From Supply and Use Tables to Social Accounting Matrices for India: A Synthesis of Methodologies

Anuradha Venkatesh[1] and Dr Barun Deb Pal[2]

27th International Input-Output Association Conference (Glasgow, June 2019)

Abstract

We contribute to India's macroeconomic database of Input-Output Tables (IOTs) and Social Accounting Matrices (SAMs) by compiling tables for an updated base year. Our methodology is a synthesis of national and global compilation techniques. Although existing approaches conform to the System of National Accounts (SNA), a convergence has not been established in the Indian context. Revisiting these methods using a common I-O table will help establish consistency among databases and provide methodological insights. The Central Statistics Office (CSO) of the Government of India has been regularly publishing IOTs since the 1960s. The latest table was published in 2012 for the reference year 2007-08. Although a Supply and Use Table (SUT) is available for 2012-13, a corresponding IOT has not been presented thus far. Given their significance in understanding complex inter-relationships within economies, it is imperative that they are regularly made available to practitioners in the field. In this study, we synthesise methodologies described in the Eurostat Manual on Input-Output Tables and the CSO's latest publications to construct a symmetric I-O flow matrix from supply, absorption and make matrices. A 140 x 140 commodity matrix comprises a uniquely detailed database, useful to practitioners and policy makers alike. We also compile satellite accounts, namely, an investment and labour matrix. Since the government has not published them for several years, we develop a methodology to undertake their construction. In addition, this study enriches India's anthology of SAMs by compiling a disaggregated matrix of 140 sectors. The SAM takes into account gender, regional and skill-wise differences in labour. Further, it classifies households according to region and income deciles. Such extensive databases find important applications in a wide range of macroeconomic policy analyses, and provide the foundation for computable general equilibrium modelling.

Keywords Input-output flow matrix, social accounting matrix, satellite accounts, supply and use tables, database creation, compilation, methodology, national accounts, macroeconomics

[1] Center for Study of Science, Technology and Policy (CSTEP, India). Correspondence: anuradha@cstep.in.
[2] International Food Policy Research Institute (IFPRI-New Delhi, India)

Introduction

Input-output economics as a conceptual framework was first presented by W. Leontief in an article published in August 1936 (W. Leontief, 1936). It aimed at providing an empirical foundation to the hitherto theoretical study of inter-relationships among different parts of a country's national economy. A key component of his study included the collection of statistical data that would empirically represent an economy's activities. Leontief borrows from Francois Quesnay and labels his own quantitative research as a "*Tableau Economique"* of the United States for the year 1919.

His work laid the foundation for developing a system of national accounting. This framework was introduced in the United Nations document, *System of National Accounts, Studies in Methods,* 1968 (United Nations Statistics Division, 2017). Quesnay's descriptive example was transformed into an analytical framework that could be used for macro and regional economic analyses. Such a multi-sector approach appealed to many thinkers across the world, with several countries adopting it as a powerful tool for economic planning.

Input-Output Tables (IOTs) derive their usefulness in understanding the structure of the entire national economy. An observer can study the linkages of a particular industry or consumer with other branches of the economy. For those analysts interested in consumption patterns, national income flows in the table will be of great interest (W. Leontief, 1936). Apart from its analytical applications in macroeconomic modelling, input-output tables help to confirm the validity of data in national accounts, which are usually drawn from a number of different sources (Eurostat, 2008).

Since the construction of IOTs for the United States for the years 1919, 1929 and 1939, national and regional tables have been constructed in many countries (United Nations Statistics Division, 2017; W. Leontief, 1936). With time, the number of sectors that describe an economy has also increased, with some tables consisting of 500 or more sectors (Leontief, 1986, p.22). Such a detailed, quantitative representation of the structure of a system helps to not only gather information about how it works, but also realistically estimate the systemic impact of introducing new changes in an economy.

Hence, IOTs and their extensions as social accounting matrices (SAMs) are the most popular macroeconomic databases used for policy analyses across the world (Pal, Pohit, & Roy, 2012). Various countries publish these databases very frequently and India is not an exception. The latest database published by the Government of India consists of a supply and use table (SUT) with 140 commodities and 66 industries. However, the I-O flow table is the most popular among researchers. Moreover, most Indian researchers generally follow the method adopted by the Central Statistics Office (CSO), Government of India, for compiling I-O flow tables. In contrast, other countries adhere to global manuals such as the *Handbook of National Accounting* (United Nations Statistics Division) and the *Eurostat Manual of Supply, Use and Input-Output Tables* (Eurostat, 2008) to compile national accounts data.

In this study, we adopt two distinct approaches to compile a symmetric, commodity by commodity I-O flow matrix for India for the base year 2012-13. This is achieved by transforming SUTs of the same year published by the CSO. We note that in a recent report, the National Council of Applied Economic Research (NCAER) (see Kanhaiya Singh & M R Saluja, 2016) has compiled a 130-sector IOT for 2013-14. However, we retain the CSO's commodity classification of 140 sectors and make our IOT consistent with the reference year of the SUT. This database will reflect a greater level of disaggregation, useful for studying evolving interdependencies in India's rapidly growing economy. While both methods are based on the global SNA guidelines, it is useful to revisit the consistency between the two approaches with the same database. This helps to check the reliability of databases before using them to construct a SAM and undertake policy analyses. Therefore, this study is a synthesis of existing methods for compiling an updated set of IOTs and SAMs for India.

