Compilation of an Input-Output Table and Social Accounting Matrix for India: 2012-13

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List of Abbreviations

CE	Compensation of Employees
CFC	Consumption of Fixed Capital
CGE	Computable General Equilibrium
CIS	Change in Stocks
CSO	Central Statistics Office
GDP	Gross Domestic Product
GFCE	Government Final Consumption Expenditure
GFCF	Gross Fixed Capital Formation
GNP	Gross National Product
GVA	Gross Value Added
I-O/IOT	Input-Output, Input-Output Table
IPP	Intellectual Property Products
MOSPI	Ministry of Statistics and Programme Implementation
MPCE	Monthly Per Capita Expenditure
NAS	National Accounts Statistics
NCAER	National Council of Applied Economic Research
NFIA	Net Factor Income from Abroad
NIC	National Industrial Classification
NSSO	National Sample Survey Organisation
OS	Operating Surplus
PFCE	Private Final Consumption Expenditure
ROW	Rest of the World
SAM	Social Accounting Matrix
SUT	Supply and Use Table

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Abstract

The main objective of this paper is to contribute to India's macroeconomic database of Input-Output Tables (IOTs) and Social Accounting Matrices (SAMs). 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 the significance of these databases in understanding complex inter-relationships within economies, it is imperative that they are regularly made available to practitioners in the field. Therefore, to maintain continuity, this paper proposes to transform the SUTs into a symmetric I-O flow matrix. A 140 x 140 commodity matrix will comprise a uniquely detailed database, useful to practitioners and policy makers alike. We also propose to compile satellite accounts based on the new I-O table. Since the government has not published such matrices for several years, we develop a methodology to undertake their construction. In addition, this study seeks to enrich India's anthology of SAMs by constructing a disaggregated matrix of 140 sectors for the Indian economy. Such an extensive database can be used for I-O, SAM and computable general equilibrium (CGE) modelling of energy, employment and climate policies for India.

Keywords: Input-Output Flow Matrix, Social Accounting Matrix, Database Creation, Compilation, National Accounts, Supply and Use Tables, Macroeconomics

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.

Leontief was concerned about the relatively simple quantifiable data that economic theory generally relied on for drawing inferences about what he believed to be a complex world. He suggests that mere indices, such as gross national product or interest rates, do not tell the whole story behind shifts in employment or prices, the consequences of which result in a flurry of unaccustomed activity among people and institutions. It seemed as if "real world" links were missing in the classical analysis of economic interactions. Acknowledging that individual transactions were too numerous to be studied in detail, he asserts that if these could be aggregated into groups, the procedure of input-output analysis would serve as a "bridge" (Leontief, 1986, p.14) between economic theory and reality.

In his 1936 publication, Leontief reinforces the notion that the various, often scattered parts of a country's economic system are highly interdependent. It is this feature that lies at the heart of any economic analysis. Interestingly, his predecessors had already established this theory; he quotes Francois Quesnay for instance, who authored the influential work *Tableau Economique* in 1758. Quesnay portrayed sales and purchase relationships between different producers and consumers in an economy ("Quesnay's *Tableau Economique*," n.d., para. 2). This later became the foundation of the multi-sectoral input-output systems of Marx, Sraffa, Leontief, and the modern general equilibrium theory[3].

Leontief explains the motivation for his work by expressing that only rudimentary numerical examples of the economy existed during the time of his research, despite the advancement in national income statistics. Separate sectors of the economy were studied, but there was a need for a more meticulous investigation of their inter-relationships. Therefore, a key component of his study included the collection of statistical data that would empirically represent an economy's activities. Leontief borrows from 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. This enables an evaluation of future growth prospects by

[3] The theory describes all economic activities in a country, postulating that an economy achieves a state of "equilibrium" when demand and supply are equal at a certain set of prices. Also, see *Walras' Law* and *Walrasian general equilibrium theory* (Levin, 2006).

providing an item-based classification of inputs and outputs. Final demand of products and services is portrayed alongside changes in income. For those analysts interested in consumption patterns, national income flows in the table will be of great interest. These examples are, however, only a segment of a very complex scheme of production, consumption, and distribution transactions in an economy (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.

Against this background, this study attempts to compile a symmetric, commodity by commodity input-output matrix for India for the base year 2012-13. This is achieved by transforming supply and use tables (SUTs) of the same year published by the Central Statistics Office (CSO), Government of India.

The CSO has not published IOTs since 2012; the latest one pertains to the reference year 2007-08. However, the publication of SUTs presents an opportunity for practitioners in input-output research to undertake the task of compiling an updated IOT. We note that in a recent report, the National Council of Applied Economic Research (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 our rapidly growing economy.

