The Social Accounting Matrix (SAM) Methodology and Web site

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The Social Accounting Matrix (SAM)

Important aspects related to this tool:

- It represents an instrument for supporting and addressing public investment policies
- It might be used on regional scale
- It is available for Public Administration
From the Project to the Instrument

- The SAM model have been developed by the research group of the University of Rome “Tor Vergata”– Centre of Economic and International Studies (CEIS)

- Application based on Excel (2006-2009) and Web (2010) with the SAM Software

http://160.80.46.47
An instrument of planning and analysis

- A Social Accounting Matrix (SAM) is a generalization of the famous Leontief Input -Output matrix. It is a square matrix that gives a statistical representation of the whole circuit of the income flow that characterizes a economic system and is the basic core of general equilibrium computable models.

- Mathematically, a SAM is a double entry matrix with each of its nonzero elements recording the value of economic transactions occur among economic actors in a given time period.

- Rows record incomes, columns record expenditures and all row sums equal the corresponding column sums.
An instrument of planning and analysis

In the SAM framework, macro (national accounts and input-output table) and micro (national surveys) data are put together under a unified data matrix in order to describe interactions of various economic agents, that are factors of production, institutions and production sectors, showing, in addition, for all transactions, who pays what to whom.
An instrument of planning and analysis

The SAM allows us to:

- make *ex ante* simulation and evaluation in order to quantify the multiplicative effects (direct and indirect) of investment projects, programs or public policies

- quantitatively examine exchange ratios and interdependent relationships existing among all the agents of an economic system

- To analyze the National Accounting System, including the Regional Accounts, in an integrated way
Strengths of a Social Accounting Matrix

- **User friendly** and strong **ability to synthesize** the economic system and the interdependences among sectors and institutions
- **Coherent framework** for the integration of statistics on wealth formation and distributions, investments, environmental and natural resources
- Possibility of **mathematical treatment** of the matrix in its wholeness or its parts considered as sub-matrices
- Possibility to use the matrix as a **base for modeling** the activity of the economic systems
- Possibility of its use as a support for programming and evaluation of the economic policies and investments (**ex ante estimation of direct and not-direct effects**)
Tool Upgrade: the SAM web site

- Added value increment of a sector directly interested by the project
- Production increases over the other concerned sectors
- Households, Enterprises, Government and Rest of the World flows of income increases.
- Standard labour units that the investment enables all over the economic sectors

MOREOVER: With the SAM web site it is possible to extend the analysis even to the **environmental** (greenhouse gases emissions, water resources) and **energetic components**.
The SAM model and Environmental Impact

In the current extension, the environmental impact might be evaluated in terms of:

- cutting costs
- tons of pollution emitted

For each SAM matrix (national and regional), it has been developed an excel sheet able to describe the environmental accounting, where for any of the 58 production sectors the emissions of the most polluting factors are taken into account (\(\text{CO}_2, \text{CH}_4, \text{N}_2\text{O}, \text{NO}_x, \text{SO}_x, \text{NH}_3, \text{COVNM, CO, Pb, PM10}\)).

Environmental accounting for Europe has been estimated on the base of the regional tables NAMEA.
The SAM model and water resources

The pilot project realized in collaboration with the Basin authorities of the Southern Appenines concerning the construction of the management plan considers:

- the elaboration of an estimation process of the water sectors in function of their use
- production and institutional sectors assignation of different water categories, each of those with their own specific value
The SAM model and the energy sector

The pilot project started in collaboration with ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development) will allow to disaggregate by 2012 the energy sector in at least six sub-sectors able to represent all the large energy production groups from both renewable and not renewable resources.

The estimation process of a single energy sector will be possible thanks to the construction of an interface between the SAM model and the estimation models used by ENEA (MARKAL - Times).
Methodological and modelling outlines of the SAM model
Economic actors represented by SAM

- Main production factors (Labour, Capital)
- Productive sectors (Agriculture, Industry, Services)
- Families (classified by class of consumption)
- Firms
- Government (Public Administration)
- Capital formation (public and private gross fixed investments)
- Rest of the economy (of the world, of country, etc)

The productive sectors are disaggregated into 58 sectors (based on Ateco 2002); in June 2010 updating (Ateco 2007) and disaggregation enlargement.
External shocks and multipliers

- Direct effects
  - Production increment of the construction sector
  - Production increment of the other sectors connected to construction sectors

- Indirect effects
  - Production factors increment (labor and capital)
  - Families incomes and consumption increment
  - Government

- Import/export
  - Rest of the World

A: production multiplier
B: added value multiplier
C: income multiplier
### The base structure

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<th>Capital formation</th>
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<th>Total inflows</th>
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Inflows and Outflows

The matrix allows to analyze the economic activity results, identifying the inflows and outflows of any aggregate (productive sector or group of economic agents)

The **columns** register the **outflows** of each aggregate respect to all the others

The **rows** represent the **inflows** of any operator
Estimation methodology

- **Step 1:** Statistics time series gathering at regional level;
- **Step 2:** Hypothetical values generated by the main aggregates through the Monte Carlo simulation;
- **Step 3:** Regional SAM estimation of each simulation through the “improved” methodology.
Database construction: data gathering
time series variables and static variables

*Detrend* of the time series variables and
construction of the multivariate distribution (mean,
variance, correlation matrix)

