Available online at www.sciencedirect.com

ScienceDirect

Journal of Policy Modeling xxx (2015) xxx–xxx

Journal of Policy Modeling

www.elsevier.com/locate/jpm

Social accounting matrix: A new estimation methodology

Pasquale Lucio Scandizzo [a], Cataldo Ferrarese [b,*]

[a] *University of Rome "Tor Vergata", Italy*
[b] *OpenEconomics, Via Tagliamento 9, 00198 Rome, Italy*

Received 22 November 2014; received in revised form 3 December 2014; accepted 12 January 2015

Abstract

In this article, we present a new methodology to develop bootstrap estimates of a social accounting matrix (SAM), by combining entropy minimization and Monte Carlo simulation techniques. An application is presented to the Italian economy, demonstrating how a set of policy measures can be evaluated by incorporating the prior degree of uncertainty on the model parameters and the historical volatility in the main variables. The results of this exercise show that the methodology proposed provides specific evaluations of the policy measures considered, as well as a rich informational structure on the extension and the limitations of the inference from the data and the economic model.

Keywords: Evaluation; Public policy; Social accounting matrix

1. A general model: social accounting matrix

The Social Accounting Matrix (SAM) is a system of national/regional/sub-regional accounts represented in a matrix format. It includes the inter-industry linkages through transactions typically found in the I–O accounts and the transactions and transfers of income between different types of economic agents, such as households, government, firms and external institutional sectors (Pyatt & Thorbecke, 1976; Stone & Brown, 1962). The SAM consists of a set of interrelated subsystems that, on the one hand, give an analytical picture of the economy in a particular accounting period

* Corresponding author. Tel.: +39 3299352391.
E-mail addresses: scandizzo@uniroma2.it (P.L. Scandizzo), dino.ferrarese@openeconomics.eu (C. Ferrarese).

http://dx.doi.org/10.1016/j.jpolmod.2015.01.007
0161-8938/

Please cite this article in press as: Scandizzo, P. L., & Ferrarese, C. Social accounting matrix: A new estimation methodology. *Journal of Policy Modeling* (2015), http://dx.doi.org/10.1016/j.jpolmod.2015.01.007

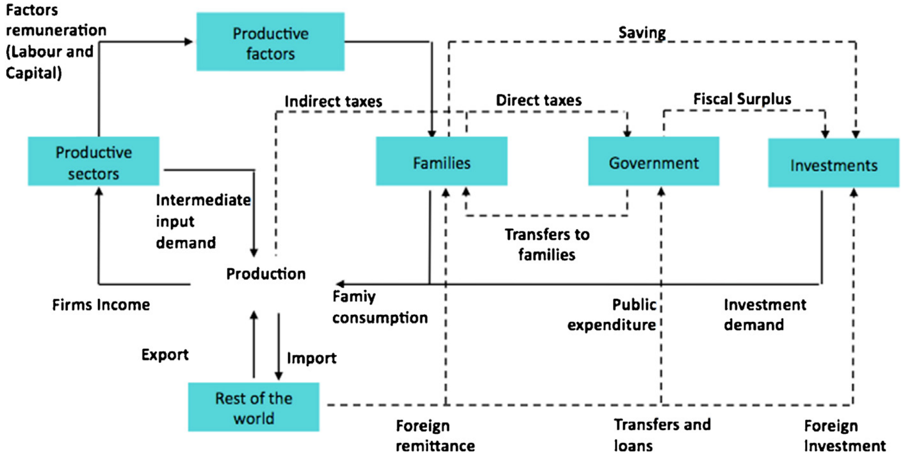


Fig. 1. The income circuit.

Source: Scandizzo et al. (2010).

and, on the other hand, serve as an instrument for assessing the effects of changes on the flows represented (injections and leakages in the system), which might be the result of policy measures. The Matrix is a double-entry table, describing the structure of the economic system through its disaggregation in key blocks, thought as origin and destination of transaction flows. Thanks to its theoretical and methodological characteristics, it can represent the distributive and redistributive income process by including the accounts headed to the institutional sectors (households, firms and government).

Following this approach, the economic system is typically disaggregated into the following blocks:

i. Primary production factors (Labor and Capital);
ii. Production sectors (Agriculture, Industry, Services and their disaggregations);
iii. Households;
iv. Firms;
v. Government (Public Administration);
vi. Capital Formation (Public and Private gross fixed investments);
vii. Rest of the Country (ROC) and Rest of the World (ROW).

Both the expenditures (columns) and revenues (rows) are defined for any productive and institutional sector. If data are available, any of the above blocks can be further disaggregated depending on the objective of the analysis. The SAM is considered an extension of the traditional Input–Output (I/O) model proposed by Leontief, which also consists of a transaction matrix and records, in quantitative terms, the exchange flows of an economic system in a specific place, for a specific period. In its usual configuration, the SAM includes the Input–Output matrix of the intermediate exchanges between production sectors, the accounts related to institutional sectors (households, firms and government), production factors (labor and capital), capital formation and rest of the economy.

The Matrix allows considering the entire structure of relations characterizing an economic system through the different phases of the production, distribution, utilization and income accumulation process as shown in Fig. 1.

Please cite this article in press as: Scandizzo, P. L., & Ferrarese, C. Social accounting matrix: A new estimation methodology. *Journal of Policy Modeling* (2015), http://dx.doi.org/10.1016/j.jpolmod.2015.01.007

In a typical SAM structure, columns represent the outflows of the different economic agents that is, the expenditure of any aggregate with respect to the others, while rows represent the inflows, namely the income formation; Since total incomes equal total expenditures, including savings and capital formation, the SAM is a square and balanced matrix. A simplified scheme of the SAM is presented in Fig. 2.

Given its ability to coherently represent all the relations characterizing an economic system and the national account structure, the SAM is both a powerful descriptive tool and a valid starting point for economic modeling.

2. Proposed estimation methodology for SAM

Starting from a base year SAM from a national accounting data base, we develop a methodology (Scandizzo, 1992; Scandizzo, Ferrarese, & Vezzani, 2010) to estimate a SAM on the basis of a richer information data base constituted by a combination of time series of national accounts and household surveys. This methodology can be formalized as a problem of constrained maximization within the context of the generalized cross entropy (GCE) model proposed by Golan, Judge, and Miller (1996) (see also Robinson, Cattaneo, & El-Said, 2001) as follows. Assume that a SAM is specified as a matrix of transactions between n sectors, factors and stakeholders. Consider each transaction (or, in normalized form, each coefficient) b_{ij} as the expected value of a random variable with support $[z_1, z_2, \ldots, z_M]$ and probabilities $[p_{1ij}, p_{2ij}, \ldots, p_{Mij}]$. The support values indicate the range of possible values for each coefficient. Since the SAM coefficients are shares of column totals, the interval of these values is comprised between 0 and 1. The corresponding range of the support values may be constituted, in the interval considered, by a discrete series of values or by a continuum. For simplicity, we assume that the first hypothesis holds and that it is possible to specify the same set of possible, but not equally probable, values M for each coefficient. Given a set of prior estimates q_{mij} of the probabilities associated to the possible values of each coefficient, posterior estimates can be obtained by solving the problem:

$$\max_{p_{mij}\geq 0} H = -\sum_{m}\sum_{i}\sum_{j} p_{mij} \log \frac{p_{mij}}{q_{mij}} \tag{1}$$

Under the constraints:

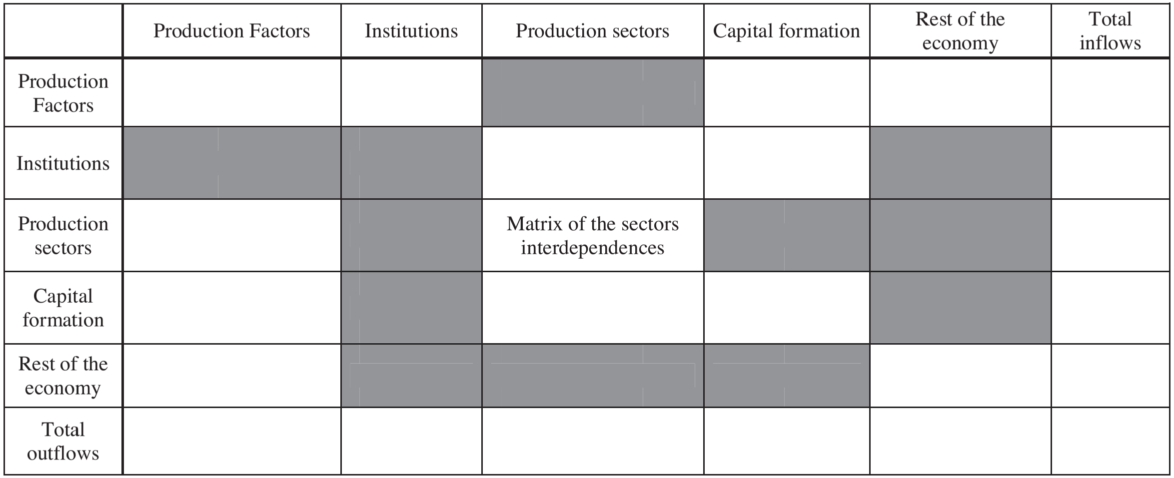
$$\sum_{m} p_{mij} = 1 \tag{2}$$

$$\sum_{i}\sum_{m} p_{mij} z_m = 1 \tag{3}$$

$$\sum_{j}\sum_{m} p_{mij} z_m v_{*j} = v_{i*} \tag{4}$$

where v_{*j} is the vector of the pre-defined column totals and v_{i*} the vector of the pre-defined row totals.

The objective function in (1) which is typically denoted as “cross entropy”, in reality is not an entropy indicator, but the sum of the entropy measures, according with Shannon’s definition (19448) for each column of the matrix and for each element of the probabilistic support $[z_1, z_2, \ldots, z_m]$, More precisely, we can define as column entropy level for the m-th state of nature the function $H_{jm} = -\sum_i p_{mij} \log p_{mij}$. This function measures the quantity of information



Source: Scandizzo, Ferrarese, Vezzani 2010

Fig. 2. A simplified SAM scheme.

Source: Scandizzo et al. (2010).

contained in the probability of each column for each state of nature as the logarithmic difference of the uniform distribution. When information is constituted only by the constraint that the probability sum must equal 1, the entropy is at a maximum, and the best estimate of the probabilities of the j-th column is that they are all equal to $1/M$. The entropy indicator thus measures the additional degree of information with respect to an informed prior distribution. If the analyst possesses a more informed prior, for example in the form of a prior probability q_{mij}, this can be incorporated in the logarithmic term of the entropy measure:

$$H_{jm} = -\sum_{i} p_{mij} \log \frac{p_{mij}}{q_{mij}}. \tag{5}$$

Given a SAM, it will thus be possible to specify a different measure of entropy for each column (or each row) or even each value of the stochastic support z_m. The “cross entropy” is the sum of these row or column entropies and represents, not itself an entropy, but only one possible synthetic index of the entropy that can be associated to the SAM’s rows and columns. Instead of a simple sum, in particular other weighting schemes can be used to reflect the different value that can be attributed to the information contained in a Sam according with the size or the variability of the flows, their statistical reliability and other special properties one may wish to consider.

Going back to the problem (1)–(4), the estimation of the coefficients b_{ij} is given by:

$$b_{ij} = \sum_{m} p_{mij} z_m$$

The corresponding Lagrangean is:

$$L = \sum_{m}\sum_{i}\sum_{j} p_{mij} \log \frac{p_{mij}}{q_{mij}} - \sum_{i}\sum_{j} \gamma_{ij} \left(\sum_{m} p_{ijm} - 1 \right) - \sum_{j} \lambda_j \left(\sum_{i}\sum_{m} p_{mij} z_m - 1 \right)$$
$$- \sum_{i} \mu_i \left(\sum_{j}\sum_{m} p_{mij} z_m v_{*j} - v_{i*} \right) = 0 \tag{6}$$

The Kuhn Tucker conditions for the solution of the problem (1)–(4), are given by the constraints (2) and (4), assuming that they are binding and by the following expressions:

$$\frac{\partial L}{\partial p_{mij}} = \log \frac{p_{mij}}{q_{mij}} + 1 + \gamma_{ij} z_m + \lambda_{ij} z_m + \mu_i v_{*j} z_m = 0_m \quad \text{or} \quad p_{mij} = 0$$
$$m = 1, 2, \ldots, M; \quad i = 1, 2, \ldots, I; \quad j = 1, 2, \ldots, J \tag{7}$$

Solving for p_{mij}:

$$p_{mij} = q_{mij} \exp(-1 - \gamma_{ij} z_m - \lambda_j z_m - \mu_i z_m v_{*i}) \tag{8}$$

Summing over m, we obtain:

$$\sum_{m} p_{mij} = 1 = \sum_{m} q_{mij} [\exp(-1 - \gamma_{ij} z_m - \lambda_j z_m - \mu_i z_m v_{*i}] \tag{9}$$

implying:

$$\exp(1) = \sum_{m} q_{mij} [\exp(-\gamma_{ij} z_m - \lambda_j z_m - \mu_i z_m v_{*i}] \tag{10}$$

And, substituting in (8):

$$p_{mij} = \frac{q_{mij} \exp[-z_m(\gamma_{ij} + \lambda_j + \mu_i v_{*i})]}{\sum_m q_{mij} \exp[-z_m(\gamma_{ij} + \lambda_j + \mu_i v_{*i})]} \tag{11}$$

From (11) one can derive the estimate of a distribution of m matrices of $I \times J$ coefficients which are function of a prior value of the probabilities and the constraints' shadow prices:

$$b_{mij} = p_{mij} z_m = \frac{q_{mij} z_m [\exp(-(\gamma_{ij} + \lambda_j + \mu_i v_{*i}) z_m)]}{\sum_m q_{mij} [\exp(-(\gamma_{ij} + \lambda_j + \mu_i v_{*i}) z_m)]} \tag{12}$$

with expected values:

$$b_{ij} = \sum_m p_{mij} z_m = \frac{\sum_m q_{mij} z_m [\exp(-(\gamma_{ij} + \lambda_j + \mu_i v_{*i}) z_m)]}{\sum_m q_{mij} [\exp(-(\gamma_{ij} + \lambda_j + \mu_i v_{*i}) z_m)]} \tag{13}$$

