A 2007 Social Accounting Matrix for Malawi

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Abstract: This paper documents a Malawian Social Accounting Matrix (SAM) for the year 2007. The SAM is based on newly estimated supply-use tables, national accounts, government budgets, and balance of payments. The SAM reconciles these data using cross-entropy estimation techniques. The final SAM is a detailed representation of Malawi's economy. It separates 37 activities and commodities; 5 types of factors of production; and 10 representative household groups. Labor and household information is drawn from a nationally representative household survey. The SAM also identifies government, investment and foreign accounts. It provides an ideal tool for economy-wide impact assessments, including SAM-based multiplier analysis and computable general equilibrium (CGE) modeling.

Suggested reference: Douilleta M, Pauw, K and Thurlow J (2012) "A 2007 Social Accounting Matrix for Malawi." International Food Policy Research Institute, Washington DC, USA.

1. Introduction

This paper outlines the construction of a 2007 social accounting matrix (SAM) for Malawi. A SAM is a consistent data framework that captures the information contained in the national income and product accounts and the supply-use table (SUT), as well as the monetary flows between institutions. A SAM is an ex-post accounting framework since, within its square matrix,

total receipts must equal total payments for each account contained within the SAM. Since the required data is not drawn from a single source, information from various sources must be compiled and made consistent. This process is valuable since it helps identify inconsistencies among Malawi's statistical sources. For example, there are invariably differences between the incomes and expenditures reported by households in Living Standards Surveys. SAMs are economy-wide databases which are used in conjunction with analytical techniques to strengthen the evidence underlying policy decisions.

Section 2 reviews the general structure of SAMs. The first step in constructing a SAM is compiling information from various sources into a SAM format or framework known as the 'prior SAM'. The construction of the prior SAM takes place in two stages. A 'macro SAM' is first constructed using aggregate information from national accounts and other macroeconomic databases. This SAM is then disaggregated across sectors, factors and households to derive a more detailed 'micro SAM'. Given the diversity of its data sources, the prior SAM is invariably inconsistent (i.e., there are inequalities between receipts and payments). Section 3 describes the data sources used to construct the updated input-output table and the prior SAM. Finally, Section 4 outlines the basic cross-entropy estimation approach used to reconcile the imbalances in the prior SAM.

2. General Structure of Social Accounting Matrices

A simple way of depicting an economy is the circular flow diagram shown in Figure 1 (at the end of the paper), which captures all transfers and real transactions between sectors and institutions. Production activities purchase land, labor and capital inputs from the factor markets, and intermediate inputs from commodity markets, and use these to produce goods and services. These are supplemented by imports (M) and then sold through commodity markets to households (C), the government (G), investors (I) and foreigners (E). In the circular flow diagram, each institution's expenditure becomes another institution's income. For example, household and government purchases of commodities provide the incomes producers need to continue the production process. Additional inter-institutional transfers, such as taxes and savings, ensure that

the circular flow of incomes is closed. In other words, all income and expenditure flows are accounted for and there are no leakages from the system.

A SAM is also a representation of the economy.[1] More specifically, it is an accounting framework that attaches actual numbers to the incomes and expenditures in the circular flow diagram. A SAM is laid out as a square matrix in which each row and column is called an 'account'. Table 1 shows the SAM that corresponds to the circular flow diagram in Figure 1 (with some additional flows not shown in the figure). Each box in the diagram is an account in the SAM, with the exception beings households, which are separated in the table into households and enterprises (i.e., firms). Each cell in the matrix represents, by convention, a flow of funds from a column account to a row account. For example, the circular flow diagram shows private consumption spending as a flow of funds from households to commodity markets. In the SAM it is entered in the household column and commodity row. The underlying principle of double-entry accounting requires that, for each account in the SAM, total revenue equals total expenditure. This means that an account's row and column totals must be equal.

Activities and commodities

The SAM distinguishes between 'activities' and 'commodities'. Activities are the entities that produce goods and services, and commodities are those goods and services produced by activities. They are separated because sometimes an activity produces more than one kind of commodity (i.e., by-products). Similarly, commodities can be produced by more than one kind of activity (e.g., leather products can be produced by the leather tanning sector and as a by-product by the livestock sector). The values in the activity accounts are measured in producer prices (i.e., farm or factory gate prices).

