Abstract

The input-output (IO) framework is a standardized depiction of the economy detailing its production processes, its supply and use of a comprehensive set of commodities, and the income (value added) generated in it as a result of its industrial sectors undertaking productive activities. The tables in the framework integrate all relevant production, expenditure and income data related to the economy into a two-dimensional sector-commodity space adhering to a standard set of definitions, concepts, classifications and accounting rules. They provide the accounting framework for establishing the coherence among data on production, expenditure, and income respecting the economic identity equating supply and use of the commodities by the various sectors of the economy, thereby enabling the computation of a number of standard measures of economic activity such as gross domestic product (GDP). The tables provide the only numerical system by which GDP can be computed by the three approaches of production, expenditure, and income, rendering it the appropriate framework for discerning and studying the evolution of, and interconnections and linkages between, various aspects of an economy such as production and trade.

The paper describes certain IO based analytical approaches that can be employed by developing economies in the Asia and the Pacific Region to improve their key economic statistics in such domains as GDP, economic growth, sectoral production, household consumption, capital formation, trade and global value chains. It also underlines the fact that appropriately constructed tables could be used to produce pertinent estimates and analyses to facilitate evidence based policy making.
I. Contents

I. Contents......................................................................................................................................................... 2
II. Introduction.................................................................................................................................................... 2
III. Input-Output Analysis Framework .............................................................................................................. 2
   A. Studying an Economy through the IO Analysis Framework ................................................................. 2
   B. Economic Statistics and IO Analysis Framework ................................................................................. 11
IV. Conclusion................................................................................................................................................... 16
V. References..................................................................................................................................................... 16

II. Introduction

The effectiveness of economic policies is critically dependent on the quality of the statistics feeding into policy development processes. The quality of a number is assessed by its relevance to a given phenomenon, the accuracy with which it describes the phenomenon and the timeliness with which it reports the phenomenon. Further, only data that are presented in a systematic and structured manner readily lend themselves to meaningful economic analysis. In the modern globalized economy dominated by increasingly fragmented and highly interconnected production processes, governments critically require a comprehensive set of statistics on any economic phenomenon that are also coherent with other relevant information to design effective policies. This paper discusses how an input-output (IO) analysis framework - comprised of the supply and use (SUTs), input-output (IOTs), direct requirement (A) and total requirement (L) tables - can not only provide high quality and detailed information about the functioning of an economy that could be instrumental in improving policy designs and outcomes but also be used to improve other relevant statistics.

III. Input-Output Analysis Framework

   A. Studying an Economy through the IO Analysis Framework

      A.1 IO Analysis Framework as a Statistical Tool
      In a world of increasingly complex and integrated economies where highly fragmented and cross-border production processes are the norm catalyzed by advances in information and

-----

1 The concepts, frameworks and analysis provided in this section are based on The Key Indicators for Asia and the Pacific 2015, Asian Development Bank (October 2015)
communication (ICT), and transportation technologies, conventional presentations, and analyses, of economic statistics are incomplete and inadequate for informing policy issues and research. Further, with intermediates dominating international trade, the design of the production process is becoming a key determinant in the content and magnitude of an economy’s productive activities, its trade and the share of its value added (income). As will be shown in this section, the data-presentation-and-analysis system provided by the IO analysis framework founded on Wassily Leontief’s economic IO model is the ideal quantitative structure for depicting and studying the workings of different economies and the interactions among them. In a nutshell, the IOTs detail the transactional linkages among various industrial, and institutional, sectors of an economy, even inter-temporally and inter-spatially. A variety of analytical methods can be applied to study various factors and facets of an economy, and to understand its functioning and evolution.

The IOTs of an economic territory are derived from its SUTs, which themselves are a standardized depiction of the economy detailing its production processes, its supply and use of a comprehensive set of commodities, and the income generated in it as a result of its industrial sectors undertaking productive activities. The SUTs integrate all relevant production, expenditure and income data related to the economy into a two-dimensional sector-commodity space adhering to a standard set of definitions, concepts, classifications and accounting rules. They provide the accounting framework for establishing the coherence among data on production, expenditure, trade and income respecting the economic identity equating supply and use of the commodities by the various sectors of the economy, thereby enabling the computation of a number of standard measures of economic activity such as gross domestic product (GDP). The SUTs and IOTs provide the only quantitative means by which GDP can be computed by the three approaches of production, expenditure, and income, rendering the IO system the appropriate framework for discerning and studying the evolution of, and interconnections and linkages between, various aspects of an economy such as production, consumption, investment and trade.

