to go beyond mathematical methods and to employ theoretical and empirical evidence to determine logically those transactions that exist but for which there may be no data.

The basic problem is that of 'unknown unknowns', which is intractable. Hence the case for using estimation techniques based on information theory that can help identify the 'unknowns'.

5.2 The SNA Production Boundary

Most undergraduate macroeconomic textbooks include a brief critique of the definition of GDP by reference to what is and what is not included in GDP. The simple critiques concentrate on those items included in GDP that are considered, by some, to not contribute to welfare, e.g., defense spending. More complex critiques all relate to what is classified as being within the SNA's production boundary and what is classified as being outside the production boundary, e.g., pollution, non-market domestic services, leisure, etc. The SNA defines the production boundary as

> *"In the SNA, production is understood to be a physical process, carried out under the responsibility, control and management of an institutional unit, in which labour and assets are used to transform inputs of goods and services into outputs of other goods and services. All goods and services produced as*

> *outputs must be such that they can be sold on markets or at least be capable of being provided by one unit to another, with or without charge. The SNA includes within the production boundary all production actually destined for the market, whether for sale or barter. It also includes all goods or services provided free to individual households or collectively to the community by government units or NPISHs."* (SNA, 2008, para 1.40, p 6)

This definition essentially revolves around the requirement that it must be possible to associate an 'unambiguous' market price to the output of activities if they are to be included within the production boundary.

Consequently, many activities that may be regarded as important are excluded, e.g., childcare by parents, care of the elderly by families, etc. These are examples of services provided by and solely consumed by households. The reason is a problem of valuation and is easy to understand. Take the case of childcare by parents: the purchaser price of childcare is the price a household would have to pay an activity that provides childcare services, but the value of parental childcare could/should be expressed in terms of the opportunity cost of foregone income. But the opportunity cost of foregone income differs across households depending upon the wages/salaries that the adult would have realised if they had sold their labour services; hence when valued at opportunity cost there is not a unique price, and the value to different households will encompass a range of prices.

This example also serves to identify one of the problems presented by the SNA production boundary. Services provided by, and solely consumed by households, e.g., parental childcare, do not contribute to measured economic activity while childcare purchased in a market does contribute. Assume a government provides universal and compulsory childcare: measured economic activity will, by the SNA definition, increase because all childcare is now within the production boundary and has an unambiguous price. But does this represent a real increase in welfare?

Another problem can arise with respect to what is included within the production boundary. Consider circumstances where activities that produce goods that can be sold on the market and/or retained for home consumption by the household activity that produced the goods, so-called home production for home consumption (HPHC). These goods can be assigned an unambiguous price, the basic price, e.g., the farm gate price. For those goods

retained for home consumption the purchaser price is equal to the basic price because no commodity taxes or marketing margins are incurred. But for those goods that are sold the purchaser prices would exceed the basic prices by cost of marketing margins and any commodity positive taxes due. HPHC is typically limited in developed economies but can account for a large share of the volume of consumption in developing countries (see Ariage *et al*, 2016, for a SAM and model with HPHC).

It is also notable that externalities associated with activities, e.g., pollution, are excluded, along with activities that deplete natural resources, e.g., deforestation, depletion of mineral reserves. These topics are being addressed by the System of Environmental Economic Accounting, e.g., UN (2012) and UN (2024) and https://seea.un.org/ .

The issues presented by how the SNA's production boundary is drawn and how models may be adjusted to better represent economic activities are beyond the scope of this description. Some research has extended models so that they, arguably, enhance the modelling of such economic activities.

5.3 Price System in a SAM

An understanding of the system of prices in a SAM is important if the data are to be used appropriately in any economic model. So far, the discussion has avoided a detailed explanation of how the prices in a SAM are defined.

Understanding the price system in a SAM is critical to the development of the price system in any CGE model. This section explains the price system in the System of National Accounts and its implications for the interpretation of a SAM consistent with the price system in the SNA.

The SNA defines three key prices (see SNA, 2008, 6.49 to 6.69):

1. Purchaser Prices - the prices paid by purchasers, which include transport and distribution margins and any VAT payable.
2. Producer Prices - the price paid to the producer by the purchaser less any VAT or other deductible tax and any transport or distribution charges invoiced separately.

3. Basic Prices - the price paid to the producer by the purchaser less any tax payable plus any subsidy receivable but excluding any transport or distribution charges invoiced separately.

These relationships between these prices are summarised in a figure (Figure 5.1).

The key prices for a CGE model are the basic and the purchaser prices. Typically, in a SAM, commodities supplied to an economy by domestic activities and the rest of the world will be valued in basic prices, while commodities used by an economy will be valued in purchaser prices. It is useful to see how these prices are recorded in a SAM, but to do so requires examining how inter-industry tables are recorded in a SAM.

Figure 5.1 SNA Price Relationships

Basic prices
+
Taxes on products excluding invoiced VAT
-
Subsidies on products
=
Producers' prices
+
VAT not deductible by the purchaser
+
Separately invoiced transport charges
+
Wholesalers' and retailers' margins
=
Purchasers' prices

Source: SNA (2008), Figure 6.1, p 103.