Activities produce goods and services by combining the factors of production with intermediate inputs. This is shown in the activity column of the SAM, where activities pay factors the wages, rents and profits they generate during production process (i.e., value-added).

[1] For general discussions of SAMs see Pyatt and Round (1985), and Reinert and Roland-Holst (1997); for perspectives on SAM-based modeling see Pyatt (1988), and Robinson and Roland-Holst (1988). For a practical gudie to using the SAM for multiplier analysis, see Breisinger et al. (2009).

This is a payment from activities to factors, and so the value-added entry in the SAM appears in the activity column and the factor row [R3-C1]. Similarly, intermediate demand is a payment from activities to commodities [R2-C1]. Finally, producers sometimes pay taxes, which are shown as a payment from activities to the government [R6-C1]. Adding together value-added, intermediate demand and producer taxes gives the value of gross output. The information on production technologies contained in the activity column is the input part of an 'input-output table' (i.e., factor and intermediate inputs per unit of output).

Part of gross output may be consumed directly by the household in the form of own consumption, such as when farmers produce agricultural products for their own households. This 'home consumption' of output is shown as a payment from households to activities [R1-C5] and forms the first part (C1) of total private consumption. The remaining gross output is supplied to markets [R1-C2] and is supplemented by imports from the rest of the world [R8-C2]. Indirect sales taxes and import tariffs are paid on these commodities [R6-C2]. Transaction costs are also incurred when goods move from the farm or factory to the market (or to and from the border in the case of exports and imports) [R2-C2]. This means that the values in the commodity accounts are measured at market prices. Commodities are purchased by a number of economic entities. As discussed, activities buy commodities to be used as intermediate inputs for production [R2-C1]. Final marketed demand for commodities consists of household consumption spending on marketed commodities [R2-C5], government consumption or recurrent expenditure [R2-C6], gross capital formation or investment [R2-C7], and export demand [R2-C8]. Household marketed consumption is the second part (C2) of total private consumption. All of these sources of demand make up the commodity row (i.e., payments by different entities for commodities). On their own, the commodity row and column accounts are sometimes referred to as a 'Supply-Use Table' (i.e., the total supply of commodities and their different kinds of uses or demands).

The SAM in Table 1 shows only single activity and commodity rows and columns. However, a SAM generally contains a number of different activities and commodities. For example, activities may be divided into agriculture, industry and services. The information needed to construct these detailed activity and commodity accounts is usually found in a country's national accounts, input-output table and/or supply-use table, which are typically published by national statistical agencies..

Domestic institutions

A SAM differs from an input-output or supply-use table because it not only traces the income and expenditure flows of activities and commodities, but it also contains complete information on different institutional accounts, such as households, enterprises and the government. Enterprises in the SAM include both large state-owned and private corporations, as well as nonfarm household enterprises. Enterprises receive the capital earnings generated during the production process (i.e., gross operating surplus or profits) [R4-C3]. Sometimes capital and other factors are subject to factor taxes (e.g., natural resource taxes in the case of mining enterprises) [R6-C3]. Enterprises may also receive transfers from the government (e.g., debt and interest payments in the case of banking enterprises) [R4-C6]. From their total income, enterprises pay corporate taxes to the government [R6-C4], remit profits to the rest of the world (e.g., for foreign owned enterprises) [R8-C4], and make 'dividend' payments to households [R5-C4]. The remaining income is reinvested into the firm in the form of enterprise savings or retained earnings [R7-C4].

Households are the usually the ultimate owners of the factors of production, and so they not only indirectly receive capital earnings via enterprises [R5-C4], but they also directly receive labor and land incomes earned during the production process [R5-C3]. They may receive social transfer payments from the government [R5-C6] (e.g., social security and pensions), and from the rest of the world [R5-C8] (e.g., remittances received from family members working abroad). Households then pay personal taxes directly to the government [R6-C5] and purchase own produced and marketed commodities [R1-C5 and R2-C5]. The remaining income is then saved (or dis-saved if expenditures exceed incomes) [R7-C5]. Information on household accounts is usually drawn from national accounts and household income and expenditure surveys, which are typically published or collected by national statistical agencies.