Construction of I-O matrix based on a
supply and use national table

Construction of relation by economic sectors,
institutional sectors and rest of the world to
balancing the account

Extraction through Monte Carlo simulation
of thousand values of all variables

The simulation result allows to obtain
1000 SAM matrices balancing by a RAS
method

MATLAB procedure allows to obtain:

• 1000 balancing matrix of the SAM
• 1000 inverse matrices and min. and max. multipliers
• Statistics over 1000 inverse matrices and multipliers
A new methodology of estimation

The economy is described by a system of equations of the following type:

\[ X_1 = b_{11} X_{11} + b_{12} X_{12} + \ldots + b_{1i} X_{1i} + \ldots + b_{1n} X_{1n} + N_1 \]
\[ \ldots \quad \ldots \quad \ldots \]
\[ X_i = b_{i1} X_{i1} + b_{i2} X_{i2} + \ldots + b_{ii} X_{ii} + \ldots + b_{in} X_{in} + N_i \]
\[ \ldots \quad \ldots \quad \ldots \]
\[ X_n = b_{n1} X_{n1} + b_{n2} X_{n2} + \ldots + b_{ni} X_{ni} + \ldots + b_{nn} X_{nn} + N_n \]

The estimation of the coefficients is generally solved by applying a constrained maximization called generalized cross entropy (GCE) . This method has been proved to be extremely useful especially in the case of partial missing information.
Considering each $\beta_{11}$ as the expected value of a random variable with support $[z_1, z_2, \ldots, z_m]$ and probability $[p_{1ij}, p_{2ij}, \ldots, p_{mij}]$ and giving a set of prior probabilities $[q_{1ij}, q_{2ij}, \ldots, q_{mij}]$ is it possible to estimate the posterior probabilities by solving the problem:

$$\max_{p_{mij} \geq 0} H = - \sum_{m} \sum_{i} \sum_{j} p_{mij} \log \frac{p_{mij}}{q_{mij}}$$

(1)

such that

$$\sum_{m} p_{mij} = 1 \quad \sum_{m} \sum_{i} p_{mij} z_m = 1 \quad \sum_{j} \sum_{m} p_{mij} z_m v_{*j} = v_{i*}$$

Where $v_{*j}$ and $v_{i*}$ represent, respectively, the column and row totals.
The estimation of the coefficients $b_{ij}$ can be written as

$$b_{ij} = \sum_m p_{mij} z_m$$

Solving the Lagrangian with respect to $p_{mij}$ is it possible to derive a distribution of $m$ matrices $IxJ$ where the coefficients are functions of the prior probabilities and the shadow prices of the constrains:

$$b_{mij} = p_{mij} z_m = \frac{q_{mij} z_m [\exp(-(\gamma_{ij} + \lambda_j + \mu_i v_{*i}) z_m)]}{\sum_m q_{mij} [\exp(-(\gamma_{ij} + \lambda_j + \mu_i v_{*i}) z_m)]}$$

with expected value

$$b_{ij} = \sum_m p_{mij} z_m = \frac{\sum_m q_{mij} z_m [\exp(-(\gamma_{ij} + \lambda_j + \mu_i v_{*i}) z_m)]}{\sum_m q_{mij} [\exp(-(\gamma_{ij} + \lambda_j + \mu_i v_{*i}) z_m)]}$$

A prior distribution $q_{mij}$ can be defined as a normal distribution with mean $b^0_{ij} = E b^0_{mij} = \sum_m q_{mij} z_m$ and variance $Var(b) = E \| b^0_{mij} - b^0_{ij} \|$
Then, a prior distribution can be the distribution of the coefficients deriving from the unbalanced matrices calculated on the base of the totals.

Moreover, although the equation describing the expected value of coefficients $b_{ij}$ can not be solved in a closed form it can be derived by applying iterative algorithms of the RAS type.

This can be done by specifying initial values $[z_1, z_2, ..., z_m]$ with associated probability $[q_{1ij}, q_{2ij}, ..., q_{mij}]$ and then, respecting the constrains of the Lagrangian, by applying a simulation in order to get proper values of $b_{ij}$ as defined by equation (3)
How to use the SAM software
Logical process

PROJECT
(and eventually alternative projects)

Exogenous shock
- Data entry
  - Investment vector
  - Historical vector
  - Alternative project vector

Multiplicative effect on
- Interest sector
- Labor
- Capital

Multiplicative effect on
- Families
- Firms
- Government
- Rest of the world

Environmental impact
How the impact analysis of the investment works

- Investment vector
- Historical vector
- Alternative project vector

- Economic impact
- Production sectors

- Social-econ. Impact
- Institutional sectors

- Environmental Impact
- Emissions Reduction costs
Crowding out effect: public spending can totally or partially replaces private spending, without affecting the national income, or reducing this.

With the SAM instrument it is possible to choose the grade of crowding out (from 10% to 100%)
STEP 1: Create a scenario

A restricted working area is reserved defining:

- the reference geographic area
- the evaluation type
STEP 2: Define the expenditure vectors

For each project to consider, investment values are located over the interested sector.
STEP 3: Result analysis

At this point it is possible:

- Display the elaboration

- Print a paper report (.pdf)

- Download the results (.csv)
And now

use the SAM website