How purchaser prices are defined can be deduced from the information in Table 3.1 and the 'law of one price', i.e.,

$$VM^{bp}_{w,c} = SAM_{w,c} + \sum_{tm} SAM_{tm,w,c}$$

$$VC^{bp}_{c} = \sum_{a} SAM_{a,c} + VM^{bp}_{w,c} = \sum_{a} SAM_{a,c} + \sum_{w} SAM_{w,c} + \sum_{tm,w} SAM_{tm,w,c}$$

$$VC^{pp}_{c} = \sum_{c} SAM_{a,c} + \sum_{w} SAM_{w,c} + \sum_{tm,w} SAM_{tm,w,c} + \sum_{m} SAM_{m,c} + \sum_{ts} SAM_{ts,c}$$

$$= \left(VC^{bp}_{c}\right) + \left(\sum_{m} SAM_{m,c} + \sum_{ts} SAM_{ts,c}\right)$$

where

$VM^{bp}_{w,c}$ is the value of imports at basic prices made up of the value of imports of *c* from country *w*, $SAM_{w,c}$, and the realised value of import duties, *tm*, on imports of *c* from *w*, $SAM_{tm,w,c}$;

VC^{bp}_{c} is the value of commodities supplied at basic prices made up of the value of imports at basic prices and the value of domestic production at basic prices, $SAM_{a,c}$; and

VC^{pp}_{c} is the value of commodities demanded at purchaser prices made up of the value of commodities supplied at basic prices plus value of margins *m* on *c*, $SAM_{m,c}$, and the realised value of commodity taxes, *ts*, on *c*, $SAM_{ts,c}$.

Note how this accounting definition ensures that the total value for each commodity at purchaser prices is uniquely defined by the transaction values in the columns of the SAM. By combining this accounting identity with behavioural relationships for how each tax and marketing margin is applied, the purchaser price for each commodity in the SAM can be defined. The same basic calculations can be conducted to derive the total value of income for each account from the respective column and with the addition of behavioural relationships the price definition for each row of the SAM can be determined.

6. Interpreting the Information in a Social Accounting Matrix

The interpretation of the information in a SAM requires practice. In this section an aggregate SAM for Botswana is used to illustrate some of the information that can be gleaned from a SAM by simple inspection.

Social Accounting Matrices (SAMs) have a disconcerting habit of being heterogeneous. Consequently, it is not possible to develop a 'universal translator' for interpreting the information content of SAMs. Rather it is argued that the best way to appreciate and understand the information contained in SAMs is by practice gained from interpreting SAMs. This section begins by providing an interpretation of the aggregated SAM for Botswana: chosen because the economy has a number of interesting features. This is followed by some suggestions about how you can simplify the process.

Experience has demonstrated that a simple, and relatively quick, assessment of the information content of a SAM is sufficient to identify potential problems that will arise if the SAM in question is used to calibrate a CGE model; thereby avoiding wasting time trying to work out why a CGE model generates 'peculiar' simulation results.

6.1 A Macro SAM for Botswana

Table 6.1 reports an aggregate or macro-SAM for Botswana that has been derived from the 1992/3 .[30]

The macro-SAM for Botswana indicates that the total value of supply of commodities is made up of 18.7% from imports (*cif*), 71.9% from domestic production, 3.7% from domestic trade and transport margins and 5.6% from taxes on commodities. Unfortunately, this macro-SAM does not separate out import duties from other (domestic) commodity taxes and therefore it is not possible to comment on the distribution of commodity tax burdens across different commodity tax instruments. The largest source of commodity demand is for intermediate inputs, but even this only accounts for 29% of total demand, the next biggest category is export demand (21%) followed by household demand (19%), government demand (13%), investment (13%), domestic trade and transport margins (4%) and finally other (domestic) institutions (less than 1%). With nearly 30% of domestic production exported and

[30] The organisation of the accounts differs from those in the published SAM. The change in structure has been made for pedagogic reasons - it makes the data structure consistent with that used elsewhere.

20% of supply imported this indicates an open economy, while the extent of the government's share of domestic demand indicates a substantial degree of government involvement in the economy.

The production structure is apparently not well developed with only a 40% share of inputs being intermediates,[31] a 59% share going to factors (primary inputs). 50% of factor incomes go to other institutions, 6% go directly to the government and the remaining 43% are distributed to households and thereby account for 89% of household incomes. The remainder of household income comes from transfers (7%) and the rest of the world (4%)[32].

Clearly the disaggregated SAM contains a substantial amount of information relating to the transactions taking place between domestic institutions, and indeed this is one of the great strengths of the Botswana SAMs.

The nature of transactions involving the other institutional accounts is revealing about the economy of Botswana. Most of the income received by other institutions comes from payments for factor services (50%), but there are also substantial payments from the rest of the world (12%) and large transfers (37%). Payments from the rest of the world are in fact dominated by earnings on foreign investments while the transfers are largely dominated by intra institutional transfers. Some of the extent of this is indicated by the fact that other institutions are responsible for 71% of the income to the transfers account with the government only contributing 16%, the rest of the world 9% and households 3%. The complexity of the intra institutional transactions is further indicated by the expenditures on the transfers account – 46% to government, 37% to other institutions, 8% to the rest of the world and 7% to households. Much of the reason for the apparent complexity lies in the pattern of the transactions whereby the government receives royalties in respect of mineral – primarily diamond – extraction, but this is only part of the reason. The rest is to be found in a combination of detailed accounting for inter institutional transactions, which capture the pathways by which incomes are received and limits on the amount of detail available in the underlying data that necessitate the transfer accounts where details about both payees and recipient are not complete.