Another contribution of this paper includes the publication of a Social Accounting Matrix (SAM) of the same 140 sectors as well as satellite accounts, namely, a capital composition matrix. A consolidation of these matrices results in a highly disaggregated database upon which a Computable General Equilibrium (CGE) model may be constructed to examine specific economic and energy policies for India. It should be noted that a large volume of quantitative data is required to construct an IOT. It is, therefore, natural that these tables refer to a time period earlier than the year of publication, given the lag between data collection and collation (Leontief, 1986).

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. We then proceed to demonstrate the derivation of satellite accounts. In Section 3, we present the formulation of a detailed SAM. Salient literature is explored, dwelling briefly on the history of SAMs in India. 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.

Section 1: Overview of Supply, Use and Input-Output Tables

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 among diverse units in an economy. Specifically, they identify the requirement of primary inputs for the production of goods and services, the points of production and subsequently the destination of consumption (Kanhaiya Singh & M R Saluja, 2016). Primary inputs comprise land, labour and capital, collectively known as *factors of production* in economic parlance. Other important information include income generation, profits earned by enterprises and trade with countries.

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. Similarly, the use table depicts end users of these goods and services. They may be used for either intermediate consumption or final use. Examples of final use include final consumption by households, gross capital formation or investments and exports (Eurostat, 2008). Additional information in the form of *gross value added* is also depicted in the use table. This is classified into four indicators, namely, compensation of employees (e.g., salaries), net taxes on production (deduction of subsidies), operating surplus (e.g., profits) and consumption of fixed capital (depreciation of fixed assets).

Such an integrated description of a country's national accounts is useful for balancing supply and demand, thus establishing a robust framework for compiling GDP (Central Statistics Office, 2016; Eurostat, 2008). 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). In particular, the *Eurostat Manual* (Eurostat, 2008) recommends that national accounts data be compiled based on a supply and use framework. Hence, the recent publication of supply and use tables by the Government of India is of great significance. These tables, therefore, form the primary data set for compiling our symmetric input-output table.

1.2 Supply and Use Tables 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, 2008*[4] (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. This database is accompanied by a comprehensive note on the methodology of compilation and a detailed description of the classifications of commodities and industries[5].

[4] See *The System of National Accounts* (*SNA*): https://unstats.un.org/unsd/nationalaccount/sna.asp
[5] See *Supply and Use Table: A Note on Compilation for the Years 2011-12 and 2012-13*

According to the CSO, the main reason for revising the series and compiling SUTs is the differences in GDP computed from two separate methods, namely, production and expenditure. Statistical discrepancies occur due to the use of different data sources for each method. The SUT is thus presented as a framework that can resolve these errors because of their detailed economy-wide characterisation (Central Statistics Office, 2016).

The following section illustrates the basic structure of SUTs. This visualisation will help derive the structure of the symmetric input-output table described in the next section.

1.3 Supply Table

The supply table is a *Product x Industry* matrix where rows of the matrix represent products (also known as commodities) and columns reflect industries. Each product appearing in the row (e.g., Paddy) is produced by its respective industry (e.g., Agriculture). Column entries denote the value of a product by kind of supplier, specifically differentiating between domestic supply and imports (Central Statistics Office, 2016). The sum total of rows equals the total supply by product, while the column total is the total output by industry.

The CSO's SUTs are rectangular; i.e., the number of products is not equal to the number of industries. All values are at basic prices, i.e. the price at which a product is produced without addition of tax, subsidy or transportation costs. However, since the use table is valued at purchasers' prices, the total supply of each product is converted to purchasers' prices in the supply table by adding net taxes on products, imports and trade and transport margins (Central Statistics Office, 2016).

Table 1: Illustrative Supply Table

Products/Industries	Agriculture	Industry	Services	**Total Supply at Basic Prices (BP)**	Imports
Agriculture (e.g., Paddy)					
Industry (e.g., Coal)					
Services (e.g., Hotels)					
Total Output	Total Output by Sector				Total Imports

Source: Adapted from Table 1.1 of (Eurostat Manual, 2008) and modified by authors

1.4 Use Table

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*. The use table 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)[6]
- Gross value-added (CE, OS, CFC)[7]

Broadly, this table shows the use of goods and services by various sectors. Moving along the columns of Table 2 illustrated below, the use of each product is shown by type of use, i.e. as intermediate consumption (IIUSE), final household consumption (e.g., PFCE), gross capital formation (e.g., GFCF) and exports (Central Statistics Office, 2016). Income from utilisation of labour and capital is presented as gross value added (Central Statistics Office, 2012).

The table of intermediate use shows intermediate consumption of products by industries. This is useful to identify goods and services mainly used in the production process to manufacture products that are ultimately sold in the market. The total for the columns of IIUSE and the 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). This matrix is valued at purchasers' prices, i.e. at prices paid by the buyers of a product or service.