A.2 The Basic Structure of the IO Framework

In integrating diversely sourced economic data in a sector-commodity space framework, the presentation of information will invariably be separated as “supply” and “use” tables. The tables will also be rectangular (more commodities than sectors) due to the (i) technological stipulations that require a given sector to use more than one commodity input in its production process, and (ii) secondary products resulting from production activities. Thus, although the information embedded in the SUTs is essential and adequate for a variety of economic and econometric analysis, given the form of its presentation, it is not sufficient for others, particularly those requiring the use of matrix methods such as economic impact analysis. In order to fully exploit the analytical possibilities of the information gathered in the framework, the SUTs are

---

2 For a detailed discussion on the compilation of Supply and Use Tables refer to Asian Development Bank. 2013. Supply and Use Tables for Selected Economies in Asia and the Pacific. ADB Research Study. Manila
transformed into IOTs by employing standard methods. The IO framework combines the SUTs into a single symmetric table in the sector–sector or commodity–commodity space.³

The utility of the IO framework in studying economic transactions can be illustrated by a simple example. Figure 3.1 depicts an elementary open economy in IOT form at a given point in time. There are three principal matrices: intermediate use, final use, and value added. The total output, or supply, by industrial sector is provided in the row vector and the total demand by industrial sector is given in the column vector, which are also the row and column sums, respectively, of the system of matrices. The economy has three industrial sectors \((i, j = 1, 2, 3)\), two final use sectors, domestic and “rest of the world” (ROW). The intermediate use matrix records bilateral and bisectoral transactions in intermediates, which are commodities used in the production of other commodities. The value added matrix details the shares of labor (compensation), capital (interest and depreciation), entrepreneurial effort (operating surplus or profit), and government (production and commodity taxes and subsidies) in a given sector’s output. The sectors produce differentiable commodities valued \(X_j\). Assume that sector 1 of the domestic economy imports an intermediate commodity valued \(M_1\), transforms or enhances it using domestic labor valued \(V_1\), and produces output valued \(X_1\). Sector 2 uses sector 1’s output as input in its production process, employing labor valued \(V_2\) to produce output valued \(X_2\), which, in turn, becomes the input in the production process of sector 3. The chain of production and bisectoral trade in intermediates continues until the product of sector 3 valued \(X_3\) is either exported \((E_3)\) to the ROW or consumed by the domestic final use sector \((F_3)\), and is thereby no longer used in the economy’s domestic production processes.

It should be noted that a commodity leaves an economy’s production processes when it is exported or when not used as an intermediate input in the production of another market-bound commodity by the domestic sector(s) acquiring it. Such transactions, including intermediate exports, are categorized as final consumption and recorded in the final use matrix of the economy. Imports, whether for intermediate or final use, categorized by the industrial sectors using them are included in the final use matrix as negative numbers in a column vector in order to remove them from the total use by the industrial or institutional sectors so that the domestic output of a sector can be equated with its use by all demanding sectors. If imports are not removed, the demand for, and use of, the output of domestic industrial sectors will be overstated by the amount of imports. In Figure 3.1, the intermediate and final use matrices include both the uses of domestically produced and imported commodities.

In the IO framework, all relevant economic identities, such as the equality between supply (row vector) and demand (column vector), and the equality between total value added and final expenditure, are respected. The industrial sector-specific columns—comprising the intermediate use, value-added, and output segments—reveal how a given sector’s output was produced. That is, the production technology employed by an industrial sector \( j \) to produce its output(s) can be discerned from the details in the relevant column; sector-specific production technologies are represented by input technical coefficients (conventionally denoted by \( a_{ij} \)), which are proportions of sector \( i \)’s contribution in sector \( j \)’s output. Likewise, the industrial sector-specific rows—comprising the intermediate use, final use, and total demand segments—detail the economy-wide demand for sector \( j \)’s output. In other words, information on how a sector’s output is used is provided in the associated row. For more advanced analysis, the columns and rows provide essential information, respectively, on backward (upstream) and forward (downstream) sectoral linkages.