The SAM in this paper describes 140 sectors of the economy, 12 types of labour according to region and household income decile classifications. In their article describing social accounting methods for analysing income and employment, Hayden and Round (Hayden & Round, 1982) succinctly present three important motivations that influence the compilation of SAMs. Firstly, a SAM brings different sources of information into a single format. This portrays structural characteristics of an economy. Secondly, a SAM provides a robust accounting framework to identify links between distributions of income among different sectors. Thirdly, it provides a benchmark database to construct a CGE model. Therefore, the compilation of a detailed, 140-sector SAM is an important contribution of this paper.

Additional satellite accounts include matrices for investment and employment. These provide sector-specific information on investment according to asset types and number of workers. We rely on literature to frame a methodology for compiling these accounts, given the dearth of robust satellite accounts in the Indian context. Scholars and policy makers will find this paper a useful contribution, both for academic and practical purposes, as it provides methodological insights, detailed databases and applications for policy making.

The rest of the paper is structured as follows: Section 1 discusses two frameworks that are essential to the objectives of this paper, namely, supply-use and input-output tables. Methods are detailed in Section 2, alongside balancing and validation procedures. The paper concludes by reiterating the twofold contribution of this paper, particularly looking ahead to the scope of policy analyses that may be undertaken with such significant databases.

1. An Overview of the Supply, Use and Input-Output Framework

1.1 The Supply and Use Framework

SUTs are an important component of the national accounts of a country. They link the flow of productive activities, identifying the requirement of primary inputs (e.g., land, capital) for the production of goods and services, the points of production and subsequently the destination of consumption (Kanhaiya Singh & M R Saluja, 2016).

As the name suggests, supply tables paint a detailed portrait of the supply of goods and services in an economy, encompassing both domestic production and imports. The CSO's supply table is a *Product x Industry* matrix where rows represent products and columns reflect industries. Each product appearing in the row (e.g., paddy) is produced by its respective industry (e.g., agriculture). Hence, the sum total of rows equals the total supply by product, while the column total is the total output by industry.

Any sector produces a particular good or service for either end-use consumption or intermediate consumption as part of a supply chain. These transactions are depicted in the use table. It is also a *Product x Industry* matrix which consists of three separate matrices:

- Intermediate use: known as inter-industry use (IIUSE)
- Final uses (PFCE, GFCE, GFCF, Valuables, CIS) [3]
- Gross value added (CE, OS, CFC) [4]

The total for the columns of IIUSE and total final use show the total use by products. The total for the rows of IIUSE and value added show the total inputs by industries (Eurostat, 2008). Finally, it is essential that the total output of products in the supply table equals the total use in the use table.

1.2 The Input-Output Framework

According to Leontief, "An input-output table describes the flow of goods and services between all the individual sectors of a national economy over a stated period of time" (Leontief, 1986). Although such flows are intuitively comprehended in physical units, input-output tables are usually constructed in monetary terms. Hence, they are classified as part of the national accounts of a country.

In essence, a symmetric input-output table rearranges both supply and use tables into a single matrix. It combines a bird's eye view of the national economy with microeconomic details on sector-specific

[3] PFCE: Private Final Consumption Expenditure; GFCE: Government Final Consumption Expenditure; GFCF: Gross Fixed Capital Formation; CIS: Change in Stocks

[4] The components of value-added consist of Compensation of Employees (CE), Taxes on Production, Operating Surplus (OS) and Consumption of Fixed Capital (CFC).

linkages. Inter-industry classifications of commodity flows are extended to include consumption, investment and trade activities of individual agents and governments. The basic structure can be conceived as a matrix, an accounting system that maps all existing players in an economy. Leontief compares it to a balance sheet - an outflow of goods from one industry corresponds to a receipt of the same goods by other industries or households (W. Leontief, 1936). Likewise, the accounting equation holds, i.e., each revenue is matched with each expenditure.

Table 1: Symmetric Input-Output Table (Commodity by Commodity) [5]

Inter-Industry Matrix					Final Uses Matrix						
Commodity/ Commodity	**Agriculture**	**Industry**	**Services**	**IIUSE**	**PFCE**	**GFCE**	**GFCF**	**CIS**	**Net Export**	**TFUSE**	**Total at Basic Prices**
Agriculture	**Intermediate Consumption**										
Industry											
Services											
Total Input											
Gross Value Added											
Net Production Taxes											
Total Output (Input + GVA + Net Production Taxes)	**Total Output by Commodity**				**Total Final Use**						

Source: Derived from Table 1.4 of *The Eurostat Manual, 2008 and modified by authors* **Notes:** TFUSE: Total Final Use

[5] For an empirical illustration of the transformation of a SUT into a symmetric I-O table, see Chapters 1 and 11 of *The Eurostat Manual (2008).*

In this table, the intermediate consumption matrix is square. Commodities are grouped across rows and industries are represented under column heads (Kanhaiya Singh & M R Saluja, 2016). The sum total of the rows depicts the total production of a firm distributed among various sectors. This represents the 'output' aspect of the I-O table. Vertically, columns inform the selection of commodities that are used as 'inputs' (e.g. raw materials) by an industry. To satisfy the accounting equation, it is essential that total inputs equal total outputs. Subsequently, the final demand of each sector is estimated.

