

Social Accounting Matrix Balanced Based on Mathematical optimization Method and General Algebraic Modeling System

Ming-Chang Lee¹, Li-Er Su²

¹National Kaohsiung University of Applied Sciences, Taiwan, No. 415 Chien Kung Rd. Kaohsiung Taiwan.

²Shih Chien University, Kaohsiung Campus, Kaohsiung Taiwan.

Ming-Chang Lee

The correspondent author: Ming-Chang Lee; E-mail: ming_li@mail2000.com.tw

National Kaohsiung University of Applied Sciences (Taiwan)

415 Chien Kung Road, Kaohsiung, Taiwan

ABSTRACT

Aims: Social accounting matrix (SAM) is a kind of important form in the national accounts calculation. The requisite data are typically collected from a number of different sources. Therefore, much of data used will not be immediately consistent. The aim of this paper present the various methods of balancing applied to social accounting matrix.

Study design: This paper solves the social accounting matrix balanced problem using iterative method (in RAS approach) and using the computer programmer about General Algebraic Modeling system (GAMS) (in other approach). The sum square error of the estimated table from the initial table is used as the main instrument to measure deviation of the updated matrices from the matrix.

Methodology: These methods (RAS, Cross-entropy (CE), least square, linear programming with L_1 , and linear programming with L_∞ method) are applied widely for develop and keep and time consistent multi-sector datasets.

Results: It is found that CE method is more accurate than the other methods.

Keywords: Social accounting matrix (SAM); System of National Accounts (SNA); Cross entropy (CE), Least square method, Linear programming norm L_1 , linear programming norm L_∞

1. INTRODUCTION

SAM is simply defined as a single entry accounting system whereby each macroeconomic account is represented by a column for outgoing and a row for incomings (Round, 1981). SAM is an approach for data organization, reconciliation, and

descriptive analysis of the structure of economy. It provides a consistent and convenient approach to organizational economic data for a country and it can provide a basis for descriptive analysis and economic modeling in order to answer various economic policy questions (Pleskovic and Travino, 1985; Reinert and Roland-Hoist, 1997). SAM is a way of logical arrangement of statistical information, concerning income flows in a country's economy within a particular period (usually a year). It can provide a conceptual basis to analysis both distribution and growth issues within a single framework. For example, SAM on the country the national accounts attempt to classify various institutions to their socio-economic backgrounds instead of their economic or functional activities Chowdhury and Kirkpatrick (1994). Bellu (2012) offers a methodological introduction to SAM for analyzing socio-economic impact of agricultural and rural development policies.

SAM needs to be supported by a large number of statistical data, but these statistics are often different sources, such as national accounts, trade data, input-output tables, the data are not consistent. How these different data sources through a means to the consistency of the data is a very important and difficult task. SAM imbalance usually appears: in exact data sources, the sum of account rows and columns are not equal which destruction the SAM table ranks of the account the principle of equal; or often abnormal data exist in the table. Table 1 is shown as an example of Macro Social Accounting Matrices.

Table 1: An example of the Macro Social Accounting Matrices

Receipts	1	2	3	4	5	Total
1. Suppliers		C	G	I	X	Demand
2. Households	Y					Income
3. Government		T				Receipts
4. Capital Acc.		S_h	S_g		S_f	Savings
5. Rest of world	Z					Imports
Total	Supply	Expenditure	Expenditure	Investment	Row	

Note: S_h =Private Savings, S_g = Government Savings, S_f = Foreign Savings, T = Tax payments, G = Government Spending

We have:

$$Y + Z = C + G + I + X \quad (\text{GNP}) \quad C + T + S_h = Y \quad (\text{Income})$$

$$G + S_g = T \quad (\text{Government, Budget})$$

$$I = S_h + S_g + S_f \quad (\text{Savings-Investment})$$

$$X + S_f = Z \quad (\text{Trade Balance})$$

Estimating from primary or disparate secondary source are often inconsistent and several alternative matrix balancing methods are available to adjust the initial estimates for

consistency (Robinson and El-Said, 2001; Round, 2003). Therefore, the aim of this paper is using the mathematical optimization method and GAMS software to balance the multi-sector datasets to estimate a SAM.