Table 2: Illustrative Use Table

	Inter-Industry Use				Final Uses					
Products/Industries	Agriculture	Industry	Services	IIUSE	PFCE	GFCE	GFCF	CIS	Net Exports	Total Use at Purchasers' Prices (PP)
Agriculture	Intermediate Consumption				Final Use Matrix					
Industry										
Services										
Total IIUSE										
Gross Value Added (GVA)	Value-Added Vector									
Total Output (IIUSE + GVA)					Total Final Uses					

Source: Derived from Table 1.2 of (Eurostat Manual, 2008), pp.4 of (Central Statistics Office, 2016) and modified by authors
Notes: IIUSE: Inter-industry Use

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

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

Finally, it is essential that the total output of products in the supply table equals the total use in the use table, i.e.

(1) **Total supply by products = Total use by products**

1.5 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. Assumptions on the relationship between inputs and outputs are employed in this transformation. It combines a bird's eye view of the national economy with microeconomic details on sector-specific linkages. Moreover, inter-industry classifications of commodity flows are extended to include consumption, investment and trade activities of individual agents and governments. In the supply-use framework, relations between products and industries are described. However, the I-O table presents statistical information related to either commodities or industries.

Thus, two kinds of I-O tables can be derived, namely *commodity x commodity* and *industry x industry*. In these, a commodity or industry classification is usually applied across both rows and columns. Adopting a commodity classification, the relationship between rows and columns depicts products used as primary inputs to produce final products (Eurostat, 2008). Appendix 2 of the CSO's publication (Central Statistics Office, 2012) is of particular interest to this study because it lucidly demonstrates procedures for deriving both I-O tables that operate under different technology assumptions.

For deriving *commodity x commodity* tables, two technology assumptions are used: commodity and industry. Briefly, the commodity technology assumption states that each product has a specific process of production, irrespective of the industry in which it is produced. Similarly, the industry technology assumption states that each industry has its own structure of production irrespective of the product it produces. In other words, the input structure of a product adopts a similar pattern to the structure of the industry in which it is produced. A mix of the two yields a hybrid technology assumption (Eurostat, 2008). Mixed assumptions are used when it is not possible to restrict secondary products to a single technology assumption.

Industry x industry tables can assume either a fixed product or fixed industry sales structure (Eurostat, 2008)[8]. The fixed product assumption is one wherein each product follows a specific sales structure, no matter which industry it is produced in. In the latter assumption, each industry abides by a unique sales structure, notwithstanding the product mix.

[8] See *The Eurostat Manual (2008)* for an explanation of the different technology assumptions and key differences among them.

The *Eurostat Manual* (Eurostat, 2008) discusses perceptions surrounding differences between the two tables. It recognises that *commodity x commodity* tables are theoretically more homogenous in their transaction descriptions and are preferred for input-output analyses. However, *industry x industry* tables are believed to be closer to actual transactions and statistical sources. Ultimately, the nature of economic analysis will decide the choice of input-output table to be compiled. In this study, we follow the design of the I-O table for 2007-08 published by the CSO and compile a *commodity x commodity* (C x C) matrix for India using the industry technology assumption.

1.6 Input-Output Tables for India

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[9] 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 globally accepted manual, the *System of National Accounts*.

A total of nine IOTs[10] 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 1998-99[11]. Further, a 130-sector classification is adopted in the 2007-08 database. Each table is accompanied by detailed methodology notes, sources of data as well as supplementary tables like input-output coefficient matrices. Later publications apprise important differences between the published tables, including brief analyses of compiled data and associated findings.

Before discussing compilation procedures, a simple illustration of the structure of a symmetric input-output table is introduced to the reader.

1.7 Structure of Symmetric Input-Output Tables

The basic structure of an input-output table can be conceived as a matrix, an accounting system that maps all existing players in an economy. Leontief compares it to a balance sheet which, as readers will be familiar, has two accounts: expenditure and revenue. An outflow of goods from one industry corresponds to a receipt of the same goods by other industries or households (W.

[9] 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 (*MOSPI, Chapter 1, Introduction*).
[10] 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.
[11] Other years include: 1973-74, 1978-79, 1983-84, 1989-90, 1993-94, 1998-99, 2003-04 and 2007-08 (*MOSPI, Chapter 1, Introduction*).

Leontief, 1936). Likewise, the accounting equation holds, i.e., each revenue is matched with each expenditure. This implies that each output of an industry or household must reappear as an input in the account of another business or household.

Table 3: Simplified Symmetric Input-Output Table (Commodity by Commodity)[12]

	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

Table 3 depicts how outputs from one sector are distributed as inputs to different sectors. Commodities are grouped across rows and industries are represented under column heads. Moving down the table, each row presents the producing sector while across the table, columns present the consuming sector (Kanhaiya Singh & M R Saluja, 2016).