The government receives transfer payments from the rest of the world [R4-C8] (e.g., foreign grants and development assistance). This is added to all of the different tax incomes to determine total government revenue. The government uses these revenues to pay for recurrent

consumption spending [R2-C6], and transfers to households [R5-C6], enterprises [R4-C6] and the rest of the world [R8-C6]. The difference between total revenues and expenditures is the fiscal surplus (or deficit if expenditures exceed revenues) [R7-C6]. Information on government accounts is drawn from state budgets published by Ministries of Finance.

Savings, investment and the foreign account

According to the ex-post accounting identity, gross capital formation, which includes changes in stocks or inventories, must equal total savings. So far we have accounted for private savings [R7-C5 and R7-C4] and public savings [R7-C6]. The difference between total domestic savings and total investment demand is equal to total capital inflows from abroad, or what is called the 'current account balance' [R7-C8]. This is also equal to the difference between foreign exchange receipts (i.e., exports and foreign transfers received) and expenditures (i.e., imports and transfers to foreigners). Information on the current account (or rest of world account) is drawn from the balance of payments, which is either published by central banks or the International Monetary Fund.

Balancing the SAM

The information needed to build a SAM comes from a variety of sources, such as national accounts, household surveys, government budgets, and the balance of payments (see Section 3). Placing these data within the SAM framework inevitably reveals inconsistencies between the incomes and expenditures of each account (e.g., government spending in national accounts may not be the same as what is reported in state budgets). A number of statistical estimation techniques exist to "balance" a SAM accounts (i.e., reconcile incomes and expenditures). Cross-entropy estimation is the preferred method (see Section 4).

3. Constructing the Prior Social Accounting Matrix

The 2007 SAM for Malawi contains the detailed accounts shown in Table 2. The macro SAM shown in Table 3 is an aggregation of the more detailed micro SAM. This section explains how each macro SAM entry is derived and disaggregated to arrive at the prior micro SAM. Each

entry in the SAM is discussed below. The notation for SAM entries is (row, column) and the values are in Millions of 2007 Malawian Kwacha. The final disaggregated SAM is quite large and is included in the accompanying spreadsheet file.

i. (Factors, Activities)… 450,498

This is the value of gross domestic product (GDP) at factor cost or alternatively, total value-added generated by labor, capital and land. Sectoral GDP for 20 sectors is drawn from national accounts (NBS, 2011) and is further disaggregated across 37 sectors (i.e., 14 agriculture, 12 industry, and 11 services) using GDP shares from the Economic Survey (NSO, 2007) for industry and services, and production quantity and price data for agriculture (MINAG, 2011). Value-added is divided into the returns to labor; capital and land using factor value-added shares from a new input-output table (see below). Labor income is further split across three education categories: (1) finished or less than primary schooling; (2) finished or less than secondary schooling; and (3) finished or less than tertiary education. Workers' incomes from wage, farm and non-farm self-employment are drawn from the 2004/05 Integrated Household Survey (IHS) (NBS, 2006).

ii. (Commodities, Activities)… 448,749

This is the value of intermediate inputs used in the production process. The technical coefficients used in the SAM are derived from a newly updated input-output table constructed using farm budgets (MINAG, 2007) for the agricultural sector, and an average of the 2005 and 2006 production costs captured in the Economic Surveys (NSO, 2007) for industry and some services. Remaining coefficients in the service sector are based on the earlier 1998 SAM for Malawi (Chulu and Wobst, 2001).

iii. *(Activities, Commodities)… 718,026*

This is the value of total marketed output. Not all output is supplied to markets since households may consume subsistence goods directly at the farm or firm. Therefore, this value is equivalent to gross output (i.e., the sum of intermediate demand and GDP at factor cost) less the amount of home consumption by households.