2. SOCIAL ACCOUNTING MATRIX AND SYSTEM NATIONAL ACCOUNTS

2.1 Constructing a SAM

The main features of a SAM are threefold. First, the accounts are represented as a *square matrix*; where the incomings and outgoings for each account are shown as a corresponding row and column of the matrix. The transactions are shown in the cells, so the matrix displays the interconnections between agents in an explicit way. Second, it is *comprehensive*, in the sense that it portrays all the economic activities of the system (consumption, production, accumulation and distribution), although not necessarily in equivalent detail. Thirdly, the SAM is *flexible*, in that, although it is usually set up in a standard, basic framework there is a large measure of flexibility both in the degree of desegregation and in the emphasis placed on different parts of the economic system. As it is an accounting framework not only is the SAM square but also the corresponding row and column totals must be equal. Clearly, at one extreme, any set of macroeconomic aggregates can be set out in a matrix format. Therefore, Keuning (1991) suggested that SAM is a basis of new system national accounts (SNA). In an open macroeconomic system, any of the implementation of the policy will have an impact on economic activity at all levels. Social Accounting Matrix has become a standard data structure of the computable general equilibrium (CGE) model.

The construction of a SAM with any significant degree of disaggregation of the principle accounts includes: (1) Supply and use tables (input-output tables), or the necessary principle survey data to compile them. (2) Household survey incorporating a labor force survey (a multi-purpose, integrated household survey). (3) Government budget accounts, trade statistics and balance of payments statistics. (4) National accounts.

Many compilers begin by assembling a macro SAM from the national accounts. This defines a set of control totals for the subsequent disaggregation and means that the SAM is consistent with any macro analysis. Often macro SAMs available for a more recent year than the detailed datasets are input-output tables, household survey. Gallardo and Mardones (2013) uses information from I-O table 2008, national account household survey, and environmental pollutant emissions to elaborate an environmentally extended SAM for Chile.

Payatt and Round (1984) have pointed out that compiling detailed SAMs can be part of a process to improve the national accounts estimates. Many countries now re-base their rational accounts periodically in accordance with a set of commodity balances

(input-output table such as a Ugandan social accounting matrix (Thurlow, 2008). Otherwise, household survey data is not always fully in estimating the national accounts (e.g. consumer expenditure is obtained as a residual in the commodity balances), so there might be a case of adjusting the macro SAM in some circumstances.

2.2 Basic Social Accounting Matrix Structure

A simple, stylized SAM framework is shown in Table 2. It is a square matrix that represents the transactions taking place in economy during an accounting, usually one year. Table 2 shows clearly the three basic forms of economic activity, production (accounts, 1, 2, and 3), consumption (accounts 4, 5, and 6), accumulation (account 7), and the transactions with the rest of the world (account 8).

Table 2 : A Basic Social Accounting Matrix (SAM)

Account			(1)	(2)	(3)	(4)
production	commodities	(1)		Intermediate consumption		Household consumption
	Activities	(2)	Domestic sale			
Factors of production		(3)		Gross value added payments to factors		
Institution	Households	(4)			Labor and mixed income	Inter- household transfers
	Corporate enterprise	(5)			Operating surplus	
	Government	(6)	Net taxes on product			Direct Taxes
Combined capital accounts		(7)				Enterprise savings
Rest of World (RoW)		(8)	Imports			
Total			Supply of products	Cost of production activities	Factor income payments	Current household outlays

Table 2: A Basic Social Accounting Matrix (SAM) (continuous)

Account			(5)	(6)	(7)	(8)	Total
production	commodities	(1)		Government consumption	Fixed capital formation and change in stocks	Exports	Demand for products
	Activities	(2)					Sales of commodities
Factors of production		(3)				Net factor incomes from RoW	Factor income receipts
Institution	Households	(4)	Distributed profits to household	Current transfers to household	Labor and mixed income	Net current transfers from RoW	Current household receipts
	Corporate enterprise	(5)		Current transfers to	Operating surplus	Net current transfers	Current enterprise receipts

				enterpris e		from RoW	
	Government	(6)	Direct Taxes			Net current transfers from RoW	Current government receipts
Combined capital accounts		(7)	Enterpris e savings	Governm ent savings	Capital transfers	Net capital transfers from RoW	Capital receipts
Rest of World (RoW)		(8)			Current external balanced		Aggregate outlays from RoW
Total			Current enterpris e outlays	Current governm ent outlays	Capital outlays	Aggregat e outlays to RoW	