1.3 Databases for India

A new series of national accounts was introduced by the CSO in 2015, with revisions based on guidelines prescribed in the System of National Accounts (SNA), 2008[6] (Kanhaiya Singh & M R Saluja, 2016). The base year for this series is 2011-12, and estimates of GDP as well as other economic indicators are reported with reference to this year. Moreover, the CSO has for the first time published SUTs of the Indian economy for the years 2011-12 and 2012-13. These consist of distinct rectangular matrices representing 140 commodities and 66 industries[7]. Such an integrated description of a country's national accounts is useful for balancing supply and demand, thus establishing a robust, economy-wide framework for compiling GDP (Central Statistics Office, 2016; Eurostat, 2008). Furthermore, this framework can also be used to construct satellite accounts like a SAM and others related to employment, land use, energy and emissions (Eurostat, 2008). Hence, these tables form the primary data set for compiling our symmetric I-O flow matrix for 2012-13.

Many countries adopted Leontief's path-breaking work on I-O tables by constructing matrices for their own economies. These studies were initially undertaken by individual researchers in India as early as the 1950s. Official undertakings began with the joint publication of a national input-output table of 60 sectors for the year 1968-69[8] by the CSO and the Planning Commission (Kanhaiya Singh & M R Saluja, 2016). Thereafter, the CSO became primarily responsible for compiling and publishing input-output matrices for the Indian economy. These are published at approximately five-year intervals according to guidelines prescribed in the SNA.

A total of nine IOTs[9] for the Indian economy are official compilations. The initial tables consist of 60 sectors; they are subsequently expanded to include 115 sectors for the years 1989-90, 1993-94 and 1998-

[6] See *The System of National Accounts* (*SNA*): https://unstats.un.org/unsd/nationalaccount/sna.asp

[7] See *Supply and Use Table: A Note on Compilation for the Years 2011-12 and 2012-13*

[8] The first officially compiled I-O table for the year 1968-69 was published in '*National Accounts Statistics, 1978'*, compiled jointly by the Central Statistical Organisation (CSO) and the Planning Commission (*CSO, Chapter 1, Introduction*).

[9] The official publication *'Input-Output table 2007-08'* elaborates on the noticeable distinctions among the nine tables, examining intermediate and final uses of specific sectors, consumption patterns and gross value added, among others.

99[10]. Further, a 130-sector classification is adopted in the 2007-08 database.

1.4 Extended Input-Output Tables: Derivation of Satellite Accounts

Within the context of macroeconomic accounts, satellite systems are constructed to extend the traditional scope and analytical capacity of IOTs to include important aspects of social relevance (Eurostat, 2008). The foundation of satellite accounts is closely linked to the central framework of national accounts and economic statistics. In addition, these accounts are specific to a particular field of study and enable cross-sector analyses. The Eurostat Manual (Eurostat, 2008) cites Germany as a reference case study, as the country is well-advanced in developing and integrating satellite systems into the input-output framework[11]. Some examples include systems that contain information on gross fixed capital formation, capital stock, employment (e.g., wage earners, self-employed), energy and emissions of various industries. Other examples include accounts that link physical data sources to monetary accounts in the I-O framework (e.g., ecological studies use I-O tables in physical units) and explore costs and benefits of human activities. Accounts have also been constructed for fields like education, health, tourism and environmental protection (Eurostat, 2008).

In this paper, we discuss the derivation of satellite accounts, namely a SAM, investment and labour matrix from our newly compiled I-O table. By providing a method for their compilation, we set the foundation for future research to holistically integrate these accounts with the I-O framework for policy analyses.

SAM and the input-output framework

The SAM is one of the most popular extensions of the I-O table. Its history can be traced to Stone's pioneering work for the UK (Stone, 1962). While developing the Cambridge Growth Model in the 1960s, he published the first SAM for the British economy for 1960 (Eurostat, 2008). His early work highlighted the need to expand the representation of statistical units from industries to commodities, establishments and other institutional units. Such an enhanced description of a variety of economic activities would help link different parts of the accounting system better to complete the circular flow of income. These ideas paved the way for the concepts later presented in the SNA, 1968 (Eurostat, 2008).

In the 1970s, the SAM became more closely associated with exploring interrelationships of income and transfer flows between different institutional units. Since the I-O framework already presented a detailed disaggregation of the production system, it was further essential to disaggregate income and outlays (Eurostat, 2008). Socio-economic analysis became, and continues to be, an integral part of the revision of national accounting concepts around the world, particularly since its application in developing countries.

India was an early leader in compiling SAMs and developed models based on these databases. To our best

[10] Other years include: 1973-74, 1978-79, 1983-84, 1989-90, 1993-94, 1998-99, 2003-04 and 2007-08 (*CSO, Chapter 1, Introduction*).
[11] For more information, see *The Eurostat Manual, Chapter 15* (Eurostat, 2008).

knowledge, Sarkar and Subbarao (Sarkar & Subbarao, 1981) from NCAER constructed the first SAM for India back in the 1980s. They used this to frame a consistent database for their CGE model. Subsequently, a number of SAMs were constructed over the years by different researchers. While SAMs for India are available from the 1980s, it is important to update the base year and construct new SAMs because these will take into account structural transformations in the Indian economy. Policy analyses based out of SAMs of earlier years may not capture the right interventions required to address pressing social and economic policy issues. Therefore, a key contribution of this paper is in presenting a detailed SAM of 140 sectors for the base year 2012-13. This is a significant step as we improve over SAMs previously constructed for 2007-08.