Although SAMs can distinguish between activities and commodities, and thus facilitates interactions between single/multiple activities and single/multiple commodities, this information is not available for Malawi. Therefore the disaggregation of this cell in the micro SAM shows a single series of entries along the diagonal of the activity-commodity sub-matrix (i.e., a one-to-one mapping).

iv. (Commodities, Commodities)… 124,874

The payment by commodities to commodities is a condensed version of the treatment of trade margins in the final micro SAM. In the micro SAM there are separate margin accounts for the trade costs incurred through the marketing of each commodity. Unlike most other entries in the SAM, this entry was first calculated on a disaggregated level, and then aggregated to arrive at a final macro SAM value. Trade margins are calculated using transaction cost rates taken from the earlier 1998 SAM (Chulu and Wobst, 2001).

v. (Government, Commodities)… 46,084

While the macro SAM shows only a single row and column for taxes, this account actually consists of a number of distinct tax accounts, including specific accounts for direct, indirect and trade taxes. The commodity tax entry can therefore be disaggregated to include indirect sales taxes (37,019) and import tariffs (9,065). These aggregate values of individual taxes were taken from government accounts (Table 14.2 in NBS, 2010). Aggregate tax revenues were disaggregated across commodities using information on value-added tax and import tariff rates from product level customs and excise data, which were proportionally scaled so that the sum of individual tax collections matches the aggregate values reported in government accounts.

vi. (Rest of world, Commodities)… 188,126

The value of total imports of goods and services was initially taken from national accounts (NBS, 2010). Goods and service imports were disaggregated using trade data from product level customs and excise data.

vii. (Activities, Households)… 181,222

This is the value of home consumption, which is consumption at producer prices by households at the farm or firm. The separation of home and marketed consumption (see below) is based on expenditure information from the IHS (NBS, 2006).

viii. (Commodities, Households)… 248,370

The payment from households to commodities is equal to household consumption of marketed production. The total level of private consumption is based on national accounts (NBS, 2010). Households in the SAM are disaggregated into representatives groups (see Table 2) based on expenditure information from IHS (NBS, 2006).

ix. (Commodities, Government)… 42,167

The total value of government consumption spending is taken from national accounts (NBS, 2010) and disaggregated across commodities in proportion to their value-added, also reported in national accounts. In the SAM, the government is treated as a sector producing government services, as well as a demander of these services.

x. (Commodities, Investment)… 103,458

The aggregate value of investment demand is taken from national accounts (NBS, 2010) and disaggregated across commodities using information from the earlier 1998 SAM (Chulu and Wobst, 2001). Note that this aggregate value includes both public and private investment. The detailed micro SAM distinguishes between gross fixed capital formation and changes in inventories or stocks (see below).

xi. (Commodities, Rest of world)… 107,741

The value of total exports of goods and services was taken from national accounts (NBS, 2010). Goods and service exports were disaggregated using trade data from product level customs and excise data.

xii. *(Factors, Rest of world)… 564*

These are factor transfers received from the rest of the world. The value of remittance receipts is taken from the balance of payments (Table 7.1 in NBS, 2010). It is equal to factor service receipts and is paid entirely to capital.

xiii. *(Rest of world, Factors)… 3,595*

These are factor transfers paid to the rest of the world. The value of remittance payments is taken from the balance of payments (Table 7.1 in NBS, 2010). It is equal to factor service payments and is paid entirely to capital.

xiv. *(Enterprises, Factors)… 145,665*

Enterprises earn the returns to capital generated during the production process after having paid any factor taxes and repatriated factor income (e.g., profits). Enterprises earn non-agricultural capital incomes; agricultural capital is paid directly to households (see below).

xv. *(Households, Factors)… 300,053*

Households receive factors includes directly from labor, capital and land. The total value of these receipts depends on composition of sectoral value-added. Factor incomes are distributed to representative household groups based on incomes reported the IHS (NBS, 2006). Labor income distribution is based on reported wage receipts and of reported farm/nonfarm enterprise earnings. Earnings from agricultural capital and land are distributed based on the farm revenues reported in the agricultural module of the survey.

xvi. *(Enterprises, Government)… 1,871*

Transfers from the government to enterprises are taken from government budgets (Table 14.1 in NBS, 2010). This is equal to loans and capital transfers.

xvii. (Government, Enterprises)… 20,601

Corporate income taxes are paid by nonagricultural enterprises to the government. The value of these taxes, and any other direct transfers, is taken from government budgets (Table 14.1 in NBS, 2010). This is treated as a residual balancing item for the government account since the government accounts are not balanced exactly.

xviii. (Households, Enterprises)… 126,416

This is indirect capital income to households, or alternatively, post-tax profits earned by households according to their capital endowments. Enterprise payments are distributed across representative household groups based on information on nonfarm enterprise earnings reported in the IHS (NBS, 2006).