Source: Round (2003)

2.3 System of National Accounts (SNA)

The System of National Accounts (SNA) consists of a set of accounts that cover all economic aspects of the working of the economy, including its dealings with the rest of the world. It is an important tool for the analysis and evaluation of economic performance within an accounting time period, usually a one-year period and, in more sophisticated situations, on a quarterly basis.

SNA can analysis: (SNA, 1993; Wilson, 2004).

- (1). The System of National Accounts (SNA) helps economists to measure the level of economic development and the rate of economic growth, the change in consumption, saving, investment, debts and wealth (or net worth) for not only the total economy but also each of its institutional sectors (such as government, public and private corporations, households and non-profit institutions serving households);
- (2). with data from SNA, economists can either forecast the future growth of the economy or study impacts on the economy and its sectors of alternative government policies.
- (3). SNA promotes the integration of economic and related statistics in a system that is based on consistent economic and statistical concepts and methods. As such, it allows domestic and international comparative analysis.
- (4). SNA consists of a coherent, consistent and integrated set of macroeconomic accounts; balance sheets and tables based on a set of internationally agreed concepts, definitions, classifications and accounting rules.
- (5). It provides a comprehensive and detailed record of the complex economic activities taking place within an economy and the interaction between different economic agents

and groups of agents that takes place in markets or elsewhere.

The various accounts were related to specific types of analysis related to research or policy management as illustrated table below (Table 3)

Table 3: Analysis underpinnings of the system of account

Supply Use	Operating assets		Production		Consumption	
	1	2	3	4	5	6
1. Financial claims 2. Net assets						
3. Commercial production 4 Non Commercial production			Input-output analysis; analysis of productivity; business cycle studies		Consumer's demand analysis, studies of government spending	
5. Final Consumption 6. Income and outlay			Production functions; analysis of productivity; analysis of factor analysis		Distribution and redistribution of income, fiscal policy	
7. Change in stocks 8. Fixed investment 9. Financial claims 10. Capital finance	Studies of net worth				Analysis of saving behavior	
11. Current transactions 12. Capital transaction			Import demand analysis		Short-term foreign and policy	
13. Financial claims 14. Net assets						
15. Financial claims 16. Net assets						

Table 3: Analysis underpinnings of the system of account (continuous)

Supply Use	Accumulation				Rest of the world		Revaluations		Closing assets	
	7	8	9	10	11	12	13	14	15	16
1. Financial claims 2. Net assets	Studies of national wealth; analysis of productivity									
3. Commercial production 4 Non Commercial production	Models of sock building and fixed capital formation; investment policy				Expert demand analysis; studies of the "globalization " phenomenon					

5.Final Consumption 6.Income and outlay	Depreciation analysis; investment allowances	Studies of the return on foreign investment; double taxation policy		Studies of the "wealth effort" on consumption
7.Change in stocks 8.Fixed investment 9.Financial claims 10. Capital finance	Monetary policy and liquidity	International finance and liquidity, long term foreign and policy	Studies of capital gains and losses; capital gains tax policy	Studies of net worth
11.Current transactions 12. Capital transaction	International finance and liquidity, long term foreign and policy	Analysis of business of trade payments		
13.Financial claims 14.Net assets	Capital revaluation			
15.Financia claims 16. Net assets	Studies of national wealth; analysis productivity			

Source: Wilson (2004)

3. VARIOUS METHODS OF BALACING

3.1 The RAS method (Fofana et al. 2005)

RAS is a widely used methodology to balance SAMs. The RAS method is an iterative method of biproportional adjustment of rows and column that has been independently developed by various researches.