A social accounting matrix may be defined as a single-entry accounting system where each account is represented by a column for payments and a row for receipts (Hayden & Round, 1982). It depicts the value of all economic transactions in the form of a circular flow of income and spending (Burfisher, 2017). The SAM is unique because the single framework depicts both micro and macroeconomic data, including social and economic data. It includes among other accounts a detailed component of household income distribution which can be extended to include different socio-economic groups, levels of education, gender attributes and additional features. From such a database, a comprehensive model may be built to examine key questions related to investment, poverty alleviation and patterns of income distribution.

2. Methodology

This section systematically delineates the methods of compiling an IOT and extending it to derive satellite accounts for the year 2012-13.

2.1 Input-Output Matrix

We derive our compilation procedures from two sources, namely, the Government of India's publication *Input-Output Table 2007-08* and the *Eurostat Manual of Supply, Use and Input-Output Tables*, mainly employing the latter's illustrative examples to enable a meticulous compilation of the required flow matrix. While subtle differences may be perceived in the methodologies, our compilation finds the final result to be consistent across all methods, affirming the underlying strength of the conceptual framework.

Transforming Supply and Use Tables into Symmetric Input-Output Tables

The I-O table presents statistical information related to either commodities or industries. Adopting a commodity classification, the relationship between rows and columns depicts products used as primary inputs to produce final products (Eurostat, 2008). In this study, we follow the design of the I-O table for 2007-08 published by the CSO in compiling a detailed *commodity x commodity* (C x C) matrix for the Indian economy using the industry technology assumption. A C x C table is more useful from a demand perspective because demand is generally for specific products or services rather than the mixed range of goods and services produced by industries.

Construction of I-O tables involves transfers of inputs and outputs among sectors and this is accomplished by combining appropriate matrices using suitable assumptions. The *Absorption* and *Make* matrices, broadly retitled as *Use* and *Supply* tables, are the sources from which symmetric input-output tables of both *commodity x commodity* and *industry x industry* classifications are constructed. Thus, as our primary database, we have a supply table valued at basic prices (including a transformation into purchasers' prices) and a use table at purchasers' prices. Transforming supply and use matrices primarily entails a change in only the production matrix (inter-industry matrix) that maps the intermediate consumption of products. Data on final uses such as consumption and investment remain unchanged and are extracted directly from the use table. All basic calculations utilise the matrix multiplication method.

Method 1

Appendix 2 of the CSO's document (Central Statistics Office, 2012) outlines the analytical approach to constructing a C x C table.

First, a coefficient matrix (B) is derived from the use table by dividing input values of each industry group by the column output. This is the *input-output coefficient matrix*. Secondly, a *make matrix* is obtained by transposing the supply table[12]. Transpose matrices are written with a superscript (T).

q is a diagonal matrix wherein total output of commodity groups is derived from the supply table. The diagonal and make matrices are used to calculate the *market share matrix*, formulated below. In this matrix, columns represent proportions in which the total output of a commodity is produced by different industries. Mathematically, it is obtained from the make matrix by dividing column entries by commodity outputs.

(1) Market share matrix **(D)** = $(\text{Supply matrix})^T$ * inverse **(q)**

Thereafter, the final intermediate matrix (W) for the *commodity x commodity* I-O table is calculated as:

(2) $\mathbf{W} = \boldsymbol{BD} * \boldsymbol{q}$

A summary of the formulae and notations are given in Table 2[13].

[12] It is to be noted that the make matrix is defined as *industry x commodity*. However, the supply table is defined as a *commodity x industry* matrix. Therefore, a transpose of the supply table yields the make matrix.

[13] For an overview of the methodology, mathematical expressions of input-output relations and matrix calculations, see *Input Output Table: 2007-08, Appendix 2, pp. 37-39*.

Table 2: Method 1

Matrix Description	Notation	Formula	Methodology
Coefficient Matrix	B	Input/Total	Derived from the use table
Diagonal Matrix	q	-	Column vector of commodity output
Market Share Matrix	D	$D = S^T * inv(q)$	Matrix multiplication of the transpose of the supply table and the inverse of *q*
Commodity x Commodity Flow Matrix	W	W = BD * q	Matrix multiplication

Source: Derived from Central Statistics Office, 2012, pp. 36-39

Method 2

The Eurostat Manual (Eurostat, 2008) approaches the computation from a slightly different perspective. The formula for the transformation matrix is similar to that of the market share matrix derived above. However, the diagonal elements of matrix (g) are defined as the column vector of industry output, in contrast to the commodity output approach of the previous method.

That aside, the remainder of the calculations follow the same pattern as Method I. The coefficient matrix is derived by dividing inputs by column totals. *V* is the transpose of the supply table and its multiplication with the inverse of diagonal matrix *g* results in the transformation matrix.

(3) Transformation matrix **(T)** = inverse [diag(**g**)] * **V**

The final intermediate matrix of the I-O table is obtained by multiplying the use matrix with the transformation matrix:

(4) $\mathbf{S} = \boldsymbol{U} * \boldsymbol{T}$

Table 3: Method 2

Matrix Description	Notation	Formula	Methodology
Coefficient Matrix	B	Input/Total	Derived from the use table
Make matrix	V	-	Transpose of supply table
Diagonal Matrix	g	-	Column vector of industry output

Matrix Description	Notation	Formula	Methodology
Transformation matrix	T	inv[diag(g)] * V	Multiplication of the inverse of the diagonal matrix and make matrix
Commodity x Commodity Flow Matrix	S	S = U * T	Use table for intermediates * Transformation matrix

Source: Derived from Eurostat, 2008, Chapter 11, p. 296

Finally, we suggest that the intermediate matrix of our required table can also be arrived at through two basic transformation steps:

- Coefficient matrix derived from the Use table
- Transpose of the Supply table

A matrix multiplication of these two yields the intermediate matrix. Subsequently, all three intermediate matrices are subtracted to check for errors. We find the results are consistent across methodologies, achieving a convergence whereby our compilation is validated.