xix. (Savings, Enterprises)… 519

Although national accounts report aggregate private savings, it is necessary to separate enterprise and household savings in the SAM. In the absence of detailed private savings information, it is assumed that enterprises save approximately 0.2 percent of their earnings. The residual private savings is assigned to households.

xx. (Savings, Investment)… 2,443

This is the value of changes in inventories or stocks, which is combined with gross fixed capital formation in the macro SAM (i.e., the macro SAM reports gross capital formation). Stock changes are reported separately in the micro SAM, but do not appear in the macro SAM. Information on aggregate stock changes is taken from national accounts (NBS, 2010) and distributed across commodities using shares from the earlier 1998 SAM (Chulu and Wobst, 2001).

xxi. (Households, Government)… 21,185

This is social security and other transfers paid by the government to households. The total level of these transfers is taken from government budgets (Table 14.1 in NBS, 2010).

This is equal to pensions and gratuities, and grants, subventions and transfers. This was disaggregated across representative household groups using information on pension receipts reported in the IHS (NBS, 2007).

xxii. *(Households, Rest of world)… 9,485*

This is remittances paid to domestic households as reported in the balance of payments (Table 17.1 in NBS, 2010). This is equal to private transfer receipts. This aggregate value was disaggregated across representative household groups using information on total household wage earnings in the IHS (NBS, 2007).

xxiii. *(Rest of world, Households)… 1,577*

This is remittances received by domestic households as reported in the balance of payments (Table 17.1 in NBS, 2010). This is equal to private transfer payments. This was disaggregated across representative household groups using information on total household wage earnings in the IHS (NBS, 2007).

xxiv. *(Rest of world, Government)… 22,252*

This is government transfers paid to the rest of the world. It includes such items as repayment of and interest on foreign debt, as reported in the government accounts (Table 14.1 in NBS, 2010). This is equal to interest on debt.

xxv. *(Government, Households)… 25,385*

Personal income taxes are paid by households to the government. The value of these taxes is taken from the government budget (Table 14.2 in NBS, 2010). This was disaggregated across representative household groups using information on household total wage income from workers who have completed secondary or at least some tertiary education, as reported in the IHS (NBS, 2007).

xxvi. (Savings, Households)… 585

As explained earlier, aggregate household savings is a residual after subtracting enterprise savings (based on an assumed savings rate) from aggregate private savings reported in national accounts. This was disaggregated across representative household groups using information on non-farm enterprise (capital) profits reported the IHS (NBS, 2007).

xxvii. (Government, Rest of world)… 70,767

Government transfers received from the rest of the world is equivalent to the value of foreign grants received as reported in the balance of payments (Table 14.5 in NBS, 2010).

xxviii. (Savings, Government)… 75,361

Government savings includes public investment and is treated as a residual balancing after accounting item for all government revenues and payments. Nonetheless, is almost exactly equal to the recurrent fiscal balance reported in government budgets (Tables 14.1 and 14.5 in NBS, 2010). This is equal to public gross fixed capital formation, debt amortization and development expenditure.

xxix. (Savings, Rest of world)… 26,993

This is the current account balance or the total value of foreign savings. It is treated as a residual balancing item after accounting for all foreign receipts and payments. Nonetheless, is similar to the current account balance in balance of payments (Table 17.1 in NBS, 2010).

4. Balancing the Social Accounting Matrix

The range of datasets used to construct the prior micro SAM implies that there will inevitably be imbalances (i.e., row and column totals are unequal). Cross-entropy econometrics is used to reconcile SAM accounts (see Robinson et al., 2001). This approach begins with the construction of the prior SAM, which as explained in the previous section, used a variety of data from a number of sources of varying quality. This prior SAM provided the initial "best guess" for the estimation procedure. Additional information is then brought to bear, including knowledge about aggregate values from national accounts and technology coefficients. A balanced SAM was then estimated by minimizing the entropy 'distance' measure between the final SAM and the initial unbalanced prior SAM, taking into account of all additional information.

Balancing procedure for the SAM

The balancing procedure takes places in two stages. First, a very detailed national SAM was constructed using the supply-use table, national accounts, state budgets and balance of payments. At this stage, the SAM contains aggregate entries for factors and households. This aggregate national SAM was then balanced using cross-entropy.