Each element in matrix T is indicated t_{ij} , where $i = 1, 2, 3, n$; is the row index, $j = 1, 2, 3, n$; is the column index.

Column sums $y_j = \sum_{i=1}^n t_{ij}$ are the column totals. Row sums $x_i = \sum_{j=1}^n t_{ij}$ are the row totals. As already mentioned, for a given k account, expenditure is equal to receipts and is shown by the fact the sum of row is equal to the sum of the column.

$$\sum_{j=1}^n t_{ij} = x_i \quad \sum_{i=1}^n t_{ij} = y_j \quad (1)$$

$$A = (a_{ij})_{n \times n} \text{ is a SAM matrix,} \quad a_{ij} = \frac{t_{ij}}{y_j}, \quad (2)$$

$$\sum_i a_{ij} = 1 \quad (3)$$

and $\sum_j Y_j = AY$, that is

$$\sum_{j=1}^n a_{ij} y_j = y_i \quad (4)$$

A classic approach to solve this problem is to generate a new matrix A^* , from the old matrix A by means of “biproportional” row and column operations:

$$a_{ij}^1 = r_i a_{ij} s_j \text{ in matrix notation : } A^1 = \tilde{R} A \tilde{S} \quad (5)$$

Where $(\sim)$ indicate a diagonal matrix of elements r_i and s_j

$$\tilde{R} = \text{diag}[r_1, r_2, \dots, r_n], \quad \tilde{S} = \text{diag}[s_1, s_2, \dots, s_n],$$

$$a_{ij}^1 = r_i a_{ij} s_j \quad (6)$$

The iterative process is as follows, and can be seen below (Ahmed and Preckel, 2007).

The original matrix of coefficients is multiplied by the row of column total y_j^* to obtain the matrix f_{ij}

$$f_{ij} = a_{ij} y_j^* \quad (7)$$

The row totals of this matrix are represented in the vector x_i . Let the ration of x_i^* to x_i be the multiplier r_i . Multiplying r_i and f_{ij} , we obtain a new f_{ij} . Row vector y_j of column totals is obtained and used to calculate the multiplier s_j . f_{ij} and s_j are then multiplied. The entire sequence of operations can be seen in EQ. 8.

$$\begin{aligned} x_i &= \sum_j f_{ij} & r_i &= x_i^* / x_i & f_{ij} &= r_i f_{ij} \\ y_j &= \sum_i f_{ij} & s_j &= y_j^* / y_j & f_{ij} &= s_j f_{ij} \end{aligned} \quad (8)$$

The iterative process in equation (8) then continuous until the conditions $x_i^* = x_i$ and $y_j^* = y_j$ are met.

The RAS method has advantage of being simple to apply iteration steps. But, this simplicity has many disadvantages: (1) a lack of economic foundations, (2) inability to accommodate other source of data than those on row and column totals, for example we cannot fix new cell values that we suppose are accurately measured (Robinson et al. 2001; Fofana et al. 2005). In the following section, we introduce the cross-entropy

method.

3.2 Cross-entropy (CE) method

Some researcher used cross-entropy approach to SAM balancing, such as (Robinson et al. 1998; Robillard and Robinson, 1999; Robinson et al. 2001; Robinson and Ei-Said, 2000). The estimation procedure is to minimize the Kullback-Leibler (1951) cross-entropy measure of the distance between the new and the prior estimated probability. Golan et al. (1994) use cross-entropy method to balance an I-O table.

The estimation procedure is to minimize the Kullback-Leibler (1951) cross-entropy measure of the distance between the new and the prior estimated probability. Applied to

the procedure of updating a SAM, the problem is to find a new SAM $A^* = (a_{ij}^*)$, close to

an existing SAM $A = (a_{ij})$

The formulas are:

$$\text{Min} \sum_{i,j=1}^n a_{ij}^* \log \frac{a_{ij}^*}{a_{ij}} \quad (9)$$

$$\text{s.t.} \quad \sum_{i=1}^n a_{ij}^* = \sum_{j=1}^n a_{ij}^*$$

From the comparison of these two methods, they found that if the focus is on column coefficients, then the CE method appears to be superior to RAS. However, if the focus is on SAM flows, then the two methods are very similar, with RAS performing slightly better (Ahmad and Preckel, 2007).