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31 In developed economies, the intermediate input share of production costs is typically in the mid-fifties.

32 The remittances from the rest of the world remain dominated by remittances from migrant workers in South Africa although these are much smaller than they were even 15 years earlier.

Table 6.1 A Macro SAM for Botswana in 1992/3

	Commodities	Activities	Factors	Transfers	Households	Other Institutions	Govt - Taxes on Products	Govt -Taxes on Production	Govt - Subsidies	Govt - Taxes on Income	Other Government	Capital	Rest of World
Commodities	(717)	5,660	0	0	3,599	151	0	0	0	0	2,596	2,545	4,083
Activities	13,922	0	0	0	0	0	0	0	0	0	0	0	0
Factors	0	8,291	0	0	0	0	0	0	0	0	0	0	0
Transfers	0	0	0	0	170	4,649	0	0	0	0	1,067	0	626
Households	0	0	3,583	272	0	0	0	0	0	0	0	0	170
Other Institutions	0	0	4,183	3,070	0	0	0	0	0	0	0	0	1,010
Govt - Taxes on Products	1,087	0	0	0	0	0	0	0	0	0	0	0	0
Govt -Taxes on Production	0	15	0	0	0	0	0	0	0	0	0	0	0
Govt - Subsidies	0	-44	0	0	0	0	0	0	0	0	0	0	0
Govt - Taxes on Income	0	0	0	0	94	1,263	0	0	0	0	0	0	0
Other Government	0	0	525	2,528	0	0	1,087	15	-44	1,356	0	0	0
Capital	0	0	0	0	105	1,190	0	0	0	0	1,731	856	-481
Rest of World	3,625	0	0	641	57	1,012	0	0	0	0	73	0	2,322
Total	19,351	13,922	8,291	6,512	4,025	8,263	1,087	15	-44	1,356	5,467	3,402	7,729

The importance of income as a source of government incomes is shown by the fact that transfers account for 46% of government income, which is slightly more than the 44% that comes from tax revenues. The government is also a major source of investment funds providing 65% of all investment funds with a further 43% coming from other institutions and only 4% from households. However, as part of government policy, the running of a trade surplus means that the balance on the capital account is negative, i.e., there is an outflow of investment funds.

Overall, even the macro-SAM for Botswana is illustrative of the potential information content of a SAM while demonstrating the importance of at the least some knowledge of an economy to assist in interpreting the information. A full version of the SAM for Botswana is included in the accompanying Excel workbook.

6.2 Suggested Methods for Aiding the Interpretation of SAM

The best option is to get copies of different SAMs and spend time analysing their information content. With practice users will find some things become second nature when confronted by a new SAM. The following are a series of steps that can save time; some of them, especially the first few, might appear so trivial that you can ignore them, but you do so at your peril. These steps can all be done in Excel; with practice the computations take a matter of minutes (certainly less time than would be required to organise the data so that they can be calculated in GAMS).

1. Before looking at the SAM learn about the economy.
    - Are there any structural features about the economy that should be reflected in the SAM, e.g., natural resource exports, income distribution, role of government, etc?
    - Are there accounts that should appear in the SAM, given the structural features of the economy?
    - What are the values of the macroeconomic indicators for the year of the SAM? (Look these up at the economy's statistical agency or the World Bank database.)
    - Was the year for the SAM a typical year, e.g., was there a drought, was there an oil price spike?

2. Check that the SAM has an appropriate set of accounts.
    - Does the account structure (commodities, activities, factor, households) reflect the structure of the economy, e.g., does a SAM for Ethiopia include the commodity teff – the staple Ethiopian grain?
    - Is there sufficient detail in the factor accounts to provide sufficient detail about sources of household incomes, and vis-a-versa?
3. Check that there are the same number of rows and columns.
    - Some practitioners have claimed that a SAM can be non-square; they are **wrong**. NB: a row or column can contain no entries, which in some programmes means the row/column is not displayed.[33]
    - Check the row and column labels are matched in terms of both the text and order; both inconsistencies are a nuisance and will cause problems later. This can be done using a simple IF statement where the value is zero if they match and 1 if they do not match.
    - Some programmes, e.g., GAMS, do not report zero values, which means that a column/row can sum to zero if the respective row/column contains a specific mix of positive and negative values. If this is the case it may be helpful to reorganise the SAM by transposing the negative values and changing the sign.
4. Check that the row totals and the column totals are identical.
    - If the row and column total are not identical then there is a consistency problem with the SAM.
        - GAMS works to double precision so identical means the same to about 12/14 decimal places. Some programmes work to single precision, e.g., GEMPACK, so identical would be about 6/7 decimal places.
    - If the row and column totals are not identical, use the computed totals and differences to determine which transaction or transactions are apparently wrong. It may be a simple typing error!!!

[33] If this is the case, then the corresponding column/row will have at least one negative value.

- If the errors are widespread in the SAM, and/or there is no obvious explanation, it is not worth analysing the information content before resolving the errors.