Final Transformation into a Symmetric Input-Output Table at Basic Prices

To finish the compilation, our next step is to evaluate coefficient vectors for the components of gross value added (GVA). Then, we address the final demand vectors comprising consumption, investment and trade. We derive the coefficient vectors using the methods outlined above. The use table provides estimates of GVA according to 66 industry groups. However, we require estimates for 140 commodity groups. Therefore, appropriate matrix multiplication procedures are undertaken to derive these vectors. The last row of the table specifies output by each commodity at basic prices, which is calculated by adding total input and GVA.

The compilation exercise is concluded by ascertaining the commodity balance: each column total must equal the corresponding row total to arrive at a balanced matrix. We choose to value the I-O table at basic prices, identical to the CSO’s approach. As there are differences in price valuations across the supply and use tables, adjustments are made to convert all equations to the same set of prices. This is achieved by subtracting trade and transport margins, imports and net product taxes from total output at purchasers’ prices.

Validation

The 140 sector I-O table is validated by two distinct conceptual methods detailed above. Further, we conduct empirical checks by comparing with numerical examples in published manuals. Another technique involves comparing estimates of GDP with official numbers released by the *National Accounts Statistics (NAS)* of India. This is tabulated below. We observe that the GDP figures calculated from our I-O table are reasonably consistent with official data.

Table 4: Validation of Input-Output Table - GDP calculation

	Production Approach	Expenditure Approach	GDP Estimate	NAS GDP	Error (%)
Formula and Value	GVA + Net Production Taxes	PFCE + GFCE + GFCF + Valuables + CIS + Exports – Imports – Net Product taxes	9,271,383	9,202,692	1%

Source: Authors' calculations. The official estimate of GDP is sourced from National Accounts Statistics (2017) data, reported at current prices for 2012-13. Values are in INR crores.

2.2 Investment Matrix

In this paper, we lay out a brief methodology for deriving a Gross Fixed Capital Formation (GFCF) matrix for all the 140 commodity sectors of our I-O table. The GFCF matrix gives useful information on investment (e.g., machinery, buildings) of the various industries. This is immensely useful to policy planners because it helps them prioritise specific sectors as investment destinations. It also permits an exploration of each sector's long-term investment trajectories in order to draft suitable funding strategies. The growth of each sector in the economy is closely tied to the quantum of investment it receives. Therefore, the utility of this matrix is established by mapping monetary flows of investment into each sector.

We source our data directly from the NAS 2017 database, which provides information on capital formation by type of asset and industry (Ministry of Statistics and Programme Implementation, Government of India, n.d.). Assets are classified into the following types: dwellings and other buildings, machinery and equipment, cultivated biological resources and intellectual property products (IPP). Monetary values of GFCF are provided for each major economic activity by each asset classification. Since our I-O table is for the year 2012-13, we consider GFCF data for the same year.

The sectors presented in the NAS database are aggregated and do not entirely correspond to our 140-sector classification in the I-O table. Hence, the first step is to prepare a concordance map between the sectors. Once our sectors are mapped, we proceed to estimate sector-wise asset ratios— the share of each asset in the total GFCF provided by NAS. For example, the first economic activity in the NAS database is Agriculture, Forestry and Fishing. This sector is subdivided into crops, livestock, forestry and fishing. The total value of GFCF is provided for each sub-category, according to each asset type. An example is shown in Table 5. We estimate each asset's share in the total GFCF of a sub-category, as shown in Table 6.

Table 5: GFCF by type of industry and assets

	GFCF	Dwellings and Buildings	Machinery and Equipment	Cultivated Biological Resources	IPP
Agriculture	265,341	189,805	68,631	6,464	441
Crops	229,219	172,816	54,854	1,161	388
Livestock	20,433	14,946	408	5,077	2

Source: Official estimates of GFCF are sourced from National Accounts Statistics (2017) data, reported at current prices for 2012-13. Values are in INR Crores.

Table 6: Percentage share of GFCF (%)

	Dwellings and Buildings	Machinery and Equipment	Cultivated Biological Resources	IPP
Agriculture	71.53	25.86	2.43	0.16
Crops	75.39	23.93	0.50	0.16
Livestock	73.14	1.99	24.84	0.009

Source: Authors' calculations

Subsequently, the output share of each I-O sector is calculated. Output here refers to the total output, i.e., a summation of inter-industry use (IIUSE) and final use (TFUSE). This share is then used to distribute the total GFCF allotted to a particular sector in the NAS database across each corresponding sub-sector of the I-O table. Next, we estimate the new value of assets based on the new GFCF for each sub-sector. Table 7 presents a snapshot of the GFCF matrix for the livestock sectors in our I-O table.