3.3 Method of least squares (LS)

We point out that the principle of least square is to minimize the sum of the square of deviations between the new values and the prior value in absolute or percentage terms.

Suppose that the elements a_{ij} and a_{ij}^* are the value of the initial SAM and the values of the estimated SAM respectively.

The formulas

$$\text{Min} \sum_{i,j=1}^n (a_{ij} - a_{ij}^*)^2$$

$$s.t. \sum_{i=1}^n a_{ij}^* = \sum_{j=1}^n a_{ij}^* \quad (10)$$

3.4 Method of linear programming by minimizing with norm L_1 (LP- L_1)

We define that d_{ij}^- is negative difference between. a_{ij} and a_{ij}^* , d_{ij}^+ is positive

difference between. a_{ij} and a_{ij}^* . Where $d_{ij}^+ = \max [(a_{ij} - a_{ij}^*), 0]$,

$$d_{ij}^- = \max [-(a_{ij} - a_{ij}^*), 0]$$

The formulas are:

$$\begin{aligned} & \text{Min} \sum_{i,j=1}^n [(d_{ij}^+ + d_{ij}^-) / a_{ij}] \\ & s.t. \sum_{i=1}^n a_{ij}^* = \sum_{j=1}^n a_{ij}^* \\ & d_{ij}^+ - d_{ij}^- = a_{ij} - a_{ij}^* \end{aligned} \quad (11)$$

3.4 Method of linear programming by minimizing with norm L_∞ (LP- L_∞)

$$\begin{aligned} & \text{Min} \sum_{i,j=1}^n (d_{ij}^+ + d_{ij}^-) \\ & s.t. \sum_{i=1}^n a_{ij}^* = \sum_{j=1}^n a_{ij}^* \\ & d_{ij}^+ - d_{ij}^- = a_{ij} - a_{ij}^* \end{aligned} \quad (12)$$

4. GAMS SOFTWARE AND PROGRAM FOR BALACING A SAM

4.1 GAMS for Balancing a SAM

General Algebraic Modeling System (GAMS) is a high-level modeling system for mathematical programming and optimization (Kendrick and Meeraus, 1988). GAMS is designed for modeling and solving linear, nonlinear, and mixed-integer optimization problems. The system is tailored for complex, large-scale modeling applications and allows the user to build large maintainable models that can be adapted to new situations

There are ten steps to balance an unbalanced SAM (Fofana et al. 2005).

- Step 1: Define matrix accounts
- Step 2: Input data
- Step 3: Normalize initial matrix cell value
- Step 4: Treatment of negative values
- Step 5: Treatment of zero values
- Step 6: Definition of variables used in optimization process
- Step 7: Definition and initialization of model estimations
- Step 8: Initialization of Variables
- Step 9: Model solving
- Step 10: Results copied to a new matrix

4.2 Choose the appropriate method

In order to choose the best optimization method, we carry out an approach between the four methods (EQ 8~EQ 12). This approach is:

(1) This approach consists in calculating the value D for each method. Sum of squared errors (SSE) is defined as:

$$D = \sum_{i=1}^n \sum_{j=1}^n (a_{ij}^* - a_{ij})^2 \quad (13)$$

(2) We exclude the condition. The value of element cell (i, j) in A (initial SAM) is not null, but the value of element cell (i, j) in A* (final SAM).

(3) We choose best method according to the minimum value of D

5. ILLUSTRATION

We use the following IO tables to compare the accuracy of the RAS, CE, LS, LP- L_1 and LP- L_∞ methods. We use iterative program to solve the social accounting matrix balanced problem (in RAS approach) and use the computer programmer about General Algebraic Modeling system (GAMS) to solve the social accounting matrix balanced problem (in CE, LS, LP- L_1 and LP- L_∞ approach).