5. Compute the column coefficients.

    - The column coefficients are cost shares and are the **most important determinants** of the results from CGE models.
        - Column coefficients for some sub matrices may be needed to 'unmask' odd entries.
    - If the column coefficients are the same for two, or more, accounts within the same group then, unless there is a known good reason the accounts should be aggregated since they contain no additional information. The interpretation of common column coefficients, assuming they are based on data, would be
        - Activities: two, or more, activities are producing an identical output;
        - Factors (expenditures): two, or more, institutions have identical patterns of factor ownership;
        - Households: two, or more, households have identical preferences.
    - Intermediate Input Use (additional column coefficient matrices)
        - it is not uncommon for data compilers to have very little information on the breakdown of intermediate input costs. Check for logically inconsistent entries, e.g., energy producing activities that use small amounts of fossil fuels, etc.
    - Factor Use by activity (additional column coefficient matrix)
        - are the factor costs logically consistent? Are the cost shares for capital logical, i.e., higher for capital intensive industries; are the cost shares for 'skilled' labour consistent with the nature of the activity, etc.
    - Households
        - Are savings and direct tax rates logical, e.g., are the tax and savings rates greater for richer households? Are the direct tax rates consistent with expectations, e.g., are poorer households paying high direct rates?

Are the consumption patterns consistent, e.g., is the share of expenditure on food higher or lower for poorer households?

- Exports
    - Are the patterns of exports consistent with expectations, e.g., diamonds from Botswana, oil from Saudi Arabia, cars from Germany?

6. Compute the row coefficients
    - Are the patterns of tax revenue to the government consistent with expectations, e.g., is the share of direct tax high for a developing economy?
    - Are the patterns of household incomes consistent with expectations, e.g., do richer households get more of their incomes from capital and skilled labour?
    - Imports
        - Are the patterns of imports consistent with expectations?

7. Satellite Accounts

An important development of the SNA has been satellite accounts. These have been given impetus by concerns about the environment and the development of environmental accounts (UN, 2000; UN, 2012), but satellite accounts are generic and relate to many socio-economic issues, e.g., demographics, factor quantities, education, emissions, commodity quantities, etc. The satellite accounts that are relevant in the context of whole economy models are matrices of data that are linked, by theory, in a meaningful way to sub matrices of transactions in a SAM.[34]

7.1 Quantity Data

SAMs are matrices of transactions values, but economic models can ofttimes be enhanced using quantity data. The options are extensive, and the choice of satellite accounts developed is likely to depend on the envisaged use of the database. Two illustrative examples are illustrated here: the first are satellite accounts with demographic data linked to two (illustrative) RHGs ('urban' and 'rural') and the second are quantity data linked to three (illustrative) activities ('agriculture', 'manufacturing', 'energy'), see Table 7.1. Other options for satellite accounts may include water, land use, health, tourism, ecology, and nutritional content of foods.

The (illustrative) demographic data provide information about the number of persons in each RHG (Adults, Children, Adult equivalents, Dependent adults) and the age profile of each RHG; these data can be useful for converting value data for each RHG into per capita data, e.g., income per capita or per adult equivalent, and assessing dependency and fertility ratios. The data on educational attainment can provide information about the inherent level of 'skills' possessed by members of the RHGs, which can be used to assess the evolution of educational status over time. These types of satellite data were those used by Stone (1971) when developing demographic accounts, which evaluate the evolution of populations and, *inter alia*, their health status and educational attainment, that can be linked to economic models.

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[34] The SNA identifies two types of satellite accounts; those that "do not change the underlying concepts of the SNA in a fundamental way" (UN, 2008, para 29.5, p 523) and those that are "mainly based on concepts that are alternatives to those of the SNA." (UN, 2008, para 29.6, p 523). In day-to-day use CGE models primarily use satellite accounts of the first type.

Table 7.1 Satellite Accounts – Quantities

2	**Activities**			0		0
3	**Factors**	**Skilled labour**		Wages		0
		Unskilled Labour		Wages		0
		Capital		Profit'		0
		Land		Rent		0
4	**Households**	**Urban**		0		Inter Household Transfers
		Rural		0		Inter Household Transfers
	Enterprises			0		
	Government			Production Taxes		Income Tax & payments to Govt
5	**Savings**			0		Household Savings
6	**Rest of World**			0		Remittances to RoW
	Totals			Cost of Production		Household Expenditure

Agriculture	Manufacturing	Energy
Factor Quantities		
Skilled labour		
Unskilled Labour		
Capital		
Land		
Emmisions		
CO2		
NO2		
Energy Use		
Coal		
Oil & Gas		

Urban	Rural
Population	
Adults	
Children	
Adult equivalents	
Dependent adults	
Age profile	
Education	
None	
Primary	
Secondary	
Tertiary	

The satellite accounts linked to activities provide details on the quantities of different factors employed by each activity, and implicitly the factor returns, the quantities of different energy inputs used, e.g., coal and oil & gas, and emissions, e.g., CO2 and NO2. The emissions data can be linked to the quantities of specific inputs, e.g., coal, or simply to the level of output by the activity.

Satellite accounts represent an important component of the links between the SNA and the System of Environmental and Economic Accounts (SEEA) (https://seea.un.org/), which is indicative of the likely future importance of these accounts to whole-economy economic models.

A1. Inter-Industry Tables and SAMs

Inter-industry tables can, typically, be presented either as input-output tables (IOT) or supply and use tables (SUT). The distinction is not trivial, and some understanding of the differences is important, especially as the formulation of IOT presented in standard economics texts can be, and usually is, misleading.