In our experience a prior distribution q_{mij} may be typically characterized as a normal distribution with mean and variance equal to:

$$b_{ij}^0 = Eb_{mij}^0 = \sum_m q_{mij} z_m, \quad i = 1, 2, \ldots, I, \quad j = 1, 2, \ldots, J \tag{14}$$

$$Var(b) = E||b_{mij}^0 - b_{ij}^0|| \tag{15}$$

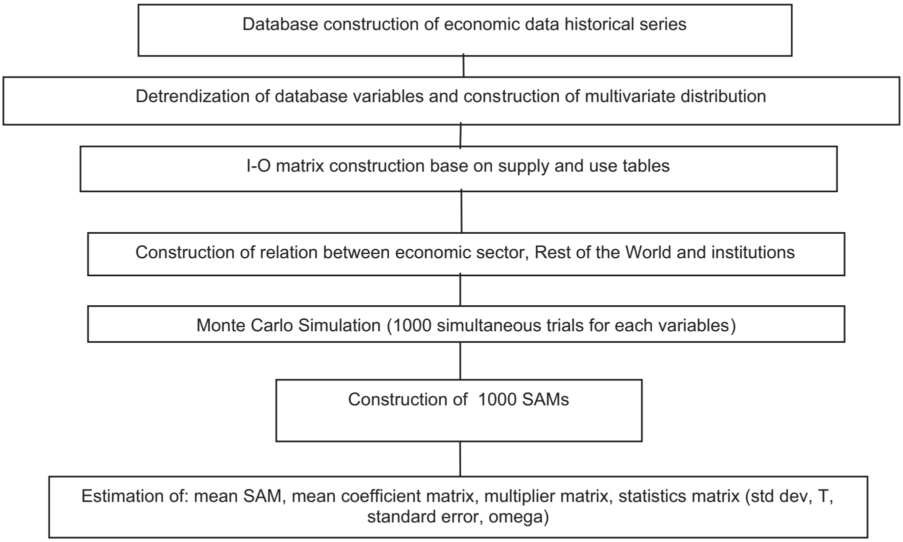
This prior distribution is the distribution of non balanced matrices derived from direct estimates of the totals from aggregating survey data, or using time series. The estimate proposed by Eq. (13), even though based on a constrained maximization, can be computed using a stochastic simulation and an iterative algorithm of the RAS type that re-proportions iteratively the columns and the rows of the matrix to estimate. The estimate can in fact be interpreted as an adaptation of an initial estimate proportional to a function of the expected value of the variable $x_{mij} = z_m \exp(-\gamma_{ij})$, to make this variable satisfy the constraints given by the sums of the rows and the columns (Scandizzo et al., 2010).

3. The Monte Carlo simulation estimation[1]

In the application presented below, we use the procedure outlined above, including Monte Carlo bootstrap estimates of the probability distribution of the SAM parameters for the Italian economy. This allows to exploit the information contained in the time series of national accounts and other statistics (including household budget surveys) and to account for the uncertainty on the estimates and the historical volatility in the main variables. To this aim, we used (detrended) time series to obtain estimates of the matrix totals statistics and to generate estimates for each cell of the matrix, according to a three step procedure:

[1] While entropy can be considered a measure of uncertainty of a probability distribution, in this section of the paper uncertainty refers to the variation over time of the variables involved in the estimation. These variables may be interested by stochastic changes. The ensuing uncertainty of the parameter estimates may be considered as reducible to its gradable components (as in the Keynesian school) and treated as giving rise to an estimation risk, which can be taken into account in the estimation procedure, by using appropriate statistics (means, variances and higher moments) of the Monte Carlo results.

Please cite this article in press as: Scandizzo, P. L., & Ferrarese, C. Social accounting matrix: A new estimation methodology. *Journal of Policy Modeling* (2015), http://dx.doi.org/10.1016/j.jpolmod.2015.01.007



Source: Scandizzo, Ferrarese, Vezzani (2010)

Fig. 3. Estimation procedure.

Source: Scandizzo et al. (2010).

1. Identify a probability distribution and related parameters for all main aggregate variables (if historical series are not available the Hp is normal distribution with standard deviation equal to 25% of mean);
2. Generate values through Monte Carlo simulation;
3. Estimate a complete SAM for each simulation through the entropy based methodology outlined above.

Fig. 3 presents a summary of the estimation procedure, in the form of a flowchart.

4. The SAM as an instrument of policy analysis

As Pyatt (1988) originally emphasized, the SAM not only provides a convenient form to present a set of national accounts (Meade & Stone, 1941), but also indicates the underlying structure of a consistent policy model of an economic system. As a basis for an economic model, the SAM is especially suited to provide measures of interdependencies among sectors, factors and institutions, and thus to explore the wider implications of specific policy measures. Unlike the traditional macro-policy models where instruments and targets are identified, respectively on the basis of government control and planning, the SAM based models rely more broadly on the distinction between the accounts that can be modified exogenously, and those that are endogenously affected by these modifications. Furthermore, in the SAM context both the levels of the exogenous accounts (for example, the level of public investment in one or more sectors) and the parameters (for example the tax rates) can be used as policy instruments (Pyatt & Thorbecke, 1976; Thorbecke, 2003).

The economic models that embed the SAM (Norton & Scandizzo, 1981; Norton, Scandizzo, & Zimmerman, 1986; Scandizzo, 1992) can be roughly classified into three basic categories: (i) the fix-price models, where input–output coefficients and prices are fixed, except for those that are varied exogenously as part of the policy experiments; (ii) the flex-price models, where suitable supply and/or demand elasticities are introduced as parameters; (iii) the general equilibrium models, where prices are allowed to fully adjust across all sectors to take into account of shifting factor supplies, foreign trade and other environmental factors. In spite of the fact that they are less flexible than the other two types, fix price models provide a simple and powerful framework to study the impact of economic policies under short term conditions of relative underemployment of key factors of production. These conditions tend to prevail in times of economic recession, as the present ones, where it may be particularly useful to evaluate the possible effectiveness of Keynesian policies of exogenous income injections and of demand driven policy changes.

J. M. Keynes pioneered the concept that the market system does a reasonable job in resource allocation, but does not perform in an acceptable way with factor employment. This "under-performance" arises from lack of effective demand, and could be the consequence of several conditions, including the preference for liquidity and the tendency to hoard money away from the economic circuit. From this point of departure, a strong current of economic thought developed over the past half a century, according to which the main trust of economic policy is to engineer exogenous shocks that can move an economy toward a higher level of employment of labor and other available resources. This line of thought was extended from the original aggregate set up of the Keynesian macro-economic model, to a disaggregated representation of the economy, through the input output analysis (Leontief, 1986), and the Social Accounting Matrix (Stone, 1947).

Most of the criticisms developed in the past years against Keynesian policies of the proactive fiscal type concern the inability of the government to permanently raise aggregate demand. The issues raised include Ricardian equivalence, supply side incentives, inflationary biases and intertemporal sustainability of the fiscal deficit (see, for example, Bajo-Rubio, Díaz-Roldán, & Esteve, 2014). They have figured prominently in the counterrevolution that has characterized economic policy since the 70s and have been repeatedly invoked, although perhaps with decreasing frequency, during the last economic crisis. Other recent studies of the so called "new economy", point to the importance of flexibility and capacity of change (Salvatore, 2003), but do not deny the effectiveness of proactive fiscal policies. Thus, for example, in discussing the structural causes of the superior performance of the US economy during the 1995–2005 decade, in addition to greater deregulation, financial innovations, and greater ITT development, "overspending" is also reported as a key factor (Salvatore, 2010).