Table 7: Investment matrix for the livestock sector

	New GFCF	Dwellings and Buildings	Machinery and Equipment	Cultivated Biological Resources	IPP
Milk	13,464.57	9,848.84	268.85	3,345.54	1.31
Wool	19.02	13.91	0.37	4.72	0.00
Egg & Poultry	2,518.02	1,841.84	50.27	625.65	0.24
Other Livestock Products	4,431.37	3,241.39	88.48	1,101.06	0.43
Total	20,433	14,946	408	5,077	2

Source: Authors' calculations. All values are in INR Crores.

Replicating this procedure for all sectors in the I-O table, we arrive at the final investment matrix. To validate the matrix, we presume that the column total of our investment matrix should be reasonably consistent with both officially available data on GFCF for the Indian economy and the GFCF total in our I-O table. A comparison reveals that the GFCF data obtained from the investment matrix are consistent, recording an error margin less than 10%.

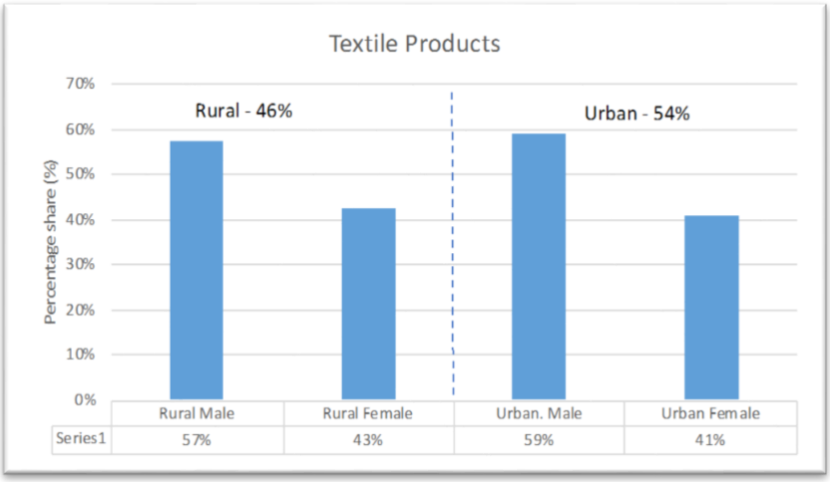
2.3 Employment Matrix

In India, the National Sample Survey Office (NSSO) provides employment information in its publication, *All India Employment and Unemployment Surveys*. This database is the primary source of information for the economy's labour force indicators at both national and state levels. We source sector-specific employment figures from the NSSO 68th round survey, *Employment and Unemployment Situation in India (2011-12)*. This survey classifies sectors according to the National Industrial Classification (NIC 2008) codes, available at the 3-digit and 4-digit levels.

Similar to the investment matrix methodology, the first step is to prepare a map of concordance between the I-O sectors and the NIC digit codes. The survey provides national employment data per 10,000 distributions of working persons by industry of work, regional (rural/urban) and gender classifications (male/female). Thus, our employment matrix largely adheres to this classification, but restricts the NIC industry classification to the 140 sectors of the I-O table.

Once the survey employment data is accurately collated for the 140 I-O sectors, we estimate the percentage share of each sector's labour in the whole. This figure is then multiplied with the total number of estimated workers. As an example, Figure 1 depicts the share of the number of workers for the Textiles sector - the number of male and female workers are estimated separately for rural and urban areas.

Figure 1: Employment matrix for the textile sector (Percentage share)



Source: Authors' calculations.

Thus, we arrive at a disaggregated employment matrix for all 140 commodity sectors of the Indian economy. Given the discrepancies in India's employment database - the NSSO continues to refine its results over time - future research will play an important role in fine-tuning the original data and validating the labour satellite accounts. The aim of this exercise is to provide a stepping stone to the development of detailed industry-wise employment information for India, consistent with national I-O and SAM accounts. As government data becomes more accurate and reliable, as a result of periodic expert reviews, the data in our matrix may be upgraded to reflect the true realities of India's workforce, particularly differentiating between organised and unorganised sectors.

2.4 Social Accounting Matrix

The SAM is commonly associated with national income accounting, a technique used to conceptually analyse the macroeconomic situation of a country; it is often described as "the matrix representation of national income accounts" (Pradhan et al., 2006, p.71). Economic transactions between sectors, factors of production, institutions and the rest of the world (ROW) are empirically structured in a matrix format (Pradhan et al., 2006). Every cell in the matrix describes a transaction that is simultaneously an expenditure by a column account and a receipt by an agent's row account. Agents include household consumers, industries, government, labour, capital and ROW. Institutions comprise households, private corporate sector, public non-departmental enterprises and government. Indirect taxes are presented separately to enable a detailed description of the structure of taxes. The aggregate supply of the economy consists of commodities, both domestic and imports. Final demand is from households, government, GFCF and exports (Pradhan et al., 2006).