In a symmetric I-O table, the intermediate consumption matrix is square, i.e., the number of rows equals the number of columns. Each row of the table indicates the commodity output produced by an industry which is then delivered to different industries for use. Hence, 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 – the 'input' aspect. To satisfy the accounting equation, it is essential that total inputs equal total outputs. Subsequently, the final demand of each sector is estimated.

[12] 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)*.

To conclude, the input-output framework conceptualised by Leontief[13] is a comprehensive attempt to empirically demonstrate an interconnected system of accounts for an economy. It is testimony to the significance of Leontief's work that this concise, highly visual structure of I-O tables is still maintained in its essence across the world. It is also 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 would and indeed do 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.

[13] 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.

Section 2: Compilation Procedures

This section systematically delineates the methods by which we have arrived at the results presented in Annexure 1.

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 I-O table. These sources describe the formulation of an I-O table in a lucid and accessible manner, particularly useful for new researchers in the field. 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. It should be acknowledged that such a compilation is often time-consuming due to large datasets involved in the process. However, the iterative process is a valuable exercise in itself as it allows for reflection on the theoretical framework. As a consequence, researchers can acquire concrete information about an economy's activities at a remarkable level of detail.

The section concludes with a short description of our validation techniques and derivation of an investment (capital composition) matrix for India.

2.1 Transforming Supply and Use Tables into Symmetric Input-Output Tables

Methodological choices are largely driven by the authors' aims for macroeconomic modelling in the areas of energy and climate policy. Since our research interest lies in compiling a fairly detailed input-output matrix for the Indian economy, we adopt the procedure for a *commodity x commodity* table of 140 sectors.

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. A close examination of these matrices reveals distinct ways of classifying products and industries, providing researchers an opportunity to refine their analysis. For instance, they can choose to disaggregate key industries into separate sectors or group relatively homogenous commodities into the same product bundle. Likewise, a brief survey of the supply matrix indicates a greater depth of product distribution while the columns clearly present a summarised grouping of industries[14]. Transforming supply and use matrices primarily entails a change in only the production matrix (inter-industry matrix) that maps the intermediate consumption of products.

[14] For a detailed description of the 140-sector product and 66-sector industry specifications, see Annexures 1 and 2 of *Supply and Use Table: A Note on Compilation for the Years 2011-12 and 2012-13*.

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.

2.1.1 Procedure I

Appendix 2 of the CSO's document (Central Statistics Office, 2012) outlines the analytical approach to constructing both *commodity x commodity* and *industry x industry* tables. Between the two technology assumptions commonly applied, the industry technology assumption is selected solely based on technical considerations.

In our table, both rows and columns comprise commodities. The flow matrix depicts the value of commodities purchased by other commodity groups. 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.

Now, we proceed to describe the matrix multiplication procedures[15].

First, a coefficient matrix (B) is derived from the use table by dividing input values of each industry group by the column output. Secondly, a *make matrix* is obtained by transposing the supply table[16]. 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.

(2) Market share matrix **(D)** = (Supply matrix)^T * inverse **(q)**

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

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

A summary of the formulae and notations are given in Table 4.

Table 4: Compilation Procedure 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*
C x C Flow Matrix (Intermediates)	W	W = BD * q	Matrix multiplication

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

[15] 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*.

[16] 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.

2.1.2 Procedure II

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 Procedure I. *V* is the transpose of the supply table and its multiplication with the inverse of diagonal matrix *g* results in the transformation matrix.

(4) 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:

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

Table 5: Compilation Procedure 2

Matrix Description	Notation	Formula	Methodology
Make matrix	V	-	Transpose of supply table
Diagonal Matrix	g	-	Column vector of industry output
Transformation matrix	T	inv[diag(g)] * V	Multiplication of the inverse of the diagonal matrix and make matrix
C x C Flow Matrix (Intermediates)	S	S = U * T	Use table for intermediates * Transformation matrix

Source: Derived from Eurostat, 2008, Chapter 11, p. 349

For comparison, intermediate matrices derived from both procedures are subtracted from one another to detect discrepancies. Our calculations find the difference matrix to be zero, implying a perfect match.

2.1.3 Procedure III: Authors' calculations

Apart from manuals sourced from literature, we undertake an independent compilation procedure. We suggest that the intermediate matrix of our required table can 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 all three methodologies, achieving a convergence whereby our compilation is validated.

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

Thus, the intermediate matrix of our *commodity x commodity* I-O table is derived. To finish our compilation, the next step is to evaluate coefficient vectors for the components of gross value-added. Then, we address the final demand vectors comprising consumption, investment and trade. It is the latter information that is used to arrive at the GDP of a country. Therefore, its explicit inclusion in the input-output framework confers a great deal of utility on this exercise, providing opportunities to conduct a wealth of policy analyses.