From a policy planning point of view, however, Keynes' original view on the multiplier and the correspondingly endogenous nature of income not only has not been seriously challenged, and both in national statistics and modeling it has been extended to a multi-sector representation of the economy and a related national accounting system. This extension has also provided a more detailed explanation of the meaning of the multiplier, and of its mode of functioning in an economy where full employment may be chronically kept at bay by lack of aggregate demand. In their SAM version, the multipliers fully capture the Keynesian concept that more than proportional boosts in demand can be generated by chains of expenditures following an autonomous injection of income. The SAM estimates go beyond that, however, in that they also incorporate the more sophisticated property that the size of the direct and indirect impacts of policy measures depend on the complexity of the value chains in the economy and the interdependencies among sectors and institutions. Thus multipliers can be created not only by exogenous policy changes in the level and structure of demand, but also by structural changes in the nature, extent and intensity of the linkages across the economic agents.

Please cite this article in press as: Scandizzo, P. L., & Ferrarese, C. Social accounting matrix: A new estimation methodology. *Journal of Policy Modeling* (2015), http://dx.doi.org/10.1016/j.jpolmod.2015.01.007

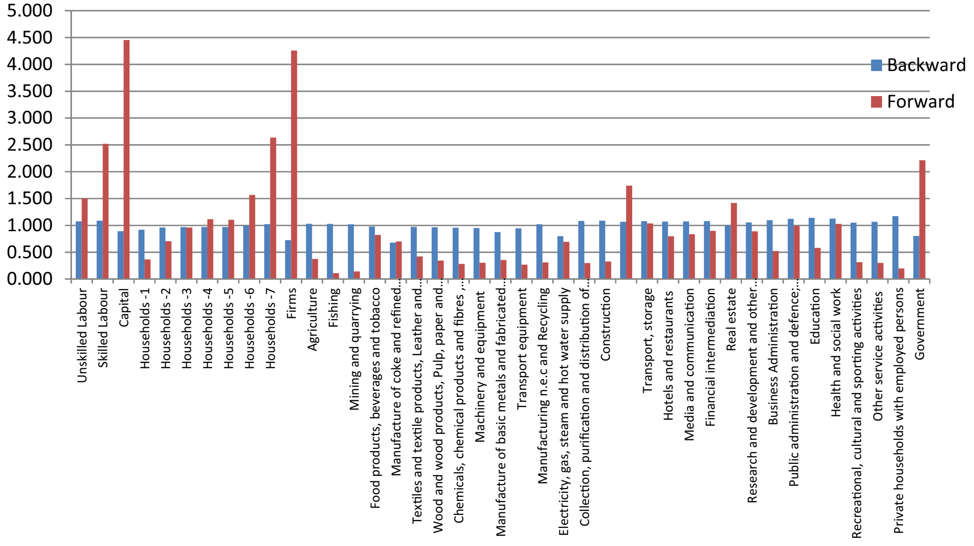


Fig. 4. The Italian SAM backward and forward linkages.

5. The multipliers of the Italian economy

The analysis of multipliers as forward and backward linkages in the economy began in the late 1950s, with seminal contributions by Nørregaard Rasmussen (1956), Chenery and Watanabe (1958), Hirschman (1958), Augustinovics (1970), Laumas (1975), and Lenzen (2003), among others. While the indexes developed in these studies are essentially unweighted means across sectors, our estimates are obtained by averaging multipliers across sectors and states of nature over the matrices constituting the pseudo-sample of the Monte Carlo simulations. As key results of our estimation of the Italian SAM, these average multipliers are summarized in Table 1 and Fig. 4, as the mean values of the SAM restricted, forward and backward multipliers and the associated 95% confidence intervals. These values measure the average increase in activity level of all sectors, factors or institutions, response to an unit increase in the activity level of a specific sector (backward multipliers) or to an increase in the activity of all sectors (forward multipliers) and are normalized by division for the average overall multiplier across all sectors. The multipliers considered are "restricted" in the sense that the balance of payment is assumed to be constrained by the base year conditions so that exports are prevented from growing to match the increase in imports. As mentioned before, the values reported are "mean" estimates, both in the sense that they are estimates of the expected values of the inverse SAM matrix (and not the values of the inverse of a single estimate of the SAM as it is usually the case) and that they are averages, for any given sector, of its response to the increases in demand downstream or upstream the value chains.

More precisely, backward mean multipliers, are indexes of linkages to upstream sectors in the value chain, and measure the extent to which a sector autonomous rise in activity level spills over all other sectors. They thus rate the importance of a sector as a center of demand for the rest of the economy and can be considered indexes of the positive externalities generated by the network structure i.e. the capacity to diffuse a positive (or a negative) shock

Table 1
The Italian SAM backward and forward linkages.

	Indexes of backward linkages (Monte Carlo mean estimates)	95% confidence interval backward linkages		Indexes of forward linkages (Monte Carlo mean estimates)	95% confidence interval forward linkages	
Unskilled labour	1.080	1.057	1.097	1.511	1.420	1.602
Skilled labour	1.090	1.068	1.106	2.540	2.405	2.675
Capital	0.890	0.872	0.910	4.480	4.047	4.914
Households-1	0.920	0.884	0.953	0.371	0.355	0.386
Households-2	0.960	0.934	0.986	0.710	0.687	0.732
Households-3	0.970	0.944	0.994	0.968	0.920	1.016
Households-4	0.970	0.946	0.995	1.124	1.087	1.162
Households-5	0.970	0.947	0.996	1.113	1.077	1.148
Households-6	1.000	0.977	1.019	1.579	1.536	1.622
Households-7	1.020	1.007	1.042	2.656	2.576	2.735
Firms	0.730	0.692	0.760	4.289	4.200	4.379
Agriculture	1.030	1.021	1.041	0.379	0.361	0.396
Fishing	1.030	1.021	1.037	0.109	0.105	0.113
Mining and quarrying	1.020	1.010	1.033	0.143	0.137	0.149
Food products, beverages and tobacco	0.980	0.957	1.000	0.829	0.793	0.865
Manufacture of coke and refined petroleum products	0.680	0.634	0.722	0.707	0.656	0.759
Textiles and textile products, leather and leather products	0.970	0.952	0.992	0.424	0.403	0.446
Wood, pulp, paper and publishing	0.970	0.941	0.990	0.346	0.328	0.363
Chemicals	0.960	0.936	0.979	0.285	0.272	0.297
Machinery and equipment	0.950	0.929	0.975	0.306	0.287	0.324
Manufacture of basic metals and fabricated metal products	0.880	0.845	0.908	0.356	0.337	0.376
Transport equipment	0.950	0.921	0.970	0.270	0.258	0.283
Manufacturing n.e.c and recycling	1.020	1.009	1.033	0.314	0.302	0.326
Electricity, gas, steam and hot water supply	0.800	0.766	0.834	0.699	0.663	0.736
Water and sewage and refuse disposal	1.080	1.071	1.092	0.301	0.288	0.313
Construction	1.090	1.078	1.096	0.328	0.288	0.368

Please cite this article in press as: Scandizzo, P. L., & Ferrarese, C. Social accounting matrix: A new estimation methodology. *Journal of Policy Modeling* (2015), http://dx.doi.org/10.1016/j.jpolmod.2015.01.007

Table 1
(*Continued*)