### A.3. Using Leontief’s Insight for Economic Analysis

A salient feature of the IOT is that it provides the mechanism for detailing the direct and indirect linkages between production and trade in a systematic and mathematical manner. Since every sector-specific production process (resulting in the production of \( X_j \geq 0 \)) can be represented as the linear combination of the contributions of all industrial sectors \( (z_{ij} > 0) \) in the sector \( i – \) sector \( j \) space \( (i, j = 1, \ldots, n) \), the intermediate use matrix \( (Z) \) and the associated matrix of technical coefficients \( (A) \) are square. Further, in the matrix representation of a realistic economy, no column sum in \( A \) is greater than 1, and at least one column sum is less than 1 (implying non-negative value added in every sector). Given these characteristics of the technical coefficient matrix \( A \), a powerful economic analytical tool known as Leontief inverse (Leontief’s insight) can be derived from it. Formulaically, it is expressed as

\[
L = (I - A)^{-1}
\]

where \( I \) is the identity matrix whose dimensions are same as that of \( A \). \( L \) is also known as the total requirements matrix, whereas the matrix of technical coefficients, \( A \), is also referred to as the direct requirements matrix. The matrix of total output \( X \) (accounting for all direct and indirect effects) required to support final demand \( F \) is given by

\[
X' = (I - A'^{-1})^{-1} F'
\]
where \( r \) refers to the economy being analyzed. \( A^r \) is the technical coefficient matrix of transactions within \( r \).

Figures 3.2a, 3.2b, and 3.2c comprise a numerical illustration of the mathematical formulations discussed above in the context of the framework set in Figure 3.1. An IOT, the corresponding direct requirements, and total requirements matrices derived from it are presented in sequence. It is worthwhile reviewing some of the fundamentals of IO economic analysis in relation to the numerical example. The IOT in Figure 3.2a gives information on what the industrial sectors produce and on which sectors, industrial or institutional, use the products and how. The direct requirements, or technical coefficient, matrix in Figure 3.2b, which is derived from the intermediate use matrix, shows an industrial sector’s direct proportionate contribution to the production of a given sector’s output; in other words, the matrix indicates how much of different sectors’ products, including imports, are needed to be employed directly in the production process of an industrial sector to produce one unit value of its output. The Leontief inverse, or the total requirements matrix, in Figure 3.2c shows how much additional output is needed by every industrial sector if a particular industrial sector is to produce one more unit value of output for final consumption including exports; thus, the industrial sectors’ direct contributions to the production process of a given industrial sector as per the definition of its production technology and their indirect contributions due to inter-sectoral linkages, or dependencies, are given in the
matrix. For this example, sector 1’s intermediate input is assumed to be internally produced and not imported. This assumption needs to be relaxed for analysis in a multi-country context.

**A.4. Measuring International Production Sharing through IO Framework**

A defining contribution of the IO system—from the SUTs to the Leontief inverse—to economic measurement and analysis is the quantified mapping of the continuum of linkages and relationships between production and trade, making it the ideal framework for studying the globalized production environment. Figures 3.3a, 3.3b, and 3.3c situate the economy depicted in Figure 3.2a–3.2c in an international context by articulating the imports and exports in the three-dimensional, geography–sector–sector space (that is, by providing the information bilaterally and bisectorally) and incorporating the IO details of the trading partners in the system of matrices, resulting in a simple international or interregional IOT with two economic territories. In this articulation, the intermediate and final use matrices are decomposed as use of domestically produced commodities and use of imports. Given that the imports of an economy are the exports of its trading partners and all commodities have to be produced, and consumed, in the world characterized by the two economies, Figure 3.3a describes a complete global system of production, trade, and consumption. The corresponding direct and total requirements matrices are shown in Figures 3.3b and 3.3c, respectively. The dimensions of these two tables are double those of Figures 3.2b and 3.2c due to the integration of the requirements of the ROW in the system and the disaggregation of intermediates as per their origin (domestic or foreign).
### Figure 3.3a: Numerical Example of an International Input-Output Transactions Table