We derive our coefficient vectors using the steps outlined in Procedure III. 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 using the following equation:

(6) **Output = Input + 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:

(7) **I-O table at Basic Prices**

=

Total at Purchasers' Prices – Trade & Transport Margins – Imports – Net Taxes on Products

Finally, the completed input-output table may be visualised in the following format:

Table 6: Illustration of Final Input-Output Table

		Inter-Industry Matrix				Final Uses Matrix			
	Commodity / Commodity	Agriculture	Industry	Services	IIUSE	TFUSE	Total at PP	Less (TTM + Net Product Taxes + Imports)	Total at Basic Prices
1	Agriculture	Intermediate Consumption at Basic Prices							
2	Industry								
3	Services								
4	Total Input at Basic Prices (1 + 2 + 3)								
5	Compensation of Employees	Value-Added at Basic Prices							
6	Net Operating Surplus								
7	Net Production Taxes								
8	Consumption of Fixed Capital								
9	Gross Value Added at Basic Prices (5 + 6 + 7 + 8)								
10	Total Output at Basic Prices (4 + 9)								

Source: Derived from Table 11.3 of The Eurostat Manual (2008) and modified by authors to reflect the current study
Notes: TTM: Trade and Transport Margins; PP: Purchasers' Prices

2.3 Validation

The 140 sector I-O table is validated by three distinct conceptual methods as detailed in the previous section. 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:

Table 7: Validation of Input-Output Table *(Rs. Crores)*

	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	92,71,383	92,02,692	1%

Source: Authors' calculations. The official estimate of GDP is based on National Accounts Statistics (2017) data, reported at current prices for 2012-13.

We observe that the GDP figures calculated using two methods from our I-O table are reasonably consistent with official data. Additional validation procedures that confirm individual transactions of the I-O table are beyond the scope of this paper and are planned to be presented in the next series of working papers.

2.4 Satellite Accounts: Investment Matrix

In this section, we discuss the derivation of satellite accounts from our newly compiled I-O table. Examples of such accounts include an investment matrix, a matrix for import use and an employment matrix. In this paper, we lay out a brief methodology for deriving an investment matrix.

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[17]. 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).

We derive a *Gross Fixed Capital Formation* (GFCF) matrix for all the 140 producing sectors of our I-O table. For the sake of clarity, the matrix is distinguished from the I-O table in Annexure 1, and presented separately.

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

[17] For more information, see *The Eurostat Manual, Chapter 15* (Eurostat, 2008).

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.

We note that 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. This is presented in Annexure 2.

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. 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 can be found under the column heading *Total Output at Purchasers' Prices (PP)* in the I-O table. 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.

We then estimate the new value of assets based on the new GFCF for each sub-sector. Table 10 presents a snapshot of the GFCF matrix for the livestock sectors in our I-O table.

Table 8: Investment matrix for the livestock sector

	Total Output (at PP)	Share of output (%)	New GFCF	Dwellings, Buildings and Structures	Machinery and Equipment	Cultivated Biological Resources	IPP
Milk	4,50,973.86	65.89	13,464.57	9,848.84	268.85	3,345.54	1.31
Wool	637.22	0.09	19.02	13.91	0.37	4.72	0.00
Egg & Poultry	84,337.30	12.32	2,518.02	1,841.84	50.27	625.65	0.24
Other Livestock Products	1,48,421.72	21.68	4,431.37	3,241.39	88.48	1,101.06	0.433
Total	6,84,370	100	20,433	14,946	408	5,077	2

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

Replicating this procedure for all sectors in the I-O table, we arrive at the final investment matrix presented in Annexure 1. To ensure consistency with the data source, all calculations are valued in *Rs. Crores*. 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%.

Section 3: Social Accounting Matrix

3.1 Overview of Social Accounting Matrices

A social accounting matrix may be defined as a comprehensive, single-entry accounting system where each account is represented by a column for payments and a row for receipts (Hayden & Round, 1982). Similar to the I-O framework, it illustrates a fundamental law of economics – for every income, there is a corresponding expenditure (Pradhan, Saluja, & Singh, 2006).

The SAM is one of the most popular extensions of the I-O table. Sir Richard Stone, a British economist, and his colleagues first developed it in the 1950s; thereafter, he won the Nobel Prize for his contributions to the System of National and Social Accounts (Pradhan et al., 2006). Stone's work captured the need to extend the I-O framework to include important information on income distribution, institutions and final demand. For example, a rise in GDP from an industry perspective sheds little light about how these incomes are distributed, or its impact on living standards. Therefore, the SAM "… attempts to classify various institutions in terms of their socio-economic backgrounds instead of their economic or functional activities" (Chowdhury & Kirkpatrick, 1994, p. 58).