	Indexes of backward linkages (Monte Carlo mean estimates)	95% confidence interval backward linkages		Indexes of forward linkages (Monte Carlo mean estimates)	95% confidence interval forward linkages	
Wholesale and retail trade; repair of motor vehicles,	1.070	1.055	1.078	1.751	1.642	1.860
Transport, storage	1.080	1.065	1.090	1.044	0.989	1.099
Hotels and restaurants	1.070	1.062	1.081	0.803	0.762	0.843
Media and communication	1.070	1.059	1.086	0.841	0.787	0.896
Financial intermediation	1.080	1.070	1.092	0.905	0.851	0.960
Real estate	1.000	0.986	1.021	1.426	1.315	1.537
Research and development and other business activity	1.060	1.045	1.067	0.897	0.857	0.936
Business administration	1.100	1.091	1.105	0.528	0.509	0.547
Public administration and defence; compulsory social security	1.120	1.116	1.128	0.999	0.943	1.055
Education	1.140	1.130	1.152	0.585	0.546	0.624
Health and social work	1.130	1.114	1.141	1.038	0.980	1.095
Recreational, cultural and sporting activities	1.050	1.037	1.063	0.316	0.307	0.326
Other service activities	1.070	1.057	1.075	0.303	0.292	0.315
Private households with employed persons	1.170	1.155	1.190	0.200	0.181	0.219
Government	0.800	0.767	0.840	2.228	2.058	2.397

Please cite this article in press as: Scandizzo, P. L., & Ferrarese, C. Social accounting matrix: A new estimation methodology. *Journal of Policy Modeling* (2015), http://dx.doi.org/10.1016/j.jpolmod.2015.01.007

from the sector affected to the other sectors. A value lower or greater than 1 indicates that the multiplier of the sector, factor or institution considered is respectively below or above the average multiplier of the whole economy (sectors, factors and institutions). This is taken to represent the average spillover, both backward and forward of any autonomous expenditure and is estimated to be around 30%. Given this estimate, the average (normalized) backward multipliers appear to be of unitary order of magnitude for most sectors and rather robust across simulations, with values in the 95% confidence intervals closely clustered around the means, although the interval is somewhat larger for some manufactures and primary industries. For institutions, on the other hand, the results are more mixed, with multipliers significantly lower than 1 for capital, lower income households, firms and, last but not least, the government.

On their part, forward linkage measures for Italy appear to differ significantly across sectors. They tend to be lower than one (i.e., given that the normalization factor is again 30%, a 100% increase in the demand throughout the economy generates less than 30% increase in the demand for the sector), and with somewhat wider confidence intervals, as compared with correspondent estimates of backward multipliers, except for key service sectors such as transport and storage, real estate, public administration, health and social services. For both primary and manufacturing sectors, where demand for capital goods could increase through investment, forward multipliers appear lower than average, thereby signaling somewhat weak downstream linkages and difficulties to share the growth of the rest of the economy. For factors of production, instead, forward multipliers are estimated to be higher than average, especially in the case of skilled labor and capital, which appear to capture most of the Italian growth, when and if this occurs. However, the rather high interval of confidence of the estimate for capital suggests that uncertainty for investors tends to persist even under favorable circumstances. Institutions, finally, do appear to be able to significantly participate to general income increases and this is especially true for firms, the government and middle and high income households. It is remarkable that the “firms” (i.e. the corporate sector or both the private and the public sector engaged in production activities) display almost twice as much capacity to ride the general growth than the government. For households, the forward mean multiplier can be interpreted as an index of economic inclusion and the results indeed show its values being much below 1 for poorer households in the first decile and then rapidly increasing to much more than unity for the top income classes. Note however that high forward multipliers, while a blessing when the economy grows, increase the vulnerability to economic downturns. Thus, high forward multipliers for skilled labor and capital imply also high sensitivity of the level of employment of both factors to negative overall economic outcomes and similar vulnerabilities appear to exist for the corporate sector, the upper deciles of the household income distribution, and the government.

In sum, the Italian SAM estimates show an economy structured mostly around service activities, with an industrial base with good vertical linkages within each sector value chain, but much less integrated horizontally across sectors, a high degree of potential sharing of overall growth on the part of factors and institutions, but also a high vulnerability of employment and business performance to economic downturns, and the highest capacity to mobilize resources and generate growth lying with the corporate sector. Key sectors, factors and institutions where resources should be concentrated, and where taxation should be reduced to achieve wider growth can be identified as trade, transport and repair services, capital and skilled labor, firms and middle income households, with the government essentially playing a residual role as a policy maker and a significant hub of forward linkages.

6. Policy experiment simulation: the impact of spending review Italian law 2014

In the final chapter of "the General Theory", Keynes identified the two evils of modern capitalism in the excessive concentration of income and in the inability of the system to sustain full employment of its workers and productive capacity. Most of the interventions of fiscal policies of modern governments have indeed tried to address this conundrum, by devising policies that at the same time improve income distribution and increase aggregate demand. The set of economic measures contained in the recent Law 66/2014 approved by the Italian government constitute an example of such an attempt, as they seek to give new impulse to the economy through consumer spending, by providing for a tax bonus for employees earning less than €25,000 per year, financed by a reduction of public expenditure and by a tax on windfall gains from the banks. This policy appears also to offer an interesting application of our SAM estimates, since it is based on the exogenous injection of purchasing power into two institutions: the firms and the households, whose expenditure profiles are singled out by the SAM estimates as rather vulnerable to economic downturns and, at the same time, as holding significant backward linkage potential. However, this particular type of intervention cannot be simply studied as the effect of an increase in households' disposable income, since it changes the tax rates and therefore has a potentially important effect on the structure of the SAM in terms of coefficients and multipliers. For this reason, we base our simulation on a variant of the fix-price linear input output model, according to the equation:

$$\Delta X = (I - A*)^{-1}[(\Delta A)X + \Delta Y],$$

where A and A* are the SAM matrices, respectively, with and without the change, and ΔY is the vector of exogenous changes in receipts or expenditure of the capital account. In the case in point, in fact $\Delta Y = 0$, since the policy examined consists only in the selective reduction of the income taxes paid by people below the threshold selected by the government.

Table 2 summarizes the effects for the years 2014–2016, which are classified in the simulation scenario (called Policy Change or PC) and the counterfactual (called Business As Usual or BAU). The PC scenario reports the composition of expenditure determined by the new Law, while the BAU scenario reports the composition of expenditure in the absence of the new policy measures. The values presented for each sector represent the balance between revenue and expenditure for the Government. We also take into account the likely increase in the tax for local services (about 1.5 Bn per year).

To evaluate the effects of the PC policy measures versus the BAU counterfactuals, we used the detailed expenditure vectors corresponding to the aggregates in Table 2 as inputs in a SAM simulation under two hypothesis (first hp: households[2] beneficiaries spent all of the tax reduction,

[2] The household are divided in seven class depending on income and expenditure. The class are:

Class	Month expenditure (€)
1	<1000
2	>1001 < 1500
3	>1501 < 2000
4	>2001 < 2500
5	>2501 < 3000
6	>3001 < 4000
7	>4001

Table 2
Effects of Law 66/2014.