<table>
<thead>
<tr>
<th>Intermediate use</th>
<th>Economy Industrial Sectors as Consumers (I)</th>
<th>Rest of the World (ROW) Industrial Sectors as Consumers (I)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Economy</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>ROW</td>
<td>1</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

**Value added**

<table>
<thead>
<tr>
<th></th>
<th>Labor, capital, and entrepreneurship</th>
<th>Government</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total value added</td>
<td>Total output</td>
</tr>
<tr>
<td>Economy</td>
<td>5  15  10</td>
<td>50  80  100</td>
</tr>
<tr>
<td></td>
<td>5  15  10</td>
<td>40  30  0</td>
</tr>
<tr>
<td>ROW</td>
<td>10 15 10</td>
<td>50 80 100</td>
</tr>
<tr>
<td></td>
<td>10 15 10</td>
<td>40 30 0</td>
</tr>
</tbody>
</table>

### Figure 3.3b: Direct Requirements Matrix

<table>
<thead>
<tr>
<th>Intermediate use</th>
<th>Economy Industrial Sectors as Consumers (I)</th>
<th>Rest of the World (ROW) Industrial Sectors as Consumers (I)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Economy</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>ROW</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>
The interpretation of the matrices is the same as discussed above, but now the input requirements of a production process are also presented in another dimension: territorial origin of inputs. The resulting total requirements matrix details, maps, and quantifies the global (direct and indirect) effects of a final consumption decision regardless of its origin in the three-dimensional, geography–sector–sector space. By relocating the production of the economy’s sector 1 intermediate input from itself to sector 1 of the ROW and by enabling the ROW’s sector 2 to use the economy’s sector 3 output, Figures 3.3a, 3.3b, and 3.3c create a new set of direct and indirect interregional and intraregional productive dependencies; we now have a simple globally shared production process or global production chain. Although in this section, we look only at a two-economy, interregional IO model, the measurement concepts and analytical methods discussed can be expanded to an n-economy global economy, which can also be easily represented by the IO system.

The total requirements matrix, $L$, can be decomposed into three components based on the intrinsic cause (demand) driving the production of the output: intraregional effect ($M_1$), interregional spillover effect ($M_2$), and interregional feedback effect ($M_3$), where $L = M_3 M_2 M_1$. Formulaically, it is expressed as

$$M_1 = \begin{bmatrix} (I - A^{rr})^{-1} & 0 \\ 0 & (I - A^{ss})^{-1} \end{bmatrix}$$

$$M_2 = \begin{bmatrix} I & (I - A^{rr})^{-1} A^{rs} \\ (I - A^{ss})^{-1} A^{sr} & I \end{bmatrix}$$

---

\[
M_3 = \begin{bmatrix}
[I - (I - A^{rr})^{-1}A^{rs}(I - A^{ss})^{-1}A^{sr}]^{-1} & 0 \\
0 & [I - (I - A^{ss})^{-1}A^{sr}(I - A^{rr})^{-1}A^{rs}]^{-1}
\end{bmatrix}
\]

where \(I\) is the identity matrix and \(0\) is the zero matrix, both with the same dimension as the relevant technical coefficient matrix \(A\). \(A^{rr}\) and \(A^{ss}\) are the technical coefficient matrices of transactions within economies \(r\) and \(s\), respectively. The coefficients related to interregional transactions are captured in matrices \(A^{rs}\) and \(A^{sr}\).

\(M_1\) captures the total output that a sector needs to produce in order to meet the total intraregional requirement for its output arising from a unit value increase in final demand for any given commodity in any given location. \(M_2\) measures the pure interregional direct and indirect demand for the sector’s product and \(M_3\) shows a sector’s or economy’s demand for its own product(s) resulting from its product(s) being used in the production of commodities which themselves are demanded by the sector or economy in question for its production process. In terms of additive decomposition, \(L\) can be given as

\[
L = (I) + (M_1 - I) + (M_2M_1 - M_1) + (M_3M_2M_1 - M_2M_1)
\]

The decomposition isolates the initial, intraregional, interregional and feedback effects. The last two terms capture the effects of interregional trade linkages on an economy’s sector-specific production activities. They could also be used as a measure of the level and evolution of integration between two or more economies. The last term in particular could also serve as an indicator of an economy’s, or one of its sector’s, intensity of participation in globally distributed production processes. A high coefficient indicates that the sector under consideration is connected to the relevant international production processes at more than one level (vertical integration). For example, an increase in the demand for luxury cars produced in Germany will increase the demand for high technology engines produced in the United States, which in turn requires German green energy technology. The demand for green energy technology is the feedback effect and could be experienced by Germany only by it being more vertically integrated in the car production process by participating at two different stages (green energy technology production and final assembly).