Thus, a fundamental distinction between the IOT and the SAM is that the latter delineates relationships between income distribution and final expenditures. In addition, the SAM paints a complete picture of the circular flow of income and spending, a significant advantage over the I-O framework (Mary E. Burfisher, 2017; Pradhan et al., 2006). The SAM can be used to study the effects of policy changes on incomes at the disaggregated household level. It can also analyse linkages between an economy's production structure and the distribution patterns of income and expenditures among households and institutions. Ultimately, the aim of such a system is to elucidate the economic, social and environmental aspects of all human activities in an integrated framework (Eurostat, 2008). From such a database, a comprehensive model may be built to examine the complete impact of any policy change.

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 and base year equilibrium solution to construct multi-sector models like the CGE (also see Pradhan et al., 2006)

Therefore, the second purpose of this paper is to construct a detailed database of 140 sectors for the Indian economy. The main contribution to the SAM literature in India is the disaggregated sector classification and a revised set of value-added components.

The following section briefly discusses the historical evolution of the SAM framework. Then we proceed to summarise the steps involved in extending the IOT and arriving at a SAM for the year 2012-13. The concluding sections briefly describe validation techniques and some applications of the SAM.

3.2 The Evolution of SAMs

The history of SAMs 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 System of National Accounts, 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.

Since the 1970s, Pyatt, Thorbecke and associated scholars (Pyatt & Round, 1979; Thorbecke & Jung, 1996) have extended Stone's work to study distribution of economic reforms in developing countries. As a result, SAMs were constructed quite early on for countries like Sri Lanka (Pyatt & Round, 1979), Malaysia (Chander Ramesh, Gnasegarah S., Pyatt Graham, & Round Jeffrey I., 1980), Botswana (Hayden & Round, 1982) and Indonesia (Thorbecke & Jung, 1996). The SAM is also popular in many South Asian countries, including Pakistan and India (Pal, Pohit, & Roy, 2012).

India was an early leader in compiling SAMs and developed models based on these databases. To our best knowledge, Sarkar and Subbarao (Sarkar & Subbarao, 1981) from the National Council of Applied Economic Research (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.

Table 11 provides an overview of the published SAMs for India and some of their salient features:

Table 9: Anthology of SAMs for India

S. No	Name of Researchers and their SAM-based study	Salient SAM Features
1.	Sarkar & Subbarao (1981)	Base year: 1979-80 **Sectors (3 in all):** agriculture, industry and services **Agents:** non-agricultural wage income class, non-agricultural non-wage income class, agricultural income class and government Factors of Production: Labour and Capital
2.	Sarkar & Panda (1986)	Base year: 1983-84 **Sectors (6 in all):** agriculture (2), industry (2), infrastructure and services **Agents:** non-agricultural wage income class, non-agricultural non-wage income class, agricultural income class and government Factors of Production: Labour and Capital
3.	Bhide & Pohit (1993)	Base year: 1985-86 **Sectors (6 in all):** agriculture (2), livestock & forestry, industry (2), infrastructure and services

S. No	Name of Researchers and their SAM-based study	Salient SAM Features
		Agents: government, non-agricultural wage income earners, non-agricultural profit income earners and agricultural income earners Factors of Production: Labour and Capital
4.	B. K. Pradhan & Sahoo (1996)	Base year: 1989-90 **Sectors (8 in all):** agriculture (2), mining and quarrying, industry (2), construction, electricity combined with water and gas distribution, and services (3) **Agents:** government, agricultural self-employed, agricultural labour, and non-agricultural self-employed and other labour Factors of Production: Labour and Capital
5.	Basanta K. Pradhan, Amarendra Sahoo, & M. R. Saluja (1999)	Base year: 1994-95 **Sectors (60 in all):** agriculture (4), livestock products (2), forestry sector, mining (4), manufacturing (27), machinery and equipment (6), construction, electricity, transport (2), gas and water supply, other services (11) **Agents:** government, self-employed in agriculture (rural & urban), self - employment in non-agriculture (rural & urban), agricultural wage earners (rural & urban), other households (rural & urban), private corporate, and public non-departmental enterprises **Factors of Production:** Labour and Capital
6.	Basanta K. Pradhan, Saluja, & Singh (2006)	Base year: 1997-98 **Sectors (57 in all):** agriculture (4), livestock products (2), forestry, mining, manufacturing (27), machinery and equipment (6), construction, electricity, transport (2), gas and water supply, other services (11) **Agents:** government, self-employed in agriculture (rural & urban), self - employment in non-agriculture (rural & urban), agricultural wage earners (rural & urban), other households (rural & urban), private corporate and public non-departmental enterprises **Factors of Production:** Labour and Capital
7.	Sinha, Siddiqui, & Munjal (2007)	**Base year:** 1999-2000. **Sectors (13 in all):** agriculture (informal), formal manufacturing (9), construction (informal), other services (formal & informal) and government service **Agents:** rural occupation class, 4 urban occupation class, government and private corporations Factors of Production: Labour and Capital
8.	Saluja & Yadav (2006)	Base year: 2003-04. **Sectors (73 in all):** agriculture (12), livestock products (4), forestry, mining (4), manufacturing (28), machinery and equipment (7), construction, energy, gas distribution, water supply, transport (2), other services (10) **Agents:** 5 rural households' expenditure classes, 5 urban households' expenditure classes, private corporation, public enterprises and government Factors of Production: Labour and Capital
9.	Pal et al. (2012)	Base year: 2003-04. **Sectors (85 in all):** agriculture and allied sectors (21), mining (9), manufacturing (23), machinery and equipment (9), construction, electricity (3), biomass, water supply, transport (5), other services (12) **Agents:** 5 rural households' occupation classes, 4 urban households' occupation classes, private corporation, public enterprises and government **Factors of Production:** Labour, Capital and Land
10	Basanta K Pradhan, M R Saluja, & Akhilesh K Sharma (2014)	Base year: 2007-08. **Sectors (85 in all):** agriculture and allied sectors (22), mining (9), manufacturing (29), machinery and equipment (3), construction, electricity, water supply, transport (4), other services (18) **Agents:** 5 rural households' occupation classes, 4 urban households' occupation classes, private corporation, public enterprises and government **Factors of Production:** Labour, Capital and Land