A1.1 Inter-Industry Tables

In the context of the SNA, when statisticians collect data for estimating inter-industry transactions, they seek answers to two key questions: what did each agent use (absorb/demand) and what did each agent supply (make). The former question provides the data for the USE table and the latter for the SUPPLY table.[35]

In a SUPPLY table the purchasing agents, in the columns, are commodities while selling agents, in the rows, are activities and the rest of the world (see Table A1.1). The SUPPLY table thus contains a subset of the matrices in the SAM illustrated in Table 3.1 and records the supply of commodities to an economy from domestic production, by activities, and imports, from the rest of the world. In the SNA, the prices paid to the producers are basic prices; thus, the prices received by domestic activities and prices paid for commodities from the rest of the world *basic* prices. The basic prices received by domestic producers can be conceived of crudely as 'factory gate' prices, i.e., before any domestic trade and transport costs have been incurred or any domestic commodity taxes have been levied. The basic prices by foreign producers can be conceived of crudely as 'dock gate' prices, i.e., after any costs incurred transporting the commodity into the country and any import duties have been paid, but before any domestic trade and transport costs have been incurred or any domestic commodity taxes have been levied.

In a USE table the purchasing agents, in the columns, are activities and institutions while selling agents, in the rows, are commodities and factors (see Table A1.2). The USE table thus contains a subset of the matrices in the SAM illustrated in Table 3.1 and records the use of commodities and factors by activities, institutions, and the rest of the world. In the SNA, the prices paid by agents are *purchaser* prices.

35 In earlier versions of the SNA these tables were known as MAKE and ABSORPTION.

The row and column totals for a SAM must be identical; thus, the value of each commodity supplied to the economy (column total) must equal the value of each commodity demand by the economy (row total). The information needed to relate basic and purchaser prices is contained in the SUPPLY table. In simple terms, the difference between basic and purchaser prices are domestic commodity taxes paid, e.g., VAT, excise taxes and general sales taxes (GST), and margins, so adding the values of commodity taxes paid and marketing margins incurred to the values, at basic prices, of commodities supplied generates the values, at purchaser prices, of the commodities supplied.

Thus, for the commodity accounts domestic production and imports should be valued in basic prices, while intermediate inputs, domestic final demand (by institutions) and exports should be valued in purchaser prices. This is how they are valued in SNA compliant SUT, which has implications for the price system in a CGE model: the tax and margin rates determine the markup between basic and purchaser prices and are, implicity, assumed identical for all commodities and agents.

Table A1.1 A Supply Table

		1 **Commodities**
1	**Margins**	Marketing Margins
2	**Activities**	Production
6	**Government**	Commodity Taxes
8	**Rest of World**	Imports of Goods & Services
9	**Totals**	Commodity Supply

Table 5.2 A USE Table

		2 **Margins**	**Activities**	4 **Households**	6 **Government**	7 **Capital**	8 **Rest of World**	9 **Account Total**
1	**Commodities**	Marketing Margins	Intermediate Inputs	Household Consumption	Government Expenditure	Investment Expenditure	Exports of Goods & Services	Commodity Demand
3	**Factors**		Remuneration of Factors					
6	**Government**		Production Taxes					
9	**Totals**		Cost of Production					

A1.2 Input-Output and Supply and Use Tables

An inter-industry table is symmetric if the row and column labels and totals are identical, the table is square, and each activity (industry) produces a unique commodity (product) and only that product. This is how input-output tables (IOT) are defined and presented, whereas supply and use tables (SUT) are asymmetric in that the row and column labels and totals are not necessarily identical, and therefore the tables are not necessarily square. In supply and use tables the row accounts are for products/commodities and the column accounts are for activities/industries;[36] each column of the supply table therefore identifies the values of different commodities produced by each (multi-product) activity while each column of the use table(s) identifies the values of different inputs used by each activity. The standard (SNA) approach is to collect data in Supply and Use formats and then to derive an input-output (or analytical) table as a reduced form by decomposing the prices in the use table and then adjusting the (revalued) use matrix/matrices using information from the Supply[37] matrix (see UN, 1999; and Miller and Blair, 1985). Hence, one way an IOT can be defined is as a square Use[38] matrix with identical row and column accounts and for which the associated Supply matrix is also square and only has entries on the principal diagonal. Thus, it appears that the SAM format discussed above applies for cases where the inter-industry data are present in either IOT or SUT formats.

But this ignores an important aspect of an IOT. In an IOT, constructed following the standard procedures, the purchases of commodities for intermediate and final demand and exports are valued at *BASIC or PRODUCER* prices[39] not *PURCHASER* prices. This means that the accounting data used to derive purchaser prices from basic prices, commodity taxes

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36 Activities refer to enterprises that engage in productive activities while commodities are the outputs (and intermediate inputs) produced by activities. A standard classification system allocates enterprises to activity groups by the principal commodity produced by an activity; consequently, many supply and use tables contain activities and commodities that have the same name although the interpretations are different. This is not necessarily the case: for instance, agriculture might be an activity that produces multiple commodities, e.g., grains, vegetables, fruit, meat, milk, wool, etc. Similarly, the agricultural activity might be subdivided into crop agriculture and animal agriculture where the former produces grains, vegetables, fruit, meat, etc., and the latter produces grains, meat, milk, wool, etc.: note how crop agriculture produces an animal product and animal agriculture produces a crop product. This reflects the fact that multi-product activities may be multi-dimensional. This becomes relevant when trying to specify production relationships.