Thus, the IO framework measures economic activity, production sharing, distribution of economic benefits, and economic integration of regions. Further, it provides detailed information about the interconnectedness between an economy’s trade and production processes thereby facilitating insightful research on trade and industrial structures and illuminating policy issues. It also has the facility to improve the quality of certain key statistics. The principal economic
indicators that could be enhanced through the IO framework are discussed in dome detail in the
next section.

B. Economic Statistics and IO Analysis Framework

Economic transactions emanating from the demand for and supply of commodities, and the
income generated by productive activities are comprehensively encapsulated in the IO
framework. The data in the IO system can be exploited to produce certain statistics that are
principally referred to in key economic decision making and policy formulation processes. This
section discusses how by instituting a periodic, ideally annual, compilation of the principal
matrices of the IO system countries could facilitate quality production of such statistics.

B.1 Current Price GDP

GDP, an important indicator of economic performance, can be estimated through three
approaches - namely production, income and expenditure – all of which in theory should yield
identical estimates. The production approach is based on the value added through the
productive processes undertaken in an economy during a specified time period. Formulaically,

$$\text{GDP (production)} = \text{total outputs} - \text{total intermediate consumption} + \text{net taxes on products}$$

In the context of the example presented earlier,

$$\text{GDP (production)} = \sum_{j=1}^{n} X_j - \sum_{j=1}^{n} \sum_{i=1}^{n} z_{ij} + T$$

Where $X_j$ is the output of a given sector $(j = 1 \ldots n)$, $z_{ij}$ is sector $j$’s intermediate consumption of
the output of sector $i$ $(i = 1 \ldots n)$. “Net taxes on products” (T) is the total taxes paid less subsidies
received by final consumers on the purchase of the products supplied to the economy by
domestic production and imports; this also is the amount by which the aggregate final
expenditures on domestically supplied products differs from the economy’s value added (=
output - intermediate consumption).
The expenditure based GDP is estimated as the total of the final consumption of domestically produced commodities. Thus,

\[
\text{GDP (expenditure)} = C + I + G + X - M
\]

This is captured by the final use matrix in the schema presented in section 2. In the equation, \(C\) is household expenditure; \(I\) represents the investment made in machinery and equipment, construction activities undertaken, net change in inventories and acquisition of valuables; all final expenditures by the public sector are captured by \(G\); \(X\) includes exports of both final and intermediate products; and \(M\) consists of all imported products, intermediate and final. Note that the Intermediate and final consumption of imports are excluded to ensure that only domestic contribution to final consumption is accounted for in the GDP estimation. Unduplicated domestic contribution is essentially the domestic value added. However, net taxes on products are embedded in the purchaser price of the final products constituting the difference between total value added and final expenditures net of imports; these are added to the economy's value added to arrive at the production based GDP.

GDP by income approach involves aggregating the production generated income allocated to the owners of primary factors and government. It is calculated as

\[
\text{GDP (income)} = \text{compensation of employees} + \text{gross operating surplus} + \text{gross mixed income} + \text{net taxes on production} + \text{net taxes on products} + \text{net taxes on imports}
\]

The value added matrix contains the data required for this calculation. Thus, the IO framework includes the complete set of data required to estimate GDP by all the three approaches.