After balancing the national SAM, it was then disaggregated across factors and households. Since the aggregate national SAM is balanced, this results in imbalances for the household accounts only. These household accounts were again balanced using cross-entropy, but holding all other non-household-related entries of the national SAM constant. Given the imbalances in the household survey between incomes and expenditures, the target household income/expenditure total for the final balanced SAM was the expenditure totals in the unbalanced prior SAM.

Cross-entropy estimation of the balanced SAM

Table 4 presents the equations defining the SAM estimation procedure. Starting from an initial estimate of the SAM, additional information is imposed in the form of constraints on the estimation. Equation 1 specifies that row sums and corresponding column sums must be equal, which is the defining characteristic for a consistent set of SAM accounts. Equation 2 specifies

that sub-accounts of the SAM must equal control totals, and that these totals are assumed to be measured with error (Equation 3). An example would be the estimate of GDP provided by national accounts, which is the total value of the Factor-Activity matrix in the prior SAM. The matrix G is an aggregator matrix, with entries equal to 0 or 1. The index *k* is general and can include individual cells, column/row sums, and any combination of cells such as macro aggregates. Equation 4 allows for the imposition of information about column coefficients in the SAM rather than cell values, also allowing for error (Equation 5).

The error specification in Equations 2 and 3 describes the errors as a weighted sum of a specified 'support set' (the V parameters). The weights (*W*) are probabilities to be estimated, starting from a prior on the standard error of measurement of aggregates of flows (Equation 8) or coefficients (Equation 9). The number of elements in the error support set (*w*) determines how many moments of the error distribution are estimated. The probability weights must be non-negative and sum to one (Equations 8 and 9). The objective function is the cross-entropy distance between the estimated probability weights and their prior for the errors in both coefficients and aggregates of SAM flows. It can be shown that this minimand is uniquely appropriate, and that using any other minimand introduces unwarranted assumptions (or information) about the errors.

Various constraints were imposed on the model according to the perceived reliability of the data. Certain values that appeared in the supply-use table and national accounts were maintained in order to remain consistent with the overall macro structure of the economy. The macroeconomic aggregates that were maintained in the micro-SAM include: total labor value-added; total capital value-added; household final demand; government spending; investment demand; exports; imports; government borrowing/saving; current account balance; sales taxes; import tariffs; direct taxes on enterprises; government transfers to enterprises; enterprise transfers to the rest of the world; enterprise transfers to government; household transfers to government; government transfers to the rest of the world; and household foreign transfers received. The same standard errors were applied to all representative household groups.

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Figure 1: Circular Flow Diagram of the Economy