Source: Pal et al., 2012

As seen in Table 11, SAMs for India are available from the 1980s. However, 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 SAM for the base year 2012-13. This is a significant step as we improve upon previously constructed SAMs.

3.3 Structure of a SAM

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). The SAM is unique because the single framework depicts both microeconomic and macroeconomic data. In the former, the SAM describes transactions made by each agent. When this microeconomic data is aggregated, the resultant description conveys information about a region's macro economy.

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).

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.

Figure 1: 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

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).

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).

3.3.1 Production, Factors of Production and Household Accounts

The SAM in our study 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 the National Sample Survey Organisation (NSSO) of India.

Similar to the I-O framework, the *commodity by commodity* section of the SAM portrays inter-industry flows of inputs and consumption of outputs. Factors of production provide primary inputs like land and labour into each sector. In return, factor payments flow as income to the different categories of households (Pal, Ojha, Pohit, & Roy, 2015).

It is important to note that the value-add received by the factors for providing services of labour and capital is also known as *GDP at factor cost* (net of indirect taxes). By adding net factor income from abroad to GDP, we arrive at GNP (gross national product) at the same factor cost (Pradhan et al., 2006).

This GNP is distributed in the form of *factor income* to households, *operating profits* to private corporations, *operating surplus* to public non-departmental enterprises and *income from entrepreneurship* to government. In addition to factor payments, households also receive income through interest on public debt and transfer payments from both the government (e.g., subsidies) and ROW. They spend their income on purchasing goods and services, pay taxes and retain the rest of their disposable income as savings.

Ultimately, total supply in the economy has to be matched by total demand by institutions and capital formation. An advantage of the SAM is that we can further disaggregate the household sector and labour market to clearly reflect different socio-economic backgrounds and regions.

3.3.2 Savings and Investment Accounts

The capital account in our SAM gives the value of savings and investments in the economy: the row titled 'Capital a/c' represents savings. Savings are attributed to households, private corporate firms, public non-departmental enterprises, the government and ROW.

Private and public enterprises earn profits as a result of their economic activities. The balance sheet of private firms may also include transfers from the government and interest on public debt. Savings are retained after payment of corporate tax. Receipts of the government consist of income from its enterprises as well as direct and indirect taxes. Its expenditure includes consumption of goods and services, transfers to households and interest payments to the private corporate sector. The difference between the revenue and current expenditure of the government is treated as its savings.

Capital formation indicates the purchase of investment goods. Investment demand constitutes *gross domestic capital formation*, which includes change in stocks and indirect taxes on purchases. This is represented by the 'Capital a/c' column. Foreign savings or current account balance is the difference between *gross domestic capital formation* and *gross domestic saving* (Pal et al., 2015).

3.3.3 Tax and Trade Accounts

The tax account comprises both direct and indirect taxes. *Net taxes* are obtained by subtracting subsidies from taxes. Examples of net indirect taxes include sales tax, excise duties on domestic production and custom duties on imported commodities. The total value of direct taxes obtained from the NAS database is distributed among households and producing sectors. For instance, self-employed agricultural households pay land revenue. The rest of the direct taxes are distributed in proportion to the personal income earned by these households.