5.1 Define matrix accounts and input data matrix

(1) Define matrix accounts

PRO	Production
ACT	Activities
ALAB	Labor value added
ACAP	Capital value added

ENT	Enterprise
HS	Household
GOV	Government
GGOV	Government grants
CAP	Capital
DEP	Depreciation
R0W	Rest of World
TOT	Total

(2) Input data matrix

Table 4: Input data matrix							
	PRO	ACT	ALAB	ACAP	ENT	HS	GOV
PRO		329.8 5				207.18	21.30
ACT	629.23						
ALAB		155.9 6		128.6 1		3.6	50.91
ACAP		134.0 4	208.2 8	131.2 4	76.95		2.08
ENT				227.6 4			20.28
HS				6.14	0.23	3.46	16.37
GOV	3.28	14.37			12.49	60.45	47.56
GGOV					0.20	0.28	8.25
CAP					21.76	12.79	
INV							
DEP					37.64	12.39	4.08
R0W	72.87		2.29	9.42	0.20	0.18	0.71
TOTAL	705.38	634.2 2	210.5 7	553.0 5	149.4 7	300.33	171.5 4
+	GGOV	CAP	INV	DEP	R0W	TOTAL	
PRO	2.21	53.11	3.41		90.54	707.60	
ACT	2.79					632.02	
ALAB						210.47	
ACAP		3.02			2.25	557.86	

ENT						148.89	
HS	3.15					301.45	
GOV	0.81	28.48	1.15		0.47	175.2	
GGOV					0.33	9.06	
CAP				54.11		88.66	
INV		4.56				4.56	
DEP						54.11	
ROW		6.05				91.72	
TOTAL	8.96	95.22	4.56	54.11	94.19		

5.2 Results

(1) A balanced SAM results

Since the requisite data are typically collected from a number of different sources. So the estimated table may have zero elements where the initial SAM has positive value. As the result, when root mean square error between the initial SAM and the final SAM. It is possible that we will get some results that are very inaccurate, especially if the initial table's values for the corresponding zero cell is very large (Ahmed and Precket, 2007). GAMS are a high-level modeling system for mathematical programming and optimization. GAMS program has been specially treated the initial table's values for the corresponding zero cell.

The matrices of coefficients are compared. These matrices are basically the full matrices with the cell in a column divided be the column total. Table 5 is denoted as the comparison of SSE values from matrices coefficient for each method

Table 5: Comparison of SSE values from matrices coefficient for each method

method s	Root mean square error (D)	zero cell
RAS	1.146	
CE	1.017	
LS	0.895	Cell (8 , 5)
LP- L_1	1.021	
LP- L_∞	0.917	Cell (8 ,5) and cell(8, 6)

(2) Comparison of SSE value of matrices of coefficients for each estimation methods

The choice of the best method, we use method of “choose the appropriate method”

(section 4.2). We obtain the following inequality between the five values of D.

$$D_{LS} < D_{LP-L_{\infty}} < D_{CE} < D_{LP-L_1} < D_{RAS}$$

From the final matrix of SAM through the LS and LP- L_{∞} , we notice the values of the elements are null: Cell (8, 5) in LS method, Cell (8, 5) and cell (8, 6) in LP- L_{∞} method.

Where as these values is not null in initial matrix of SAM. The LS and LP- L_{∞} method do not reflect the latter. Therefore, the value of D is very low in the method of CE.

6. CONCLUSION

A SAM is a single accounting framework with the rows and columns, arranging income and expenditure accounts of various economic agents in a country. A SAM framework is not only a statistical tool but also a framework for macroeconomic analysis. It provides a framework for the organization of information about economic and social structure of a country and a service as dataset for a model of the economy. Since estimating cell value from primary or disparate secondary source are often inconsistent. There are several alternative matrix balancing methods are available to adjust the initial estimates for consistency. We detail describe five types the matrix balancing methods. The RAS method is an iterative method of "biproportional" adjustment of rows and column that has been independently developed by various researches. We present a GAMS code and CE, LS, LP- L_1 and LP- L_{∞} to balance an unbalanced SAM in ten steps. Finally, we present a comparison of SSE values from matrices coefficient for each method.