37 Also known as the MAKE matrix.

38 Also known as the ABSORPTION matrix.

39 "the SNA recommends products to be measured as homogeneously or uniformly as possible in the SIOT, preferably in basic prices. When that is not possible, they can be valued at producers' prices instead." (UN, 1999, para 3.6).

and trade and transport margins are not immediately available. There are methods by which a SAM can be structured so that purchases of commodities can be recorded at basic prices and the associated taxes, and trade and transport margins can be explicitly recorded in the SAM. While such a presentation has merits, and may arguably be regarded as ideal, it is not without difficulties; not the least of which are the very large additional data requirements.

To understand the scale of the data problem this presents it is useful to consider a process that may be followed to determine an IOT at *basic* prices. First, the (Combined) Use table at purchaser prices must be decomposed into a series of matrices with dimensions commodities in the rows and intermediate (activities) and final (institutions and RoW) in the rows: one such matrix is required for each commodity tax instrument and one such matrix for each trade and transport margin. Subtracting these matrices from the Use matrix in *purchaser* prices produces a 'Use' matrix valued in *basic* prices.[40] Second, the dimensions of the IOT must be defined as either the commodity or activity accounts; the former produces a so-called commodity by commodity IOT and the latter a so-called activity by activity IOT. Third, decisions need to be taken about the technologies used to produce secondary products by each activity, i.e., the off-diagonal elements in the Supply matrix, a so-called technology assumption. A range of technology assumptions are known (and used): these include a commodity technology assumption (CTA) – each commodity is produced using the same technology irrespective of the producing activity; a industry technology assumption (ITA) – each commodity is produced using an industry specific technology; a hybrid technology assumption – generally a mix of CTA, ITA and other technology assumptions (see Miller and Blair, 2009, Chapter 5; UN, 1999). These technology assumptions use the information in the Supply matrix and Use matrix to effective a linear transformation of the Use matrix consistent with producing a square and diagonal 'supply' matrix.

Note that the chosen liner transformation must be imposed on every matrix derived from the Use matrix. In theory this process will produce an IOT valued at basic prices with a series of matching matrices that record purchasing agent specific tax payments for each tax instrument and agent specific trade and transport margin payments for each margin instrument. These detailed tax and margin matrices are very rarely published.[41] Rather IOT tables are presented with a row of total tax payments and a row of total margin payments if

[40] If the Use matrix in purchaser prices is segmented between the use of domestically produced and imported commodities the number of matrices that need to identified is doubled.

[41] The only known example is Australia. Such data are not known to be published by any other country>

the IOT transactions are valued at *basic* prices. If a row for total margin payment is not included, it is reasonable to presume, until contrary evidence is available, that the IOT transactions are valued at *producer* prices.

The problem this presents for any price driven GE model is that the commodity specific tax rates are required and that each tax instrument should be separately identified to allow for differences in how tax instruments are defined.[42] Similarly, if the analyses seek to evaluate how economic and/or technology changes that change trade and transport margins impact on an economy then commodity specific margins are required, and each margin instrument should be separately identified.[43]

An example of how such a model may be formulated is GTAP. In the GTAP database an aggregated commodity tax is reported for each transaction with agents paying for purchases in 'two' parts – the commodity and the associated tax. Implicitly, commodities in GTAP are valued at *producer* prices,[44] so that adding the commodity tax results in *purchaser* prices. However, because the revenues from different commodity tax instruments are not separately quantified differences in how tax instruments are applied are not considered.

Without these data it is common for analyst to seek a transformation of the data that retains the IOT data for the demand side and adds estimates of the commodity specific taxes and margins with an implicit presumption that they are applied following the 'law of one price' (LOOP). An example of this can be found in the presentation of a SAM by Dervis *et al*., (1985), but it is unclear to what extent purchases have been revalued at purchaser prices

It is consequently argued that SAMs with inter-industry data presented using a SUT format are a preferred compromise. First, SUT are produced regularly, often annually, for many economies. Second, in an SUT based SAM commodity tax data can be more easily augmented to represent revenue from different tax instruments: this represents an expressed preference for recognizing differences in how tax instruments are applied while accepting the limitations of the LOOP.[45] Third, in an SUT based SAM margins data can be more easily augmented to represent expenditures on different margins instruments; again, at the expense of accepting the limitations of LOOP. Fourth, the imposition of technology assumptions in the

42 For instance, a GST may be applied *ad valorem* while an excise tax may be imposed on the quantity of the commodity purchased.

43 If the IOT is valued in producer prices, then margin expenditures are embedded in the TVS.

44 This is not acknowledged in the GTAP documentation.

45 Some of these limitations can be partially circumvented in the formulation of a model's behavioural and price formation relationships

formation of an IOT based SAM are avoided; this requires that a model's behavioural relationships address the matter of secondary production. And fifth, the process of data generation is simplified (greatly).

Ultimately the choice between and SUT and IOT based SAM will always a compromise. Given 'perfect' data there are strong arguments for an IOT based SAM. But in the absence of 'perfect' data an IOT based SAM involves either a very large estimation problem or substantial compromises in a model's behavioural relationships and price definitions. An SUT based SAM should be produced with an explicit recognition of the limitations imposed by the LOOP and the need to model secondary production. However, these may be offset by the ease of producing a reliable database.