Realistically, however, due to data quality and data gap issues, no two approaches are likely to produce identical estimates of GDP. In official statistical releases, the differences are conventionally shown as statistical discrepancies on the side on the approach with relatively weaker data sources. Further, calculating GDP outside a framework like the IO system severely limits the ability to comprehensively cross-verify and cross-validate the overall and componential estimates, and to identify and rectify possible sources of biases and weaknesses in the
numbers at a fundamental level. In most countries in the Asia and the Pacific Region, the statistical systems could ensure only internal consistencies among data gathered on a specific theme (e.g. household income and expenditure). Usually coherence analysis is conducted using only highly aggregated data. To respect economic and statistical identities relevant estimates are generally reconciled only at a highly macro level. This approach to validating data and producing key statistics not only results in lower quality estimates but also, possibly, preclude the identification and analysis of important economic issues.

The IO framework is a system in which data from several sources can be integrated, analyzed, validated, and reconciled in a systematic and scientific manner in order to produce well-defined statistics. It ensures that data from any source on a theme or subject matter is not only consistent internally but also cross consistent with other relevant information at a more granular level. There are many statistical and economic consistency tests and identities that need to be satisfied at multiple industry, product and institutional levels – e.g. gross value added (GVA) >= 0. Such detailed product-industry-institutional-geography level data validation and reconciliation is possible only through the IO framework. Further in providing a coherent framework to systematically compile and integrate varied economic data from multiple sources as per well-established concepts, definitions, classifications, accounting rules, conventions, and standards, the IO system functions as an economic analysis ecosystem where analysis of pooled data and integrated information could reveal interesting facets and identify issues about the economy.

Thus, it can be stated that if, at the time of compiling the matrices of the IO system and balancing the tables all the data quality and data gap issues could be identified and addressed, the resulting final product is most likely to be of good quality. The GDP estimated by any approach using the IO system is also therefore likely to be of higher quality since the IO based data constituting GDP have already been verified, validated and reconciled with other relevant information.

B.2 Constant Price GDP and Growth Rate
Although current price GDP estimates are essential in measuring economic performance, it is also important to know how much of the performance is attributable to growth in volumes (“real” change) and how much is attributable to changes in prices. Certainly, nominal growth resulting solely from price inflation does not change the quantity of the commodities produced, or the amount of value added and the income generated from productive activities in real terms. But the same unit volume of any given item now costs more. It is important to know how GDP has changed in real terms, i.e. if the economy is producing more or less products in volume terms now compared to another reference period. To arrive at estimates in volume terms and calculate real growth rates, the effect of price changes should be removed. With price changes factored out, the indicators can be expressed in constant prices, with a carefully selected year providing the base price levels.

In statistical systems where GDP is estimated without the IO framework, the process for expressing GDP and its components in constant year prices involves using the data compiled
GDP by production and expenditure approaches and a number of associated price indices as inputs. The expenditure based GDP at constant price can be expressed as

\[
GDP(E) = \sum_{i=1}^{n} \sum_{s=1}^{p} (c_{si}/p(c_{si})) + \sum_{j=1}^{n} \sum_{s=1}^{p} (i_{sj}/p(i_{sj})) + \sum_{k=1}^{q} \sum_{s=1}^{p} (g_{sk}/p(g_{sk})) + \sum_{l=1}^{n} \sum_{s=1}^{p} (x_{sl}/p(x_{sl})) - \sum_{m=1}^{n} \sum_{s=1}^{p} (m_{sm}/p(m_{sm}))
\]

Where \( p(c), p(i), p(g), p(x) \) and \( p(m) \) are year specific prices of the products for household consumption, investment, government consumption, exports and imports respectively in relation to the base year prices. As shown in the equation, products within a final demand category are deflated by the relevant price indices and the resulting estimates aggregated to obtain the category specific final demand expenditures \( (C, I, G, X \text{ and } M) \) in constant prices. The sum of these gives the reference year's GDP expressed in base year's prices (i.e. in constant price terms). This estimate of constant price GDP should in theory yield the same results as constant price GDP calculated using data from the production method, that is

\[
GDP (P) = \sum_{j=1}^{n} \sum_{s=1}^{p} (x_{sj}/p(x_{sj})) - \sum_{j=1}^{n} \sum_{s=1}^{p} (z_{sj}/p(z_{sj})) + \sum_{k=1}^{q} \sum_{s=1}^{p} (t_{sk}/p(t_{sk})
\]

This approach involves the double deflation method of deflating the outputs and inputs as well as taxes by the appropriate price indices \( p(x), p(z) \) and \( p(t) \). However, as with the current price GDP, in practice due to data quality and data gap issues the constant price estimates derived from different approaches will not be identical. Generally, in order to maintain equality the difference is allocated to the estimate based on weaker data sources as statistical discrepancies.