Sector	2014		2015		2016	
	PC scenario	BAU scenario	PC scenario	BAU scenario	PC scenario	BAU scenario
Net households taxation reduction	5,945	0	7,694		7,013	
Net firms taxation reduction	92	0	3,000		2,700	
Public administration Expense	0	3,698		2,806		2,806
Transfer to agriculture	0	379		395		395
Public administration consultants	0	18		27		27
Construction	122	0	122			
Transfer to wage management and transport	0	70		100		100
Bank taxation		1,994				
Incentives				7,488		6,385
Total	6,159	6,159	10,816	10,816	9,713	9,713

Data in Million Euro.

second hp: households spent part of tax reduction according to their historical pattern), using the Monte Carlo method combined with an estimate of the impact of the multipliers. The results obtained are represented by a probability distribution of the economic effects of the difference between PC and the BAU scenarios. In order to be able to perform a more complete evaluation, we also hypothesized a third scenario in which the tax benefit is extended to low-income households (unemployed and no tax area) from the next year to 2016 (Table 3 summarizes this scenario).

Table 3
Hypothesis of the impact of a more extended tax benefits for poor households.

Sector	2014		2015		2016	
	PC scenario	BAU scenario	PC scenario	BAU scenario	PC scenario	BAU scenario
Transfer to households	5,945	0	10,894		10,213	
Firms taxation reduction	92	0	3,000		2,700	
Public administration expense	0	3,698		3,806		2,806
Transfer to agriculture	0	379		395		395
Public administration CONSULTANTS	0	18		27		27
Construction	122	0	122			
Transfer to wage management and transport	0	70		1,100		1,100
Bank taxation		1,994				
Incentives				8,688		8,585
Total	6,159	6,159	14,016	14,016	12,913	12,913

Data in Million Euro.

Table 4
Simulated effects of the policy measures.

		2014	2015	2016
Value added	PC total expenditure	5,053	12,899	13,273
	PC partial expenditure	3,600	10,524	10,882
	Alternative scenario	3,597	13,848	14,595
Agriculture	PC total expenditure	53	105	137
	PC partial expenditure	−24	−16	13
	Alternative scenario	−24	198	235
Industry	PC total expenditure	2,050	2,971	3,167
	PC partial expenditure	1,562	2,176	2,371
	Alternative scenario	1,561	3,191	3,361
Energy and water	PC total expenditure	287	921	978
	PC partial expenditure	107	627	684
	Alternative scenario	107	1,041	1,004
Construction	PC total expenditure	−674	−769	−825
	PC partial expenditure	−548	−563	−620
	Alternative scenario	−548	−1,017	−1,097
Services	PC total expenditure	6,477	9,260	9,954
	PC partial expenditure	4,786	6,515	7,207
	Alternative scenario	4,783	8,489	9,024
Public services	PC total expenditure	−1,199	3,010	3,266
	PC partial expenditure	−1,763	2,097	2,351
	Alternative scenario	−1,764	3,362	3,525
Firms	PC total expenditure	4,685	−1,038	−108
	PC partial expenditure	3,915	−2,214	−1,317
	Alternative scenario	3,916	−1,400	−444
Government	PC total expenditure	3,488	1,851	3,046
	PC partial expenditure	3,088	1,278	2,481
	Alternative scenario	3,094	3,634	4,832
Capital formation	PC total expenditure	−1,561	−2,330	−2,484
	PC partial expenditure	−1,173	−1,699	−1,851
	Alternative scenario	−1,172	−2,433	−2,561

Data in Million Euro.

A summary of the results is presented in Table 4. The net effects of the law in terms of value added per year average €10 billion. Estimates for 2014 fall in the interval €3,597–€5,053 million with a positive impact on GDP between 0.26% and 0.36%. While all macro-economic aggregates show a positive increase, the sector distribution is uneven and agriculture, construction and public services appears to be heavily penalized. The effect on households appears largely positive and in line with the main objective of the economic measures (Fig. 5;Table 5).

The effect on Households show a positive effect for the beneficiaries of the policy but a positive effect for other class, also. In third scenarios the total growth is higher than the first two scenarios and decrease the inequality level of income distribution for Italy (Fig. 6).

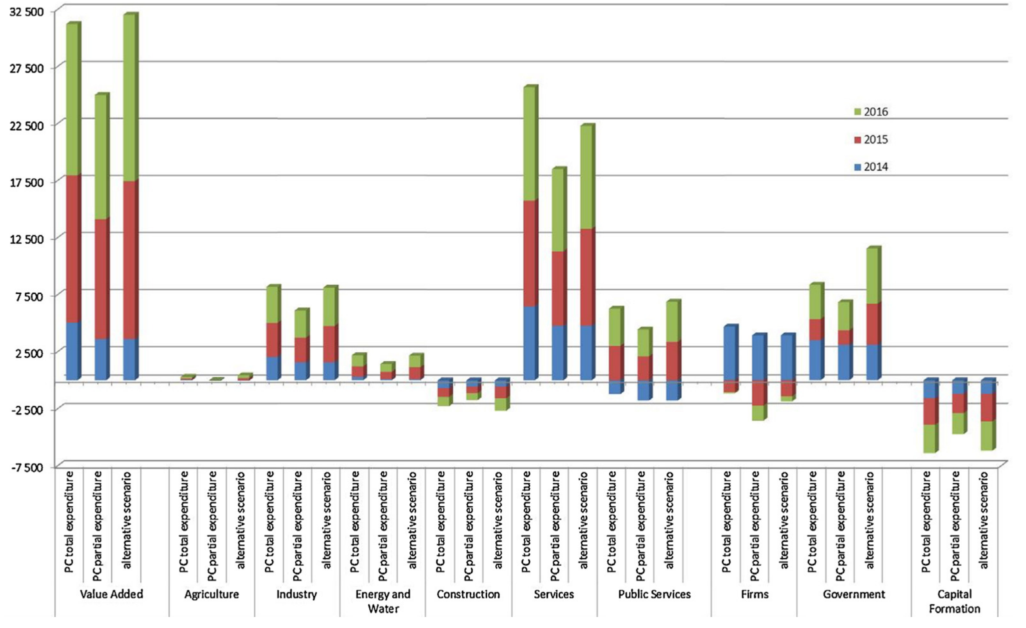


Fig. 5. Simulated effects of the policy measures.

Table 5
Effects on GDP growth.

	2014 (%)	2015 (%)	2016 (%)
PC total expenditure	0.36	0.92	0.94
PC partial expenditure	0.26	0.75	0.77
Alternative scenario	0.26	0.99	1.03

7. Effects on growth and income distribution

In the policy scenario where households spend all their disposable income increase, income for the main beneficiaries of the tax reduction (households with incomes between 15,000 and 23,000 Euro grows on average 20% in the three year period, while for the second class incomes between 23,000 and 25,000) beneficiary income grows only 7%. Over the three year period, the cumulated GDP growth is estimated to be about 2.2% (Fig. 7).

These percentages are only slightly different if households only spend their historical proportion of the disposable income freed by the tax reduction, but tend to fall more than proportionally with the reduction of the share of the income spent (Fig. 8).

In the scenario where all poor households receive either the tax break or a direct income transfer, Income for poor households grows over 22% in two years, total household income grows over 4% and GDP about 2.3% (Fig. 9).

In annexes[3] we present all detailed results in terms of averages and standard deviations.

[3] See Annexes http://www.openeconomics.eu/wp-content/uploads/2014/12/Numerical-Results.pdf.