A2. From T-accounts to a SAMs

This section demonstrates how the single-entry bookkeeping method in a SAM represents the data presented in conventional presentations of disaggregated national accounts. Typically, national accounts are reported as a series of aggregates – GDP, GNI, private consumption (*C*), government consumption (*G*), savings (*S*), investment (*I*), internal balance (government borrowing) and external balance (surplus on the current account). These are the elements of the national accounts commonly encountered when students first study macroeconomics and form the bedrock of the Keynesian income and expenditure model.

In theory, these aggregates should be calculated as totals of the disaggregated underlying data; the (disaggregated) national accounts. It is such disaggregated national accounts that provide the empirical data used to construct a SAM and are used to form supply and use tables (SUT) that serve to benchmark the aggregate national accounts.

A2.1. T-Accounts

The most well-known form for the presentation of detailed national accounts is as a series of T-accounts, which follow standard double entry bookkeeping practice where incomes are recorded in the left-hand column and expenditures in the right-hand column. Table A2.1 provides an illustrative T-account for the private household account in a stylised economy; income (100) comes from three sources – employment (75), property (15) and transfers (8 + 2 =10) – and there are four forms of expenditure – consumption (63), taxes (12), transfers (4) and savings (21), which are typically defined as residual or balancing item. Logically it would be expected that savings and income taxes by the private household will also be recorded as incomes in the capital (savings and investment)[46] and government accounts respectively. Accordingly, in the capital account for this economy, see Table A2.2, there is an income item for household savings that matches the expenditure item from the household account. In the capital account the stock changes serve as the residual or balancing item.

Consequently, there is an implicit T-account for every agent in the economy, including all commodities and activities[47].

[46] The capital account appears with different labels in different representations, e.g., the SNA uses the label Gross Capital Formation for the expenditure side.

[47] For activities/industries the balancing item will be gross or net operating surplus, while for the commodity accounts it will be changes in the stocks of the individual commodities. The requirement for a residual or balancing item is a basic aspect of double entry bookkeeping.

Table A2.1 Stylised T-Account for Private Household

Incomes		Expenditures	
Income from employment	75	Private consumption	63
Income from property	15		
		Income taxes	12
Transfers from government	8		
Transfers from rest of world	2	Transfers to rest of world	4
		Savings	21
Total	100	**Total**	100

If every T-account is fully reconciled with ALL other T-accounts, i.e., each and every income item has a matching expenditure item in another account, then the accounts will be consistent. Note also how the fundamental *ex-post* accounting identity that total income equals total expenditure is satisfied; if it not satisfied for all the T-accounts then the system of accounts is incomplete. Therefore, a set of national accounts can be defined as complete and consistent if every transaction is accounted for – complete – and every expenditure transaction is exactly matched by a counterpart income transaction – consistent. Such a complete and consistent set of national accounts will record the full circular flow of an economy.

Table A2.2 Stylised T-Account for Capital Account

Incomes		Expenditures	
Household Savings	21	Gross Domestic Capital Formation	36
Enterprise Savings	6	Stock Changes	2
Government Savings	4		
Depreciation	5		
Current Account Balance	2		
Total	138	**Total**	38

The familiarity of the T-account representation to economists should not be surprising since it underpins (empirical) macroeconomics, and such national accounts were primarily driven by the needs of the (Keynesian) macroeconomics literature and the desire to quantify major macroeconomic aggregates.

A2.2 Inter-Industry Transactions and National Accounts

Arguably details about transactions between the agents within each aggregate are substantial omissions from aggregate national accounts. Thus, while aggregate national accounts identify payments to labour and capital in the production accounts, they often do not provide details about the use of, or payments to, labour and capital by different activities nor do they provide

information about purchases and sales of intermediate inputs. However, in the late 1930's Wassily Leontief produced a data framework that is known today as an input-output table (Leontief, 1953), and whose fundamental objective was to provide data about transactions between industries and between industries and other agents in an economy.

An important development in national accounting was the integration of inter-industry data into national accounts (see Stone, 1961), which was made a central feature of the revised 1968 System of National Accounts (SNA). However, it is important to note that the inter-industry data in the SNA were presented in two or three tables; a make/supply table and one (domestic) or two (domestic and import) absorption/use tables rather than in the form of an archetypal symmetric input-output table (see below).

Table A2.3 Stylised T-Account for an Activity Account

Incomes		Expenditures	
Income from commodity 1	120	Intermediate inputs	65
Income from commodity 2	25		
		Payments to labour	40
		Gross Operating surplus	20
		Taxes on production	5
Total	125	**Total**	125

The T-accounts for activities and commodities are identical, in principle, to that for other agents. The activity T-accounts record the income and expenditure accounts for domestic production activities. In Table A2.3 the activity is recorded as selling two different commodities – principal and secondary commodities – to generate income, while the expenditures are the costs of production – intermediate and primary inputs and taxes levied on production.[48] In the accounting process the balancing item will be gross operating surplus, i.e., the surplus before allowing for depreciation of productive assets. In the process of converting these accounts into a SAM appropriate for a CGE model it will be necessary to allocate GOS between payments for capital services and the labour services of the proprietors.

The T-accounts for commodities are similar (see Table A2.4). Income is realised by sales of commodities to different domestic (intermediate and final demand) and foreign (exports valued free on board (*fob*)) agents, valued at purchaser prices. Expenditures are the

[48] Note that corporation taxes are not taxes on production, rather they are the taxes paid by incorporated business enterprises that may own multiple production activities.

payments to domestic and foreign (imports carriage, insurance and freight (*cif*) paid) producers (valued at basic prices) plus any domestic trade and transport costs associated with transferring the commodity from producer to purchaser and any domestic commodity taxes levied. Note how import duties are separately identified, since the value of imports *cif* plus import duties is the value of imports at basic prices.