The primary data sources for a SAM are the input-output table, national accounts statistics, consumption expenditure and household income statistics. Therefore, this framework plays an important role in reconciling the I-O, macroeconomic and social accounts within a unified statistical framework. This helps identify any inconsistencies within the statistical system of the economy (Pradhan et al., 2006). It is important to note that the value add received by the factors for providing services of labour and capital enables us to calculate *GDP at factor cost* (net of indirect taxes) (Pradhan et al., 2006). The following illustration gives an overview of the basic structure of a SAM, with row and column headings indicating inter-linkages among all agents in a hypothetical economy. This basic structure can be modified depending upon the nature of analyses, by specifically defining or disaggregating any account within the SAM (Pradhan et al., 2006)

Figure 2: Structure of a hypothetical SAM

Table 2.1 A schematic social accounting matrix (SAM) for India. (Source: Pradhan et al. 2006)

Expenditures									
Receipts	*Production account*	*Factors of production*	*Households*	*Private corporate*	*Public nondepartmental*	*Government*	*Indirect taxes*	*Capital account*	*Rest of the world (ROW)*
Productionaccount	Input-output table A11		Private consumption A13			Government consumption A16		Investment A18	Exports A19
Factors of production	Value added (VA) A21								Net factor income A29
Households		VA income A32				Government transfers, interest on debt A36			Net current transfers A39
Private corporate		Operating profits A42				Interest on debt A46			
Public nondepartmental		Operating surplus A52							
Government		Income from enterprises A62	Income and wealth taxes A63	Corporate taxes A64			Total indirect taxes A67		Net capital transfer A69
Indirect taxes	Taxes on intermediate A71		Taxes on purchases A73			Taxes on purchases A76		Taxes on investment goods A78	Taxes on exports A79
Capital account		Depreciation A82	Households savings A83	Corporate savings A84	Public nondepartmental savings A85	Government savings A86			Foreign savings A89
Rest of the world (ROW)	Imports A91								

Source: Pal et al., 2015

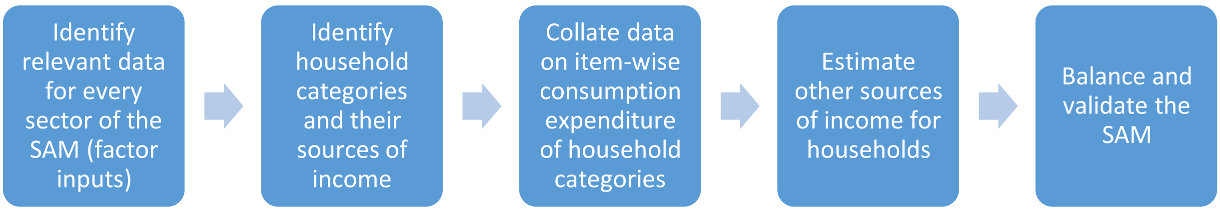
Our SAM consists of 140 producing sectors, 2 factors of production (labour, capital) and 4 economic institutions (households, private corporate firms, public non-departmental enterprises and government enterprises). The household sector is further divided into two broad classifications: rural and urban. It is further split into decile classes based on monthly per capita expenditure given by NSSO.

The SAM is balanced when all incomings (receipts) account for all outgoings (payments), i.e., the total of rows and columns must be equal for each account in the SAM. This is a constraint that every agent has to meet (Burfisher, 2017). At the macro level, this translates into the aggregate spending of an economy being equal to its aggregate income. Thus, the economy is in an initial state of equilibrium and the balancing equation must be maintained for all sectors (Taylor & Adelman, 1996). Such a balanced database is a necessary condition for models such as the CGE.

Compilation Procedures

The compiled input-output table forms the basis for constructing a SAM of 140 sectors. Our procedures are largely based on the methodology adopted by Pal and Bandarlage (see Pal & Bandarlage, 2017) in their construction of a value-added disaggregated SAM for 2007-08. We choose to differentiate our SAM by expanding the sector classification and updating the base year. Further, we make our SAM consistent with the new series of national accounts published by the CSO (of base year 2011-12) and socio-economic information from NSSO surveys. Briefly, the following steps are used while constructing a SAM.

Figure 3: Method of SAM construction



<u>Identification of relevant data</u>

For our proposed SAM, labour input is classified according to 12 types of labour. Three indicators are used for the classification, namely region, education and gender. The next step is to obtain data on payment received by these labour types according to the SAM sectors. We estimate the distribution of labour payment using unit-level household survey data on employment and unemployment in India. The NSSO conducts detailed household surveys at five-year intervals separately for consumption expenditure and employment-unemployment. We use the 68th round survey data, which pertains to the year 2011-12. Prior to this, survey data are available for the years 2009-2010 (66th round) and 2004-2005 (61st round).

Table 8: Indicators to classify labour input

Region	Education	Gender
Rural	Primary school	Male
Urban	High school	Female
	Graduate and above	

With an expansion in economic growth, the structure of the Indian economy has changed over the years. This has also led to changes in the structure of employment. To capture recent changes, the NSSO 68th round is selected to estimate the required data.

The employment survey classifies industries at the 5-digit level according to guidelines prescribed in the National Industrial Classification (NIC). First, we organise the demographic and social profile of households to classify types of labour according to the description in Table 10. In addition, a map of concordance is prepared which maps the sectors of the proposed SAM with the NIC 3, 4 and 5 digit classification of industries.

Item-wise consumption expenditure of households

This data is estimated using the NSSO 68th round survey data on households' consumption expenditure. Since commodity definitions in this database are inconsistent with our sector definitions in the SAM, a map of concordance is prepared to map 140 commodities with the NSSO items. It should be noted that item codes are mapped with only those sectors which have a value for PFCE. If PFCE values for a sector are zero, this indicates no consumption of that particular commodity; that sector is, therefore, not considered during the mapping process.

Identification of household classes and their sources of income

One objective of our value-added disaggregated SAM is to present a profile of the structure of consumption expenditure across decile classes of households. Households are classified into 20 classes using monthly per capita expenditure as an indicator, and further differentiated into rural and urban regions.