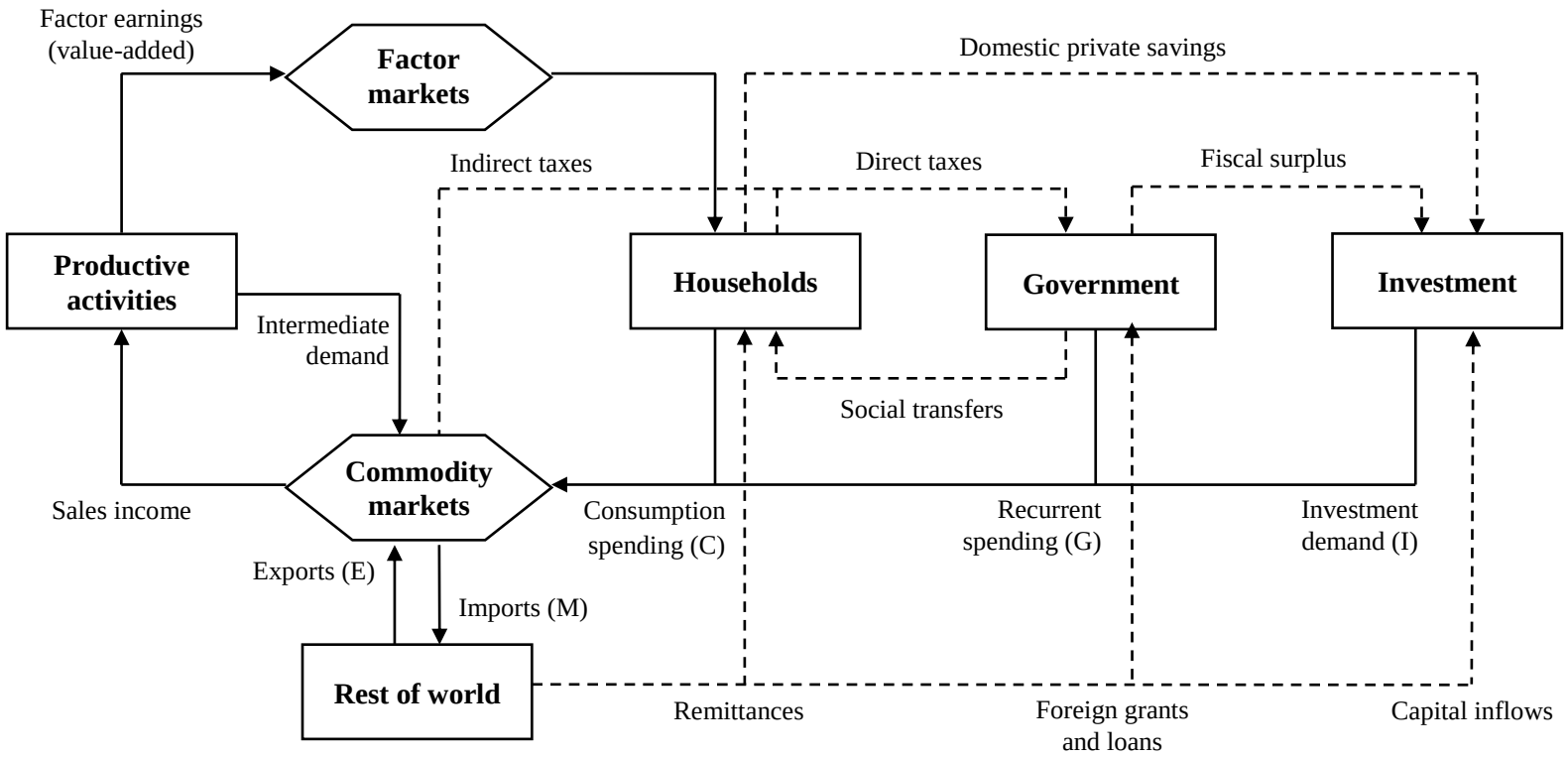

Table 1: Basic structure of a Social Accounting Matrix

	Activities (C1)	Commod-ities (C2)	Factors (C3)	Enterprises (C4)	Households (C5)	Government (C6)	Investment (C7)	Rest of the World (C8)	Total
Activities (R1)		Marketed output			Home consump-tion				Activity income
Commodities (R2)	Inter-mediate inputs	Transaction costs			Marketed consump-tion	Government consump-tion	Investment, change in stocks	Exports	Total demand
Factors (R3)	Value-added							Foreign factor earnings	Factor earnings
Enterprises (R4)			Factor income to enterprises			Transfers to enterprises		Foreign enterprise receipts	Enterprise earnings
Households (R5)			Factor income to households	Indirect capital payments	Inter-household transfers	Transfers to households		Foreign remittances received	Household income
Government (R6)	Producer taxes	Sales taxes, import tariffs	Factor Taxes	Corporate taxes	Personal taxes			Government transfers from rest of world	Government income
Savings (R7)				Enterprise savings	Household savings	Government savings		Foreign savings	Savings
Rest of the World (R8)		Imports		Repatriated earnings	Foreign remittances paid	Government transfers to rest of world			Foreign exchange outflow
Total	Gross output	Total supply	Factor expenditure	Enterprise expenditure	Household expenditure	Government expenditure	Investment	Foreign exchange inflow	

Table 2: Detailed accounts in the 2007 SAM for Malawi

Activities(a) and commodities (c)	
maiz	Maize
rice	Rice
ocer	Other cereals
cass	Cassava
root	Roots
puls	Pulses
hort	Horticulture
toba	Tobacco
cott	Cotton
sugr	Sugarcane
ocrp	Other crops
live	Livestock
fore	Forestry
fish	Fishing
mine	Mining
food	Food processing
beve	Beverages and tobacco
text	Textiles and clothing
wood	Wood and furniture
petr	Petroleum products
chem	Chemical products
nmet	Non-metal minerals
mach	Machinery
oman	Other manufacturing
cons	Construction
elec	Electricity and water
trad	Trade services
hotl	Hotels and catering
tran	Transport services
comm	Communications
fsrv	Financial services
bsrv	Business services
real	Real estate
gsrv	Government administration
educ	Education
heal	Health
osrv	Other services