Finally, foreign trade is represented as rest of the world (abbreviated as ROW) in the SAM. Export and import data are available from the I-O table, while allied data may be compiled from the NAS and Reserve Bank of India statistics. Total imports represent foreign exchange outflows from the country to the rest of the world. The column indicates foreign exchange inflows, comprising exports, earnings from abroad reported in terms of net factor income (NFIA), net capital transfers to the government, current transfers to households and private corporate firms and finally, foreign savings.

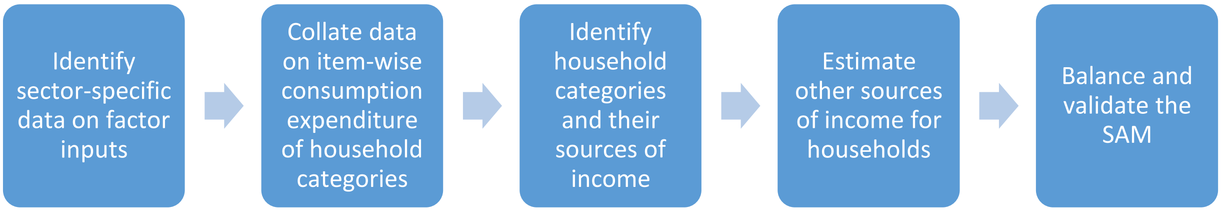
To conclude, the SAM is balanced when all incomings (receipts) account for all outgoings (payments), i.e., the total of rows and columns must be equal for each account in the SAM. This is a constraint that every agent has to meet (Mary E. Burfisher, 2017). At the macro level, this translates into the 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.

3.4 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. The SAM for India for 2012-13 is given in Annexure 1.

Briefly, the following steps are used while constructing a SAM.

Figure 2: Method of SAM construction



Labour data

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.

Table 10: Indicators to classify labour input

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

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).

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 by NSSO 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 12. 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. This is presented in Annexure 1.

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. This is also presented in Annexure 1. 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 validating the SAM

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. 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. 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).

We adopt balancing procedures similar to the ones detailed in the value-added SAM (Pal & Bandarlage, 2017). Estimation techniques use NSSO data to determine distribution patterns of households' factor income from types of labour, item-wise consumption expenditure and sector-wise labour payment. A *pro-rata adjustment method* is applied to distribute the data of the SAM according to the distribution patterns. This simply means a proportionate allocation of each portion of data according to its respective share in the whole fraction. These methods ensure that the NSSO data is adjusted with the aggregate level data obtained from the 2012-13 SAM. After data is extracted for key macroeconomic indicators, this is compared with official data for 2012-13.

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 policy analyses of the Indian economy.

Conclusion

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). Further, a SAM multiplier analysis can include additional crops or sectors that can, for example, help identify economic activities to reduce rural income inequality. In addition, 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 a tedious job which requires readily available data. Without this data, information has to be culled from different sources and compiled into the format of a single matrix. The magnitude of this task can be substantially reduced if the Government of India regularly publishes national input-output tables that correspond to each round of the NSSO surveys. Also, a latest available SAM will help us observe structural transformations in the economy since the base year 2007-08. 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. 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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Annexures

Annexure 1 presents an Input-Output matrix, Investment matrix and Social Accounting matrix for India (2012-13). In addition, it depicts a map of concordance between the sectors of the SAM, NSSO data and the NIC-digit classifications of Indian industries.

- Input-Output Matrix: http://www.cstep.in/I-O-Tables/Draft Matrices for Annexures_Revised.pdf
- Investment Composition Matrix: http://www.cstep.in/I-O-Tables/Investment Matrix.pdf
- Map of Concordance between Sectors of the SAM and NSSO 68th Round Survey Classification of Commodities: http://www.cstep.in/I-O-Tables/NSSO.pdf
- Map of Concordance between Sectors of the SAM and NIC-digit Classification of Indian Industries: http://www.cstep.in/I-O-Tables/NIC.pdf
- Social Accounting Matrix: http://www.cstep.in/I-O-Tables/SAM.pdf

Annexure 2

Table 11: Concordance map between NAS sectors and I-O Table (2012-13)

NAS Sector Name	IOT (2012-13) Sector No.
Crops	1-20
Livestock	21-24
Forestry and Logging	25-27
Fishing and Aquaculture	28-29
Mining and Quarrying	30-40
Manufacturing	41-112
Electricity, Gas, Water Supply and other Utility Services	114-116
Construction	113
Trade and Repair Services	117-118
Hotels and Restaurants	119
Railways	120
Road Transport	121
Water Transport	123
Air Transport	122
Services incidental to Transport	124
Storage	125
Communication and Services related to Broadcasting	126, Part of 140
Financial Services	127
Real estate, Ownership of Dwellings and Professional Services	128-134
Public Administration and Defence	136
Other Services	135, 137-139, Part of 140

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