Subsequently, we estimate sources of income accruing to these households from types of labour and capital. The authors of the 2007-08 value-added SAM (Pal & Bandarlage, 2017) note that data on capital stocks according to type of households is not readily available for India. Therefore, the income of households is used as a proxy for capital income. Again, the main database is the NSSO 68th round survey on employment and unemployment. We use this to map household categories with types of labour. This information is then mapped with the labour and household classifications defined in this study.

Estimation of other sources of income for households

So far, we have estimated the data required for constructing specific accounts of the SAM. In the last step, we proceed to complete the construction by procuring household income data apart from factor income. This additional income includes transfers from the government, interest received through holding public bonds and remittances from abroad. This data must correspond to the categories of households defined in our SAM. The distribution of aggregated data of the SAM among the decile classes of households is done according to their share in the aggregate consumption expenditure obtained in Step 2.

Balancing and Validation

A significant portion of the methodology requires consolidating data from various secondary sources. For instance, NAS provides aggregate data for several macroeconomic indicators like GDP, PFCE, NFIA and savings of households. The compiled IOT provides data on inter-industry transactions at factor prices for 2012-13. Finally, data on consumption expenditures are obtained from the NSSO unit-level survey of 2011-12. The NSSO data is obtained through primary sample surveys valued at market prices. Given the discrepancies in data sources and price valuation, it naturally follows that the SAM is not balanced. Therefore, an important step is to ensure that for every row in the SAM, there is a corresponding column; the system is complete only if the corresponding row and column totals are equal, yielding a balanced matrix (Pradhan et al., 2006). The final balancing is done with the help of manual adjustments to price valuations and a complete examination of the whole table.

As the NSSO data has been adjusted to fit into our SAM framework, it is necessary to check if the SAM still retains the essential macroeconomic picture of the Indian economy for the year 2012-13. Therefore, data is extracted for key macroeconomic indicators and compared with official data published for 2012-13. Ideally, the data obtained from our constructed SAM should not differ by a large margin with official data available for the Indian economy.

Table 9: Validation of SAM

Macroeconomic indicator	**SAM data**	**NAS data**	**Error (%)**
GVA	925,808,256	920,269,200	1%
NVA	819,717,756	814,178,700	1%
Income from property and entrepreneurship	16,977,500	16,977,500	0%
Net savings of non-departmental enterprises	14,224,900	14,224,900	0%
Savings of private corporate sector	52,319,100	52,319,100	0%
Net factor income from rest of the world	5,594,200	5,594,200	0%
Compensation of employees	308,982,056	303,230,900	2%
Private final consumption expenditure	579,454,673	561,448,500	3%
Gross national income	931,402,456	982,725,000	5%

Source: Authors' estimates. NAS data is sourced from National Accounts Statistics (2017) data, reported at current prices for 2012-13. All values are in INR Lakhs.

We note that our attempts to use the latest macroeconomic data published by NAS in our compilation process proved to be relatively difficult. Due to changes in the reporting structure of this database, extraction of data was both challenging and time-consuming, compared to utilising data from the old series. For instance, some key items that were not reported directly in the NAS 2017 database had to be calculated afresh, carefully scrutinising the various individual publications. If the same item was reported in two different accounting statements, informed choices were made regarding its inclusion in the SAM. Despite these obstacles, we have used the 2017 database in the hope that our updated SAM will be useful for both short and long-term socio-economic policy analyses of the Indian economy.

Conclusion

The input-output framework conceptualised by Leontief[14] is a comprehensive attempt to empirically demonstrate an interconnected system of accounts for an economy. It is worthwhile to note that the I-O illustrations in his 1936 publication (W. Leontief, 1936) provide a glimpse of the structure of the U.S. economy during 1919. Future compilations see the inclusion of a very different set of sectors, providing insights into the economy's structural trajectory. This exercise may be adopted for India too, particularly envisaging new sectors that could play a role in India's economy over the next decade or two.

Since its inception into the academic literature by the pioneering work of Stone (Stone, 1962), the SAM has been applied across various countries to study a range of policy issues. In India, it was adopted as a policy planning tool for the government during the 1980s and 1990s. However, limited efforts have been made to extend the existing structure of SAMs to include detailed accounts that capture micro-level analyses. This paper has presented the construction of a value-added disaggregated SAM of 140 sectors for India, thereby closing the gap in the country's macroeconomic database.

Several applications may be drawn from this database. For instance, we can study sector-specific contributions to national income and analyse employment and income situations of social groups of households. A key application is its role in providing a balanced database for building a CGE model. The SAM can also be used to analyse policies on achieving inclusive growth and income equality; it can explore the impact of policies on labour demand (skilled, unskilled). Similar to the satellite accounts presented in this paper, the basic I-O and SAM framework may be extended to quantify indicators for environmental pollutants, natural resources, GHG emissions and allied areas of interest (Pal et al., 2015). Such analyses are crucial for informing suitable policy options in emerging economies like India, wherein achieving sustainable development goals is a key priority moving into the future.

It should be acknowledged that constructing a SAM of 140 sectors is an elaborate task which requires readily available data. In the absence of an updated I-O table, we undertake the task of compiling one from government-published information on supply and use tables. Also, a latest available SAM will

[14] See Leontief's 1936 publication (W. Leontief, 1936) for an illustration of the entire input-output matrix including a description of sectors and statistical procedures.

help us observe structural transformations in the economy since the base year 2007-08. This is a key contribution of the paper as we present an updated, highly disaggregated, 140-sector I-O table and SAM for India, 2012-13.

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