Factors (f)	
lab-p	Labor - finished or less than primary schooling
lab-s	Labor - finished or less than secondary schooling
lab-t	Labor - finished or less than tertiary schooling
lnd	Crop land
cap	Capital

Households(hhd)	
r1	Rural - quintile 1
r2	Rural - quintile 2
r3	Rural - quintile 3
r4	Rural - quintile 4
r5	Rural - quintile 5
u1	Urban - quintile 1
u2	Urban - quintile 2
u3	Urban - quintile 3
u4	Urban - quintile 4
u5	Urban - quintile 5

Other accounts	
trc	Transaction costs
ent	Enterprises
gov	Government
dtax	Direct taxes
mtax	Import tariffs
stax	Sales taxes
s-i	Savings-investment
dstk	Changes in inventories
row	Rest of world
total	Total

Table 3: 2007 Macro SAM for Malawi (Millions of Kwacha)

	Activities (C1)	Commod-ities (C2)	Factors (C3)	Enterprises (C4)	Households (C5)	Government (C6)	Investment (C7)	Rest of the World (C8)	Total
Activities (R1)		718,026			181,222				899,247
Commodities (R2)	450,498	124,874			248,370	42,167	103,458	107,741	1,077,109
Factors (R3)	448,749							564	449,313
Enterprises (R4)			145,665			1,871			147,536
Households (R5)			300,053	126,416		21,185		9,485	457,139
Government (R6)		46,084		20,601	25,385			70,767	243,929
Savings (R7)				519	585	75,361	2,443	26,993	105,901
Rest of the World (R8)		188,126	3,595		1,577	22,252			215,549
Total	899,247	1,077,109	449,313	147,536	457,139	243,929	105,901	215,549	

Source: 2007 Malawi SAM.

Table 4: Cross-entropy SAM estimation equations

Index	
i, j	Row (i) and column (j) entries
k	Set of constraints
w	Set of weights
Symbol	
T_{ij}	SAM in values
$A_{ij}, \bar{A}_{ij}$	SAM in column coefficients
G_{kij}	Aggregator matrix for each constraint k
$\gamma_{ij}, \bar{\gamma}_{ij}$	Aggregate value for constraint k
e_k	Error on each constraint k
e_{ij}^A	Error on each cell coefficient
$W, \bar{W}$	Weights and prior on error term for each constraint k or cell coefficient i,j
$\bar{V}$	Error support set indexed over w for each constraint k or cell coefficient i,j

Equations

$$\sum_i T_{ij} = \sum_j T_{ij} \tag{1}$$

$$\sum_i \sum_j G_{kij} \cdot T_{ij} = y_k \tag{2}$$

$$\gamma_k = \bar{\gamma}_k + e_k \tag{3}$$

$$A_{ij} = T_{ij} \Big/ \sum_i T_{ij} \quad \text{with} \quad \sum_i A_{ij} = 1 \forall i \tag{4}$$

$$A_{ij} = \bar{A}_{ij} + e_{ij}^A \quad \text{for some i and j} \tag{5}$$

$$e_k = \sum_w W_{kw} \cdot \bar{V}_{kw} \tag{6}$$

$$e_{ij}^A = \sum_w W_{ijw}^A \cdot \bar{V}_{ijw}^A \tag{7}$$

$$\sum_w W_{kw} = 1 \quad \text{with} \quad 0 \leq W_{kw} \leq 1 \tag{8}$$

$$\sum_w W_{ijw}^A = 1 \quad \text{with} \quad 0 \leq W_{ijw}^A \leq 1 \tag{9}$$

$$\min \left[\sum_k \sum_w W_{kw} \cdot (\ln W_{kw} - \ln \bar{W}_{kw}) + \sum_i \sum_j \sum_w W_{ijw}^A \cdot \left(\ln W_{ijw}^A - \ln \bar{W}_{ijw}^A \right) \right] \tag{10}$$