As with any statistic, price indices also face data quality and data gap issues. For the resulting country level indices to be correct the item level prices constituting the indices should be truly nationally representative. Estimating such a price is a challenge not the least due to locationally variable price of the relevant item. Incorrectly estimated or weighted price indices result in over or understating constant price GDP and GDP growth rates. In using the production and expenditure approaches to arrive at constant price GDP one faces the same data verification, validation and correction challenges described in subsection 3.1. To calculate the constant price GDP through the IO system, all the components of the SUTs need to be deflated using a number of relevant price indices and the tables fully rebalanced respecting all the identities and accounting rules. Consequently all the components of the GDP by production, expenditure and income approaches are, directly or residually, deflated. The integrated and coherent approach to data analysis afforded by the IO framework enables one to identify and possibly rectify data
quality issues through data confrontation and, by identifying and bridging data gaps. Further, given the integrated nature of the IO framework, coherence analysis and data verification can be conducted at a more granular level and from multiple production, intermediate and final consumption, value added, income, supply, demand angles and estimates corrected as required. Consequently in a deflated and fully balance IO system GDP can be estimated such that estimates of constant price GDP by all the three approaches will be equal. Thus, having the additional data sources, and data confrontation and verification facilities incorporated into the estimation process would lead to the enhancement of the quality of the key constant price statistics.

**B.3 Other Key Economic Statistics**

A number of other important statistics can also be derived from the IO system. Principally, it provides critical information about the structural state of the economy and, if compiled periodically, how it has been evolving over time. Further, by situating a country in the global economy and tracing its international trade linkages the IO framework illustrates the country's role in the global market and how international linkages through trade affects the economic activity and the role of government in the country. Through the analysis of the technical requirement and total requirement matrices, the calculation and the decomposition of the multipliers the domestic and cross country effects of any given economic action can be studied. Using an IO framework that is elaborated to accommodate multi-country analysis, one can readily estimate indicators measuring a country's participation in international production sharing arrangements via GVCs. These rather non-conventional statistics further facilitate the analysis of the state and evolution of the economy.

Other specific statistics that can be estimated and improved by the IO framework include GDP by industrial sector, GVA by sector, household consumption by product categories, capital formation by specific type, inventory accumulation by industrial sector, trade by product categories, the role of labor, government, capital and entrepreneurship in the sector specific production processes etc. Currently in many countries these statistics are compiled through individual or single sources such as household income and expenditure survey, economic survey, capital expenditure survey, customs records and income tax records. Again, it is difficult to comprehensively verify and fully validate the numbers by establishing their coherence with other relevant information. The IO framework however provides the required facility. For example, recently released GDP estimates and growth rates of a country were widely challenged as not being consistent with a number of other relevant indicators. Had the country instituted IO framework based production of key economic statistics all such issues of consistency and coherence could have been identified and addressed at the initial analysis stage itself; either the published estimates would have been different (corrected) or the divergence between the indicators well-explained.
IV. Conclusion

As countries plan to develop economically by implementing targeted and broad-based policies, there is a strong requirement for high quality statistics to understand and measure a wide range of economic transactions and developments. Further, in the increasingly globalized economic environment, a comprehensive and coherent data integration and analysis framework is needed to measure and study any economic phenomenon by considering the contributions and effects of all possible factors. In this paper, we stressed that the IO analysis framework provided the facility to bring together highly diversified yet relevant data from several sources in a very systematic and scientific manner to facilitate a variety of statistical measurement and economic analysis. The framework can also be used for data confrontation and coherence analysis to improve the quality of standard key statistics such as GDP and GDP growth rate. Further, its statistical richness can be exploited to develop relevant indicators to measure and study emerging phenomena like GVCs. It is therefore recommended that national statistical offices in the Asian and the Pacific Region take the necessary steps towards integrating the production of SUTs and IOTs in their operational plans.

V. References