REFERENCES

- Ahmed, S. A. and Preckel, P. V., A comparison of RSA and entropy methods in updating IO tables. American Agricultural Economics Association, 2007 Annual Meeting, July 29-August 1, 2007, Portland, Oregon 1-20. <http://purl.umn.edu/9847> (accesses 18 august 2013).
- Bellu, L. G., Social accounting matrix (SAM) for analyzing agricultural and rural development policies conceptual aspects and examples, Analytical tools Easypol module 130, 2012. <http://www.fao.org/easypol>. (accesses 15 august 2013)
- Chowdhury, A. and Kirkpatrick, C., *Development policy and planning: an introduction to models and techniques*, London and New York: Routledge, 1994.
- Chung-I Li, J., *A 1999 social accounting matrix (SAM) for Thailand*, TWD Discussion paper No 95, International Food Policy Research Institute, and Washington D.C. 2002.

Fofana, I. Lemelin, A. and Cockburn, J.), Balancing a social accounting matrix: theory and application. , 2005.

http://www.un.org/esa/policy/sanjoes_training-mdges/fofana_lemelin_cockburn_2005.pdf.

(Accesses 15 august 2013)

Gallardo, A. and Mardones, C., environmentally extended social accounting, *Development and Sustainability*, 2013, 15(4), 1099-1127.

Golan, A, Judge, G. and Robinson, S., Recovering information from incomplete or partial multisectoral economic data, *Review of Economics and Statistics*, 1994, 76, 185-193.

Kendrick, B. and Meeraus, A., *GAMS – A user's guide*, the scientific Press Redwood City, CA. ,1988.

Keuning, S. J., Proposal for a social accounting matrix which fits into the next system of national accounts, *Economic Systems Research*, 1991, 3(3), 233-248,

Kullback, S. and Leibler, R. A. (, On information and sufficiency, *The Annals of Mathematical Statistics*, 1951, 22(1), 79-86.

Moulton, B. R., The system of national account for the new economy: what should change?, *Review of Income and Wealth*, 2004, 5(2), 261-278.

Payatt, G. Round, J. I. and Denes, J. (1984), *Improving the macroeconomic database: a SAM for Malaysia, 1970*, World Bank Working Paper No 646, The World Bank, Washington, D. C.

Pleskovic, B. and Travino, G., *The use of a social accounting matrix framework for public sector analysis: the case study of Mexico*, ICPE Monograph series, 1985, No, 17.

Reinert, K. A. and Roland-Hoist, D. W. , *Social Accounting Matrices: Applied methods for trade policy analysis. A Handbook*, Cambridge University Press, Combridge: 1997, pp. 94-121.

Robillard, A. S. and Robinson, S., *Reconciling household surveys and National accounts data using cross entropy estimation method*, IFPRI, Discussion paper No. 50, 1999.

Robinson, S. and Ei-Said, M., *Games code for estimating a social accounting matrix (SAM) using cross entropy (CE) methods*, IRPRI, Discussion paper No. 64, 2000.

Robinson, S. Cattaneo A. and El-Sald, M., Updating and estimating a social accounting matrix using cross Entropy methods, *Economic Systems Research*, 2001, 13(1), 47-64.

Robinson, S. Cattaneo, A. and El-Said, M., *Estimating a social accounting matrix using cross entropy methods*, IFPRI, Discussion paper No. 33. 1998.

Round, J. (1981), *Income distribution within a social accounting matrix: a review of some experience in Malaysia and other L.D.C.'s*, *Development economics research cent-University of warwick*, Discussion paper No. 3, March, 1981.

Round, J. I., Constructing SAMs for development policy analysis: Lessons Learned and Challenges ahead, *Economic Systems Research*, 15(2), 2003, 161-183.

SNA, *System of National Accounts*, Commission and European Communities,
International Monetary Fund, Organization for Economic Co-operation and Development,
United Nations, World Bank / Luxembourg, New York, Paris, Washington D.C. 1993.

Tames, T., A, 2007 social accounting matrix for Uganda, International Food policy
Research Institute (IFPRI), 2008, 1-19.

Wilson, K., *the architecture of the system of national accounts: a three-way international
comparison Canada, Australia and the United Kingdom*. 2004.

<http://www.nber.org/chapters/c0314> (accesses 18 august 2013)