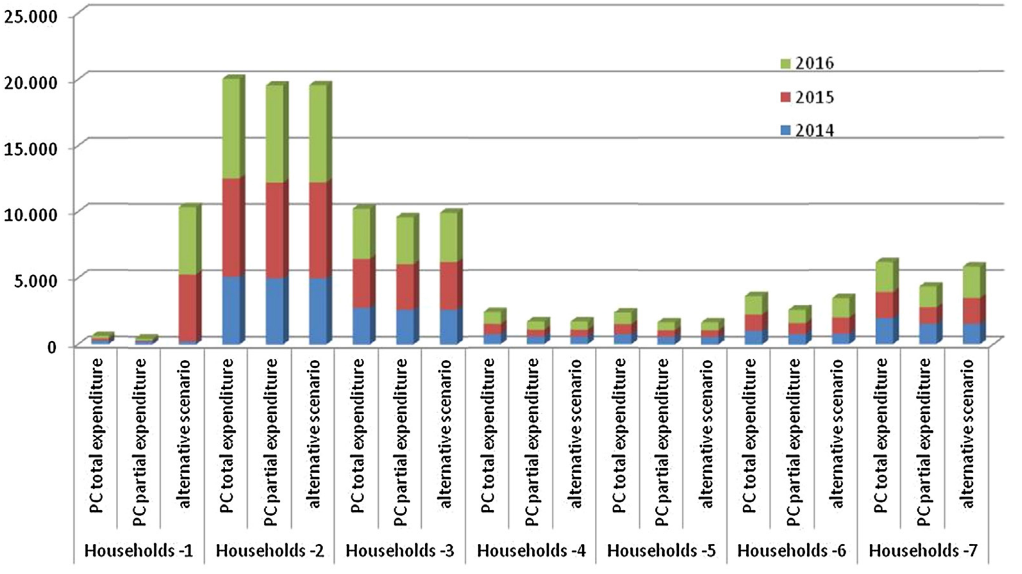


Fig. 6. Simulated effects of the policy measures oh households.

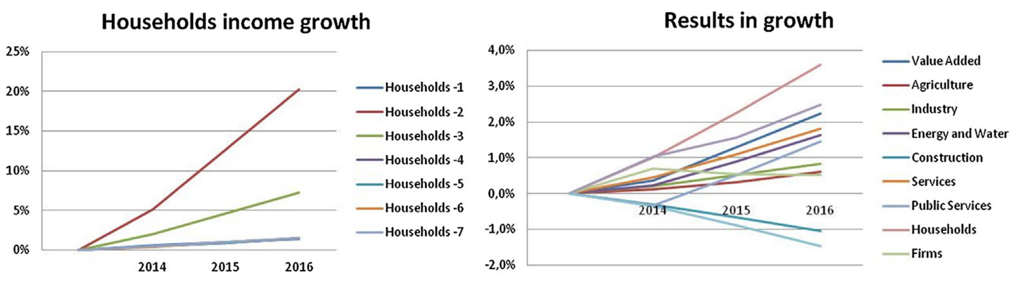


Fig. 7. Scenario total expenditure growth rates.

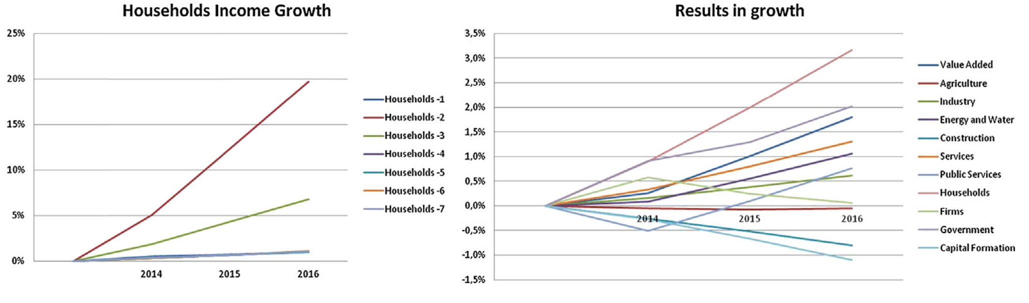


Fig. 8. Scenario partial expenditure growth rates.

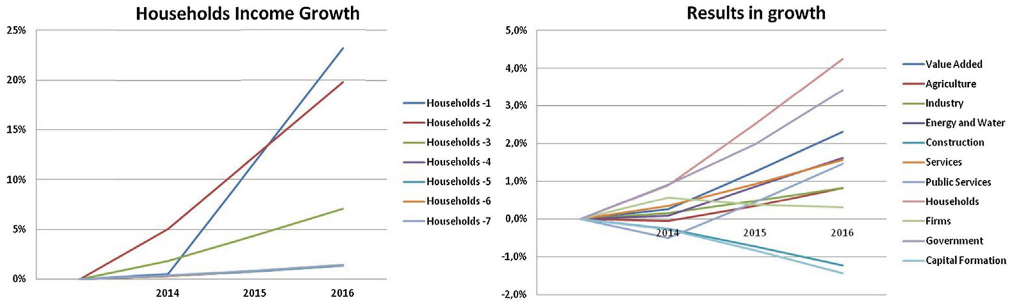


Fig. 9. Alternative scenario growth rates.

8. Conclusions

In this paper we have presented a new method to estimate a Social Accounting Matrix (SAM) that combines maximum entropy estimation with a bootstrap technique based on Monte Carlo simulation. The procedure outlined incorporates a large statistical information base, by constructing a SAM and an associated probability distribution from a complex data set that includes time series of national accounts as well as from household surveys. The results of the methodology proposed are illustrated by the application to Italy and to the evaluation of a recent and much discussed set of policy interventions from the Italian government. The Italian SAM estimates appear themselves interesting as they depict an economy with a dense network of backward and forward linkages, with a well connected, but rather compartmentalized industrial base, with a strong prevalence of backward over forward linkages, but nevertheless with a good potential to exploit inter-industry and income multipliers in proactive fiscal policy making of the kind recommended by Keynesian and post-Keynesian economists. In addition to the low forward multipliers of industrial sectors, the estimates also show some imbalances in the income distribution and in the structure of interdependencies. Among these, it is worth highlighting the low degree of inclusion of poorer households and the high vulnerability of employment, business activity and government finances on the economy downturns. This vulnerability is somewhat paradoxical as it appears to be the consequence of a high degree of forward linkages on the part of factors and institutions, which make them more dependent on the performance of all other sectors and, ultimately, exposed to recession as a form of systemic risk. We also present an evaluation a specific set of measures recently enacted by the Italian government, which is both interesting in its own right and because it is a type of intervention that embodies both income distribution and demand stimulation features and could be repeated and extended in the future, if it proves to be successful. The rich informational structure of our model allows us to simulate in detail the distribution of two policy scenarios, to show that, more than in a typical aggregate Keynesian model, in the highly interdependent equilibrium system of the Italian economy, a targeted transfer of income through a decrease in taxes may display a large expansive effect, even under a strict balanced budget policy. This effect is due to the increase in the multipliers determined by the variation of the tax rates, by the positive shock caused by the absolute reduction in taxes and by the endogenous changes in consumer spending, which are more closely related to a sort of permanent income hypothesis. These changes in turn are function of the changes in the parameters of the matrix and of the degree of spending incorporated in the estimates of the marginal propensities to consume.