Table A2.4 Stylised T-Account for a Commodity Account

Incomes		Expenditures	
Intermediate inputs	60	Purchases from domestic activities	80
Private consumption	45	Purchases of imports (cif)	20
Government consumption	10		
Investment	26	Trade & transport margins	15
Stock changes	-1		
		Import duties	5
Exports (fob)	10	Domestic commodity taxes	30
Total	150	**Total**	150

Details about inter-industry transactions in the commodity and activity accounts are important since they identify the costs and values of production, the purchasers of commodities by different agents and the imports and exports of commodities. These data are important if a model is to accurately represent the supply and demand of commodities in an economy.

References

CSO (1990). *Social Accounting Matrix 1985/86*. Gaborone: CSO.

CSO (1996). *Social Accounting Matrix 1992/93*. Gaborone: CSO.

Defourny, J. and Thorbecke, E., (1984). 'Structural Path Analysis and Multiplier Decomposition Within a Social Accounting Matrix Framework', Economic Journal, Vol 94, pp 111-136.

EC (2003). Handbook on Social Accounting Matrices and Labour Accounts: Leadership group SAM. (Population and social conditions 3/2003/E/N°23). Luxembourg: EC. ()

Keuning, S. J., & de Ruuter, W. A. (1988). Guidelines to the construction of a Social Accounting Matrix. *Review of Income and Wealth*, 34(1), 71-100.

King, B. (1981). What is a SAM? a layman's guide to social accounting matrices. World Bank staff working paper (463), 1-59

Keuning, S.J., (1994). 'The SAM and Beyond: Open, SESAME!', *Economic Systems Research*, Vol 6, pp 21-50.

Miller, R.E. and Blair, P.D., (2009). *Input-Output Analysis: Foundations and Extensions 2nd Edition*. Englewood Cliffs: Prentice-Hall.

Pyatt, G., (1987). 'A SAM Approach to Modelling', *Journal of Policy Modeling*, Vol. 10:327-352.

Pyatt, G., Roe, A.R. and Associates, (1974). *Social Accounting Matrices for Development Planning with Special Reference to Sri Lanka*. Cambridge: Cambridge University Press

Pyatt, G. and Round, J.I., (1979). 'Accounting and Fixed Price Multipliers in a Social Accounting Matrix Framework', Economic Journal, 89, 850-873.

Pyatt, G. and Round, J.I. (ed), (1985). Social Accounting Matrices: A Basis for Planning. Washington: World Bank.

Pyatt, G., (2001). 'Some Early Multiplier Models of the Relationship between Income Distribution and Production Structure', *Economic Systems Research*, 13:2, 139-163.

King, B.B., (1985). 'What is a SAM?', in Pyatt, G. and Round, J.I. (ed), Social Accounting Matrices: A Basis for Planning. Washington: World Bank.

Pyatt, G. and Round, J.I., (1977). 'Social Accounting Matrices for Development Planning', Review of Income and Wealth, Vol 23, pp 339-364.

Pyatt, G., (1991). 'Fundamentals of Social Accounting', *Economic Systems Research*, Vol 3, pp 315-341.

Pyatt, G., (1994). 'Modelling Commodity Balances: A Derivation of the Stone Model', *Economic Systems Research*, 6:1, 5-20,

Pyatt, G., (2005). Sir Richard Stone: an appreciation

Pyatt, G. and Round, J.I., (2012). 'Distributional Invariance and the Design of SAMS', *Economic Systems Research*, 2012, Vol. 24(3), September, pp. 251–273

Reinert, K.A. and Roland-Holst, D.W., (1997). 'Social Accounting Matrices' in Francois, J.F. and Reinert, K.A., (eds) (1997). Applied Methods for Trade Policy Analysis. Cambridge University Press: Cambridge.

Stone, R., (1962). *A Social Accounting Matrix for 1960*. Volume 2 in A Programme for Growth. London: Chapman and Hall.

Stone, R., (1974). 'Forward' in Pyatt, G., Roe, A.R. and Associates, Social Accounting Matrices for Development Planning with Special Reference to Sri Lanka. Cambridge: Cambridge University Press.

UN (2012). *System of Environmental-Economic Accounting 2012 Central Framework*. New York: UN. (https://seea.un.org/content/seea-central-framework)

UN (2024). *System of Environmental-Economic Accounting Ecosystem Accounting*. (https://seea.un.org/ecosystem-accounting)

Intersecretariat Working Group on National Accounts (ISWGNA), (1993). *System of National Accounts*. New York: UN. (https://unstats.un.org/unsd/nationalaccount/sna.asp)

Intersecretariat Working Group on National Accounts (ISWGNA), (2009). *System of National Accounts 2008*. New York: UN. (https://unstats.un.org/unsd/nationalaccount/sna.asp)

Intersecretariat Working Group on National Accounts (ISWGNA), (2025). *System of National Accounts 2025*. New York: UN. (https://unstats.un.org/unsd/nationalaccount/sna2025.asp)

UN, (1999). *Handbook of Input-Output Table Compilation and Analysis*. Studies in Methods Series F, No. 74, Handbook of National Accounting. New York: United Nations.