Please cite this article in press as: Scandizzo, P. L., & Ferrarese, C. Social accounting matrix: A new estimation methodology. *Journal of Policy Modeling* (2015), http://dx.doi.org/10.1016/j.jpolmod.2015.01.007

Annex 1. Detailed results

	Total Expenditure			Partial Expenditure			Alternative scenario		
	2014	2015	2016	2014	2015	2016	2014	2015	2016
Unskilled labour	449	999	1,085	262	698	782	262	910	1,004
Skilled labour	901	3,453	3,688	463	2,740	2,969	462	3,936	4,464
Capital	3,703	8,446	8,500	2,875	7,086	7,131	2,873	9,002	9,127
Households-1	265	160	193	221	92	124	221	5,048	5,081
Households-2	5,092	7,432	7,515	4,986	7,218	7,325	4,986	7,239	7,326
Households-3	2,768	3,682	3,782	2,622	3,431	3,541	2,623	3,587	3,716
Households-4	742	781	897	572	512	626	572	747	905
Households-5	746	757	877	576	489	605	576	731	892
Households-6	1,026	1,234	1,398	779	841	1,000	779	1,235	1,465
Households-7	1,974	1,950	2,261	1,534	1,254	1,555	1,534	1,951	2,366
Firms	4,685	−1,038	−108	3,915	−2,214	−1,317	3,916	−1,400	−444
Agriculture	30	74	104	−42	−41	−12	−42	161	197
Fishing	23	31	32	19	24	26	19	37	39
Mining and quarrying	26	47	50	17	34	37	17	53	53
Food products, beverages and tobacco	1,123	1,529	1,603	918	1,192	1,266	917	1,841	1,935
Manufacture of coke and refined petroleum products	557	806	856	426	592	642	426	821	866
Textiles and textile products, leather and leather products	325	431	462	257	321	351	257	454	492
Wood and wood products, pulp, paper and paper products, publishing and printing companies	41	121	133	9	70	81	9	102	92
Chemicals, chemical products and fibres, Pharmaceuticals, plastic products, non-metallic mineral products	−6	16	21	−15	1	6	−15	−13	−13
Machinery and equipment	−52	−74	−76	−44	−62	−63	−44	−99	−103
Manufacture of basic metals and fabricated metal products	−61	−62	−62	−58	−57	−57	−58	−93	−101
Transport equipment	24	33	44	8	6	17	8	14	23
Manufacturing n.e.c and recycling	73	124	136	45	78	90	44	113	117
Electricity, gas, steam and hot water supply	394	781	826	259	561	606	259	912	912
Collection, purification and distribution of water, sewage and refuse disposal, sanitation and similar activities	−107	140	152	−152	66	79	−152	129	92

	Total Expenditure			Partial Expenditure			Alternative scenario		
	2014	2015	2016	2014	2015	2016	2014	2015	2016
Construction	−674	−769	−825	−548	−563	−620	−548	−1,017	−1,097
Wholesale and retail trade; repair of motor vehicles,	1,697	2,288	2,443	1,335	1,700	1,853	1,334	2,523	2,695
Transport, storage	832	626	720	659	353	445	659	−754	−557
Hotels and restaurants	651	865	936	502	623	693	501	866	949
Media and communication	364	698	751	215	455	509	215	699	680
Financial intermediation	302	672	733	142	411	473	141	589	570
Real estate	2,000	2,889	3,018	1,615	2,256	2,385	1,614	3,514	3,642
Research and development and other business activity	92	435	482	−35	231	278	−35	334	298
Business administration	14	174	201	−59	57	85	−59	91	59
Public administration and defence; compulsory social security	1,375	1,880	1,976	1,120	1,462	1,558	1,120	2,202	2,325
Education	−3,515	7	57	−3,599	−125	−75	−3,600	−160	−190
Health and social work	941	1,124	1,233	716	760	868	716	1,321	1,390
Recreational, cultural and sporting activities	133	144	165	97	86	107	97	129	146
Other service activities	266	303	329	215	220	245	215	328	357
Private households with employed persons	126	165	176	101	123	135	100	171	186
Government	3,488	1,851	3,046	3,088	1,278	2,481	3,094	3,634	4,832
Capital formation	−1,561	−2,330	−2,484	−1,173	−1,699	−1,851	−1,172	−2,433	−2,561

References

Augustinovics, M. (1970). Methods of international and intertemporal comparison of structure. In A.-P. Carter, & A. Bródy (Eds.), *Contributions to input–output analysis* (pp. 249–269). North-Holland, Amsterdam

Bajo-Rubio, O., Díaz-Roldán, C., & Esteve, V. (2014). Deficit sustainability, and monetary versus fiscal dominance: The case of Spain, 1850–2000. *Journal of Policy Modeling*, *36*(5), 767–956.

Chenery, B., & Watanabe, T. (1958). International comparisons of the structure of production. *Econometrica*, *26*, 487–521.

Golan, A., Judge, G. G., & Miller, D. (1996). *Maximum entropy econometrics: Robust estimation with limited data*. John Wiley & Sons.

Hirschman, A. (1958). *The strategy of economic development*. New Haven: Yale University Press.

Laumas, P. S. (1975). Key sectors in some underdeveloped countries. *Kyklos*, *28*, 62–79.

Lenzen, M. (2003). Environmentally important paths, linkages and key sectors in the Australian economy. *Structural Change and Economic Dynamics*, *14*, 1–34.

Leontief, W. (1986). *Input–output economics* (2nd ed.). New York: Oxford University Press.

Meade, J. E., & Stone, R. (1941). The construction of tables of national income, expenditure, savings and investment. *Economic Journal*, *LI*(202–203), 216–231.

Nørregaard Rasmussen, P. (1956). *Studies in inter-sectoral relations*. Copenhagen: Einar Harks.

Norton, R., & Scandizzo, P. L. (1981). General equilibrium computations in activity analysis models. *Operations Research*, *29*(2), 243–262.

Norton, R., Scandizzo, P. L., & Zimmerman, L. (1986). Portugal's entry into the EEC: Aggregate and distributional effects determined by means of a general equilibrium model. *Journal of Policy Modeling*, *8*(2), 149–180.

Pyatt, G. (1988). A SAM approach to modeling. *Journal of Policy Modeling*, *10*(3), 327–352.

Pyatt, G., & Thorbecke, E. (1976). *Planning techniques for a better future*. International Labour Office.

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

Salvatore, D. (2003). The new economy and growth in the G-7 countries. *Journal of Policy Modeling*, *25*(5), 531–540.

Salvatore, D. (2010). Growth or stagnation after recession for the U.S. and other large advanced economies. *Journal of Policy Modeling*, *32*(5), 637–647.

Scandizzo, P. L. (1992). Trade liberalization and agricultural prices. *Journal of Policy Modeling*, *14*(5), 561–582.

Scandizzo, P. L., Ferrarese, C., & Vezzani, A. (2010). La matrice di contabilità sociale. *Il Risparmio Review*, *58*(3), 19–62.

Stone, R. (1947). *Definition and measurement of national income and related totals, appendix to measurement of national income and construction of social accounts*. Geneva: UN.

Stone, R., & Brown, A. (1962). *A computable model for economic growth*. Cambridge, UK: Cambridge Growth Project.

Thorbecke, E. (2003). The social accounting matrix, deterministic or stochastic concept? *Economic Systems Research*, *15*(2).

Please cite this article in press as: Scandizzo, P. L., & Ferrarese, C. Social accounting matrix: A new estimation methodology. *Journal of Policy Modeling* (2015), http://dx.doi.org/10.1016/j.jpolmod.2015.01.007